# A Comprehensive Study on the Development of Smart Cities in India from a Computer Science & Engineering Perspective - keeping in view the UN SDG'S

# Muskaan Jain, Rashi Arora, Abhishek Vyas

Abstract— Abstract- In recent years the Central Government of India has decided to develop some of tier 1 and tier 2 cities in every state of India as a smart city. Generally, smart cities can be defined as places where urbanization and development happen keeping in view the latest technological developments and improving the quality of life of inhabitants of that city. NITI Aayog- a GOI organization is developing the standards of smart cities in India. This review paper tries to present to the reader a comprehensive survey about the development of smart cities using a Computer Engineer's perspective keeping in view the UN SDGs. This paper explores the avenues using which there can be sustainable economic and technological development of smart cities. Here, the authors are trying to show how the inclusion of the latest tools and techniques such as ML, AI, IoT, Robotics, etc. can help the societies attain the UN SDGs by 2030.

**Keywords**- Smart cities, SDGs, sustainable development, cyber security, IoT, Singapore, Bhubaneswar, GOI, Niti Aayog.

#### I. INTRODUCTION

What is a Smart City? A transformed city using technologies like ML, AI, IoT, Robotics, etc. [1] which helps in the development and economic growth of any country is termed as Smart City or we can say a smart city is the integration of technology to provide infrastructure, services, and utilities in the urban area. The components of smart cities are:

- Smart Citizen
- Smart Infrastructure
- Smart Building
- Smart Transportation
- Smart Energy

Manuscript revised on May 9, 2019 and published on June 5, 2019 Muskaan Jain, Department of Computer Science Engineering, JK Lakshmipat University, Jaipur, Rajasthan, India. Email(s): muskaanjain@jklu.edu.in Rashi Arora, Department of Computer Science Engineering, JK Lakshmipat University, Jaipur, Rajasthan, India. Email(s): , rashiarora@jklu.edu.in Abhishek Vyas, Department of Computer Science Engineering<sup>1, 2, 3</sup>, JK Lakshmipat University, Jaipur, Rajasthan, India<sup>1, 2, 3</sup> Email(s): abhishek\_vyas@msn.com<sup>3</sup>

- Smart Health Care
- Smart Technology



Figure 1: Components of smart cities [40]

The smart city mission is introduced by Government of India (GOI) to deal with the future challenges associated with urbanization, quality of living (QoL), sustainability. According to the International Organisation for Standardization (ISO) smart cities are quite diverse and the standards provide us with the technical and functional performance of any smart cities.[3] Why do we need the evolution of cities into smart cities? As smart cities provide us with the platform of inculcating and growing into various domains like opening a business, providing different services that impact the social development of a country. But does smart city achieve sustainability in its approach? To answer this approach, we need to look at the different indicators of sustainable development. How change can be achieved? Firstly, upgrading the infrastructure of cities, by making them more energy efficient by adopting different strategies.

Smart City Mission (SCM) an initiative taken by GOI in June 2015 to develop 100 smart-cities in India proposed in a 5-year Plan. The selection of smart cities has not specified sustainable model. Each participant city in India developed its Smart City Proposal (SCP), which is based on the needs of its citizens and to achieve it; different cities are competing against each other in a national-level completion of sorts,

which has two stages: intra-state level selection and national-level selection. In the first stage of the competition, the Government of India will select potential smart cities based on a scoring criterion. In the next round, the top 100 cities will prepare their own SCP followed by an implementation plan. Those cities who fail the second round will improve their SCP for the selection.

There are many challenges in building up the smart cities as they are very complex and are governed by various factors like socio-economic, environmental, political, geographical etc. [4] These challenges are being achieved by GOI using different techniques that will be discussed in this paper further. This paper will discuss how a city can be transitioned into a smart city involving different steps which are as follows:

- Brainstorming & Analysing the problem.
- Mapping the proposed plan.
- Implementation of the proposed technology.
- Fusion of technology & resources for the purpose of achieving sustainability.
- Executing the conceptualized vision.

This review paper, goes through the different frameworks of smart cities and the implementation of one of the technologies incorporating it with sustainability, so as to bring about the necessary change. [15, 16, 17]

#### **II.** FRAMEWORK

There are different kinds of framework which lead to the development of a smart city and they are:

#### 2.1 Technology Framework

The development of smart city relies majorly on the technology which is not just one technology but the combination of more than one technology which give rise to all new concept of the smart city. It broadens up to various kinds of cities like digital city, virtual city, information city, intelligent city [2]. This concept helps in creating an environment for connecting citizens to several facilities and services which help in the development of their daily life.

#### 2.2 Human Framework

It is the crucial part in transforming a city into a highly-educated city by providing a wide area of the workplace so that knowledge can be imparted to a huge number. This framework helps in learning, creating a city having educated individuals who are not only educated but skilled in their field of work.

#### 2.3 Institutional Framework

With the upgrading and advancing tools and techniques for the transformation of a smart city, the development moved towards IT industry which helps in linking the smart growth of the city with the support of corporate organizations. This linkage was brought up with the backing and support of the Government, which could provide assistance for a better living- leading to smart growth of the cities.

#### 2.4 Energy Framework

Energy Framework relates the smart city with the layer of energy to develop an urbanized area with proper energy-work flow along with smarter energy infrastructure.

#### 2.5 Data Management Framework

This framework links the smart city initiative with the data of a particular city. It not only allows the flow of data of a particular city or a place but also keeps the security and privacy of a particular citizen's data. It conjugates the data with the technology for better functioning and development of a city.[3]



Figure 2: Initiative and working of smart city.[39]

#### **III. LITERATURE REVIEW**

"In one of the reviewed papers authors have tried to explain the various aspects of smart city keeping in mind the basics which involves the definition, terminologies describing what is smart city, the evolution (transformation), the promotion in standards of living of the people, urbanisation, the workflow of education and how the change has led to upgradation in the quality of life of the citizens." [17]

"Through this, the authors not only have gone through the superficial study of the framework but also the detailed description of various domains which has led to the development of India. Different corporate-organizations, NGO's and Government have helped to achieve this goal. Many issues have been solved through the accomplishment of smart city challenge, which was put forward by GOI. The solution raised some issues - in respect of controlling the traffic, health issues, transportation, pollution and climate change."[40]

In another one of the papers authors have tried to "explain all the factors that have led to the development, only through the interaction of technology with the physical needs and requirements. The technology which has contributed and supported the transformation of the living

standards is IoT, which is referred as the backbone of the industry because it has linked the various sectors of industries into the development of the city. IoT has interconnected various sensors which have led to the change in quality and standards of living of the inhabitants. From the daily routine to the jobs everything has diversed into various categories which are interconnected very well through a proper chart (lifecycle) which shows the dependency of an individual. The technology has contributed to a great extent which has helped in keeping the safety of the health of an individual, keeping safe the data without any leak."[5]

"In another reviewed paper, the authors have elaborated the different initiatives which are taken by different cities to achieve the smart city tag. These initiatives are not just verdicts given but implemented in various categories like technology, management, organisations, people, and communities. A city progressing towards a smart city, was the outcome of these initiatives which were taken in different categories." [37]

# **IV. INTERNET OF THINGS PERSPECTIVE**

The major evolution is led by one of the technologies i.e. IoT which has brought about the major change in the social, economic and environmental growth of a city as it lays the foundation of a smart city. This is due to the ever-increasing population, the advancing technologies and the requirements of the living. It has simplified the problems of day-to-day life. One of the major characteristics of IoT is the improvement of the quality of life. [5,6,7] IoT makes the smart city feasible with three key features-intelligence, interconnection, and instrumentation. It helps in making the system more smart, safe, reliable and secure. It is a dynamic network of networks. It has many components like the internet, cloud, etc. It has its use in fetching up the secured data which has its server storing the database. IoT with cloud technologies has brought about more reliability and speed - in terms of data fetching and processing. From setting up the infrastructure- to the client-server relationship IoT needs a particular medium which connects via Wi-Fi, LAN or any other well-defined network connection protocol.



Figure 3: IoT Applications for Smart City [26]

## V. HOW BHUBANESWAR HIT THE LIST OF SMART CITIES IN INDIA?

Bhubaneswar ranked one in the list of smart cities by the survey carried out by different institutes. It is named as one of the fastest-growing cities in India. It was the first choice of the GOI to be selected for the execution of the plan because of its increasing growth, sooner it hit the list of global smart cities which included foreign cities like, Singapore, Portland, London, etc. The social, economic and environmental infrastructure has led Bhubaneswar to attain the position of fastest growing smart city. To hit the list of Smart-Cities Bhubaneswar Municipal Corporation (BMC) had proposed programs, so that its citizens could contribute to it. It was brought about by polling in which lakhs of people polled out for improving transport facility, drinking water supply, online parking ticket system. To improve, enhance these facilities the State-Government and BMC joined hands together and worked together which helped the citizens meet their needs. Adding to the same requirements, a greater number of parks were raised so that the city could be made more ecologically sustainable. To make it more secure and safe for females, a number of actions were taken into consideration which was the addition of surveillance cameras at major traffic circles to ensure safety and decrease rate of crimes. Further, few assets which were left to enhance Bhubaneswar are undertaken. To do so, technology has played its vast role and in which IoT has been the backbone.



Figure 4: Bhubaneswar as Smart City [24]

# VI. HOW SINGAPORE BECAME A SMART CITY?

Singapore has skyrocketed its name - in the list of global Smart-Cities with its smart plan which has brought about vast changes and developments which has improved every one of its citizen's living standard. Singapore is one of the leaders in Asia in technology and innovations. The Government of Singapore has announced various outstanding changes like using a carpool system enhancing the technological features on which ride share/rent technology giant Uber. To make it a secure place, the Government has laid down new technologies which would make it a more secure place to live and for this, the Government has taken a move to ban the access of free wi-fi internet there. The alternative for accessing the free-internet is through the technique of air-gapping, which would reduce the cyber-attacks. Not only is Singapore known for its smart plans and initiatives but also known for its high-quality education which is by bringing in different tools infused with technology, thus enhancing the learning and competency of school students in retaining and understanding knowledge. With this diversity of development, Singapore has secured - the first position globally to achieve its full-smart-nation plan by early 2030s.

## VII. GAP ANALYSIS: BHUBANSEWAR vs. SINGAPORE

After going through various phases of developments, it is clear to differentiate how both the cities vary on different parameters but the same technology. The implementation of technology is the basis, which has made the difference in raising the individual city to a certain level. The below table tries to show the various differences between the two cities.

S. No.	Parameters	Singapore	Bhubaneswar
1.	Traffic management	High*	Low#
2.	Urbanization	High	Low
3.	Innovation	High	Low
4.	Internet services	Low	High

TABLE I. COMPARISON TABLE

THIS GAP ANALYSIS SHOWS THE DIFFERENCES WHICH HAVE LED THE VARIATION AND HOW SINGAPORE TAKES AWAY THE STAGE OF THE SMART CITY

> \*High means → better implementation #Low means → not an average implementation

#### VIII. CONCLUSION

A city is a link or a system which helps in the dynamic movement of a lifestyle of an individual. This interconnection has now been widened up to large levels and finally resulted in a challenge which is to improve the conditions of living of cities inhabitants. A "smart" city with computer science perspective relates to technology and the technology which was glanced over here in the paper is IoT. With various walks of life and the time Bhubaneswar has hit its name amongst the top twenty globally smart cities. Various factors have contributed to its development as well as of Singapore but few differences have shown the growth of Singapore better than Bhubaneswar but few aspects still remain untouched which now can be achieved by Bhubaneswar and the two most common ones are:

#### 1. Smart Waste management

The waste management in Bhubaneswar lacks because of which it doesn't hit among the top 10 clean cities. To make it as clean as Singapore we can adopt the incineration of non-recyclable waste method which Singapore uses. Incineration is done so that the non-recyclable waste collected can be burned up and the heat is recovered which can be used to turn the EMF-turbine and generate electricity. Also, smart bins can be used to collect the waste which will reduce the littering of wastes.

## 2. Cyber Security

Cyber threats are increasing daily not at a particular place but in every corner of the world which has threatened the lives of people all around. Resulting to the same Singapore adopted air-gapping measure and with this measure the network connectivity was done physically. Just as Singapore appropriated air-gapping method from Scandinavian Countries, even Bhubaneswar can appropriate this measure which will ensure the computer network-security for millions of its inhabitants.

Bhubaneswar can also become one of the top-rated and ranked Smart-Cities in Asia and the World if it follows the Singapore model keeping in mind the UN-SDGs.

#### REFERENCES

- [1] Shapiro, Jesse M. "Smart cities: quality of life, productivity, and the growth effects of human capital." *The review of economics and statistics* 88, no. 2 (2006): 324-335.
- [2] Sharma, Narayan, Nirman Singha, and Tanmoy Dutta. "Smart bin implementation for smart cities." *International Journal of Scientific* & Engineering Research 6, no. 9 (2015): 787-791.
- [3] Bélissent, Jennifer. "Getting clever about smart cities: New opportunities require new business models." *Cambridge, Massachusetts, USA* (2010).
- [4] Kumar, Nallapaneni Manoj, Sonali Goel, and Pradeep Kumar Mallick. "Smart cities in India: Features, policies, current status, and challenges." In *Technologies for Smart-City Energy Security and Power (ICSESP), 2018*, pp. 1-4. IEEE, 2018.
- [5] Zanella, Andrea, Nicola Bui, Angelo Castellani, Lorenzo Vangelista, and Michele Zorzi. "Internet of things for smart cities." *IEEE Internet of Things journal* 1, no. 1 (2014): 22-32.
- [6] Fortino, Giancarlo, and Paolo Trunfio, eds. Internet of things based on smart objects: Technology, middleware and applications. Springer Science & Business Media, 2014.
- [7] Theodoridis, Evangelos, Georgios Mylonas, and Ioannis Chatzigiannakis. "Developing an iot smart city framework." In *Information, intelligence, systems and applications (iisa), 2013 fourth international conference on*, pp. 1-6. IEEE, 2013.
- [8] Vilhjálmsson, Hannes, Nathan Cantelmo, Justine Cassell, Nicolas E. Chafai, Michael Kipp, Stefan Kopp, Maurizio Mancini et al. "The behavior markup language: Recent developments and challenges." In *International Workshop on Intelligent Virtual Agents*, pp. 99-111. Springer, Berlin, Heidelberg, 2007.
- [9] Chen, Jun, Ian Dowman, Songnian Li, Zhilin Li, Marguerite Madden, Jon Mills, Nicolas Paparoditis et al. "Information from imagery: ISPRS scientific vision and research agenda." *ISPRS Journal of Photogrammetry and Remote Sensing* 115 (2016): 3-21.
- [10] Mahabir, Ron, Arie Croitoru, Andrew Crooks, Peggy Agouris, and Anthony Stefanidis. "A critical review of high and very high-resolution remote sensing approaches for detecting and mapping Slums: Trends, challenges and emerging opportunities." Urban Science 2, no. 1 (2018): 8.
- [11] Kitchin, Rob. "The real-time city? Big data and smart urbanism." *GeoJournal* 79, no. 1 (2014): 1-14.
- [12] Jin, Jiong, Jayavardhana Gubbi, Slaven Marusic, and Marimuthu Palaniswami. "An information framework for creating a smart city through internet of things." *IEEE Internet of Things journal* 1, no. 2 (2014): 112-121.
- [13] Gabrys, Jennifer. "Programming environments: environmentality and citizen sensing in the smart city." *Environment and Planning D: Society and Space* 32, no. 1 (2014): 30-48.
- [14] Scuotto, Veronica, Alberto Ferraris, and Stefano Bresciani. "Internet of Things: Applications and challenges in smart cities: a case study of IBM smart city projects." *Business Process Management Journal* 22, no. 2 (2016): 357-367.
- [15] Parra, Lorena, Sandra Sendra, Jaime Lloret, and Ignacio Bosch. "Development of a conductivity sensor for monitoring groundwater

resources to optimize water management in smart city environments." Sensors 15, no. 9 (2015): 20990-21015.

- [16] Glasmeier, Amy, and Susan Christopherson. "Thinking about smart cities." (2015): 3-12.
- [17] Albino, Vito, Umberto Berardi, and Rosa Maria Dangelico. "Smart cities: Definitions, dimensions, performance, and initiatives." *Journal of Urban Technology* 22, no. 1 (2015): 3-21.
- [18] Zinkernagel, Roland, James Evans, and Lena Neij. "Applying the SDGs to Cities: Business as Usual or a New Dawn?" Sustainability 10, no. 9 (2018): 3201.
- [19] Mora, Luca, Roberto Bolici, and Mark Deakin. "The first two decades of smart-city research: A bibliometric analysis." *Journal of Urban Technology* 24, no. 1 (2017): 3-27.
- [20] Burte, Himanshu. "The 'smart city'card." *Economic and Political Weekly* 49, no. 46 (2014): 22-25.
- [21] Singapore and Bhubaneswar as smart city.
- https://bit.ly/2Ubf66m, https://bit.ly/2RRqvvs
- [22] Randhawa, Aman, and Ashwani Kumar. "Exploring sustainability of smart development initiatives in India." *International Journal of Sustainable Built Environment* 6, no. 2 (2017): 701-710.
- [23] Monostori, László. "Cyber-physical production systems: Roots, expectations and R&D challenges." *Procedia Cirp* 17 (2014): 9-13.
- [24] Jain, Ruchi, and Surinder Kaur. "Impact of work environment on job satisfaction." *International Journal of Scientific and Research Publications* 4, no. 1 (2014): 1-8.
- [25] Joshi, Sujata, Saksham Saxena, and Tanvi Godbole. "Developing smart cities: An integrated framework." *Procedia Computer Science* 93 (2016): 902-909.
- [26] Perera, Charith, Arkady Zaslavsky, Peter Christen, and Dimitrios Georgakopoulos. "Sensing as a service model for smart cities supported by internet of things." *Transactions on Emerging Telecommunications Technologies* 25, no. 1 (2014): 81-93.
- [27] Angelidou, Margarita. "Smart city policies: A spatial approach." *Cities* 41 (2014): S3-S11.
- [28] Lee, Jung Hoon, Marguerite Gong Hancock, and Mei-Chih Hu. "Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco." *Technological Forecasting and Social Change* 89 (2014): 80-99.
- [29] Nitti, Michele, Virginia Pilloni, Giuseppe Colistra, and Luigi Atzori. "The virtual object as a major element of the internet of things: a survey." *IEEE Communications Surveys & Tutorials*18, no. 2 (2016): 1228-1240.
- [30] Ylipulli, Johanna. "A smart and ubiquitous urban future? Contrasting large-scale agendas and street-level dreams." *Observatorio* (*OBS*\*) 9, no. ESPECIAL (2015): 85-110.
- [31] Ijaz, Sidra, Munam Ali Shah, Abid Khan, and Mansoor Ahmed. "Smart cities: A survey on security concerns." *International Journal of Advanced Computer Science and Applications* 7, no. 2 (2016): 612-625.
- [32] Bifulco, Francesco, Marco Tregua, Cristina Caterina Amitrano, and Anna D'Auria. "ICT and sustainability in smart cities management." *International Journal of Public Sector Management* 29, no. 2 (2016): 132-147.
- [33] Vanolo, Alberto. "Smartmentality: The smart city as disciplinary strategy." *Urban Studies* 51, no. 5 (2014): 883-898.
- [34] De Jong, Martin, Simon Joss, Daan Schraven, Changjie Zhan, and Margot Weijnen. "Sustainable-smart-resilient-low carbon-ecoknowledge cities; making sense of a multitude of concepts promoting sustainable urbanization." *Journal of Cleaner production* 109 (2015): 25-38.
- [35] Trindade, Evelin Priscila, Marcus Phoebe Farias Hinnig, Eduardo Moreira da Costa, Jamile Marques, Rogério Bastos, and Tan Yigitcanlar. "Sustainable development of smart cities: A systematic review of the literature." *Journal of Open Innovation: Technology, Market, and Complexity* 3, no. 3 (2017): 11.
- [36] Letaifa, Soumaya Ben. "How to strategize smart cities: Revealing the SMART model." *Journal of Business Research*68, no. 7 (2015): 1414-1419.
- [37] Ramaswami, Anu, Armistead G. Russell, Patricia J. Culligan, Karnamadakala Rahul Sharma, and Emani Kumar. "Meta-principles for developing smart, sustainable, and healthy cities." *Science* 352, no. 6288 (2016): 940-943.
- [38] Marsal-Llacuna, Maria-Lluïsa, Joan Colomer-Llinàs, and Joaquim Meléndez-Frigola. "Lessons in urban monitoring taken from sustainable and livable cities to better address the Smart Cities

initiative." *Technological Forecasting and Social Change* 90 (2015): 611-622.

- [39] Letaifa, Soumaya Ben. "How to strategize smart cities: Revealing the SMART model." *Journal of Business Research*68, no. 7 (2015): 1414-1419.
- [40] Mohanty, Saraju P., Uma Choppali, and Elias Kougianos. "Everything you wanted to know about smart cities: The internet of things is the backbone." *IEEE Consumer Electronics Magazine* 5, no. 3 (2016): 60-70.