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Defining "Four C's" On Smart City: Concept, Components, Challenges, and Clarifications

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Abstract
It hardly needs any justification that Indian cities are enjoying the status of 'engines of growth and productivity', yet the state of housing and basic infrastructure facilities remain awfully poor. This calls for 'smart city' solutions in India as vision out with the concept of "Smart Cities". With this novel concept, the country is in a new process of smart transformations. This paper uniquely specifies four C's of smart cities that are: concept, components, challenges and clarifications. It is based on the content analysis of various reports and articles which are explored for the purpose. Overall, it is concluded that concept and components of smart city are interlinked. There are different ways people are defining smart city, and accordingly various components of smart city have been described under various approaches. The three main approaches regarding components of smart city remained: four components approach, six components approach, and smart diamond approach of eight components. The path of smart city initiative is not free from various challenges which needs to be overwhelmed. So, further clarifications or strategic solutions on this matter are described. The findings are directed towards applying a team work approach for achievement of the vision of smart city with shared responsibility of all the stakeholders in the society. Also, the progress of this mission must be monitored regularly to plug all loopholes including delays, financial leakages and corrupt practices.

Keywords: *Components, Smart People, Smart Cities, Solutions, Challenges*

I) Introduction

India is in a new process of smart transformations with the novel concept of smart cities. From the very past times, India has been seen as a country of rural population living in villages; and with the name of county India, a picture of rural background is perceived. But now, the whole scenario is changing and India is on a path of massive urbanization (Goel, 2011). In line with Jain (2015), India has an urban population of 377 million living in 7936 cities and towns; and it has been projected that by the year 2030, 78 cities in India will become metropolitan and around 600 million people will live in urban areas. Fortu-

nately, Indian cities are the engines of productivity and growth by generating two third of Gross Domestic Product (GDP). Moreover, 9 to 10 per cent of growth in GDP depends fundamentally on making Indian cities more livable and inclusive (Planning Commission, Government of India, 2008). But at the same time, cities are facing various challenges including lack of adequate infrastructure and basic services, poverty and slums, inadequate housing, mobility issues, congestion, pollution which needs to be overcome by adopting smart solutions in terms of transforming traditional cities into smart cities (Bhagat, 2014). Moreover, creation of new smart cities, and up-gradation of the existing ones will bridge the rural-urban divide and consequently reduce social inequity, a highly desirable psychological benefit of planned urbanization (Thirumaran and Santhiya Rani, 2015).

With the fabrication of the thought of smart cities, this paper is an endeavor to set out and define its four C's. The discourse presented in the paper is based on the content analysis of various reports, articles and websites which are explored for attaining the purpose. Aligning with this, next section defines the concept of smart cities.

2) CONCEPT OF SMART CITY

The mission of 'making 100 smart cities' within the duration of five years from 2015-16 to 2019-20, was launched on 25 June 2015, by Prime Minister Shri Narendra Modi. Allied with this, as declared by Ministry of Defense, Government of India; six cantonment areas will also be converted into 'smart cantonments' on the line of Central Government's 'Smart City' project. These six cantonments include: Ambala, Ferozpur, Deolali, Pune, Merut and Secunderabad cantonments (Goswami, 2015). This mission is started with the objective of stimulating cities that provide core infrastructure, appreciable quality of life, and sustainable environment along with inclusive development (Jain, 2015). However, for smart city mission, Government of India has committed financial support of rupees five billion per city over five years. An equal matching amount is to be contributed jointly by the State and Urban local Governments.

According to Ministry of Urban Development, Government of India (2015), these 100 Cities have been distributed among the States and UTs on the basis of equitable criteria. The formula gives equal weightage (50:50) to urban population of the State/UT and the number of statutory towns in the State/UT. Based on this formula, each State/UT will, therefore, have a certain number of potential Smart Cities, with each State/ UT having at least one.

Now, the first and foremost question arises about the meaning and connotations of smart city. Ministry of Urban Development, Government of India (2015) affirmed that there is no universally accepted definition; and a smart city means different things to different people. The conceptualization of Smart City, therefore, varies from city to city and country to country. Also, the concept is subjected to the level of development, willingness to change, resources and aspirations of the city residents. Likewise, a smart city has a different orientation in India. Even within the country, there is no one way of defining a smart city. However, the development under smart cities is represented by the four pillars of comprehensive development that are: institutional, physical, social and economic infrastructure.

In spite of the vagueness in its concept, different academics have tried to define its meaning. As per Bhagat (2015), smart city may be a digital up gradation to our inbuilt urban infrastructure. However, given by US office of Scientific and Technical Information, a smart city is a city that monitors and integrates conditions of its critical infrastructures, better

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optimize its resources, plan its maintenance activities and monitor security aspects while maximizing services (Bhasin, 2015). Also, defined by Department of Business Innovation and Skills, UK, the concept of smart city is a process or series of steps by which cities become more livable, resilient and able to respond quicker to new challenges (Bhasin, 2015). In radiance with these notions about smart city, it is apparent that smart city is to promote cities that provide core infrastructure, give a decent quality of life to its citizens, and provide a clean and sustainable environment and application of 'Smart' Solutions. Therefore, the focus is on sustainable and inclusive development and the idea is to look at compact areas, create a replica which will act as a benchmark to other aspiring cities. Indeed, consistent with Raghupathi (2015), and Ministry of Urban Development, Government of India (2015) a smart city may be a city with the following elements:

- Smart Housing
- Adequate Water Supply
- Assured Electricity Supply
- Sanitation and Solid Waste Management
- Smart Mobility and Urban Transportation
- Efficient Internet Connectivity and Digitalization
- E-Governance and Citizen Participation
- Safety and Security of Citizens
- Health and Education
- Sustainable Environment
- Inclusive Development

Accordingly, taken from Ministry of Urban Development, Government of India (2015), some features of comprehensive development in Smart Cities are presented here.

- *Promoting Mixed Land Use in Area-Based Developments* – It implies planning for 'unplanned areas' containing a range of compatible activities, and land uses close to one another in order to make land use more efficient. The States will enable some flexibility in land use and building bye-laws to adapt to change.
- *Housing and Inclusiveness* – It stands for expanding housing opportunities for all.
- *Creating Walkable Localities* – This is to reduce congestion, air pollution, resource depletion and boost local economy, promote interactions and ensure security. The road network is created or refurbished not only for vehicles and public transport, but also for pedestrians and cyclists, and necessary administrative services are offered within walking or cycling distance.
- *Preserving and Developing Open Spaces* – Here, the emphasis is on the development of parks, playgrounds, and recreational spaces in order to enhance the quality of life of citizens, reduce the urban heat effects in areas and generally promote eco-balance.
- *Promoting a V ariety of T ransport Options* – It indicates Transit Oriented Development (TOD), public transport and last mile para-transport connectivity.
- *Making Governance Citizen-Friendly and Cost Effective* – This feature entails increasing rely on online services to bring about accountability and transparency, especially using mobiles to reduce cost of services and providing services without having to go to municipal offices; form e-groups to listen to people and obtain feedback and use online monitoring of programs and activities with the aid of cyber tour of worksites.
- *Giving an identity to the city* – This is based on the main economic activities, such as local cuisine, health, education, arts and craft, culture, sports goods, furniture, hosiery, textile, dairy, etc.
- *Applying Smart Solutions to infrastructur e and services* – This point towards area-based development in order to make them better. For ex-

ample, making areas less vulnerable to disasters, using fewer resources, and providing cheaper services.

Now, regarding smart cities, based on its concept different components and approaches have been evolved which are discussed in next section.

3) Components of Smart City

As the concept of smart city is gaining momentum, academics and researchers have started defining the components of smart city in their own gracious way. Here taken from the available literature in this field, three approaches to the components of smart city are defined. The first approach defines its four components, second six components and third approach elaborates upon eight components from a diamond like figure as defined later in this section.

Four Components Approach: Researchers including Jain (2015), Raghupathi (2015) and Rumi Aijaz (2016) demarcated four components of smart city. By reading these components, it can be understood that these are actually the short form of the above mentioned concept of smart city. These four components are as follows:

- *Retrofitting* – This component deals with the city improvements and transformation of existing built up area into smart that is more efficient and livable. For this purpose, an area of more than 500 acres will be identified by the city in consultation with citizens.
- *Redevelopment* – This component deals with the city renewal. It involves replacement of decrepit built up environment and creation of new layouts with enriched infrastructure. In this regard, urban local bodies (ULBs), by consultation with citizens, will identify an area of more than 50 acres.
- *Green Field Development* – This component is concerned with city extension. It will take account the needs of the poor and expanding population. Under it, vacant areas of more than 250 acres will be brought under smart solutions.
- *Pan City Development* – This component envisages the application of smart solutions to the existing infrastructure by the use of technology, information and data to make the services better.

However, these four components makes it clear that smart city approach is area-based instead of a whole-city approach as per which smart solutions for various urban infrastructure and services will be designed and applied in an integrated manner by using appropriate technology.

Six Components Approach: Cohen (2012) explained six components of smart city which are shown in figure 1 (on next page)

- Smart Living – It implies better access to city facilities and services like housing, utilities, and thus ensures improvement in quality of life.
- Smart People – Citizens possessing better educational levels and skill building, good health, lifelong learning and higher participation at community level.
- Smart Mobility – It indicates optimum movement of people, goods and information and sustainable, innovative and safe transport systems.
- Smart Environment – This term implies sustainable development, sustainable resource management, optimal use of water resources and energy, environmental protection, balance between built and green areas.
- Smart Economy – It requires entrepreneurship, innovative spirit, local and global inter-

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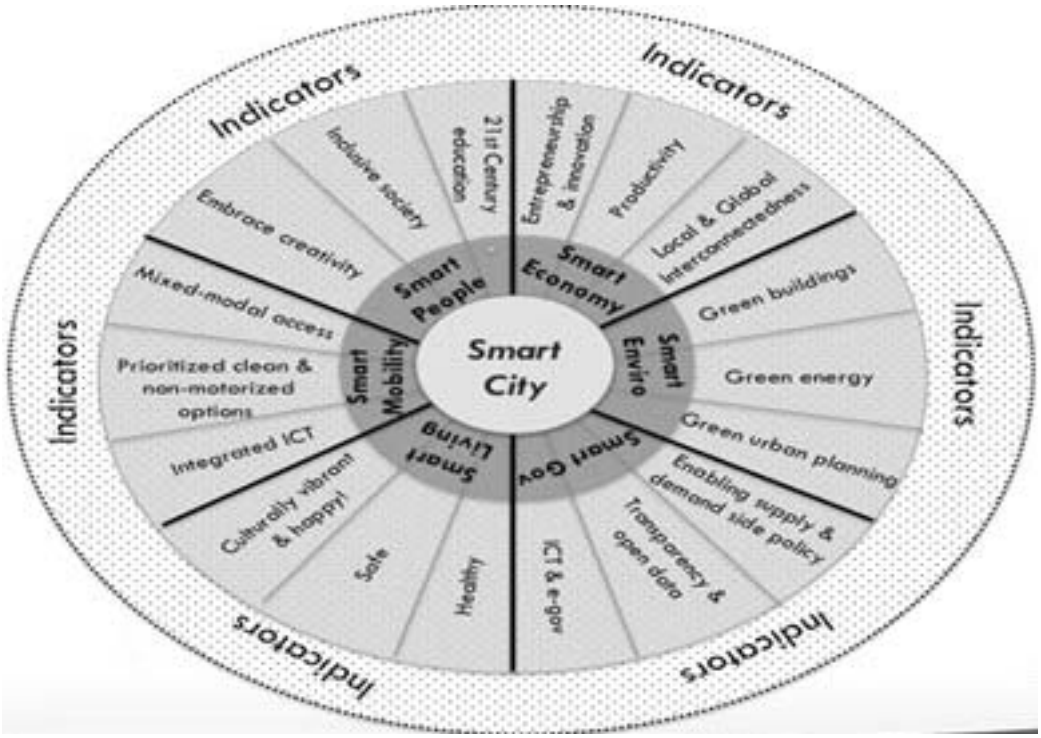

Figure 1 : Six Components of Smart City

Source: Cohen (2012)

connectedness, productivity, competitiveness, ability to transform or respond to change.

- Smart Governance – It means stakeholder involvement in policy making and implementation, leveraging technology to facilitate the process, better transparency, accountability, responsiveness, and use of e-governance and ICT. However, in order to provide smart governance to its citizens, firstly, government has to be SMART: that is simple, moral, action oriented, responsive and transparent (Goel, 2011).

Smart Diamond Approach: Khaund (2013) provides a smart diamond approach while defining the components of smart city. As it is a diamond approach, smart city is defined having eight components. Components in the diamond approach are depicted in figure 2.

The parameters of eight components of smart city can be further shown on the basis of the study by Khaund (2013) as follows:

- Smart Energy: Digital management of Energy
  - Smart Grids
  - Smart Meters
  - Intelligent Energy Storage
- Smart Buildings: Automated Intelligent Buildings
  - Renewable Energy Integration
  - Building Integrated Photovoltaic
- Smart Mobility: Intelligent Mobility
  - Advanced Traffic Management system
  - Parking Management
  - ITS-Enabled Transportation Pricing System
- Smart Technology: Seamless Connectivity
  - 4G Connectivity

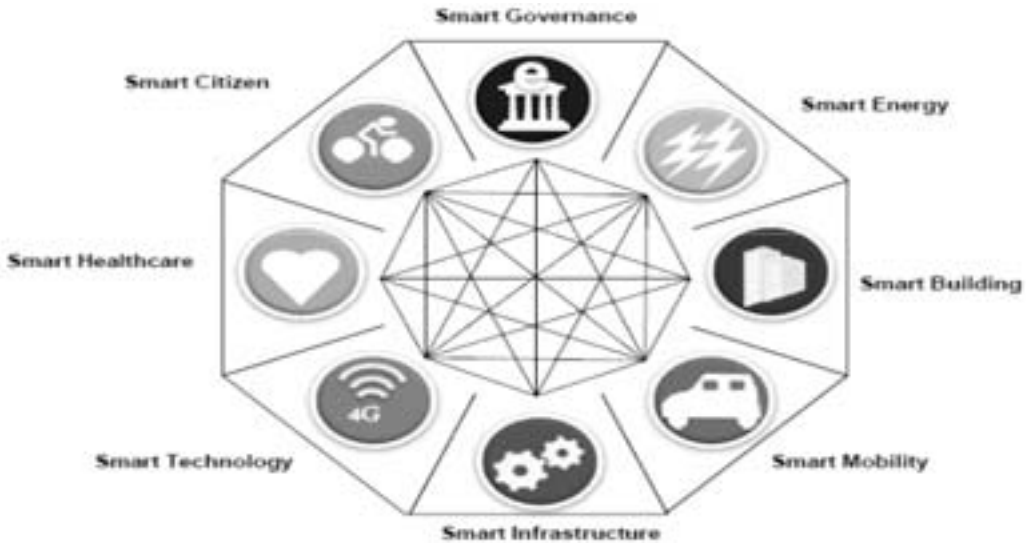

Figure 2 Smart Diamond to Define Smart City

Source: Khaund (2013)

- Super Broadband
- Free Wi-Fi
- 1Gbps download speeds

❖ Smart Infrastructure: Digital Management of Infrastructure
- Sensor Networks
- Digital Water and Waste Management

❖ Smart Governance: Government-on-the-go
- e-Government
- e-education
- Disaster Management Solutions

❖ Smart Healthcare: Intelligent Healthcare Technology
- Use of e-health and m-health systems
- Intelligent and connected medical devices

❖ Smart Citizen: Civic Digital Natives
- Use of green mobility options
- Smart lifestyle choices

In this way, it is clear that components of smart city are derived from the concept of smart city. As there is no consensus for the meaning and concept of smart city; components may vary from the viewpoint of stakeholders. So, to make the cities smart there are many components upon whom the work should be done. But, the path is not so easy, many challenges may has to be faced as are defined in next section.

4) Challenges in the Pathway

Various challenges can arise in the path of progress which need due attention. Some of the points are arranged in the text below.

- *Development Inequities* – Under smart city mission, only one part of the city will undergo a transformation, while remaining parts of the city will be developed in the usual manner. This approach will lead to development inequalities.
- *Environmental Concern Neglect* – Smart city mission deals with development on vacant land around cities while various social, economic, development and environment problems will be neglected which is a serious cause of concern.
- *Absence of Master Plan* – Formation of master

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plans or a city development plan is pre-requisites for smart city planning and implementation. But most of Indian cities lacks such plans.

- *Co-operation and Team Spirit* – Coordination and cooperation is required among various levels of Governments regarding financing and sharing of best practices and service delivery processes and also institutions providing various municipal amenities.
- *Self-Reliance for Finance* – Financially self-reliant urban local bodies (Municipal Corporation, Municipality etc.) is necessary for the success of smart city mission. Timely availability and flow of adequate funds for smart city projects is also a major challenge.
- *Care of Vulnerables* – Smart city plan does not provide sufficient information on how the living standard of slum dwellers, informal sector workers (working as street vendors and hawkers) and vulnerable sections of the society would be improved.
- *Ignorance of Traditional Mechanisms* – The formation of special purpose vehicle (SPV) to deal with urban development will leave a little scope for traditional development and governance mechanisms (like municipalities); but, these traditional mechanisms are very urgent to fulfil the resource needs of SPVs and to look after those areas of the city which will not covered under the smart city mission.
- *Timely Completion* – Failure of urban local bodies (ULBs) in raising recruitments, will hampers the timely and cost-effective implementation and subsequent operations and maintenance. It will be necessary to complete all projects timely for which all clearances should use online processes and be cleared in a time-bound manner. Lack of quality manpower will cause delays in most ambitious projects and capacity building programs.
- *Selection Difficulties* – Another challenging task is to handle complex combinations of smart city solutions developed by multiple technology vendors which supply various components of software infrastructure in cities. Universal access to utility services including electricity, water, telephone or broadband services with the existing supply and distribution system is not so easy.
- *Cascade Effect* – Selection of cities for more than one flagship programmes will create issue of convergence resulting into cascade effect. For example, Varanasi is included under both Smart City Mission and the Heritage City Development and Augmentation Yojana (Vaidyanathan and Bhattacharya, 2016).

Any initiative firstly face criticism and hindrances. But, there is an old saying 'where there is a will, there is a way'. These ways in the form of strategic solutions to overcome the challenges presented in next section.

5) Clarifications to Work for Smart Cities

Here, some of the strategies are discussed upon to make the vision of smart cities a reality. Figure 3 as taken from Ministry of Urban Development, Government of India (2015) clarify for the smart solutions to have a smart city. However, the points arranged here which are integrated from Bhasin (2015), Chandrasekhar (2015), Jain (2015) and Raghupathi (2015) place additional weight and clearly highlight some of the clarifications and recommendations for the purpose.

- *Technology* – There should be digital technologies for innovative and efficient solutions to transportation, water-electricity supply, sewerage, solid waste management, pollution, health and education.
- *Financing* – The initiative of smart cities will need funding; and government, financial institutions, private sector, international agencies all should synergize for the cause.

Figure 3 : Smar t City Solutions

Source: Ministry of Urban Development, Government of India (2015)

- *Tele Surveillance and Integrity* – There should be open access to all information which will empower service providers and users so that they can help in improving the quality of life.
- *Energy* and *Environment* – Green, clean and renewable energy solutions should be maintained and optimization of the use of energy should become the norm of smart cities. Clean and green environment, bio-diversity, parks, rain water harvesting should become the hall mark of the smart cities.
- *Climate Change Resistance* – This is a strategy that at the time of planning of smart cities, resilience to the climate change should be built in.
- *Disaster Fr ee* – The disasters could be floods, earthquakes, fires, landslides etc., accordingly, smart cities need to be prepared for disaster risk management.
- *Reforms* – For sustaining the changes and maintaining the infrastructure, implementation of reforms may be a strategic way.
- *Governance and Operations* – The concepts of e-governance and its operations must be fully accelerated.
- *Intelligent Community Framework* – A community framework of smart education and health must be maintained.
- *Smart People* – The maintenance and preservation of smart cities is in the hands of local residents. Thus, people must be motivated and make aware for their social responsibilities.
- *Collaborative Response Efforts* – The infrastructure developed for smart cities should allow organizations and people to take action in one system.

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6) Conclusion and Policy Implications

Overall, it can be concluded that concept, components and strategic solutions of smart city are interlinked. The concept is in its infancy stage. So, there are different ways people are defining smart city; and accordingly various components of smart city have been described in various approaches. Further, strategic solutions imply how the components of smart city can be achieved; and how the vision of smart city can be strategically launched. Actually, in India this vision is a dream and for its conversion into reality, it must become a shared approach with shared goals; and everyone must have shared and understood responsibility for the cause. But sharing does not imply that one cannot be held responsible for others' share. Rather, there must be team work and co-ordination to give synergy effect to the outcomes. In this regard, Government departments as well as Indian citizens have to understand their responsibilities. Moreover, there will be requirement of refining strategies of smart city mission according to economic and political environments.

The smart city mission must not ignore the problems including living standard of poor and vulnerable persons; unemployment; drinking water, drainage and sanitation deficiencies; environmental degradation, vehicular emissions and traffic congestion; encroachments and unauthorized constructions etc. There is a strong case for the strengthening of urban local bodies (ULBs) and civic agencies on the ground of manpower, financial and technical capabilities so that they can play their role in project implementation and enforcement of laws. And, there must be proper system for reporting complaints, and their solutions. Besides, State and local governments should have sufficient resources for the implementation of new development projects. However, the inclusion of NGOs and private sector in the urban reform process will be helpful for the success of smart city mission. Last but not least, Government must adopt good governance at all levels of decision making to plug financial leakages and to keep check on corruption so that smart city initiative can become successful.

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