WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

IoT Integration in Smart Cities: A Study

Dr. S. Manju [1], Dharshana. K [2], Jenitta Supriya. T [3]

[1] Associate Professor, Department of Master of Computer Applications (MCA), PSG College of Arts and Science, Coimbatore.
[2,3] I MCA, Department of Master of Computer Applications (MCA), PSG College of Arts and Science, Coimbatore.

ABSTRACT:

To implement smart city in real time, a variety of technologies like artificial intelligence, grid modernization and Internet of Things are required. The Internet of Things (IoT) can be defined as the entire network of interconnected devices as well as the technology that allows devices to communicate with one other and with the cloud. The various aspects of smart cities like Healthcare, Living & Infrastructure, Mobility & Transportation, Economy, Governance, Energy, Environment and Industry are monitored using IoT sensors. This paper discusses about the various methods to integrate IoT solutions in smart cities.

Keywords: Smart city, Internet of Things, sensors, layers, factors.

Introduction

The United Nations Organization has estimated that the world's population will reach 2 billion within the year 2050. If the world's population keep on increasing, basic living resources such as water, food, and shelter can become shortage for all. If living resources are improperly distributed to common people, it can create an imbalance and chaos in the world. To avoid this crisis, smart cities are seen as a possible solution. Smart cities can be defined as the technologically advanced metropolitan region that gathers specialized data using various electrical systems and sensors. The Information Communication Technology has tremendous growth nowadays, and smart cities are not a dream anymore [1].

Smart cities are referred to as "a city in which governance, IT connectivity bandwidth, sanitation, housing, mobility are in the best quality possible". The US Community Analysis Bureau first used databases, aerial photography, and cluster analysis in the 1960s and 1970s to gather information, allocate resources, and publish reports in an effort to manage services, lessen poverty, and prepare for calamities. This is when the idea of smart cities first emerged. A smart city should offer its citizens an urban setting that fosters economic expansion and a high standard of living. This entails providing citizens with a portfolio of integrated services at a lower cost of infrastructure. The Internet of Things (IoT) can be a better choice for such suite. A city can attain smart city status through deploying IoT technology in large scale [5].

The Internet of Things (IoT) is a system which consists of components like appliances, vehicles, distribution and power generation connected with advanced communication and automation technologies [4]. IoT has become a recent trend to work because all the essential components of IoT have become more affordable nowadays. These components can help in building a smart city. There are certain areas in which IoT sensors can play a crucial role such as Public Transportation, Smart Waste Management, Smart Meters, Street Lights, Air Quality Monitoring and EV charging stations.

The Government of India has the flagship program: "Smart Cities" which was launched on 25th June 2015 under the Union Ministry of Urban Development (MoUD) to initialize the smart cities in India. 100 cities from all over India are selected for this flagship program to improvise them to a new smart status. The smart cities program is dependent on social and entrepreneurial value applications, current technology advances and competencies that make IoT sustainable and affordable. The citizens of India can use smart solutions for the menial problems they face daily.

Literature Review

Various researchers talk about the smart city and IoT's implementation in it. Saraju P. Mohanty [1] presented his work on smart cities discusses the core concept about smart cities. It explains the complex nature of IoT and how it can be made possible in today's context. It explains the components, attributes, themes and infrastructure of a smart city. Iqra Rafiq et.al [2] shows the current status of IoT features, architecture, communication infrastructure and applications. The paper briefly explains about the possible IoT applications in smart city. Work by Badis Hammi et.al. [3] discuss the current and future trends of smart city and IoT. It also shows the interaction between smart cities and IoT and explains some of the drivers behind the evolution and development of IoT and smart city and the weaknesses of IoT and how they can be addressed when used for smart cities. Hafedh Chourabi et.al [4] shows the directions and agendas for smart city research and outlines practical implications for government professionals. It also contains the working definitions of smart cities and success factors of smart city initiatives. Rashmi Dongre et. al [5] contains the collective overview of the IOT paradigm for smart cities,

research methodologies, integrated ICT network types, doable opportunities and considerable requirements. Suha Alawadhi et. al [6] their research work discusses the results of an analysis primarily based on semi-structured interviews with government officials and managers. Research work by H. Samih [7] displays the emergence, characteristics, components and architecture of the smart city. Duda O.M' s research work [8] displays the sensory structure and Generalized Architecture of the "Smart City" Information-Technological Platform. Research by Arsalan Shahid et. al. [9] shows the use cases of IoT in smart cities such as Smart Grids and Residential E-Meters.

Research by Abbas Shah Syed et.al [10] contains the survey about IoT technologies, practices and challenges. Gaurav Sarin's [11] primary purpose is to study the role of IoT in development of Indian smart cities, understand the India IoT policy, find out the key drives and advantages of IoT based smart city and identify the consumer preferences and demographics of Indian citizens who prefer IoT based smart city solutions. Shwet Ketu et. al. [12] paper illustrates a contemporary survey of IoT-based smart cities with their potential, current trends and developments, amenity architecture, application area, real-world involvement, and open challenges. Jose Joaquín Peralta Abadía et. al [13] work contain definitions of the terms "smart city" and "IoT framework" in condensed form, consolidated concepts and guidelines of smart cities and IoT frameworks. Seconded European Standardization Expert in India [14] discusses the smart city implementation in India. It shows the implementation of smart cities, Mission monitoring, Financing of smart cities, current status of Smart Cities Mission and cities selected under the mission. Khusboo and Divya shree [15] presents a literature analysis on IoT architecture and IoT- enabled city components. Kartik Krishna Bhardwaj et. al. [16] discusses about the ways to include fog computing and IoT in smart city scheme. Taewoo Nam et. al. [17] aims to fill the research gap by building a comprehensive framework to view the smart city movement. Hardik Tanti et. al. [18] claims that a mobile application will enable a user to check parking space availability and reserve a certain parking lot in accordance with such information. Prof. (Dr.) Vijay Mane [19] proposes a model to monitor the environment using IoT sensors. Puja Sharma et. al. [20] work displays the data on the webserver and monitor the real-time data of weather using environmental parameter or sensor.

Smart City Implementation

Rashmi Dongre et. al. states that the concept of smart city varies from city to city. The planning behind the implementation of smart city depends on city development level and citizen's living standards [5]. The whole idea behind implementing smart city is to make the citizens of the city live a safer and easier life. H. Samih showcases the fundamental concepts of a smart city which are technological, Institutional and Human factors. All these concepts contain sub-factors which are listed below [7]:

Concepts	**Sub factors**
Technological	Physical ICT infrastructure, Smart technologies, Mobile technologies, Virtual technologies and Digital network.
Institutional	Governance, Policy, Regulations / directives
Human	Human infrastructure, Lifelong learning, Cosmopolitanism, Social capital, Ethnic plurality

Table 1: Fundamental concepts of smart city and its sub factors

Applications related to smart cities often have four components: data collection, transmission and reception, storage, and analysis [10]. A smart city as an innovation harnesses the transformational potential of smart technologies (for example, instrumentation with intelligent sensors), mobile technologies, virtual technologies, cloud computing, and digital networks such as Mobile wireless and Metropolitan Area Networks (MANs) [17].

A set of guidelines known as the "Smart city guidance package" was released by the European Innovation Partnership on Smart Cities and Communities (EIP-SCC) is a road map outlining the necessary stages to implement smart cities and facilitating coordinated planning and execution of such initiatives. The guidelines have seven steps which is listed below:

- **Envision**: Long-term goals and vision are created or modified. Furthermore, opportunities for cooperation inside the city are investigated.
- **Decide and commit**: A strategy is the materialization of the long-term vision. The parties agree on how to begin putting the plan for the smart city's implementation into action.
- **Plan**: A plan with specific tasks, goals, benchmarks, and key performance indicators (KPI) is developed based on the preceding step's strategy.
- **Do**: The plan's real execution is carried out. Changes, modifications, and additions are anticipated.
- **Check**: Based on the KPI defined in the plan step, the progress is tracked. We investigate solutions if issues arise.
- **Act**: The previous step's problems are solved and put into practice.
- **Replicate and scale up**: The dissemination and exchange of experience aids in the duplication and expansion of effective solutions.

The components of a smart cities include the following: smart infrastructure, smart buildings, smart transportation, smart energy, smart healthcare, smart technology, smart governance, smart education, and smart citizens [1].

IoT in smart city

IoT can be defined as a network of interrelationships between smart devices or a mesh of networks [12]. Suha Alawadhi et. al. insists that there are several aspects of a traditional city which can be easily managed if the IoT concept is included. Some of them are Technology, Management and Organization, Policy Control, Governance, People and communities, Built Infrastructure and Natural Environment [7].

IoT frameworks are developed using a wide range of technologies, and several methods for creating expansive functional architectures based on Open System Interconnection (OSI) have been put forth [5]. The reference five-layered IoT framework architecture's tiers for applications in smart cities are as follows: Sensing Layer, Network Layer, Middleware Layer, Application Layer and Security Layer [13].

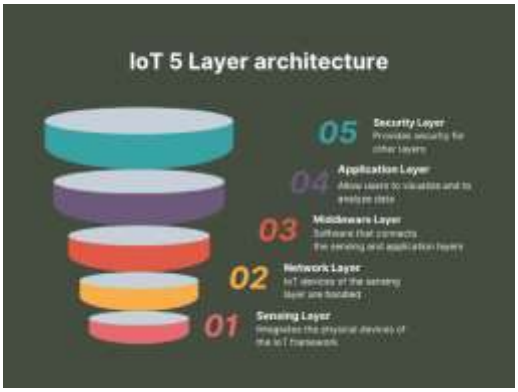

Fig 1: Reference five-layered IoT framework architecture

Smart Parking, Environmental pollution, Weather and water system, Smart Home, Vehicular Traffic and Surveillance & Safety are the sub factors which constitute Router data of Smart IoT systems [8].

Smart Cities in India

India is a seventh-largest country by area with a population of 141.72 crores. Rural population accounts for 68.8% and urban population accounts for 31.2% in the overall country's population. Urban's population has been increasing exponentially in the past 2 decades. The Union Government has launched the smart city scheme to manage the ever-growing urban population.

The Mission will be carried out at the urban level by a Special Purpose Vehicle (SPV) that has been specifically designed for that purpose. The Smart City development initiatives will be planned, assessed, approved, monies released, managed, operated, monitored, and evaluated by the Special Purpose Vehicle (SPV) [14].

- **Smart Parking**

  Hassle-free vehicle entry and exit are made more convenient by method of payment. The Arduino pins 4 through 9 are connected to six infrared sensors. The Arduino's 5v supply is connected to the infrared sensors VCC pins. An infrared sensor will be used to detect automobiles. This is the Nodemcu ESP8266 Wi-fi module, which allows us to monitor the parking spaces for cars from any location in the world. The Arduino IDE is the technology used to connect the IoT objects [18].

- **Environmental Pollution**

The data processing micro-controller, data collection sensors, and wireless data transmission sensor network are the tools that an automated monitoring system will use to control and monitor. In a wireless sensor network, nodes are capable of sensing and transmitting and receiving information. Numerous sensor nodes are either based on the predetermined structure or are fixed randomly on the restricted region. Arduino UNO, 10WATT1K, L293D, LDR, LM35, POT-HR, RELAY ULN2003A are the components of a proposed IoT system to monitor the environmental pollution [19].

- **Weather Monitoring System**

The problem with farming arises from severe rainfall because of the frequent occurrence of rainy conditions. In this case, knowing the status of the weather before planting or harvesting the crops is crucial. Therefore, using a weather monitoring system to monitor the weather in this scenario would be beneficial to farmers. Three sensors—designated as modes1,2, and 3 in the proposed model—are used to measure temperature, pressure, humidity, and rainfall. It lists the modes as temperature and humidity (MODE-1), barometric pressure (MODE-2), and raindrop sensor (MODE-3) [2].

There are many other IoT solutions like the above mentioned are implemented in smart city.

Challenges in smart cities implementation

Though the smart city scheme is seen as a boon to all modern day urban related issues, it cannot be implemented in all urban areas at once. It has some constraints to be executed in real time. Few of them are listed below:

- **Complexity and Big Data Analytics:** The Internet of Things (IoT) network will be connected to billions of devices, systems, and things, making it more complex than the current system. Its heterogeneous nature, which includes a variety of systems with distinct architectures, designs, and communication infrastructures, presents a significant challenge to developers of software, hardware, and communication protocols and makes deployment difficult [2].
- **Security and Privacy issues:** Sensing data and control information are transmitted over local networks and the internet in smart cities. Furthermore, a number of smart city components tend to be crucial to a city's functioning and are deeply entwined with its residents' personal and social lives. Typical security strategies may not always be as effective in securing the Internet of Things for Smart Cities, necessitating the development of novel techniques to address security and privacy concerns [10].
- **Reliability:** All of the IoT infrastructure is solely dependent on sensors or sensors that are already incorporated into the device. These smart devices produce data, which is wirelessly transferred to the cloud and among several other linked devices. As a result, we need to guarantee that the data being transmitted is accurate [12].
- **Sustainability:** There are five issues: 1)strategic evaluation of the indicators to determine a SC's significance and assist in setting priorities; 2)reduce the impact of ICT on infrastructure development because its advantages also degrade ecosystems; large corporations' systems; 3)products, and services could monopolize and undermine the viability of cities, while small initiatives' efforts to advance their management would be difficult to achieve significant change; 4) Cities' ICT proficiency needs to improve in order to match large corporations and submit sufficient ICT demands; 5) to establish a specialized committee to evaluate ICT investments would help the city government concentrate on sustainable growth.

Conclusion

This paper presents a broad coverage about smart city implementation and the ways to integrate Internet of Things (IoT) with it. It briefly discusses about the smart city fundamental concepts and how to transform a traditional city into a smart city. The Internet of Things (IoT) is the backbone of the smart city scheme. IoT applications are used in smart cities without the need for human intervention. IoT devices are interconnected and can communicate with one another for a variety of purposes. Using IoT sensors, we can check and analyse the pattern of growth of smart city parameters. It depends on the managerial sector to wisely implement the technologies for the wellbeing and welfare of the citizens of the smart city.

References

1. Saraju P. Mohanty: Everything You Wanted to Know About Smart Cities
2. Iqra Rafiq, Anzar Mahmood, Sohail Razzaq, S.Hassan,M.Jafri, Imran Aziz: IoT applications and challenges in smart cities and services
3. Badis Hammi, Rida Khatoun, Sherali Zeadally, Achraf Fayad, Lyes Khoukhi: Internet of Things (IoT) Technologies for Smart Cities
4. Hafedh Chourabi, Taewoo Nam, Shawn Walker, J. Ramon Gil-Garcia Shel Mellouli, Karine Nahon Theresa A. Pardo, Hans Jochen Scholl: Understanding Smart Cities: An Integrative Framework
5. Rashmi Dongre, Meera Deshmukh: Internet of Things (IOT) and Smart City- Transformation of Cities through IOT
6. Suha Alawadhi, Armando Aldama-Nalda, Hafedh Chourabi, J. Ramon Gil-Garcia, Sofia Leung, et. al. Building Understanding of Smart City Initiatives.11th International Conference on Electronic Government (EGOV), Sep 2012, Kristiansand, Norway. Pp.40-53, 10.1007/978-3-642-33489-4_4. Hal-01543596
7. H. Samih (2019) Smart cities and internet of things, Journal of Information Technology Case and Application Research, 21:1, 3-12, DOI: 10.1080/15228053.2019.1587572
8. Duda O.M, Kunanets N.E., Matsiuk O.V, Pasichnyk V.V: Information-Communication Technologies of IoT in the “Smart Cities” Projects
9. Arsalan Shahid, Bilal Khalid, Shahtaj Shaukat, Hashim Ali and Muhammad Yasir Qadri: Internet of Things Shaping Smart Cities: A Survey.
10. Syed, A.S.; Sierra-Sosa, D.; Kumar, A.; Elmaghraby, A. IoT in Smart Cities: A Survey of Technologies, Practices and Challenges. *Smart Cities* 2021, *4*, 429–475. https://doi.org/ 10.3390/smartcities4020
11. Gaurav Sarin: Developing Smart Cities using Internet of Things: An Empirical Study
12. Shwet Ketu, Pramod Kumar Mishra: A Contemporary Survey on IoT Based Smart Cities: Architecture, Applications, and Open Issues

13. Jos´e Joaquín Peralta Abadía, Christian Walther, Ammar Osman, Kay Smarsly: A systematic survey of Internet of Things frameworks for smart city applications
14. Seconded European Standardization Expert in India: Report on Smart Cities Mission in India
15. Khushboo, Divya shree: Impact of IoT in smart cities
16. Kartik Krishna Bhardwaj, Siddhant Banyal, Deepak Kumar Sharma, Waleed Al-Numay: Internet of things based smart city design using fog computing and fuzzy logic
17. Taewoo Nam and Theresa A. Pardo: Smart City as Urban Innovation: Focusing on Management, Policy, and Context
18. Hardik Tanti, Pratik Kasodariya, Shikha Patel, Dhaval H. Rangrej: Smart Parking System based on IOT
19. Prof. (Dr.) Vijay Mane, Riddhi Selkar, Varda Shelgaonkar, Bhavin shah, Alfisher Sayyed: Environmental Monitoring Using Internet of Things
20. Puja Sharma and Shiva Prakash: Real Time Weather Monitoring System Using Iot