SUSTAINABLE SMART CITIES: CONCEPT, CHALLENGES AND REALIZATION

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Abstract: In recent years migration from the rural areas to the major city centres has been growing exponentially stressing the infrastructure on already burdened metropolis resources. To alleviate these challenges lawmakers and industrial leaders have been scrambling to devise smart technologies solutions so the effect of massive population pressure coupled with uncontrolled migration and worsening availability of resources will not be faced by the coming generations. Aiming this "The Smart Cities Mission" has been launched by the Government of India, to produce 100 smart cities in the country for a better future. In the present paper, various challenges and the effective means for realizationof the concept of smart cities has been discussed.

Keywords: Smart cities, Urbanization, Concept, Challenges, Realization.

1.   Introduction

With increasing urbanization the three important economies of India which will be under stress are physical infrastructure, social infrastructure and institutional infrastructure. Therefore, the main focus of almost all the research is to present a strategy to mitigate the problems generated by the urban population growth. In this context, a smart city brings enormous opportunities and exciting challenges. Smart city will be the hub of manufacturing industries giving a promising bright future to all citizens. Smart city is more about technology, safe transport, abundance space, modern lifestyle amenities. In next few decades, there will be a better future with the development of smart cities but to realize these cities there are many Challenges to be faced by the developers and planners. This paper discuses the concept, challenges and effective means of realizations for setting these sustainable smart cities.
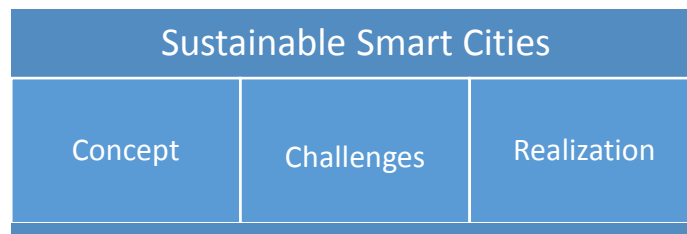

Fig 1: Sustainable smart city

1.1.   Concept of Smart cities

The megacities face resource and infrastructure crisis due to the quick transition of small and medium town population to these cities. The scarcity of resources coupled with environmental pollution obstructs the urban environment and makes the cities unhealthy and unsustainable. Cities all over the world are at the height of seeking optimal solutions to face new challenges that grow variably over space and time. Some of the areas that need attention are: Sustainable development, education, energy, environment, safety and public services. Those challenges have led urban areas to be compound social ecosystems in which sustainability and good quality of life are important to be ensured. Thus a smart city concept or urbanization process is related to economic development, social development and environmental protection. [1].

In order to improve the management of urban processes and inhabitants' requirements administrations all over the world have presented significant number of future city's models in which technology, connectivity, sustainability, comfort, safety and attractiveness shape the crucial objectives to be achieved [2-4].Smart city could be a possible solution to all these problems. Smart is not just about technology-enablement, but also about power, water, transportation, solid waste management and sanitation. A smart city's core infrastructure is information technology, where a network of sensors, cameras, wireless devices, data centers form the key infrastructure providing all important services. The India's Union Cabinet in June 2015 cleared the Smart Cities Mission under which 100 smart cities would be built [5-6]. The Smart Cities Mission is touted as one of the most ambitious urban transformation programs undertaken by the Indian government to date. Prime Minister Narendra Modi has also spoken extensively about the linkages of the growth of Indian cities and the mitigation of urban poverty. While the smart city is an area of opportunity for infrastructure

companies and developers, it's a long-term project that will need no less than 20 years. Many countries have shown interest already including Japan, which is keen on developing Varanasi as a smart city, and Singapore, which has indicated Andhra Pradesh's new capital as its choice.

1.2.   Smart City Definition

Smart city is mainly concerned with 'smart governance', 'smart energy', 'smart environment', 'smart people', 'smart transportation', 'smart IT and communications', 'smart buildings' and 'smart living' at large. Different sources have given different definitions for smart cities. To make things easier to understand, consider that the city is just a system that gathers many systems [7-8]. A city can be defined as smart when investments in human and social capital and modern transport and communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" [9]. 'Smart Growth' has varied components. It's not just transportation. It's a mindset towards creating a more holistic community [10]. A forward-looking city creating solutions for modern problems in economy, people, governance, mobility, environment & ecosystem, built on the smart combination of endowments and activities of decisive, independent and responsive citizens. Thus, smart city can be defined as a 'System of Systems'.The broader definition of smart city is shown in Fig 2.
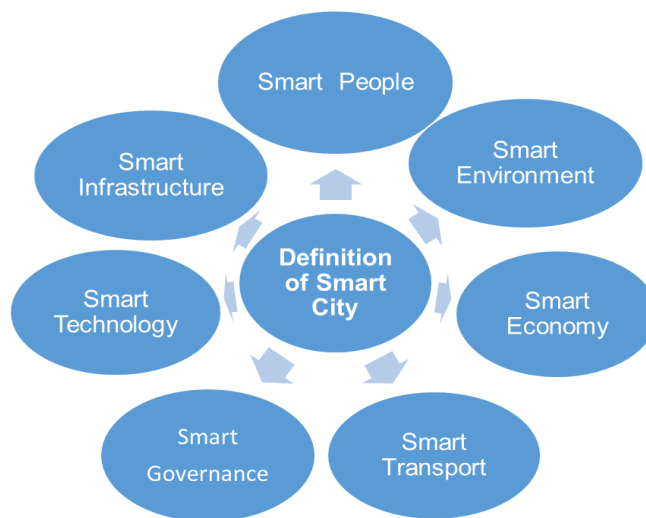

Fig 2: Definition of Smart City

2.   Challenges Faced by Smart Cities

With the development of the concept of setting smart cities in India, there has been an average increase in smart city developers, technology setters, planners, strategy makers, but still they are facing many challenges in creating the sustainable smart cities. The three most difficult challenges being faced by developers of India's smart city are geographic, transport congestion and increased population exacerbating the environment & living conditions in smart cities. These challenges if not mitigated will affect the generations to come.

2.1   Geographic Area Congestion

The concept of smart city is not only about connecting cities or making digital cities it should also preserve history, culture of each city in turn assimilating them into urban city. The urbanization rate of India is 2.74% and it is growing at a fast rate making 38% of India's population to be residing in the urban areas by 2030. By the end of 2030, India's three megacities; Delhi, Kolkata and Mumbai will bear more population stress. More and more people from rural places will like to settle in the cities which are futuristic smart cities. More resources would be required to fulfil the needs of the growing population. More land and accommodation would be required which will further add stress to the already crumbling infrastructure of these metropolitan cities. India is planning to have more megacities such as Ahmedabad, Hyderabad, Bangalore and Chennai by next decade to support the existing megacities. Flow of migrants is a continuous process and in order to pacify the needs of increasing migrants from rural areas, more new cities would be needed to be established. According to planners and developers the whole new set up of smart cities will establish new communities and support metropolis to preserve their assets. The building of new smart cities is quicker and cheaper than improving the infrastructure of the already existing megacity. India's plan of new smart cities are Rohini, Dwarka and Narela as extensions to Delhi, Navi Mumbai to Mumbai, Salt Lake City to Kolkata and Yelhanka and Kengeri to Bangalore. Noida, Greater Noida, Manesar, Pimpri-Chinchwad, Rajarhat, Dankuni, etc are the examples of such new towns [6, 11].

2.2Urban Transport Congestion

The rapid development of the cities sans proper planning transportation causes problems that effect the wellbeing of citizens in urban areas. Most of research in this area conclude that the use of private cars is still the transportation mode dominated in cities. And the main issues are the heavy use of private car instead of other mobility mode such as public transport, cycling and walking. Yet, the automobile city is the solution that fills citizens' needs of privacy, independence, freedom, flexibility, etc. On the other hand, this mode of transportation has big effect on a city's future, the large energy consumed by cars which produce noise and air pollution produces climate change and damages the environment, increasing accidents and congestion. The big challenge now of a smart mobility is to develop a transport system which is able to fulfill citizen needs in a green, environment and sustainable way.

2.3   Healthcare Obstacles

Healthcare is considered one of the most important factor in order to improve the wellbeing of citizen. Exponential population growth rate creates numerous healthcare challenges in modern world. Citizens in even the most developed cities still suffer from high cost and hospital crowding. As a result, conventional medical practices are insufficient to handle healthcare demands of world's population, thus becoming obsolete and invalid. The condition worsens, as the number of medical practitioners in healthcare domain do not grow proportionally with the population. Subsequently, increasing the risk of prescribing wrong medication, receiving inappropriate diagnosis and misinterpreting infectious and epidemic diseases. The gap between expectations and reality of healthcare is furthered by shortages in resources and superfluous demand [12].

3.   Realization

To accomplish the vision of smart city, it is imperative to have good coordination between local, state and central authorities. It would also require a perfect public private partnership to develop smart cities in India. Government should focus on some of the key areas for overcoming the challenges laid in the path of realization of these smart cities in the country.

3.1.   Smart Technology

The uses of digital technologies to enhance performance and well-being to reduce costs and resource consumption and to engage more effectively &actively with its citizens can be brought under broad framework of smart cities.The new technologies which seem to be promising in the India's future smart cities are IOT [13], Artificial intellegence, nano-technology and use of renewable energy sources.

From a technological perspective, the smart city ecosystem is a complex one comprising   many   technology areas. Technological literacy is key to turn a city into a smart city which is well connected, sustainable and resilient; where information isn't just available, but also seek able. This aim can't be turned into reality without technology. Some of the most essential technologies without which the smartness of a city can't be enhanced are [13-15]:
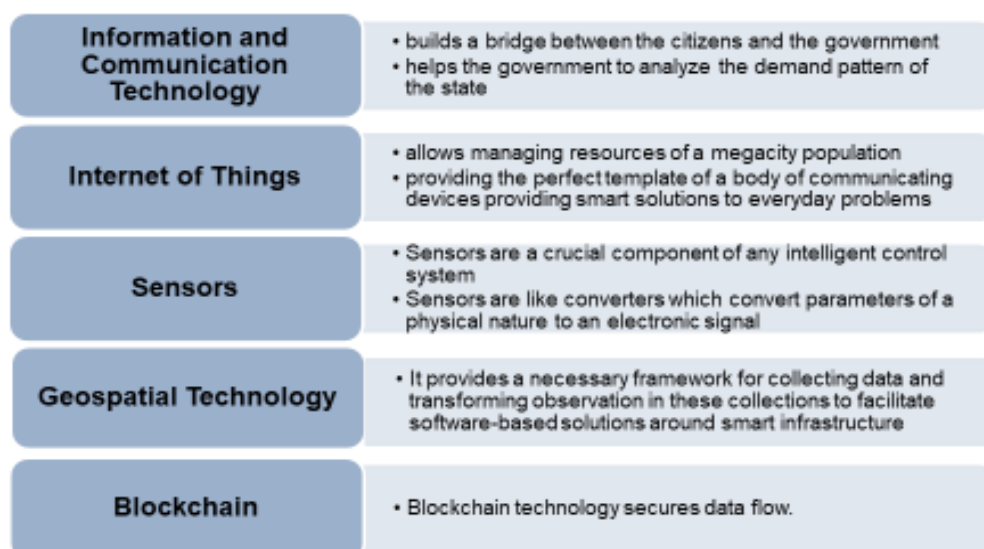

Information and Communication Technology	• builds a bridge between the citizens and the government • helps the government to analyze the demand pattern of the state
Internet of Things	• allows managing resources of a megacity population • providing the perfect template of a body of communicating devices providing smart solutions to everyday problems
Sensors	• Sensors are a crucial component of any intelligent control system • Sensors are like converters which convert parameters of a physical nature to an electronic signal
Geospatial Technology	• It provides a necessary framework for collecting data and transforming observation in these collections to facilitate software-based solutions around smart infrastructure
Blockchain	• Blockchain technology secures data flow.

Fig 3: Smart Technologies

3.2.   Green Infrastructure

The smart cities should also be green cities which can provide fresh and healthy environment to all. The mass generation of waste in cities needs to be technologically processed and reutilized in such a form that it can generate energy.

Renewable energy: One of the essential requirements of all smart city proposals is a strategy that ensures 10 per cent of the city's electricity supply is generated through solar energy. The present contribution of renewable energy sector to the power sector requires to be enhanced from 10% to 20%, thereby having parallelpositive implications on employment and better environment and health applications.Incorporating renewable energy sources is another compulsory approach to ensure sustainability of city operations and to manage scarcity of non-renewable energy sources [16].

*Green streets:*Defining street networks in urbanized areas is an integral part of the ecological network of cities. A green street is a storm water management approach that incorporates vegetation, soil and engineered systems (e.g., permeable pavements) to filter and purify storm water runoff from impervious surfaces (e.g., streets, sidewalks). Green streets protect water quality in rivers and streams by removing up to 90% of pollutants. They replenish groundwater supplies, absorb carbon, improve air quality and neighborhood aesthetics and provide green connections between parks and open space. Green streets can incorporate a wide variety of design elementsincluding bioswales, water retention and detention ponds for ground water recharge,infiltration trenches, green parking spaces and lots. Streets comprise a significant percentage of publicly owned land in most communities, thereby offering a unique opportunity to incorporate green street elements that will not only protect the environment, but can improve community health and prosperity.

Intelligent street lighting also referred to as adaptive street lighting, dims when noactivity is detected, but brightens when movement is detected. This type of lighting isdifferent from traditional, stationary illumination, or dimmable street lighting thatdims at pre- determined times.

*Integrated Water Management:*Water availability is a major problem in Indian cities. To address this problem, the digital water meters, intensive pipelines and rain water harvesting systems should be well laid.

Low Carbon Footprint: The global warming is considered as a serious threat to the very survival of mankind and other living creatures. The full complexity of the carbon-smart urban development can be addressed and managed in the areas of transport and land-use planning, energy, water, and waste. It should be mandatoryto perform infrastructure, buildings 'Life Cycle Analysis' to evaluate extent of green house gas emissions in various production systems. Modern building materials consume higher embodied energy and can cause bigger carbon footprints. Conducting LCA for production systems for engineering infrastructure (water, sewerage, roads, power, drainage, solid waste) and typologies of buildings (vernacular, glass encased, predominantly concrete) is essential to defining codes and practices for sustainable development. This type of development can be done through connected networkings and information sharing with ICT and sustainable technology applications

3.3.   Sustainable and Smart Transport

The roads, highways, metro and other transport facilities should be environmentally friendly, affordable and accessible for all. A city will become problem solving and solution building city by initiating or providing its people good traffic management solutions. A city should be provided with mass rapid transit system(metro- mono rail), enable real time travelplanning, e-Bus rapid transport (GPS enabled), smart parking, multi- modal transit integration.

There are some objectives associated with smart trans-portation such as Congestion control on roads because of heavy traffic, Incident detection mechanism, Road condition monitoring , Information dissemination in case of any acci-dent, Coordinated transport modes for effective and efficient life and Reduce energy consumption. These objectives re-quires smart sensing, short and long range communication technology, computation technology and a well connected infrastructure There are some objectives associated with smart trans- portation such as Congestion control on roads because of heavy traffic, Incident detection mechanism, Road condition monitoring , Information dissemination in case of any acci-dent, Coordinated transport modes for effective and efficient life and Reduce energy consumption. These objectives re-quires smart sensing, short and long range communication technology, computation technology and a well connected infrastructure There are some objectives associated with smart trans-portation such as Congestion control on roads because of heavy traffic, Incident detection mechanism, Road condition monitoring, Information dissemination in case of any acci- dent, Coordinated transport modes for effective and efficient life and Reduce energy consumption. These objectives re-quires smart sensing, short and long range communication technology, computation technology and a well connected infrastructure There are some objectives associated with smart trans- portation such as Congestion control on roads because of heavy traffic, Incident detection mechanism, Road condition monitoring, Information dissemination in case of any acci- dent, Coordinated transport modes for effective and efficient life and Reduce energy consumption. These objectives re- quires smart sensing, short and long range communication technology, computation technology and a well connected infrastructure There are also some objectives associated with smart transportation such as Congestion

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3.4.   Safety and Security

The safety and security of a city includes its general security as well as cyber security wherein the latter has been an area of focus since the last few years.Safety ensured through ICT network based systems (supply to public realm, public spaces inprivate realm). ICT network can provide more secured and smart environmentsolution to security systems. Insurance, subsidies, cash transfers, loans etc., fast delivery of services should be enabled through ICT based networks [18].

3.5.   Public Health and Welfare

The Government of each country aspires to provide a better health to its citizens and e-healthcare solutions is an approach in this context which aims to use technology in health sector. A smart e-health system comprises clinical care, remote monitoring, early intervention, prevention and emergency responses [19-20]. It contains several solutions for hospital challenges from the point of view of healthcare professionals, doctors and politicians. E-health will be an indispensable way of promoting healthcare industry particularly for those living with chronic conditions Many solutions and projects are under development in healthcare in several axes like: telemedicine, telecare: it is a set of service carried out off location. Services typically include tele-consultation and tele diagnosis, which let experts perform diagnostics with medical instruments without the physical presence of the patient. This solution has proved very efficient on patients with chronic illnesses. Technology trend has proved its efficiency in storing, researching and analyzing data in healthcare context of accessing complete history of diagnoses and records of a patient (Electronic Health Record) communicated by specialist. Health or m-Health is another form of e-health that improve the communication, the sensing, the monitoring part of health data, in order to provide real time information and results to patients, researchers and doctors through mobile.

India's Plan For Sustainable Smart Cities

India has a population of around 1.32 billion and urban population accounts for nearly 31.1% that is expected to increase more rapidly in years to come. The annual growth of population in India is 1.51% of population and the annual urban growth rate is around 2.43% of urban population. To accommodate and resolve the problems associated with rapid urbanization, the Government of India has planned to build 100 new smart cities. Worlwide all countries are ready to establish smart cities and India is also ready to develop its first smart city. The first plan of developing smart cities includes -- Uttar Pradesh, Haryana, Rajasthan, Gujarat, Maharashtra and Madhya Pradesh in alliance with Japan as a manufacturing and trading hub. The plan is to develop these cities to meet all of the global parameters set for sustainable urbanization like unceasing water and power supply, fast and modern means of transport, smart grids, energy consumption to be measured by digital meters, optimsed use of energy sources and proper recycling of waste. In the next ten years, there will be an increase in employment, production of goods and export business with the development of manufacturing centres that're planned to be set up along Delhi Mumbai Industrial Corridor (DMIC).

India's first smart city master plan is ready to develop Dholera village in Gujrat. The other set of smart cities to be developed in next few years are Manesar-Bawal in Haryana, Indore-Mhow in Madhya Pradesh, and Dighi and Nasik-Igatpuri in Maharashtra -- all along the Delhi-Mumbai Industrial Corridor.

4. Conclusion

This paper aims to define different definitions of smart cities given over the time by planners and developers of the sustainable smart cities and also describes about the challenges and realizations to be faced while setting these smart cities.Development of smart city plan is a combined task where policy, stakeholders, company, community and citizens must all work together with more transparency, technology and developers should work on new affordable technologies on the other hand. Academic and professional researchers need to work on technicalandtechnological challenges to be faced while setting sustainble smart cities.No doubt, with urbanization there will be a shortage of natural resources like water and land as more people from rural area will migrate to smart cities.India 's objective of setting 100smart cities is not only to develop physical infrasture with all modernizations but the biggest challenge is sustaining these developed smart cities, which generate jobs and optimially use the resources.The challenge is to to upgrade the existing cities into smart cmrt cities or set up new cities. Hence, India's plan should be to balance the multiple facets of sustainability while seamlessly transforming to urbanization.

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