IOT in Smart Cities: A survey

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ABSTRACT

Internet of Things (IoT) is currently one of the most buzzing and discussed topic in research field. The Internet of things is used as an umbrella keyword for combining and covering the major aspects related to the extension of the Internet and Web into the physical world, by means of vast deployment of spatially distributed devices that contains embedded identification, sensing and/or actuation capabilities. A smart system characterized by the interaction between infrastructure, capital, behaviours and cultures, achieved through their integration is used in a smart city. The Information of Communication Technology (ICT) covers all field of smart cities such as government facilities, buildings, traffic, electricity, health, water, and transport.

This paper gives the systematic literature review of current use of IoT in smart cities. The aim of performing the survey is to gain better knowledge of IoT and its application in development of smart cities.

Keywords: IoT, Smart Cities, Information and Communication Technology (ICT), Wireless sensor network (WSN), Big Data

I. INTRODUCTION

The term Internet of Things (IOT) has been around since the last few years. In recent time, it is getting more attention due to the advancement and increase in use of wireless technology. The basic idea is due to the variety of objects- such as RFID, NFC, Sensors, actuators, mobile phones, etc. which can interact with each other by having a unique address. IoT empowers substantial/conventional objects to see, hear, think and perform jobs by having them "talk" with each, to share information and to synchronize pronouncements. IoT transforms these conventional objects from being conventional to being smart by manipulating its underlying technologies such as omnipresent and pervasive computing, embedded devices, communication technologies, sensor networks, protocols and applications.

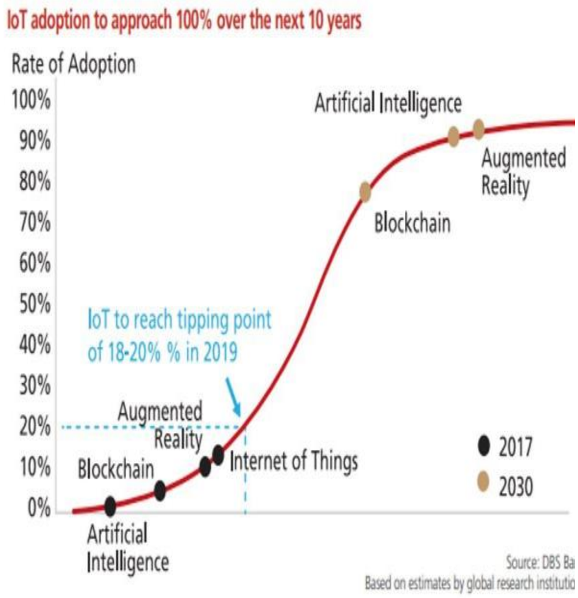
II. INTERNET OF THINGS

When, IoT was introduced, Radio frequency (RFID) seemed to be necessary for it. There are a number of technologies similar to RFID, Near Field communications (NFC), Machine to Machine (M2M) and vehicular to vehicular communications (V2V), which can be used to implement the modern idea of IoT [1]. The life of end user/common people can become easy and comfortable by adopting various technologies based on IoT. In addition, IoT has dramatic effect on domestic sphere, such as assisted living, smart homes, smart cars, etc. In business sector,

IoT has noticeable advancement in manufacturing and service industry such as better services, more production and superior quality. The worldwide adaption of above-mentioned technologies does appear smooth but involves lots of issues, that needed to be solved before it worldwide acceptance. The major issues that IoT is of security because of Internet hackers.

Some of the other problems in IoT implementation are standardization issues, addressing problems and scalability problems etc. Due to this reason, intensive research is needed to resolve these complicated issues. Cisco approximates that IoT will consist of 50 billion devices connected to the Internet by 2020 and will achieve deeper insight with analytics using Cisco IoT System to enhance productivity, generate new revenue streams and create new business models [2].

IoT devices and services will reach an acceptance point of 18% to 20% adoption in 2019. DBS Asian Insights is predicting that the IoT installed base will grow from 6.3M units in 2016 to 1.25B in 2030 [3].



IoT adoption gaining momentum

	2016	2017	2018	2030
IoT units installed base - total (m)	6,382	8,381	11,197	125,000
Consumer devices (m)	3,963	5,244	7,036	75,000
Consumer devices as a % of total devices	62%	63%	63%	60%
Connected devices per person	5	5	5	5
World population (m)	7,400	7,600	7,700	8,500
IoT adoption rate	11%	14%	18%	176%

Source: DBS Bank based on estimates by Gartner, United Nations, World Bar

Figure1: IoT adoption rate graph

As per the estimates, the IoT is on the verge of achieving mainstream adoption with a ~14% global consumer adoption rate. According to estimates, there were ~5.2b consumer IoT units globally in 2017. Assuming that an individual owns on average five connected devices, this translates to a global consumer IoT adoption of ~14%.

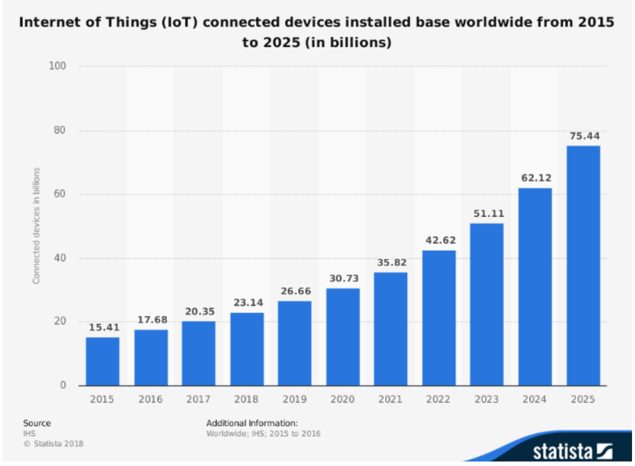


Figure2: Number of connected devices to IoT

This statistic done by statista shows the number of connected devices (Internet of Things; IoT) worldwide from 2015 to 2025. For the year 2020, the installed base of Internet of Things devices is forecast to grow to almost 31 billion devices worldwide. The complete Internet of Things market increase is projected to be worth of more than one billion U.S. dollars annually from 2017 onwards [4].

The web search popularity, as measured by the Google search trends during the last 8 years for the terms Internet of Things, Smart cities, Wireless Sensor Networks, Cloud Computing and Big Data are shown in Figure.

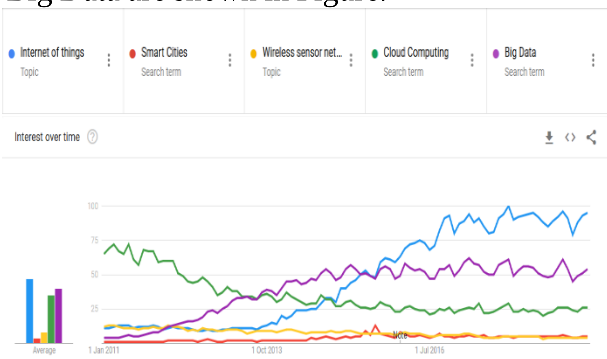


Figure3: Google search trends for 5 search terms

Google search trends since 2011 for terms internet of things, smart cities, wireless sensor networks, Cloud Computing and Big Data.

As it can be seen, since IoT has come into subsistence, search volume is consistently increasing with the falling trend for Wireless Sensor Networks and Cloud Computing. It can be noted that search volume of smart cities is still very less compared to IoT and that of big data is around all time high for itself. As per Google's search forecast (dotted line in Figure 3), this trend is most likely to continue, as it is, as other enabling technologies converge to form a genuine and full potential Internet of Things [5].

III. IoT TECHNOLOGIES

Various technologies are involves implementing the idea of IoT. Such as:

- Radio frequency Identification (RFID)
- Near Field Communication (NFC)
- Machine-to-Machine Communication (M2M)
- V2V Communication [6]
- Low-Energy Bluetooth
- Low-Energy Wireless
- Radio Protocols
- LTE-A
- Wi-Fi Direct [7]

IV. APPLICATIONS OF IOT

Huge number of applications are built using IoT concepts. Because many of the domains and environments needs the little improvements to their levels. In coming years, IOT will be more revolutionized because of the RFID, NFC, M2M and V2V communications.

These can be classified into the following domains:

- SMART Cities
- Telecommunication industry
- Medical and Healthcare industry
- Logistics and supply chain management
- Aerospace and aviation industry
- Automotive industry
- Transportation industry

i. Medical and Healthcare Industry

As IOT with healthcare technology is present data analysis plays an important part as to predict what next or after continuous health monitoring by data analysis one can predict about the health of a patient and this can lead to quick casualty handing. For example, if an elderly person's heart rate pulse is not normal, by checking the results we can predict the disease and treat that person before any major casualty takes place. In these cases only real time monitoring helps but the major security challenge as no data should go undetected and get alter [8].

ii. Smart Parking

The concept of Smart Cities and its implementation has always been a dream for humanity. Since the past few years huge advancements have been made in making smart cities a reality. The growth of Internet of Things and Cloud technologies have given rise to new possibilities in terms of smart cities. Smart parking facilities and traffic management systems have always been at the core of constructing smart cities.[9].

iii. Logistics

It uses the IoT concepts and operations. RFID equipped used items and smart shelves are tracking the items in real time. Exchanging the RFID data can use the logistics and supply chain management and environmental issues are tracked. Smart building functionalities can provide the commercial building functions [10].

iv. Smart grid

Smart grid is an electrical grid, which is designed to advance the efficiency of power transmission, and quality service to end-user. All the devices in this network are connected with sensor that regularly send the data related to power consumption to the central server. Central server determines the consumption pattern and amount of power. This will improve the production to achieve the transient power targets [11]

V. IOT IN SMART CITIES

The proportion of the population of the world in cities is more than 50%, and it is expected that this percentage will increase up to 70% by 2050. The one of many problems in providing infrastructure and public services [12] for the population in cities can be solved through investment in Information and Communication Technology (ICT) and infrastructure technology. It is necessary to link the ever-growing numbers of people, with necessary services anywhere and anytime, and hence the idea of creating a smart city project was created, which aims at organizing daily life through building infrastructure with the use of computer networks [13]. Nowadays, Information and Communication Technology is an essential part of urban development, and it is necessary for all developing smart cities. Smart concepts include smart transit, smart people, economy, living and smart management to improve quality of life, and new infrastructure, with prudent management of natural resources through government involvement [14]. A smart city is a self-contained town in terms of evolution of information and communication infrastructure technology [15]. A modern city should offer intelligent solutions and help organize daily life with the help of sensors which receive data, information, references, and analysis it, and then retransmits the analysed data. Making cities smarter is usually achieved by the use of ICT-intensive solutions. In fact, ICT is already at the heart of many current models for urban development.

One advantage of smart cities is that it can also include a pollution monitoring system which makes for an eco-friendly environment. The considerable use of ICT also empowers the development of essential services such as health, security, police and fire departments etc. A smart city can transform our lives into energy efficient ones. Wireless innovations will be able to support public health, giving doctors access to medical records anytime, anywhere, easily and at minimal cost. The main goals will be automated diagnosis and health care for patients in dangerous situations. This will be achieved by sensor devices, which can monitor temperature, rate of breathing, etc. and provide a personal picture for diagnosis [16].

VI. LITERATURE REVIEW

In order to have clear cut, unbiased, complete and broader prospective many sources have been explored. The literature review has been carried out according to the guidelines proposed by Kitchenham. The objective of carrying literature review was to gain deeper understanding of mitigation techniques that exists in literature and to find gap in the study. The extensive literature review has been carried out in the following journals:

1. ACM Digital Library
2. IEEE Explorer
3. Science Direct
4. Wiley Online Library
5. Springer

The reason behind exploring these databases is their library of journals with high impact factors. The review also takes into account conference proceedings.

The Search term was **"IoT in Smart Cities**". The search was filtered to include the papers and conferences of previous 10 years. This was done to limit the scope of research to the present trends instead of exploring unverified and undeveloped techniques.

The results are summarized as follows in the table:

Total 51 relevant papers were selected for review. The papers in journals and conferences are taken into consideration.

S. No.	JOURNAL NAME	SEARCH RESULTS	RELEVANT PAPERS

1.	ACM	1068	9
2.	IEEE	384	10
3.	SCIENCE DIRECT	2495	21
4.	WILEY	737	7
5.	SPRINGER	260	4

In 2013, one of the earliest paper, Antonio Cimmino, Tommaso Pecorella, Romano Fantacci, Fabrizio Granelli, Talha Faizur Rahman, Claudio Sacchi, Camillo Carlini and Piyush Harsh [17] considered the communication aspects of Smart City applications, specifically, the role of the latest developments of Long-Term Evolution-Advanced standard, which forecast the increase of broadband coverage by means of small cells. They demonstrated the novel concept of small cell fully meets the emerging communication and networking requirements of future Smart Cities. To this aim, a feasible network architecture for future Smart Cities, based on small cells, was discussed in the framework of a future smarter and user-centric perspective of forthcoming 4G mobile technologies.

In 2014, Andrea Zanella, Nicola Bui, Angelo Castellani, Lorenzo Vangelista and Michele Zorzi [18] analysed the solutions currently available for the implementation of urban IoTs. The discussed technologies were close to being standardized, and industry players are already active in the production of devices that take advantage of these technologies to enable the applications of interest.

Rodger Lea and Michael Blackstock [19] outlined the growing interest in a hub-centric approach to the IoT and discuss our own experiences in building an IoT hub for two Smart City projects, one in the UK and the other in Canada.

In 2015, Eiman Al Nuaimi, Hind Al Neyadi, Nader Mohamed and Jameela Al-Jaroodi [20] discussed various opportunities available by integrating big data to the smart city project.

Antonio S. Montemayor, Juan J. Pantrigo and Luis Salgado [21] prepared a special issue on real-time computer vision in smart cities.

Tobias Franke, Paul Lukowicz and Ulf Blanke [22] presented the evolution of a smartphone based crowd management system from a simple research prototype to a full blown event management solution which was at that time and still being commercialized.

Riccardo Petrolo, Valeria Loscrì and Nathalie Mitton [23] considered the IoT platforms as a viable solution to make cities smarter. We have shown how the proliferation of ICT represents new opportunities for the development of novel services, contributing to make the cities more sustainable.

In 2016, Matthew Hause and James Hummell, [24] studied and presented traffic management system and connected systems in a large city and how an MBSE and SoS approach will help guide development to incorporate in smart cities.

M. Mazhar Rathore, Awais Ahmad, Anand Paul and Seungmin Rho [25] proposed a combined IoT-based system for smart city development and urban planning using Big Data analytics. They proposed a complete system consisting of various types of sensor deployment, including smart home sensors, vehicular networking, weather and water sensors, smart parking sensors, and surveillance objects.

Yunchuan Sun, Houbing Song, Antonio J. Jara and Rongfang Bie [26] promoted the concept of “smart and connected communities (SCC)”, which was evolving from the concept of smart cities. SCC are envisioned to address synergistically the needs of remembering the past (preservation and revitalization), the needs of living in the present (livability), and the needs of planning for the future (sustainability).

Seiji Sakakibara, Sachio Saiki, Masahide Nakamura and Shinsuke Matsumoto [27] proposed an indoor environment sensing service using autonomous sensor box to adapt the previous sensor box for the smart city. To confirm the effectiveness of proposed service, we deploy autonomous sensor boxes on practical indoor environments.

Mohammad Amin Taherkhani, Ryoma Kawaguchi, Navid Shirmohammad, Masaaki Sato [28] presented BlueParking, an architecture for efficient reservation of parking slots based a smart IoT solution for smart cities. In the proposed architecture and with high precision, the reservation algorithm can be applied from a start point by using a traffic estimator service on the top of IoT basic services.

Talal Shaikh, Salih Ismail and Joseph D. Stevens [29] proposed Aura Minora: a novel architecture for IOT and smart cities, based on a bottom-up approach. The approach in the paper was to see, how the user centric architecture would help end users as well as the smart city governing body to use existing Internet infrastructure to provide services. They also focused on user privacy and security aspect within the architecture.

Nam K. Giang, Rodger Lea, Michael Blackstock and Victor C. M. Leung [30] explored the process of developing Smart City IoT applications from a coordination-based perspective. They illustrated that a distributed coordination model that oversees such a large group of distributed components is necessary in building Smart City IoT applications. In particular, they propose Adaptive Distributed Dataflow, a novel Dataflow-based programming model that focuses on coordinating city-scale distributed systems that are highly heterogeneous and dynamic.

Claudio Rossi, Manuel Gaetani and Antonio Defina [31] proposed Aurora: a low-budget, easy-to-deploy IoT control system that exploits the ubiquity of cellular networks (2-4G) and scalable Cloud computing architectures to allow Smart Cities to save on the public lighting electrical bill.

Takuro Yonezawa, Tomotaka Ito, Jin Nakazawa and Hideyuki Tokuda [32] introduced SOXFire, a multi-community city-wide sensor network for sharing social big sensor data in smart cities. The goal of SOXFire was to provide practical distributed and federated infrastructure for IoT sensor data sharing among various users/organizations in a way that is scalable, extensible, easy to use and secure with preserving privacy. SOXFire supported not only access to physical IoT sensors but also crowd sensing and SNS/Web sensing where city employees, citizen and WEB developers contributed in a different ways but unified APIs.

Ahmed Hefnawy, Abdelaziz Bouras and Chantal Cherifi [33] suggested Service Lifecycle Management (SLM) concepts and Lifecycle Modeling Language (LML) to analyze, plan, specify, design, build and maintain IoT-enabled Smart City Service Systems.

In 2017, Rongxia Zhuang, Haiguang Fang, Yan Zhang, Aofan Lu and Ronghuai Huang [34] conducted preliminary analysis on the characteristics of typical learning environments in smart cities from perspective of lifelong and lifewide learning. They concluded that smart learning is an important part of the construction of smart city. The indicators for the five typical learning environments in smart cities can reflect the status of the construction not only of a learning society but also of smart cities.

Cristian González García, Daniel Meana-Llorián, B. Cristina, Pelayo G-Bustelo, Juan Manuel, Cueva Lovelle, Nestor Garcia-Fernandez [35] proposed that analysis of pictures through Computer Vision to detect people in the analysed pictures. With this analysis, they were able to obtain if these pictures contain people and handle the pictures as if they were sensors with two possible states. Their proposal, as a possible solution, is the analysis of entire sequence instead of isolated pictures for using pictures as sensors in the Internet of Things.

Terence K.L.Hui, R. Simon Sherratta and Daniel Díaz Sánchezb [36] defined the major requirements for building Smart Homes.

Seven unique requirement recommendations were defined and classified according to the specific quality of the Smart Cities building blocks.

Bhagya Nathali Silva, Murad Khan and Kijun Han [37] proposed a Big Data analytics embedded smart city architecture, which is further integrated with the web via a smart gateway. Integration with the web provides a universal communication platform to overcome the platform incompatibilities of smart things using IoT.

Bindiya Jain, Gursewak Brar, Jyoteesh Malhotra, Shalli Rani [38] proposed a WSN-IoT paradigm for real-time applications. The main focus was to find the means of providing information as early as possible to receiver which is prerequisite in smart cities. The routing was based on the shortest path which was selected using TOPSIS optimization and achieved balance between performance and energy consumption with regard to some criteria.

Lyudmila Vidiasova, Polina Kachurina and Felippe Cronemberger [39] presented the results of world practice benchmarking for 20 smart cities and it seeks to determine the most successful cases that could be of interest for better urban development. B. Cohen's Smart City Wheel was used as the system of indicators, and expert assessment, document analysis, and statistical methods were applied to the research.

Pablo Sotres, Juan Ramón Santana, Luis Sánchez, Jorge Lanza and Luis Muñoz [40] presented practical solutions to the main challenges faced during the deployment and management of a city-scale IoT infrastructure, which encompasses thousands of sensors and other information sources. The experience gained during the deployment and operation of the IoT-based smart city infrastructure carried out at Santander (Spain) has led to a number of practical lessons that are summarized in their paper.

Tie Qiu, Kaiyu Zheng, Min Han, C. L. Philip Chen and Meiling Xu [41] proposed EARS, an efficient data-emergency-aware packet scheduling scheme for smart cities. EARS described the packet emergency information with the packet priority and deadline. Each source node informs the destination node of the packet emergency information before sending the packets. The destination node determines the packet scheduling sequence and processing sequence according to emergency information.

Nader Mohamed, Jameela Al-Jaroodi, Imad Jawhar, Sanja Lazarova-Molnar and Sara Mahmoud [42] outlined the functions and features needed in a middleware infrastructure to support smart city applications. Based on these functions, a service-oriented middleware that integrates and utilizes the cloud of things (CoT) and fog computing and provides a set of services to support smart city applications was proposed.

In 2018, Maninder Singh Raniyal, Isaac Woungang, Sanjay Kumar Dhurandher and Sherif Saad Ahmed [43] proposed two novel passphrase proxy-based schemes (PPIDA-IC and PPIDA-PKI) for smart homes, which are meant to protect the secret and private keys using a passphrase or passphrase. In its first authentication level, the OTP-server provides the passphrase in such a way that the secret/private keys can be loaded. Afterwards, the PPIDA-IC scheme partially authenticates the devices and establishes a temporary session key using the DH key exchange algorithm. In its second authentication level, the OTPs are distributed over an IR channel and are used to form the final session key. Finally, the OTP hash is exchanged to achieve a complete mutual authentication of devices.

Michael M. Losavio, K. P. Chow, Andras Koltay and Joshua James [44] studied Legal challenges with digital forensics, privacy, and security in smart city.

Yuhuai Peng, Xiaojie Wang, Dawei Shen, Wei Yan, Yanhua Fu and Qingxu Deng [45] tried to integrate cloud computing, big data, Internet of Things, edge computing, and other modern information technologies.

Sai Ji, Rui Huang, Jian Shen, Xin Jin and Youngju Cho [46] proposed a certificateless signcryption scheme for SHNets which can provide biometric-based user identity authentication in smart cities/homes.

Didier Grimaldi and Vicenc Fernandez [47] contributed to the topical subject of smart cities and analysed the performance of an IoT-platform based solution. It evaluated if an IoT platform project can achieve business, environmental and social objectives all together.

Syed Hassan Ahmed and Shalli Rani [48] identified the framework, challenges and trends of Smart city IoT and use case for the smart street highlights the importance of proposed structure. Furthermore, Smart City projects were discussed to recognize the importance of IoT in smart cities and its future.

Asif Iqbal, Farman Ullah, Hafeez Anwar, Kyung Sup Kwaka, Muhammad Imran, Waseef Jamal and Atta ur Rahman [49] proposed an interoperable Internet-of-Things (IoTs) platform for a smart home system using a Web-of-Objects (WoO) and cloud architecture. The proposed platform controlled the smart home appliances from anywhere and also provides the homes' data in the cloud for various service providers' applications and analysis.

Paola G. Vinueza Naranjoa, Zahra Pooranian, Mohammad Shojafar, Mauro Contib and Rajkumar Buyya [50] presented a Fog-supported smart city network architecture called Fog Computing Architecture Network (FOCAN), a multi-tier structure in which the applications are running on things that jointly compute, route, and communicate with one another through the smart city environment.

Sheshadri Chatterjee, Arpan Kumar Kar and M.P.Gupta [51] did a study to identify those factors affecting successful implementation of information system enabling IoT coupled with Artificial Intelligence in the proposed Smart Cities of India (SCI).

Bogdan-Cosmin Chifor, Ion Bica, Victor-Valeriu Patriciu and Florin Pop [52] proposed a lightweight authorization stack for smart-home IoT applications, where a Cloud-connected device relays input commands to a user's smart-phone for authorization. This architecture is user-device centric and addresses security issues in the context of an untrusted Cloud platform.

Shailaja Fennell, Prabhjot Kaur, Ashok Jhunjhunwala, Deapika Narayanan, Charles Loyola, Jaskiran Bedi and Yaadveer Singh [53] focused on linking proposed smart city strategies to smart village policies to ensure that rural youth have improved opportunities for employment through ICT initiatives to ensure digital inclusion, using primary surveys undertaken in India.

Zeeshan Ali Khan [54] developed an approach using trust management and investigated how it can be improved to work more energy-friendly. In particular, he adapted the IEEE 802.15.4 protocol. Further, he analyzed the outcome of these adaptations finding out that they can reduce the active listening time of IoT nodes significantly helping in smart cities.

Harish Kumar, Manoj Kumar Singh, M.P.Gupta and Jitendra Madaan [55] explored all the possible services among various city dimensions which can make a city smart. The ideas related to smart services were collected from the peer vetted creative crowdsourcing process performed online in India. The findings suggest multi-dimensional service classification along with required basic infrastructural development. Further, the Smart City Transformation Framework (SCTF) was proposed to help the policy makers, urban developers, government officials and service providers in terms of understanding and to draw more insights from the suggested smart solutions for development of smart cities.

Vasileios A.Memosa, Kostas E.Psannisa, Yutaka Ishibashib, Byung-Gyu Kimc and B.B.Gupta [56] described the then upcoming IoT network architecture and its security challenges and analyze the most important researches on media security and privacy in wireless sensor networks (WSNs).

Subsequently, they proposed an Efficient Algorithm for Media-based Surveillance System (EAMSuS) in IoT network for Smart City Framework, which merges two algorithms introduced by other researchers for WSN packet routing and security, while it reclaims the new media compression standard, High Efficiency Video Coding (HEVC).

Trevor Brauna, Benjamin C.M.Fung, Farkhund Iqbal and Babar Shah [57] identified and offered possible solutions to five smart city challenges, in hopes of anticipating destabilizing and costly disruptions. The challenges included privacy preservation with high dimensional data, securing a network with a large attack surface, establishing trustworthy data sharing practices, properly utilizing artificial intelligence, and mitigating failures cascading through the smart network.

Lei Cui, Gang Xie, Youyang Qu, Longxiang Gao and Yunyun Yang [58] proposed an overview of smart cities to provide an integrated context for readers. Then, discussed the privacy and security issues in current smart applications along with the corresponding requirements.

Maria Fazio, Rajiv Ranjan, Michele Girolami, Javid Taheri, Schahram Dustdar and Massimo Villari [59] covered all aspects of design and implementation, as well as deployment and evaluation of solutions aimed at the osmotic convergence of IoT, edge, and cloud computing, with specific reference to the smart cities application scenario.

Shilin Zhang and Hangbin Yu [60] presented a deformable convolution based scheme for the person re-ID task, which is a simple, efficient, deep and end-to-end solution to model dense spatial transformations for smart cities.

Moussa Witti and Dimitri Konstantas [61] proposed a framework to ensure security and protecting citizen's privacy for smart city.

Amin Anjomshoaa, Simone Mora, Philip Schmitt and Carlo Ratti [62] proposed City Scanner, a highly-customizable, self-sufficient platform that allows for cost-efficient drive-by sensing.

In 2019, Rama Krishna Reddy Kummitha and Nathalie Crutzenb [63] conducted a field-based study in Hyderabad, a south Indian smart city, using a qualitative explorative research methodology. The research found that, although a supportive regulatory environment helps to create a positive regulatory and cognitive institutional context, normative institutions continue to discourage the positive environment that this context has created. Such a scenario may lead to a ‘talent-in and talent-out’ situation that reduces the entrepreneurial potential of the cities. Thus, city governments in emerging economies need to focus on building not only a regulatory environment, but also create a conducive environment for the key stakeholders in the ecosystem to encourage and promote citizen-led IoT interventions that would result in building inclusive smart cities.

Haojun Tenga, Yuxin Liua, Anfeng Liuab, Neal N. Xiongc, Zhiping Caid, Tian Wange and Xuxun Liuf [64] found that there are hundreds and thousands of mobile vehicles moving in the city, which can be used as the code mules to disseminate code with low cost. A novel low-cost code dissemination model was proposed which disseminate the update code by using the mobile vehicles in the city with an opportunistic communication style.

Sadia Din, Anand Paul, Won-Hwa Hong and Hyuncheol Seo [65] proposed a Constrained Application Protocol (CoAP)-based group mobility management protocol, named CoAP-G. In the proposed scheme, one of the sensor functioned as a coordinator to exchange all the control messages with web-of-things mobility management system (WMMS) on behalf of other sensors to make smart cities.

James Heaton and Ajith Kumar Parlikad [66] presented a smart asset alignment framework that creates an alignment between the information captured at the infrastructure asset level and citizen requirements within a Smart City framework. The framework contributed to the debate on designing and developing Smart City solutions in a way that will deliver value to the citizens.

Md. Abdur Rahman, Md. Mamunur Rashid, M. Shamim Hossain, Elham Hassanain, MOHAMMED F. ALHAMID And MOHSEN GUIZANI [67] proposed a Blockchain-based infrastructure to support security- and privacy-oriented spatio-temporal smart contract services for the sustainable Internet of Things (IoT)-enabled sharing economy in mega smart cities.

VII. CONCLUSION

The systematic review has been carried out in an order to find out the current work done in respect of IoT in Smart Cities. The future prospect for the filed was also taken into consideration and. A number of IoT technologies which are being used were studied, at the same time a number of new and future technologies were also witnessed.

Intensive research and study was done in the field to study and get in depth knowledge about the topic.

As the smart city concept might look as to be a boon to the society, the huge data generated on a daily basis needs to be stored and protected at the same time. We need to come across some robust and reliable way to save, process and store this Big Data without putting it in risk of misuse and mis interpretations.

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