INTERNET OF THINGS (IOT) TECHNOLOGIES FOR SHIMLA CITY-A CASE STUDY

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Abstract: The large deployment of Internet of Things (IoT) is actually enabling Smart City projects and initiatives all over the world. Objects used in daily life are being equipped with electronic devices and protocol suites in order to make them interconnected and connected to the Internet. According to a recent Gartner study, 50 billion connected objects have been deployed in smart cities by 2020. These connected objects will make our cities smart. However, they will also open up risks and privacy issues. As various smart city initiatives and projects have been launched in recent years, we have witnessed not only the expected benefits but the risks introduced. The current and future trends of smart city with respect to IoT have been described. It also discussed the interaction between smart cities and IoT. The drivers behind the evolution & development of IoT and smart cities have been explained. Finally, the IoT weaknesses and how they can be addressed when used for smart cities has been discussed.

Keywords: IoT Technologies, Smart Cities, Sustainability, Sustainable Development

I.INTRODUCTION

The large amount of urbanization leads to creating a burden on the cities. The exhaustion of resources makes an addition to that. A prediction from the United Nations states that about double of the current urban population will be residing in the cities by 2050. This may cause more pressure on the resources required for the standard living of the people. There arise a lot of opportunities as well as challenges for the cities of the future. It may lead to environmental deterioration, management of solid waste, congestion of traffic, parking problems, and public safety etc.

IoT has the potential to rescue us from all such challenges. The pressure of urbanization can be tamed through IoT in order to meet the needs of a growing civic population. It can play a vital role in making the daily life of residents more easier, comfortable, and secure. The term IoT refers to the number of digital devices, which can communicate and interact with one another over the network, and they can be controlled and monitored remotely. The IoT includes smart sensors and other devices. The number of such devices is in billions and with the evolution of smart cities it is growing exponentially. The transformation of urban areas into smart cities brings new opportunities for optimum management of traffic, waste, congestion, parking, public safety, and many other such utilities. The inclusion of such smart devices poses new kinds of threats to humans, such as privacy issues, data leak, etc.

The study highlights the inherent benefits of IoT devices in the context of smart cities. It also discusses the probable risks associated with it. The applications of technology in the current scenario of smart cities have been brought to fore. The future applications of IoT concerning smart cities have also been discussed. A case study of Shimla city, capital of Himachal Pradesh (India) has been taken to understand the real time implications of the technology. The study is partitioned into the objectives, as mentioned:

The following methodology is followed in order to achieve the objectives of the study:

II.LITERATURE REVIEW

A study conducted by Dubey et. al in 2021 in context of indian smart cities infers the management of solid wastes. It

used the method of field study for data collection about the solid waste management projects in smart cities. The study equips the authorities with transition to sustainable waste management systems. It lacks an integrated approach for the smart city management systems as well as the effective usage of IoT devices [4].

Hammi in 2015 highlighted the significance of IoT technologies in the emergence and development of smart cities. It brought to the fore the strengths and weaknesses of IoT devices. The study maintains that if IoT brings advantages for its users, it also poses risks to privacy. The benefits of interconnection amongst the devices and their connectivity to the internet can be riped but the lack of security protocols for IoT devices risks the privacy of people.

In 2016 Sarin performed an empirical study to determine the role of various factors responsible for the success of IoT in Indian smart cities. It identified key drivers of smart city projects such as IoT policy of India, progression of smart city projects, to find out preferences of users concerning the demographics of India.

Oro in 2016 performed a study on the ecosystem of IoT and its impact on the daily life of humans. It highlight the trends of IoT technology and the way its changes the humans. Oro has taken the case of IoT applications in cars, smart cities, traffic solutions, supermarkets, medical records etc [10].

In 2018 an empirical analysis of IoT technologies has been conducted by Chatterjee et. al. The study has taken the note of 100 smart cities project initiative by Government of India. It mentioned the role of artificial intelligence in implementing IoT. The study identified the factors responsible for successful implementation of IoT technology in connection with artificial Intelligence [2].

Sultana and Tamanna in 2021 explored the field of IoT specifically in context of Bangladesh during the Covid-19. It tried to determine the benefits of this new technology and the challenges faced. During conducting the study the data has been collected from various stakeholders of different sectors. The results are then concluded considering various factors [16].

III. CURRENT TRENDS OF SMART CITIES APROPOS IOT

The urban space has become a hotbed of ideas. The implementation of IoT technologies in smart cities is an awful demonstration of such ideas. The migration trend of people to urban areas still continues. The rising density of population brings problems in abundance, such as mountains of garbage, fresh water scarcity, air pollution, and rise in traffic. So, the cities are required to be more efficient to keep up with the surging populations. The applications of IoT have become the new normal in major metropolitans around the world. The smart cities are powered by IoT technologies in the following ways:

A. Smart Waste Management

It is observed that most of the operators for waste management are indulged in inefficient practices. The waste is collected as per predefined schedules. This approach is inept due to unproductive use of waste containers, which in turn, leads to dispensable use of fuel consumption by the waste collecting trucks.

The waste level tracking enabled by the IoT is one of the smart solutions. It can also be helpful in route optimization of trucks collecting waste and in operational analytics. The waste containers equipped with sensors gather information about the level of waste in the containers. After the waste reaches a certain threshold, the waste management solution receives the sensor data to be processed. Accordingly, a notification is sent to a truck driver. It then empties the full container instead of the half ones. Thus, optimizing the consumption of fuel usage for waste collection [4].

B. Smart Infrastructure

There is a dire need for the smart infrastructure to be put in place. It is required to plan the urban infrastructure efficiently and sustainably placing the IoT technologies appropriately. It is observed that most of the countries these days are migrating to the use of electric cars in order to lower the carbon emissions. The trend of green buildings is on the rise to achieve energy efficiency and make it suitable for the environment. Smart lighting solutions are getting popular to make optimum use of electricity. The light is given only when someone walks past the smart light, and also adjusts the brightness considering the lighting conditions [12].

C. Air Quality Management

Smart cities are making use of tools to capture the air quality and level of pollution in real time. The IoT enables us to make predictions in relation to emissions. Thus, it can be helpful in locating the root cause of the problem. The strategy can be devised to limit the emission [8].

D. Smart Parking

The cities are getting benefitted through IoT using smart parking solutions. Variety of devices are used to locate a vehicle in the parking, to keep track of vehicle check-in & check-out time, to identify vacant spaces and allocate to the inline vehicles. Smart parking has become reality today, debaring complex infrastructure and high investment, making it an ideal utility for growing cities [3].

E. Traffic Management

One of the biggest problems for large cities is the rising queues of traffic. Los Angeles is one of the busiest cities in the world and has implemented an intelligent transport solution to control the traffic flow. Pavement integrated sensors send real-time updates of traffic flow to a central traffic management platform, which analyzes the data and automatically adjusts traffic lights to the traffic situation within seconds. At the same time, historical data is used to predict where traffic can go – and none of these processes require human involvement [8].

F. Environment

IoT enables tracking of various parameters, which are critical to a healthy environment. It can be helpful in maintaining optimum level of such parameters. The network of sensors can be deployed over the water grid in order to keep a check on quality of water. The measure of pH level, dissolved oxygen, leakage of water, and chemical composition of water can be maintained through the sensors. The data can be used by the water management system to send alerts regarding, if any, contamination is observed in the water [1].

G. *Public Safety*

The surveillance system driven by IoT can be helpful to enhance public safety. The analysis of CCTV data and the social media feed may be vital in avoiding untoward situations or any clashes and predicting any potential crime scenes [11].

IV. FUTURE TRENDS OF SMART CITIES APROPOS IOT

A glimpse of futuristic IoT devices has been presented here:

A. *The Vision Van of Mercedes-Benz*

This van by Mercedes-Benz comprises several technologies on board. An autonomous drone delivery within the radius of 10 kms is beneficial to save a lot of valuable time for carrying parcels. The manual delivery on the other hand takes a lot of time [15].

B. *Smart Eye*

The smart eye technology is quite similar to Google's project 'The glass'. The eye is equipped with sensors, wi-fi, and bluetooth to provide options and accessibility features right in front of your eye without any distraction. Through this technology one can read messages, access the internet and many more things right in front of one's eyes [11].

C. *City Air Management*

The management of air quality and pollution index in the high population cities through IoT is going to be a crucial help. The real time data for pollution can be collected through IoT devices and predictions can be made. It is thus helpful in making effective strategies for reduction of emissions. A cloud based approach for the collection and analysis of real time data should be followed in order to meet the short term and long term goals of reduction in emissions [8].

V. CASE STUDY

A case study to understand the implications of IoT technologies on smart cities has been undertaken. Shimla city has been the case candidate. Shimla is the capital of north Indian state Himachal Pradesh. The city has a vast historical background. It was the summer capital of India under British rule. The city also owes a UNESCO World Heritage site, i.e. Kalka-Shimla railway line built during the British era. It attracts a large number of tourists due to its serene beauty. The influx of tourists has also been a factor in adding a burden on the resources of the city. The key for efficient management of resources is the use of IoT technology. The city has been chosen under the smart city mission by the Govt. of India in 2015. It has been observed that under smart city management a number of projects have been completed while many are still in progress. A glimpse of some of the projects has been presented:

A. *Smart parking*

It refers to the usage of IoT technology for the better management of parking spaces. The efficient use of resources such as space and time for the purpose of faster and easier access of parking spaces in dense population areas. The population density in Shimla city is also growing, giving a rise to the issue of parking. The steep terrain also counts to that. Under the smart city project a number of parking spaces have been developed and a lot more is still to come up at different locations. It is required to make adequate use of IoT technology for the effective use of parking spaces. An integrated approach for the management of these spaces is required. The city still needs to go a long mile to achieve the goal of smart parking [3].

B. *Smart pedestrian path*

As the population is growing in major cities of the world, the need for pedestrians is also increasing. The pedestrians are vital in faster movement of traffic, which consequently reduces congestion. In smart city Shimla, there is an upcoming project for smart pedestrian movement. An ease of use of pedestrians improves the walkability of people, which is further helpful in reducing the usage of other means of transport and avoids harmful emissions in the environment. The pedestrians can also be used as a path for cyclists [15].

C. *Smart bus stop*

The concept of smart bus stop provides the passengers with all the facilities required before boarding the bus. As buses are the most common mode of public transport across the globe and in India. A smart bus stop is expected to be equipped with all the user-friendly amenities such as seating facilities, newspaper/magazine tray, tea/coffee vending machine, and a display board capable of displaying the relevant information. The display board must specify the climatic information, routes to major points of the city area, information about the arrival and departure of buses. It must also display the real time information about the buses. This information can be quite useful for the residents as well as for the tourists. In the context of Shimla city, these smart bus stops can be very useful in providing significant information to the residents and the tourists. This can prove to be another attraction for tourists visiting the city. Additionally, it can be supportive in developing the feeling of convenience and comfort amongst the tourists, which is an important factor for a tourist city. The smart bus stops can also be very helpful for the specially-abled people. The projects for smart bus stops are in progress at various locations of the city [15].

D. *Surveillance*

The security system is the basic component of the smart cities. It can be achieved through integrated surveillance over the network. The IoT enabled devices can be useful in making the cities safer for the commuters. Smart cities promote not only public surveillance but it also encourages the people to have such systems at their places of residences and work. Thus, enabling the people to get equipped with smart connectivity. The case candidate is also equipped with surveillance systems at different locations of the city. It prevents the threat of theft of personal and public belongings [13].

E. *Smart metering*

A smart meter is an electronic device, which inscribes information about the consumption of electricity, current, voltage level etc. These meters are connected through a web based system with the supplier of electricity. Thus, providing real time information about the usage of the subscriber and its usage behavior. It then enables both the suppliers and customers to plan for effective utilization of power resources. The smart metering project is underway in Shimla smart city. It will then empower the city to make effective utilization of power resources and to plan for self-sufficiency of its energy

needs. Also it is going to be an asset in enhancing the revenues [7].

VI. CONCLUSIONS

The development and validation of facets of IoT systems have been discussed in the present study. The concept of IoT has provided the world with several prevalent services that have enabled the deployment of smart cities. It has introduced the world to new opportunities like the ability to manage and monitor the devices remotely, simultaneously analyzing and taking actions from the data received. The study represents the best way to make a smart city model given the case of Shimla city. The study depicts that the IoT can be implemented to a number of various scenarios ranging from smart parking, metering, environmental sustainability, waste management, pollution control along with reducing carbon footprints.

The present research has given an overview of the IoT in the context of Shimla city and how it can contribute to enhancing the smartness of the city. The risks and weaknesses of the present systems are also discussed.

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