
Smart city - An assessment of information technology dimensions

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ABSTRACT

Since the primary technology solutions needs are satisfied in developed countries, they are also ready for disaster management. In contrast, essential solutions are not being fully developed in developing countries. The extensive use of technology to provide intelligent solutions to the problems faced by the region's people is the aim behind Smart City. This technology primarily exists in mobile phones and other handheld smart devices. Smartphones have become the basic need of any person, so will be the case with Smart cities. With the innovation of technology, the city's assets are made more secure, be it people, infrastructure and following of discipline or policies for mankind's betterment. This digital infrastructure enhances every living thing's quality of service and livelihood. The essential features of a smart city are digital infrastructure, e-governance and intelligent solutions to the problems faced in daily life. Hardware, software, and communication technologies are the digital ecosystem required for making cities smarter. IoT, sensors, Big data analytics, connectivity, and smart apps integrate the stakeholders and provide them with services.

KEYWORDS: Smart city, Top 50 cities, smart parameters, smart energy, smart peoples, smart infrastructure, smart governance, smart mobility.

1. INTRODUCTION

A city is a region with an extensive human population and where the people are facilitated with modern amenities and infrastructure. It has better governance, and with infrastructure, the life of people is much smoother than that of a village setting. Therefore, the term 'Smart city' is a 'city' with 'smart' solutions to the city people's problems. The definitions vary from city to city and from country to country. For developed countries, a Smart city is about the utilisation and implementation of 'Smart solutions' to the problems and issues faced. In contrast, it is the incremental development of Information Technology

(IT) infrastructure for the organisation, physical, social, and economic infrastructure in developing countries.

2. OBJECTIVES OF THE STUDY

- To perform a systematic literature review of various Smart city initiatives
- To study multiple dimensions and pillars of Smart city

3. REVIEW OF LITERATURE

To fully understand the vast scope of the ‘Smart city’ concept, this paper's papers from the IEEE explore and presents fundamental concepts of factors regarding ‘Smart city’. Other research papers and articles are also studied to study more dimensions regarding the Smart city.

The documents published data from 2000-2020 regarding Smart City have been gathered from the IEEE Explore database (Fig. 1), which shows that most of the articles are from Journals. Fig. 2 indicates that Hunan University is the leading University where the majority of the research articles are being published; the details are Hunan University (48), Department of Computer Science, City University of Hong Kong, Hong Kong (34), National University of Defense Technology (32), School of Communication and Information Engineering, Shanghai University, China (29), Centre for Smart Energy Conversion and Utilization Research, City University of Hong Kong, Hong Kong (25). Furthermore, the ‘Index terms’ majorly are ‘smart cities’, ‘internet of things’, ‘smart phones’ etc., shows the use of various techniques in the development of smart cities (Fig. 3). The trend of Conference location showing interests in ‘Conference location’ is given in (Fig. 4), Sydney, NSW (296), San Francisco, CA (341), Shanghai (368), Guangzhou (372) and Zhangjiajie, China (398) are the topmost publishing Conference location.

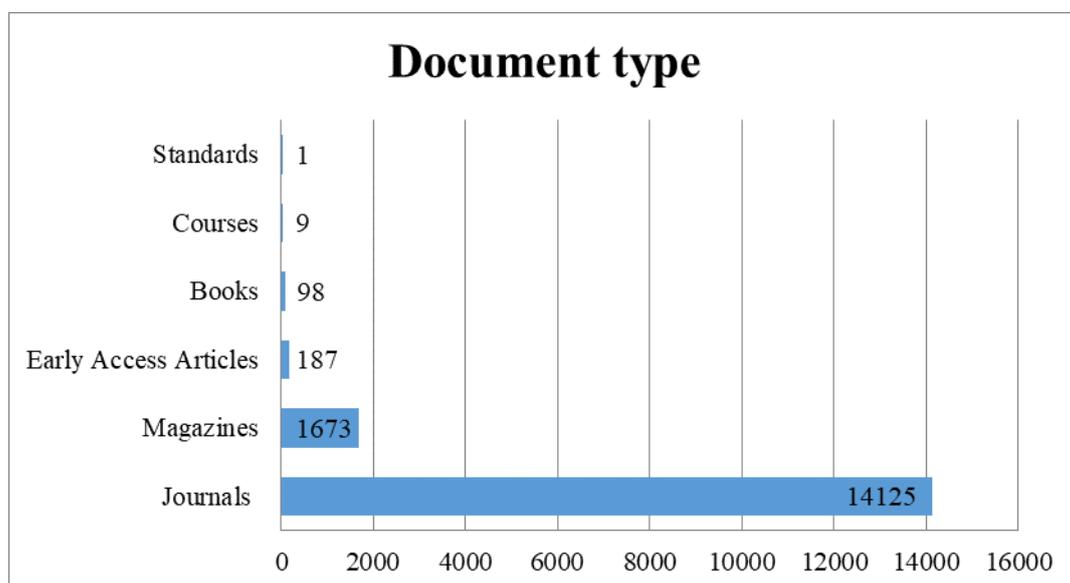


Fig. 1 Various articles published on ‘Smart city’ in IEEE Explore.

In Fig(2), the top ten Universities' list of research articles is given; apart from Queen's University, Ontario, Canada (25), the other nine universities belong to China. The researcher also has attempted to find out the research ‘Index terms’ associated with ‘Smart city’; the list of few associated index words are Internet of Things, mobile computing, cloud computing, smartphones, learning (artificial intelligence), smart power grids, internet, town and country planning, traffic engineering computing, wireless sensor networks and Big Data. An in-depth study of Fig (3) tells that the Smart city study studies technology, efficient utilisation of technology, applications and city planning. Fig. (4) and (5) show the Conference locations where the IEEE conferences were conducted and Publication titles.

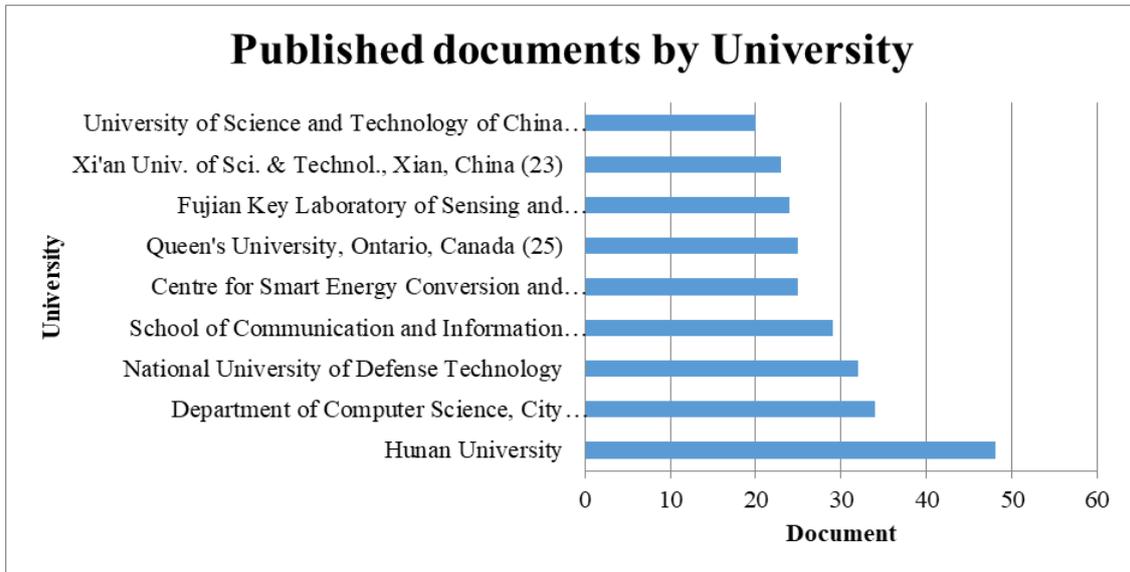


Fig.2 Top ten Universities publishing research articles on ‘Smart City’

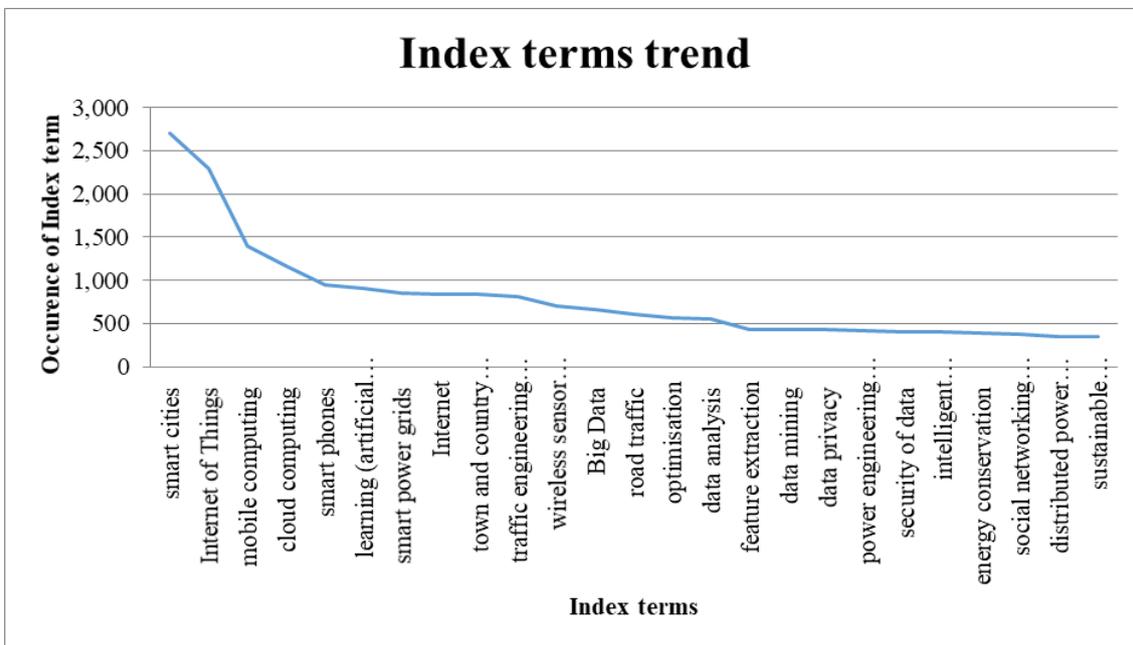


Fig. 3 Index words associated with Smart City

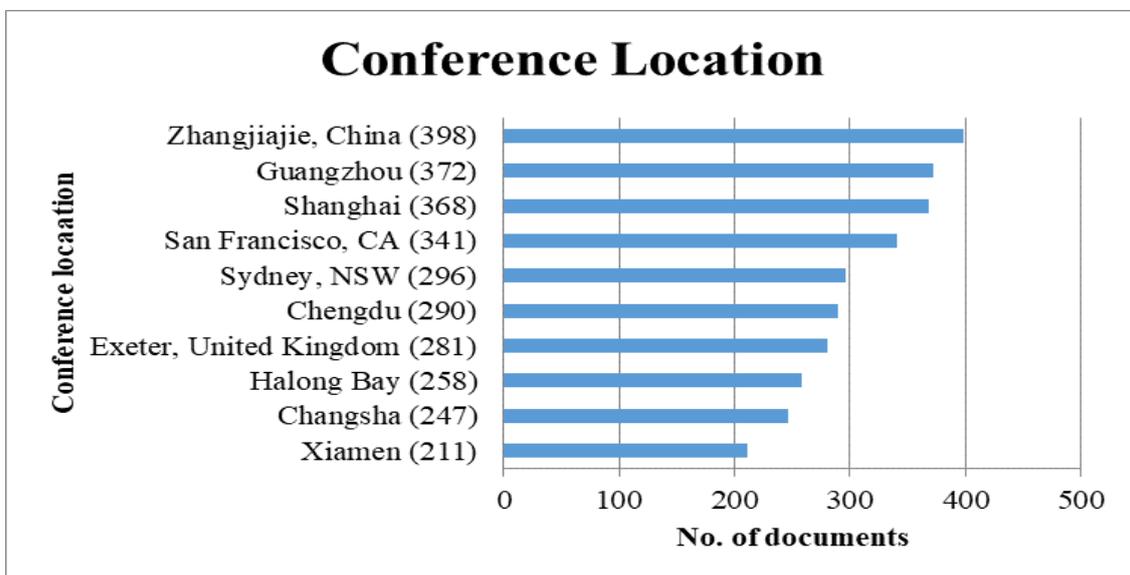


Fig. 4 IEEE conference locations

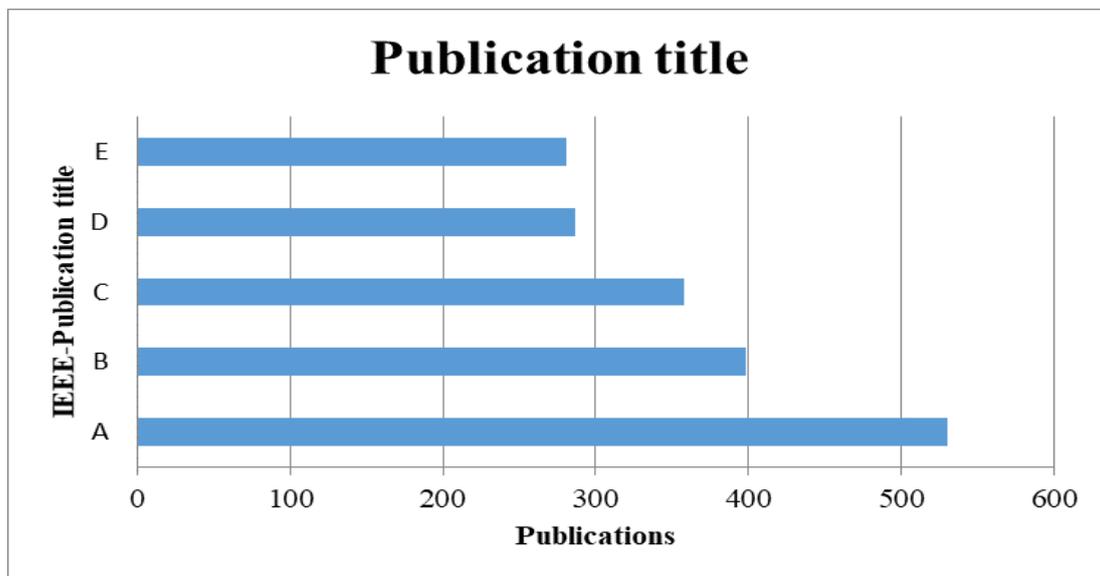


Fig. 5 Publication titles in the IEEE database

4. HISTORY

In early 1994, after the experimentation for ten weeks, the term “digital city” concept was coined concerning city transformation using telecommunication service (Darby, 1994) in Amsterdam. The name was The De Digitale Stad, Dutch Digital City (DDS) and due to the extensive use of free nets and the virtual public domain, the project gained much popularity in the press and from researchers. After seven years of internet growth, it was later stopped being a virtual public domain. (Besselaar, 2003) The brief history of DDS comprises four phases, from mid-1993 to the project end. The record is well depicted using the following Fig. (6).

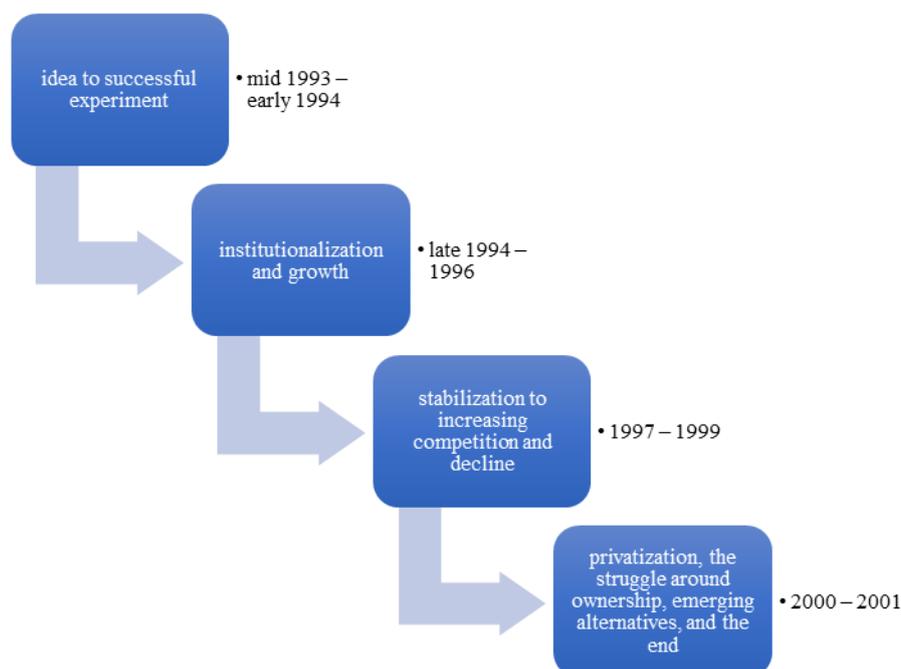


Fig. 6 History, The De Digitale Stad, Dutch Digital City (DDS)

DDS changed aims, goals, design and content, so there was a greater need to analyse DDS's pre-development and development era. (Neirotti, 2014) . The concept has many definitions and synonyms, each talking about ‘technology variant’ and ‘city’ as a common words. These variations are “cyberville”, “digital city”, “electronic city”, “flexicity”, “information city”, “telicity”, “wired city”, and “smart city” (Mohanty, 2016, Albino, 2015). A comparative trend from 2004 till recent times is shown in Fig. (7) of a few alternatives of ‘smart city’ are compared using ‘Google trends’ to analyse the search trend. As per this trend

analysis, it is found that the term ‘information city’ and ‘digital city’ were more popular initially; however, nowadays term ‘Smart city’ has become more popular.

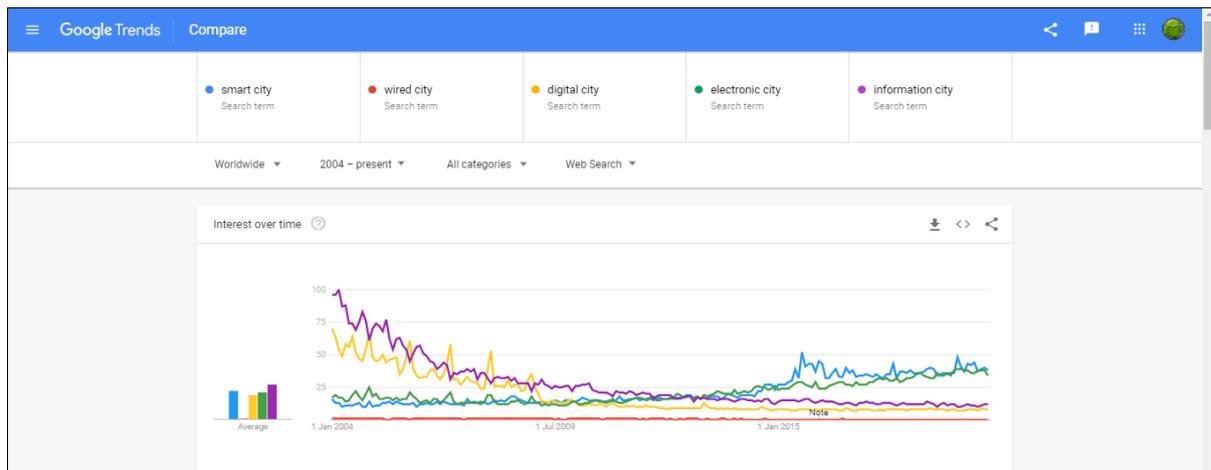


Fig. 7 Comparative analysis of a few of the ‘smart city’ alternatives using Google trends

5. SMART CITY TAXONOMY

After an in-depth study of various research articles, it was of the term Smart city; it was found that many aspects surround the concept, ‘technology’, smart pillar pillars on which it resides. Technology is the foundation for the Smart City, including IoT, Big Data, Cyber-Physical systems, Connectivity and ICT. As per the study, the author has identified the six pillars which give a city to become ‘Smart’; they are mentioned below: The foundation, pillars, and roof form a three-layered framework, which is explained below.

The Technology Foundation

Technology has laid a strong foundation for constructing a Smart city; the latest technologies cater to societal needs. The factors contributing to the development of SC are peer-to-peer connectivity and communication among various devices and human beings. Thus, high-speed connectivity and reliable, large networks are required to track consumer internet utilisation and machine-to-machine and machine-to-human beings. According to a report by CISCO, by 2020, 50 billion devices will be connected globally through the internet. (Zheng, 2014, Curry, 2016)

The six Pillars

a) Smart Mobility & Transport

Smart Mobility and transport is an approach that provides congestion-free roads, a greener environment, conserves energy, and optimises journeys and cheaper transport. The traffic congestion is intimated to the information consumers regarding mobility patterns, best route, and traffic conditions from various information sources to make the journey smoother and smarter. By 2024, there is expected to be tremendous growth in the global mobility infrastructure, from \$5.1 billion in 2015 to \$25.1 billion. Multiple apps play essential roles in Smart mobility and transport pillar; “MobyPark and “Parker” by Street Line in the Netherlands and New York City are examples of apps which searches for parking spaces before entering into parking zone; “TraficCam” is one of the smart signals in Moscow.

Bicycle sharing or bicycle commuting or bicing:

Bicing is the fastest mode of transport for short distances in many popular cities, such as Beijing, Shanghai, and Amsterdam. Beijing and Shanghai. The bicing in Budapest is a 98 stations network with 1000 bicycles and more than one million rentals. The innovation added to it is to book bicycle, find the nearest pick-drop points, and traffic conditions specified in the bike lane map of the city.

Car-pooling: the concept is based on a straightforward philosophy of not letting the empty seats travel to the destination. Instead, initiatives such as Carma, ZipCar and Zimride perform a mapping between drivers and passengers travelling along the same route.

Intelligent Transport Systems

Intelligent Transport Systems (ITS) integrates multimode transport system facilities such as GPS-enabled and tracked vehicles, smart street lighting, RFID plate numbers, Fast tags, and traffic regulation. Shenzhen Intelligent Transport System and CIVITAS are examples of the Intelligent transport system deployed in China and Bologna.

b) Smart energy management

The world is facing several problems regarding energy management, such as over-consumption, price hike, non-renewable energy, depleting resources leading to hikes in its costs and global warming. To develop an innovative and sustainable city, Smart energy services must be generated using sensors, energy meters, and renewable energy resources to track, monitor, and automate energy management.

Smart-Energy management provides environment-friendly, cost-effective, innovative solutions using smart energy infrastructure, such as smart electric vehicles, appliances, smart grids, distributed renewable generation, microgrids, smart grid technologies, energy storage, automated demand response (ADR), and virtual power plants.

Furthermore, there is a need for Smart water management to conserve water, deploy rainwater harvesting and other innovative and smart solution to save water, its reliable transportation, water flow, water pressure, and water leakages. A smart water management strategy is adopted in Mumbai, India, where 50% of water is used for loss during its transportation, smart water solutions of installation of smart water meters to control water leakage and prevent the loss of 700 litres of water. These water meters have a remote control which provides information about pipe leakage.

Smart Waste Management

‘Waste’ generation directly affects livelihood and hygiene and increases health risks. So there is a need to create a waste management system that deals with smart solutions which are environment friendly, cost-effective, waste segregation, waste recycling, reuse and smarter disposal techniques and thus provide quality of life services. Smart bins- waste containers are deployed in Sharjah, UAE, with battery-powered sensors to sense weight and temperature. The data will be sent to the network to be stored in the cloud server for analysis.

c) Smart Governance

Government departments work in isolation, where information sharing is a barrier to making decisions. This requires integrating departments to facilitate information flow through an IT application. Smart governance comes in various models, such as Government to Citizen (G2C) model, Government to Business (G2B) model, Government to Government (G2G) model, Government to Employee (G2E) model. Smart governance requires modern ICT tools to create an e-society that is sustainable, corruption free, and inclusive of citizen’s participation in every government ‘move’.

Centro de Operações Prefeitura do Rio de Janeiro (COR),

Brazil, uses Google satellite and street maps to know the real-life conditions. COR has integrated 30 departments of municipality and private organisations for emergencies, and disruptions arise. A large wall screen displays the city’s needs in graphs, video feeds from Camera footage regarding city bus status, nearest hospitals in case of emergency or natural disasters, transit lines, trash details, transportation, and sanitation.

An example is the bottom-up approach the Amsterdam city government deployed called “Smart Citizen Kit. The approach is bottom-up, as the citizens know various air factors to measure its composition, humidity, temperature, and brightness. The project was

developed by a non-Government organisation - WAAG, society and Amster dam-government to follow a collaborative community-oriented approach.

Smart living

Bright lighting provides citizens a better life in various aspects such as healthcare, education, smart home, and social services through smart physical and digital infrastructure implementation.

d) Smart Healthcare

When the health parameters such as blood pressure, pulse rate, heartbeats, and glucose are recorded and converted to medical facts through remote patient sensing is termed Smart healthcare. The concept further includes precautions, diagnoses, and treatment in real-time and records the patient's digital health, termed Smart healthcare. The digital environment is provided to in/outpatients so that the right resources are available for the right person at the right time.

Reducing Maternal and Newborn Deaths (ReMiND) project, India

ReMiND project is a community health program deployed primarily to cater for the needs of pregnant and new mothers in rural parts of India. The project would sense the pregnancy and delivery associated risks and would give danger signs to the registered Women. The complications and health factors were identified, and the project provided solutions.

Smart Education

Teaching pedagogy involves teaching-learning-evaluation methods, which are teacher-centric; hence, the teacher's perspective is considered in the classroom. An intelligent education uses smart teaching pedagogy that is learner-centric, not teacher-centric.

e) Smart People

Smart people should always lead a Smart city; however, the technology is getting more mature daily, but when it comes to people, they must acquire relevant skills for SC implementation. So, human skills development becomes a primary requirement for the digitisation of a city.

Citizen engagement involves the participation of the stakeholders of the entire city's ecosystem to make it a digital ecosystem using the 'collective intelligence' of people. To make a city smarter, a digital dialogue among citizens is needed through the development of various apps, the conduct of Hackathons to create a technical community, design user-centric approach. The examples are the Code for America program, Milton Keynes in the United Kingdom and the European Union's citizen city project, respectively.

MOOCS, m-learning solutions and other ICT tools

Massive Open Online Courses (MOOCs) and other e-learning platforms such as Coursera, Khan Academy, and edX provide online, flexible, open, affordable access to several users and hence prove to be a great learning resource acting as a bridge between citizens, smart city solutions and technology.

National Skills Development Corporation (NSDC), India

This is the initiative undertaken by the Government of India in partnership with the private sector with 49% shares under the Ministry of Skill Development & Entrepreneurship (MSDE). This ambitious project aims to train 50 crore people and generate a pool of jobs and other youth opportunities.

f) Smart Cities

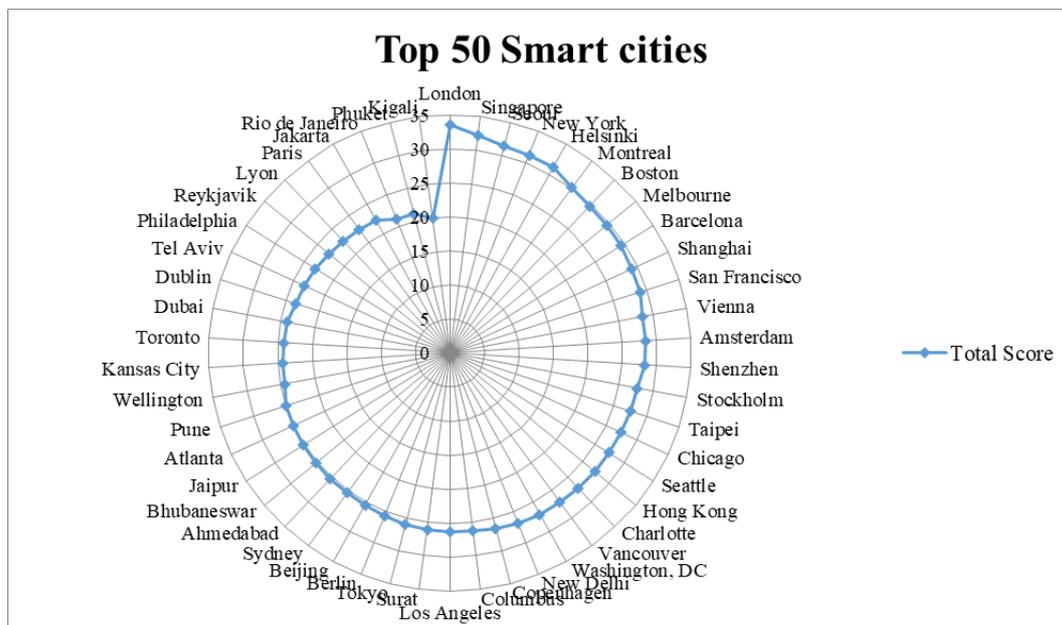


Fig. 8 Top 50 Smart Cities

The top 50 SCs in this globe are given in Figure 8: these cities were ranked based on parameters shown in Figure 9. The top city, London, scored 33.5 and the city with the lowest score, Kigali, is 20. The parameters on which the scoring was given are given in Figure 9. The Indian cities which are among the top 50 SCs with their ranking are given below:

Ranking	City	Total Score
23	New Delhi	27
27	Surat	26.2
32	Ahmedabad	25.3
32	Bhubaneswar	25.3
34	Jaipur	25.2
36	Pune	25

New Delhi is among the top 25 SC, and New Delhi and Pune scored the highest score on individual parameters Talent-Readiness and People Centricity, respectively. On average, SC scores high in People Centre city, followed by Vision, Leadership, and Budget, while Policy implementation is still a challenging factor to be overcome for SC implementation. Figure 9 and 10 shows a radar chart depicting the score of six SCs in the race of World SCs and horizontal bars for showcasing the score of these SCs.

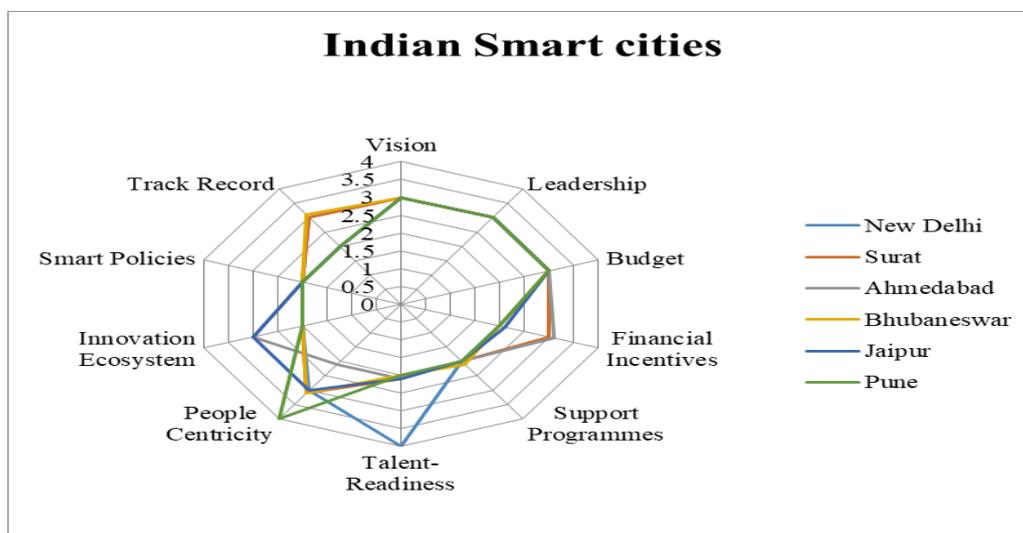


Fig. 9 Indian Smart cities with parameters score

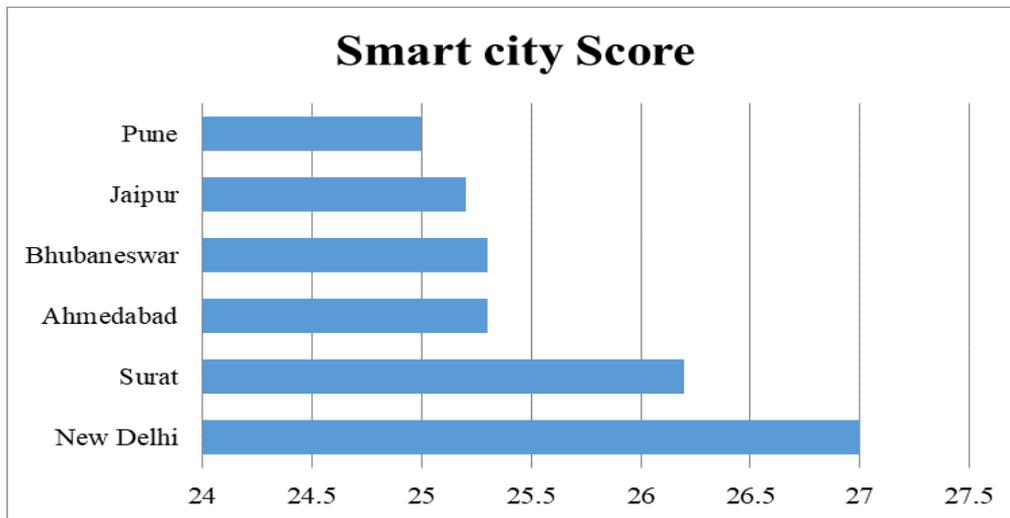


Fig. 10 Indian Smart City with their score

6. CONCLUSION

Technology has transformed how we think, live, and dream of technology implementation to make our life better than the previous generation. A gigantic leap and quality enhancement towards leveraging technology usage to cater for the needs of urban life and metro expectations is achieved through Smart City. The meaning of a Smart City is multi-fold; for some, it's a State of infrastructure; some look for solutions; some work for sharpening the KSA component, integrating technology and various stakeholders, etc. Making the city 'Smart' is not the task of government, but together the citizens need to adopt collaborative, integrated, tech-savvy solutions to the city's problems.

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