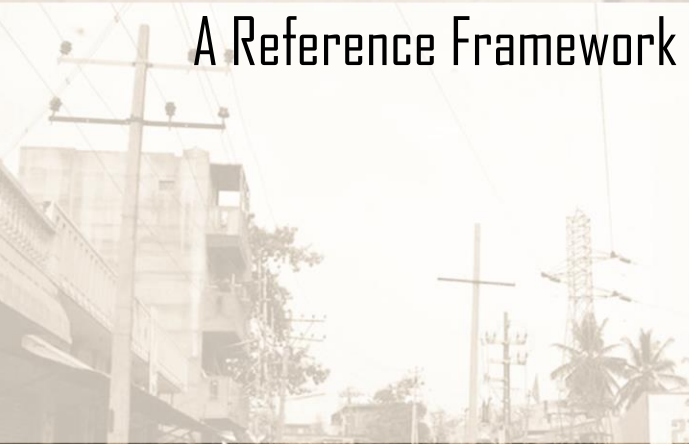




Reconceptualising Smart Cities:

A Reference Framework for India



Reconceptualising Smart Cities: A Reference Framework for India

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**Center for Study of Science, Technology and Policy
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Message from NITI Aayog

I am very pleased to release the report “Reconceptualising Smart Cities: A Reference Framework for India”, an outcome of research carried out by the Center for Study of Science, Technology and Policy (CSTEP), a policy Think Tank based in Bengaluru. I appreciate the initiative taken by CSTEP in preparing such a comprehensive assessment of reconceptualising various notions associated with smart cities in India and globally, and proposing a framework for taking India’s urban development agenda forward.

The simultaneous launch of the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Housing for All and the Smart Cities Mission (SCM) on June 25, 2015, was a big step in the evolving story of urban India and its development Agenda. The message of convergence emerged from the common launch of all three programmes. The SCM Guidelines highlight the need for a holistic approach to urban development, requiring an integration of physical, institutional, social and economic infrastructure with people at its centre. Such framework which focuses on a more process-oriented path than a simple project-oriented path, should be the overarching and all – encompassing umbrella guiding all urban development and related schemes to achieve sustainable urban development in India.

I am happy to note that CSTEP has developed a reference framework based on key imperatives that emerge from the Guidelines along with various other perspectives on smart cities. I am sure that this work would enrich the approach of the policy makers and implementing agencies at all levels of Governments i.e; local, State and Central in fine tuning urban strategy in India.

I congratulate CSTEP in this research effort and for their strategic work in this realm, and in particular Dr. V.S. Arunachalam and Dr. Anshu Bharadwaj for their leadership in this project.


(Sindhushree Khullar)
CEO, NITI Aayog



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Foreword

Towns and cities, unlike rivers and mountains, are human creations. They reflect our aspirations and respond to the challenges of that era. Cities are the response to social, political or technological transformations. New Delhi was built for ease of ruling a large land, while Jamshedpur was created as a company town for the steel makers, presenting all modern conveniences of a city in a state that was largely rural. Unfolding technologies can create new opportunities that old towns could not even imagine. The new towns of midland England were the consequences of the Industrial Revolution, which created extensive opportunities for work and play. More recently, the Silicon Valley was created, transforming the rich agricultural Californian land for unleashing the multitude of opportunities that silicon chips create. India too has its own Electronics City in Bangalore where Information Technology rules.

Just two centuries back, the world was rural and cities were exceptions. Economic growth came from the land and was almost static. This changed with advent of technological innovations and political transformations. The ratio between rural and urban population got reversed. Villages in many countries were abandoned, and died. In a few countries such changes were forced on people by the rulers, leading to violent uprisings. In many, market forces alone enticed people to move to cities with the new opportunities that towns provided. In India too, the population ratio between the rural and urban is changing fast. We are becoming a nation of 'cities and towns'. Agriculture has become more efficient as also its machinery, and needs far fewer people. Unemployment and even underemployment have become a worrisome phenomenon in Indian villages. In the words of a villager, 'the village has become a dump with no good schools or hospitals or even cinemas. The attraction of cities with its thousand lights has become irresistible.'

Can our cities absorb this exodus? Except a handful of cities and company towns, India has not built any new cities and the whole exodus has been accommodated in the existing structures. This has led to the creation of slums in India and pinminkus in China. The cities in these countries are not capable of absorbing such an exodus and the urban infrastructure is tearing at its seams. Even basic needs such as accommodation, energy, water, and sanitation are in short supply. Urban transportation is grossly overstretched and people, in the midst of traffic jams, measure distances to travel in terms of the time taken. China has attempted to solve these problems by controlling the immigration into cities and building a number of new cities. Even with such initiatives - some of which are quite drastic, the atmosphere in Beijing remains polluted and Delhi has received the dubious reputation for having the most polluted air.

Are these deprivations remediable and can we clean up our cities or build new ones? If we go in for building new cities, can we integrate such initiatives with the answers that new technologies provide? Potential solutions lie in considering the adoption of sustainable energy systems, recycling and efficient and clean public hygiene systems. And CSTEP is well aware of such options.

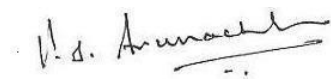
For the past few years, Sujaya and her colleagues at CSTEP have been working on identifying and solving the challenges in building liveable, modern and efficient towns for saving cities from overcrowding and collapse of basic communal and social infrastructure. The lessons they have learned from these studies have come to a good stead in our understanding of the government's initiative of Smart City programmes.

What is a "smart city"? We presume it meets the sustainability criteria laid out by the United Nations (UN) that provide for an efficient and clean environment with equal opportunities for all.

This CSTEP study describes the UN's four guidance principles and defines a Smart City Reference Framework that should provide the overarching principles and guidance to smart city programmes. Details such as energy needs, public sanitation or public transportation all emerge as outputs from the four guidance principles defined in this report.

New cities make new technologies come alive, often replacing inefficient alternatives. Electricity illuminated 19th century England and became commonplace. Introduction of water-based sanitation systems eliminated diseases from spreading. Efficient transportation of goods provided relief to islands of deprivation. Now, the Internet is spreading a communications revolution that promises to change the way we work and play. Optical fibre has become as ubiquitous as electricity became in the last century and promises to minimise travel. A smart city must take all these innovations into account.

We at CSTEP welcome the opportunities that the Smart City programmes offer and plan to pursue projects that will help in the implementation of these programmes. This report is a step towards that goal.

A handwritten signature in black ink, reading "V.S. Arunachalam". The signature is written in a cursive style with a horizontal line underneath the name.

V.S Arunachalam

Chairman and Founder, CSTEP

Executive Summary

The Government of India (GoI) initiated the '100 Smart Cities Mission' in 2014. This has triggered deliberations across the country on the concept of smart cities, the need and the orientation of the Mission in the context of India's present urbanisation scenario. The concept of a 'Smart City' is a relatively new phenomenon in India. This report is a step towards synthesising various aspects related to smart cities that has led to the formation of a proposed Reference Framework by CSTEP, for the Smart Cities Mission in India. The report is expected to guide policy makers and urban practitioners in making critical decisions, in an accountable manner and spirit, which will truly make Indian cities smart.

The report begins by carving out the following scope, for India:

- What is the level of clarity on critical aspects of smart city development internationally and the lessons it holds for India?
- Where does the Smart Cities Mission fit in India's larger urban development trajectory?
- What is needed to orient the Smart Cities Mission such that it addresses India's pressing urban sector challenges and enables different stakeholders to implement the Mission with consistent objectives, to attain a common goal?

Globally, the notion of smart cities is not new. There are multiple ideas, definitions and approaches to smart cities. An analysis of international approaches and the underlying semantics related to smart cities reveals that the concept has only evolved partially. This includes non-clarity in definition, indicators and measures, and standardisation of critical aspects. There is no 'one size fits all' model for smart cities that can be replicated in India. The current scenario indicates a critical need for defining and contextualising the various aspects of smart city development.

This report argues that the larger notions of sustainability and good governance encompass the overarching goals of smart cities across the globe. Technology, especially Information and Communication Technology (ICT) is an important enabler in attaining sustainability and good governance. However, technology needs to be supported by an enabling policy environment. This would need a carefully designed framework, which would provide guidance for the realisation of India's urban agenda. As an important step in India's urban sector programme trajectory, the Smart Cities Mission needs to be equipped to provide solutions to India's urban challenges. The report places the Smart Cities Mission as an opportunity to:

- Create an efficient urban management system
- Enhance the capacity of urban institutions
- Push a decentralisation agenda
- Reduce conflicts in the urban environment
- Create enabling conditions for inclusive and equitable urbanisation.

The interventions for achieving the opportunities mentioned above need to be systemic; they cannot be 'stand-alone' in nature. *The point of departure (from existing urban development programmes) that would make a difference in an increasingly resource constrained world is how judiciously one plans a city. This has to be supported by the enhanced power of technology, an aware and engaged citizenry and a competent and capacitated set of people working within an*

accountable framework. This process would determine the 'smartness' of a city and herein emerges the need for a Smart City Reference Framework.

The Smart City Reference Framework, which is the culmination of this report, offers directions to both practitioners and theorists. The Framework is driven by the following four guiding principles:

- a) Well-being
- b) Equity
- c) Efficiency
- d) Foresight.

These guiding principles have been derived from the United Nations' (UN's) draft Sustainable Development Goals (SDGs). The Reference Framework includes major action stages in the Smart Cities Mission and identifies a set of reference guides to support the agencies responsible for carrying out the action stages. The processes of city selection and indicator designing for base lining have been explained within the Framework. The Framework aims to crystallise future pathways for smart cities development in India, by laying emphasis on the process of city development that leads to sustainable outcomes.

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Abbreviations

3Es	Economy, Environment and Equity
AD	Anno Domini
ADB	Asian Development Bank
AUWSP	Accelerated Urban Water Supply Programme
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
ANSI	American National Standards Institute
BC	Before Christ
BJP	Bhartiya Janta Party
BPL	Below Poverty Line
BSI	British Standards Institute
CAA	Constitutional Amendment Act
CDP	City Development Plan
CISCO	Computer Information System Company
CMP	City Mobility Plan
CSP	City Sanitation Plan
CSTEP	Center for Study of Science Technology and Policy
DCR	Development Control Regulations
DMIC	Delhi Mumbai Industrial Corridor
DTCP	Department of Town and Country Planning, Government of Karnataka
EU	European Union
EWS	Economically Weaker Section
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GIFT	Gujarat International Finance Tec-City
GIS	Geographic Information System
GHG	Green House Gases
GoAP	Government of Andhra Pradesh
GoI	Government of India
GoK	Government of Karnataka
HPEC	High Powered Expert Committee
HRIDAY	Heritage City Development and Augmentation Yojana
HUDCO	Housing and Urban Development Corporation Ltd
IBM	International Business Machines
ICT	Information and Communication Technology
IDRC	International Development Research Center
IDSMT	Integrated Development of Small and Medium Towns
IEC	International Electrochemical Commission
IEEE	Institute of Electrical and Electronics Engineer
IHSDP	Integrated Housing & Slum Development Programme
IIED	International Institute for Environment and Development
IMechE	Institution of Mechanical Engineering
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standards

ITU	International Telecommunication Union
IUDP	Integrated Urban Development Programme
IUT	Institute of Urban Transport
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JTC	Joint Technical Committee
KMRP	Karnataka Municipal Reform Programme
LIG	Low Income Group
MDG	Millennium Development Goals
MIT	Massachusetts Institute of Technology
MNRE	Ministry of New and Renewable Energy
MoU	Memorandum of Understanding
MoUD	Ministry of Urban Development, Government of India
MoHUPA	Ministry of Housing and Urban Poverty Alleviation
MPC	Metropolitan Planning Committee
NASSCOM	National Association of Software and Service Companies
NER	North-East Region
NIC	Network Information Center
NIUA	National Institute of Urban Affairs
NCRPB	National Capital Region Planning Board
NHB	National Housing Bank
NRY	Nehru Rozgar Yojna
NSHM	National Sustainable Habitat Mission
NSHSCM	National Sustainable Habitat and Smart City Mission
NUIS	National Urban Information System
NURM	National Urban Rejuvenation Mission
OG	Out Growth
PM	Prime Minister
PPP	Public Private Partnership
QoL	Quality of Life
RAY	Rajiv Awaz Yojana
RRY	Rajiv Rozgar Tojana
RTI	Right to Information
SBM	Swachh Bharat Mission
SCAS	Smart City Action Stage
SCRF	Smart City Reference Framework
SCRG	Smart City Reference Guide
SD	Sustainable Development
SDG	Sustainable Development Goals
SEBI	Securities and Exchange Board of India
SEG	Self-Evaluation Groups
SJSRY	Swarna Jayanti Sahari Rozgar Yojna
SLB	Service Level Benchmarking
SMB	Standardization Management Board
SPV	Special Purpose Vehicle
SPUHS	Sardar Patel Urban Housing Scheme
SSC	Smart Sustainable Cities

TC	Technical Committee
TCPO	Town and Country Planning Organisation
TECOM	Technology, Electronic Commerce and Media
TMB	Technical management Board
ToR	Terms of Reference
UA	Urban Agglomeration
UBSP	Urban Basic Services for Poor
UD	Urban Development
UDD	Urban Development Department
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
ULB	Urban Local Body
ULCRA	Urban Land Control and Regulation Act
UN	United Nations
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
URDPFI	Urban and Regional Development Plans Formulation and Implementation
URIF	Urban Reform Incentive Fund
VAMBAY	Valmiki Ambedkar Awas Yojna
VGF	Viability Gap Funding
WC	Ward Committees
WG	Working Group

1. India's 100 Smart Cities Mission¹

The intention of building smart cities was declared in the pre-election manifesto² of the now ruling government led by Prime Minister Narendra Modi³. A review of the Smart Cities Mission suggests that the initial idea was to build 100 new cities with state-of-the-art technology. Since then, deliberations on the Mission as well as the larger concept of smart cities have expanded to various quarters, including civil society. The core ideas of the Mission have evolved as well. In August 2014, state governments were first asked to select three existing cities in each state for development under the 'National Sustainable Habitat and Smart City Mission'⁴. This clearly indicated a shift in the Mission's focus from Green Field development⁵ to Brown Field development⁶. Thus the orientation changed from building '100 new Smart Cities' to 'making existing cities smart'⁷. This subtly expresses the recognition of the need to create smart cities as sustainable habitats. Figure 1 illustrates a timeline-based representation of key policy discourses on the Smart Cities Mission till date.

The National Conclave on Building Smart Cities organised by GoI in September 2014⁸ had stressed on the following three key aspects for smart cities:

- 1) Competitive (attracts investors and residents),
- 2) Sustainable (social, financial and environmental)
- 3) Capital Rich (human and social).

¹ The name of the initiatives under the 'Smart Cities' umbrella has been referred with different nomenclature in different documents and in various media platforms such as the Smart Cities Scheme, the Smart Cities programme, etc. On June 25 2015, the Ministry of Urban Development has released the official guidelines under the name of 'Smart Cities Mission. For the purpose of this report, all the activities related to smart cities by the Government of India and state governments since April 2014 has been referred to as the 'Smart Cities Mission' and in places, as the 'Mission'.

² "100 new cities; enabled with the latest in technology and infrastructure - adhering to concepts like sustainability, walk to work etc., and focused on specialised domains". Source: Election Manifesto, 2014, Bharatiya Janata Party

³ The attempt to create Smart Cities backed by governments in India however could be seen during previous regimes as well. Some examples are GIFT (Gujarat International Finance Tec-City) city in Ahmadabad, new cities and smart communities along Delhi Mumbai Industrial Corridor (DMIC), Krishnapattam port city among others.

⁴ TCPO Communication to DTCP dated 21 August, 2014, File No. CP-TCPO/TECH/Smart Cities/2014

⁵ Green Field development- Greenfield development is the creation of planned communities or industries or commercial hubs etc on previously undeveloped land. This land may be rural, agricultural or unused areas on the outskirts of urban areas. Greenfield development is perceived as convenient as there is no limitation of previous or surrounding areas while developing a Greenfield site. This kind of development requires good amount of financing since there is no previous infrastructure provision, as well as procurement of suitable land is required. Research suggests green field development puts pressure in the rural urban fringe and there is a tendency of encouraging urban sprawl.

⁶ The lands that have been built-on previously, but are now vacant or in need of redevelopment are known as Brownfield sites. These areas can have historic use as an industry or commercial site, and are mostly located in urban areas. Researchers argue that Brownfield development can help in creating high efficient walk able communities leading to more sustainable urban development. These sites are located in areas where there is existing infrastructure such as public transport, waters sewer, electricity etc. Once remediated, these sites find reuse for any type of development, from parks and housing to new commercial and industrial development.

⁷ Refer to Record of discussion held with Commercial/Business/Non-Profit Organizations and Professionals on "Smart City Scheme" on 22nd September, 2014

⁸ Draft Concept Note on Smart Cities Scheme, revised as on 03.12.2014, available at <http://indiansmartcities.in/downloads/CONCEPT NOTE -3.12.2014 REVISED AND LATEST .pdf>

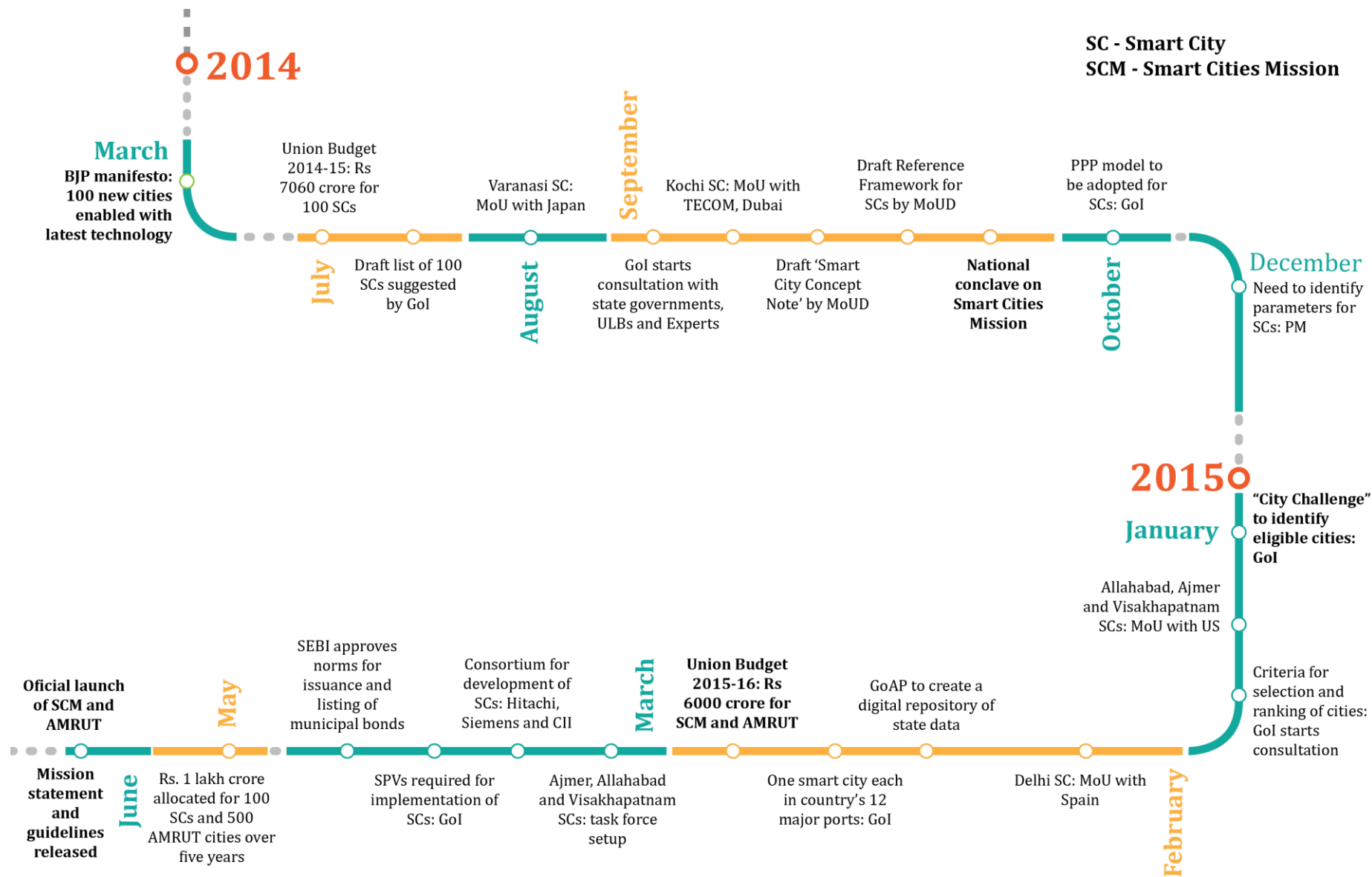


Figure 1: Timeline of Developments related to the Smart Cities Mission in India

Source: CSTEP Analysis

The Government of India (GoI) also expressed the view that it is 'keen to promote Wealthier, Healthier and Happier cities for better urban life' and that 'Technology will play a major role in Smart City governance'. The use of technology, specifically ICT as a key aspect of smart cities, was also recognised at the Conclave.

GoI had allocated INR 7060 crore for the Smart Cities Mission in its interim budget of 2014-15. The budget of 2015-16 has a provision of INR 6000 crore for the Mission and the development of 500 habitations under the National Urban Rejuvenation Mission (NURM)⁹. A government panel has approved the allocation of INR 2.73 lakh crore over the next 10 years for the development of 100 smart cities and 500 cities under NURM¹⁰.

The 'Mission Statement and Guidelines' for the Smart Cities Mission released by the Ministry of Urban Development (MoUD) on June 25, 2015 attempt to provide clarity on some of the smart city related aspects and on the Mission itself. Strategic components identified in the Mission include:

- a) Retrofitting
- b) Redevelopment
- c) Green Field development
- d) Pan-city development.

The guidelines further elaborate on the selection process for cities to be covered under the Mission through the 'City Challenge' programme. According to this programme, the initially shortlisted cities in the different state will need to prepare Smart City Proposals (SCPs). The final selection will be based on an evaluation of SCPs by an Expert Committee.

Other important points elaborated in the guidelines include:

- Implementation of the Mission by Special Purpose Vehicle (SPV)
- Financing of selected cities and process of releasing funds
- Monitoring process to be adopted for the Mission
- Convergence with other government schemes.

The last point is critical in achieving development goals for a city and has been an issue highlighted in previous urban development programmes as well.

However, the various aspects of the Mission and the very concept of smart cities lack clarity. Highlights from the international and domestic debates on smart cities are presented in the next section to understand the challenges and opportunities associated with building smart cities better, in the Indian context..

⁹ Expenditure Budget Vol.I 2015-16 available at <http://indiabudget.nic.in/ub2015-16/eb/stat04.pdf>

¹⁰ Source: <http://www.hindustantimes.com/india-news/top-govt-panel-approves-rs-2-73-lakh-crore-to-modernise-cities/article1-1331666.aspx>

1.1. Major Issues and Challenges

The following are the major issues raised in various platforms on the smart cities concept in general and specifically the Smart Cities Mission, in India.

i. The Right Model for Smart Cities in India's Socio-Political Context

Smart cities are largely being projected as an epitome of India's educated citizens' aspirations. It is feared that it will lead to non-inclusive developments; smart cities will meet the requirements of only the educated middle class and their aspirations, and there will be profitable real-estate ventures in the form of restricted enclaves. Opportunities for marginalised groups will not be created in such an urban environment as it may not yield economic returns. There has been no consensus on defining the indicators for an Indian Smart City till date. This may result in fragmented concepts of smart cities being implemented, leading to further exclusion.

ii. Social Acceptability, Liveability and Sustainability Concerns¹¹

The Smart City Mission lacks clarity in its conceptualisation. The focus seems to be on technology implementation, without an overall framework to understand the need and impact of the same. There is a lack of clarity in understanding the end (Smart City) and the means to reach the end (ICT). The image of smart cities is projected as heavily instrumented and automated. Also, there are concerns over the privacy and security of sensitive personal data being accessible by unintended users. This raises issues related to liveability in a smart city and its acceptability in India's social context. The resource requirements, including energy and its associated environmental impact in an instrumented city raise concerns on the environmental sustainability of these cities.

iii. Convergence with Other Urban Sector Programmes

There is ambiguity on whether the initiatives under the Smart Cities Mission will be one-time investments with asset creation as a goal or whether it will be an approach to introduce certain critical structural reforms in the way Indian cities are planned and managed. Recent developments suggest that there are some convergences between the Mission and the New Urban Rejuvenation Mission. Similarly, programmes such as the Swachh Bharat Mission should be aligned with and complement the Smart Cities Mission. However, a clear roadmap is required. Adequate incorporation of the spatial aspect of a city is of critical importance¹². In addition to these concerns, how the smart cities programme will anchor and drive growth in the larger hinterland, is not clear.

iv. Roadmap, Process and Scale of the Smart Cities Mission

If the Smart Cities Mission is an attempt to upgrade existing cities and prepare them for the future, then there is a need for a universal approach/framework to be developed under the

¹¹ The notion of Sustainable Development was defined by the World Commission on Environment and Development in 1987 as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs." The UN further elaborated this as following: "It is generally accepted that sustainable development calls for a convergence between the three pillars of economic development, social equity, and environmental protection". These pillars are popularly known as 3Es (i.e., Economy, Equity and Environment) of sustainable development. Aspects of liveability in a city are discussed in Annexure 1 based on different city typologies.

¹² The City Development Plans (CDPs) of JNNURM has been criticised for not being in convergence with the Master Plans/ Regional Plans (Kundu.D., 2014).

Mission. The design and development of a sustainable, economically viable framework will help in achieving a city's growth objectives in a participatory and inclusive way. Currently, the notes released by GoI do not provide information on any such framework. Also, the on-ground projects named Smart Cities, across the world, show that India needs to appropriate internationally practiced approaches to suit the scale, size and context of its cities. The selection of cities as pilots under the Smart Cities Mission has been widely understood as a political decision. There is a need for a more objective process to be followed in selecting cities to better ensure their success and enhance the possibility of replication in other cities.

v. Funding Strategy for Smart Cities

It is anticipated that developing smart cities will entail substantial investments, which will be locked-in for a long term, and in turn shape India's urban future. According to the High Powered Empowered Committee on Urban Infrastructure (HPEC), INR 7 lakh crore is required for the next 20 years to bridge the existing gaps in India's urban infrastructure. This amounts to INR 35000 crore per year¹³. The need for private sector investment in urban development, including smart cities, is thus important. Without an urban development policy and an urban planning framework, private sector dominance at this juncture of urbanisation is indeed a challenging situation due to the following reasons:

- Private sector (real estate developers, IT companies, etc.) investment will be ad hoc and will be driven mainly by profit motive
- Foreign capital will only be targeting investments that have higher rate of return, and many public services may not fall in this realm. These investments will ensure return on risk, and will rely on financially sustainable business models. The regulatory, financial and institutional environment is still not geared for this type of investment
- Without a substantial share of funding coming from GoI and states governments, Urban Local Bodies (ULBs) in poor financial health will be deemed as unattractive, even if there is growth potential. This may further lead to favouritism with more funds being given to richer states and richer ULBs (HPEC, 2011).

vi. Programme Design, Operationalisation and Institutional Arrangements

Any new programme or scheme proposed by the Central government should be in cognisance with the fact that the governance of a city is a State Subject (under the Indian Constitution). The problems with previous programmes that the Mission needs to address include:

- Lack of capacity in smaller cities to implement urban development programmes. The existence of a big-city bias is evident from JNNURM evaluation studies (Kundu, 2014)
- GoI's control over programme implementation and sanctioning of funds may lead to delays. Studies have indicated that involvement of higher levels of government increasingly affect the process of empowerment of local bodies (Pancholi, 2014).
- Lack of use of participatory approach in capturing a local community's needs and local solutions (HPEC, 2011). The role of ULBs in programme design and operationalisation are limited.

¹³ The budgetary allocation for urban development in 2015-16 (around INR 16000 crore) is thus inadequate.

- Programmes generally lack critical inclusion aspects. More opportunities for livelihood do not automatically translate into inclusion, especially gender concerns (UN WOMEN, 2012).
- Planning tools used in programmes (such as CDPs under JNNURM¹⁴) fell short of effectively linking city growth plans with its spatial character. Use of template-based and over-simplified retrofitting city growth models resulted in less contextualised plan targets and generalised strategies.
- Fragmented nature of programme implementation led to non-achievement of some of the key agendas such as creation of world class cities (Mahadevia, 2011).
- Selection procedure of cities and towns and geographical and population coverage are critical factors in determining a programme's success. Previous urban development programmes were found to be lacking in this aspect. This is partially responsible for the non-fulfilment of their respective development agendas (National Institute of Urban Affairs, 1990) (Kundu, 2014).
- Sectorial bias led to over-emphasis of certain types of infrastructure creation. For example, 63% of the JNNURM funding was received by water supply, drainage and sewerage sector in Mission cities.

vii. Capacity of Institutions to deliver Technology-centric Reforms

The last decade saw the initiation of e-governance programmes as part of the municipal reform agenda. While there are positive structural changes that have taken place through the implementation of these programmes, some of the major challenges they faced are mentioned below:

- Creating and retaining a capable human resource pool, especially at the small and medium town levels
- Creating capacity and motivating staff across ULBs to use technology-enabled tools
- Continuing the use of manual systems of capturing data and complaints in parallel with computerised systems, creating dual databases (Mohan, Cutrell, & Parthasarathy, 2013).

viii. Achieving the Good Governance Agenda

Delivering good governance has been emphasised as a key agenda of GoI. The fact that technology can be an enabler in fostering good governance characteristics¹⁵ has been recognised by governments and experts (Torres, Pina, & Royo, 2005). However, technology in itself is not neutral. It works in certain contexts and yield results accordingly (Mohan, 2014).

¹⁴ For example, CDPs under JNNURM was seen as an investment plan for projects in the short term. These are not vision documents, neither have statutory status (Grant Thornton, 2011)

¹⁵ According to the United Nations (UN, 1997), good governance entails the following:

- Participatory – From men and women, freedom of expression
- Consensus oriented – Mediation of all stakeholder views
- Accountable – supported by transparency and rule of law
- Transparent – Availability and accessibility of information
- Responsive – Service within reasonable timeframe
- Effective and efficient – result oriented, judicious management of resources
- Equitable and inclusive – Opportunities to vulnerable
- Follows the rule of law – availability of legal framework,

Thus there are concerns over how a technology driven idea of smart cities can be successful within the current scheme of things.

Overall, one of the critical questions emerging from the concerns mentioned above regarding the Smart City Mission is: *Where is the point of departure from previous urban development programmes?*

This study sets its objectives in providing solutions to the gaps and concerns arising out of the discussions presented in this section.

1.2. Objectives of the Study

This study positions itself against the ambiguities mentioned in the previous sections on the larger concept of smart cities and India's Smart Cities Mission. It attempts to bring (greater) clarity to concept of smart cities and the Smart Cities Mission by delving deeper into the following questions:

1. What is the global level of development in the understanding of smart cities? Does it provide answers to the concerns raised on India's Smart Cities Mission?
2. Where does the Mission fit in India's larger urban development agenda? What should be the larger orientation of this Mission to address the shortcomings of previous programmes?
3. What is needed to support the Mission so it can achieve its objectives? What specific components should come from different quarters?
4. Can there be an objective way forward for selecting cities under this Mission and designing the right indicators for an Indian Smart City?

These questions are addressed in detail in this report in order to identify knowledge gaps, and attempts were made to answer a few of them and set a direction for future research endeavours.

1.3. Study Approach

The study approach was largely based on a literature review of secondary data drawn from existing smart city related frameworks and case studies. This study assesses the international and domestic deliberations on smart cities and positions its objectives against the gaps arising from these deliberations. The theoretical and practical discourses of smart cities from all over the world were critically examined. A global-level critical enquiry was made on smart city definitions, indicators, certifications and standards. Important inferences for the Indian scenario were identified from this analysis. It is assumed that the orientation of the Smart Cities Mission needs to be cognisant of the challenges and opportunities posed by the present urbanisation scenario in India. Thus an assessment of India's urban sector situation was done to identify important imperatives. The international experiences/approaches were then juxtaposed with the Indian scenario to identify areas where the Mission can intervene. This led to the formulation of a Reference Framework for the Smart Cities Mission.

This Smart City Reference Framework has been anchored to a set of guiding principles derived from the Sustainable Development Goals and Targets proposed by the United Nations (UN).

1.4. Structure of the Report

The context laid out in this Chapter (1) is used to discuss the global concept of smart cities, its evolution and variations in Chapter 2. The status of some critical factors, such as standardisation aspects related to smart cities, have also been considered. Critical observations and inferences drawn from this analysis can potentially guide the development of smart cities in India.

In Chapter 3, an assessment of the present context of urbanisation in India and its challenges is elucidated. With reference to the observations from this assessment, the chapter attempts to position the Smart Cities Mission so as to deliver on the challenges identified.

Based on the findings of Chapters 2 and 3, a *Reference Framework* for development of smart cities in India has been developed in Chapter 4. This includes identification of a set of guiding principles, major action steps and a set of reference guides that would be needed to implement a set of *action steps*. Further, a definition of *Smart Cities in India*, process for pilot city selection, and methodology for designing indicators for baselining of cities have been elaborated.

This report concludes with Chapter 5, which enlists a set of way forwards and recommendations for various levels of governments towards materialising the Smart Cities Mission in India.

The Annexure includes elaborations of important aspects as reference to this report. The report is also accompanied by a Compendium listing important sources of reference for smart city definitions, sources for indicators for urban areas and a set of recommended additional reads.

2. Review of ‘Smart’ Concepts for Cities: Lessons for India

The Mission statement and deliberations at national level suggest that the Mission aims to create economically competitive and environmentally and socially sustainable cities and urban settlements primarily with technological interventions. Literature suggests that these are not new notions to be attributed for the success or failure of cities. The nature of interventions required for meeting these goals might need alteration with changing time and context. Efforts towards achieving these goals need to be cognisant of the main drivers and influencing factors for cities. In order to enrich the process of reconceptualising smart cities for India, the next section gives a brief perspective on the main drivers and influencing factors that have shaped the global urban trajectory.

2.2. Evolution of the Smart City Concept

In 1992, “Smart Growth” emerged as a concept aimed at suggesting an alternative paradigm to the urban sprawl, detached housing and dependence on automobiles. This was primarily driven by planners, architects, community activists, and historic preservationists. The concept proposed that the concentration of growth in a city takes place in compact (mixed land-use and compact design) and walkable urban centres (range of transportation and housing options), where the community participates in making development decisions that are fair, predictable and cost effective (sense of community living). Creative ways of urban planning and design emerged during this time. This concept gained immense popularity in the 1990s but gradually faded away, and a new concept called “Intelligent Cities” emerged. Intelligent cities included how data and information technology could impact the way cities function. From these debates on smart growth and intelligent cities, the idea of a ‘Smart City’ emerged. Much of the discourses during the same time also came from ‘intelligent’ and ‘smart’ enterprises (such as IBM, CISCO, and Siemens). Other technology giants like Hitachi and Microsoft also came up with ‘smart’ technologies for cities. The Massachusetts Institute of Technology (MIT) laboratories also contributed to this discourse (Townsend, 2014)(Harrison, 2011).

The discourse on smart cities gained prominence with the break of the global economic crisis in 2008. This period saw extreme cuts in urban finances and social welfare, and sought the assistance of the private sector to provide public urban services (Paroutis, Bennett, & Heracleous, 2014). Thus emerged a Smart City Model, which provided an interface where the city is treated as a system of complex information flow. The model assumed that there is a common goal for the city which can be optimised to increase efficiency in different sectors such as transport, health care, etc., so as to benefit the city as a whole¹⁶ (Steiner & Veel, 2014). In 2011, the ‘Smarter Cities’ trademark was officially registered to IBM.

Concepts defining smart cities are still emerging and there are a range of conceptual variants such as Digital City and Intelligent City (Hollands, 2008). Consequently, the use of the label ‘Smart City’ has not been consistent (Chourabi et al., 2012).

¹⁶ Cities for Smart Environmental and Energy Futures Energy Systems 2014, pp 291-303, Date: 03 Jul 2013
For the Smarter Good of Cities: On Cities, Complexity and Slippages in the Smart City Discourse Henriette Steiner, Kristin Veel

The following sections present analyses of definitions, indices, measures, standards used and a few examples of what is being developed on the ground under the label of a 'Smart City' globally. These analyses aim to provide a better understanding of the evolving paradigm and the gaps and opportunities it poses.

2.3. Review of Smart City Concepts

Definition of Smart Cities

There is substantial literature on the definition of smart cities which could be categorised into three major sources:

1. Research and academic view - Puts sustainability, (mainly environmental sustainability) as the primary agenda to be achieved, where quality of life and economy emerge as second-level priority factors.
2. Corporate sector's (mainly technology companies) definition - Looks at ICT as a panacea, assuming that the required outcomes such as city efficiency, management, infrastructure, environment, and quality of life follow automatically. Notably, there is nominal emphasis on the overall functionality, resilience, city form and urban design of the smart city.
3. Government sector - This sector reflects a larger understanding of the use of ICT in delivering governance, recognises the critical relevance of human resources, and puts emphasis on quality of life as well as environment. However, a very limited number of definitions have emerged from this sector.

Smart City Definitions

"The rudiments of what constitutes a Smart Sustainable City which we define as a city in which ICT is merged with traditional infrastructures, coordinated and integrated using new digital technologies."
(Batty, et.al, 2012)

A Smarter City uses technology to transform its core systems and optimize finite resources. At the highest levels of maturity, a Smarter City is a knowledge-based system that provides real-time insights to stakeholders, as well as enabling decision-makers to proactively manage the city's subsystems. Effective information management is at the heart of this capability, and integration and analytics are the key enablers. (IBM, 2013)

Figure 2 provides a visual representation of the different aspects mentioned in definitions pertaining to smart cities and the weightage assigned to them.

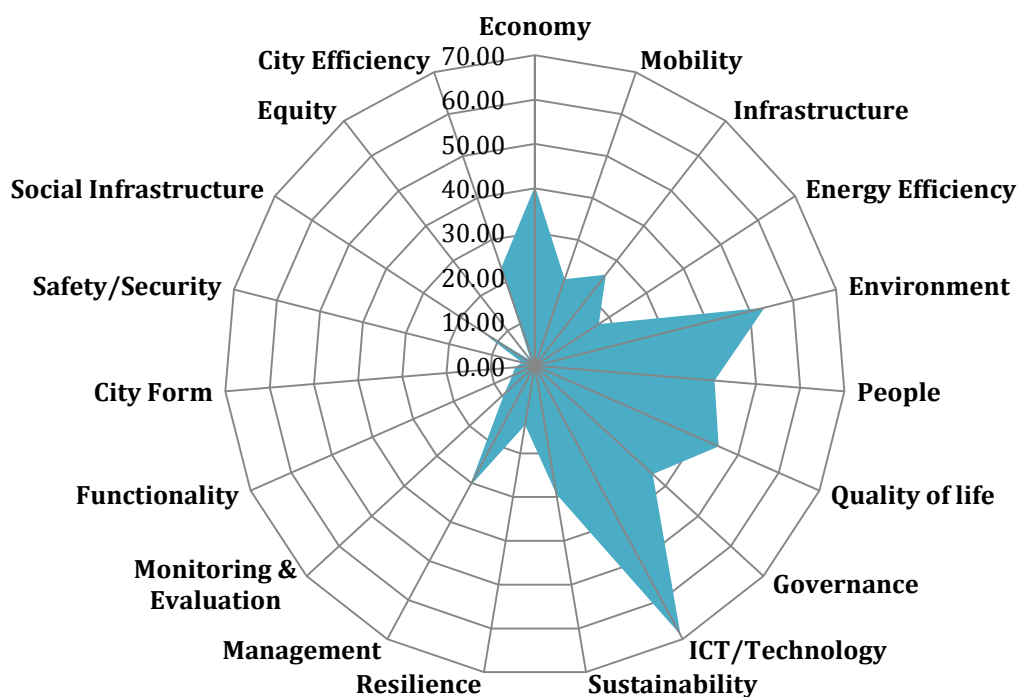


Figure 2: Definitions of Smart City in Literature as a Combination of Various Aspects

Source: CSTEP Analysis

A deeper review, of approximately 100 definitions, combining all three sources¹⁷ shows that the majority of them posit ICT as the prime aspect, explicitly or implicitly (refer to Figure 2). However, the importance of the integration of systems and compatibility of frameworks on which a city functionally operates, are largely missing. This shows a lack of clarity in balancing sustainability constraints with a city's aspirational goals. Also, equity as an outcome of a sustainable city fails to get mentioned and is often represented through the idea of 'people' in general. This partially indicates a lack of conscious effort to leverage the capabilities of smart attributes to include the marginalised and disadvantaged within a city's development plans¹⁸. Overall, there is a sense of confusion, between the end and the means.

Indices and Standards for Smart Cities

Designing a set of indicators to describe a city as smart has been and is being attempted by various organisations¹⁹ (refer Annexure 1: Smart City Indices, Annexure 2: Standards and Certifications for Smart Cities, Annexure 3: Smart City Projects).

Review of available literature shows that there are a wide range of examples and models being pursued as smart cities which substantially vary in their scale, objectives and the geo-political

¹⁷ Refer to Compendium for the definitions referred to in this report.

¹⁸ It is worth mentioning here that more inclusive and equitable development have been an objective of India's national development agenda in general and specifically for Smart City development in India according to the Draft Concept Note on Smart Cities.

¹⁹ The International Organization for Standards (ISO) is also working towards developing indices for smart cities as a part of Smart City standardisation.

context in which they are built. Thus the suitability of these smart city examples for replication in the Indian context demands a careful examination and necessary alterations and contextualisation.

Observations

A review of definitions, indices, rankings, project scale and priorities of smart cities highlight the following:

No widely accepted single concept for smart cities

Absence of a common conceptual model for smart cities has created confusion. Furthermore, too many definitions with varying focus leads to a differential understanding of the objective of a smart city.

Partially evolved standardisation domain for smart cities

In the present city development models, cities are not treated as ‘systems of systems’ (ISO and IEC, 2014). For example, the standards related to smart cities on sustainable communities, mentioned in TC 268, broadly cover indicators on smart urban infrastructure. However there are others standards related to city services, its built and non-built environment and aspects falling under a city’s functional cycle, which have not been addressed. There is not much evidence that these are integrated into the standardisation process of smart cities. There is a lack of clarity on the specific scope of each of the standards. There is also a need for coordination by a centralised authority for the development of standards and guidelines for smart city interoperability.

Lack of consistency in indicators for smart cities

There is a plethora of indicators for smart cities. While many of these indicators have similar principles, the methodologies for developing the indicators and smart city indexing vary, leading to inconsistency. There is no accepted methodology for ranking cities as smart. Moreover, there is an overlap in the criteria considered for ranking cities as smart as well as under various other genres. While all the indicators intend to reflect enhanced quality of life for its citizens, the lack of standardisation across indicators has created a confused state of understanding for aspiring cities in choosing the right path to become a ‘smart city’.

Inadequate attention to privacy, security, resilience and sustainability concerns

Issues and concerns related to the smarter development of cities are primarily associated with privacy, security and long-term resilience (ISO and IEC, 2014). There is no clarity on the suitability of regulatory frameworks to ensure the privacy of citizens and data in a certain societal and geo-political context²⁰. Also, the measures to ensure long-term sustainability of technologies, in terms of material and energy usage, do not get adequate attention in the overall deliberation.

No ‘One Size Fits All’ smart city development model

The present smart city projects show examples of technology applications that can help to improve various city functions, as well as achieve good governance characteristics. However, these examples do not establish how a range of measures covering all city services can work

²⁰ ICT domain in India is governed by the Information Technology Act, 2000

seamlessly within a given institutional hierarchy involving various tiers of government and in a variety of socio-economic contexts. This assumes significance for developing economies like India, where there is wide gap in liveability conditions and aspirations between different stakeholder groups within a city.

To summarise, the observations mentioned in this section indicate that the Smart Cities Mission needs to be formulated cautiously before borrowing from any particular model. It becomes important to decide the direction in which the Mission can afford to go. Discussions in this Chapter suggest that the existing resources and knowledge need to be contextualised so that they can meaningfully assist in crystallising the Smart Cities Mission. Replication of attempts towards smart cities needs to be carefully examined, especially in a country like India with an extremely diverse social and human development canvas, and with growing constraints in critical resources such as land, water, energy, finance. As India gets prepared to embrace a more urbanised future, it becomes extremely crucial to build the right smart city development model while being cognisant of the negative externalities.

Key Messages:

1. The notions of sustainability largely encompass the larger goals of a smart city
2. Technology is an important enabler in attaining sustainability and good governance in a city
3. There is no 'one size fits all' model for smart cities that can be adopted in India
4. There is a critical need for contextualising various aspects of smart city development, which is an opportunity for India to chart its own path towards smart city development.

3. Smart Cities Mission: An Opportunity to Attain India's Urban Goals

GoI's Smart City Mission focuses on redefining urban development initiatives that make cities more livable, inclusive, and centres of economic growth. Since independence, the perceived role of the 'urban' in India's larger development goals has undergone substantial evolution (refer to the box below). Thus, it is important that the Mission is conceived in the wider context of urbanisation in India and the related policy paradigm.

Attitudes to urban growth within the country tend to swing between two extremes. Cities are seen either as an unavoidable evil or in a more positive way as 'engines of growth'. There is, in fact, evidence to show that urbanisation is likely to have been a key determinant of economic growth in the 1980s and 1990s, boosted by economic liberalisation.

Planning Commission, 10th Plan, 2002

Although the theme of a 'rural-urban divide' still colours some policy discourse in India, there is a growing recognition that urbanisation is necessary to realise India's growth potential, and that rural-urban linkages must be strengthened. Indeed this will accelerate growth of the rural sector also.

Planning Commission, 12th Plan, 2012

Urbanisation is an irreversible trend. Rather than viewing it as an evil, we have to make it an integral part of our policy for development. Urbanisation has to be viewed as an opportunity to use modern technology to create a wholesome and secure habitat while reaping the economic benefits that it offers.

Cabinet Resolution on creation of NITI Aayog, 2015

3.1. Urban Development Framework in India

Evolution of India's Urban Agenda: Increasing Focus on Urban Management

Since independence, until about 2011, the trajectory of India's urban policy domain can broadly be divided in three phases. (Batra, 2009). The 1st to 3rd Five Year Plans had a fragmented approach towards urban development. These three Plans were marked by efforts towards housing provisions, slum clearance and rehabilitation. The master planning approach endorsed during this time resulted in expensive and low-density urban settlements.

The next three Plans (4th to 6th Five Year Plans) initiated a significant departure in policy; from slum clearance to slum improvement and upgradation. Emphasis was given to balanced regional development and development of small and medium towns, while containing the growth of metropolitan cities, making land available for provisioning of services and urban poor housing, and control of land prices.

The 7th to 11th Plan accompanied India's economic liberalisation, and the urban sector reflected this policy shift. Some key developments during this period included the opening-up of the sector to private participation, participatory approach in city planning, strengthening the link between urban growth and economic development and employment generation. An agenda for decentralisation was pushed through the 74th CAA, seeking greater accountability for ULBs and "moving away from state transfers and subsidy based urban infrastructure financing regime to market based financing regime" (Batra, 2009). The process of urban reform which began culminated in JNNURM. (Refer to Figure 3 for a Plan period-wise policy focus).

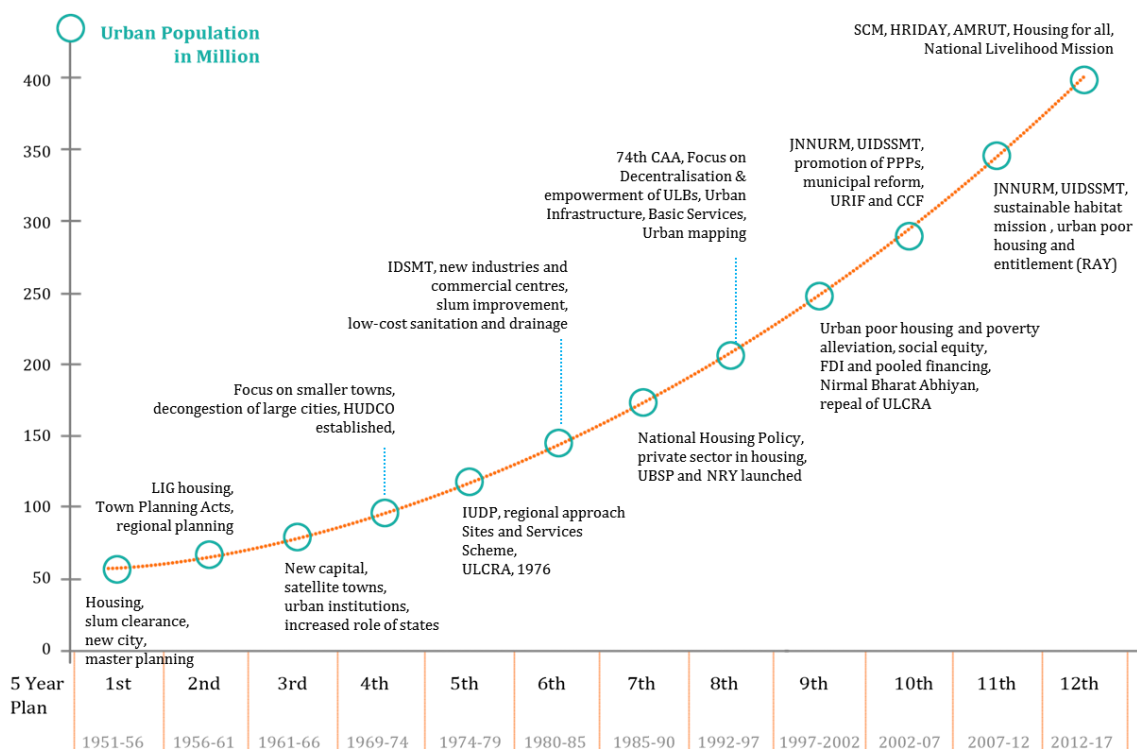


Figure 3: Urban-related Development Focus in India's Five Year Plans

Source: Various and CSTEP Analysis

Table 1 shows some of the major urban sector programmes initiated by GoI since 2014.

Table 1: Major Ministry of Urban Development Programmes since 2014

Programme Name	Budget allocated in 2015-16 (INR crore)
Smart Cities Mission	2020
Atal Mission for Rejuvenation and Urban Transformation (AMRUT)- Replacing JNNURM	3919
Swachh Bharat Mission (SBM) - Replacing Nirmal Bharat Aviyen	1000
Sardar Patel Urban Housing Scheme (SPUHS) - Replacing Rajiv Awas Yojna and Rajiv Rozgar Yojna (RAY & RRY)	4150
National Heritage city Development and Augmentation Yojana (HRIDAY)	200

Source: Various, CSTEP Analysis

Planning Process for Urban Areas results in Multiple Plans for Cities

Master planning and regional planning have been two major exercises that evolved out of the planning process endorsed in India since independence²¹. The last decade of urban reform has led to the emergence of City Development Plans (CDPs) as a product of JNNURM and UIDSSMT. While Master Plans continue to be the spatial planning tool with a set of Development Control Regulations (DCR) enforced by the ULB/development authorities, CDPs stand as project-investment plans for cities, with minimal spatial reference. Moreover, there are plans pertaining

²¹ The Urban and Regional Development Plans Formulation and Implementation (URDPFI) guidelines suggest hierarchies of plans in accordance with the 74th CAA. The guidelines aim to facilitate integration of spatial, social and economic dimension of planning.

to different sectors such as transportation (City Mobility Plans, CMP), water, sanitation (City Sanitation Plans, CSP), drainage, etc. at the city or regional level based on specific institutional jurisdictions.

The simultaneous existence and functioning of multiple plans result in a complex hierarchy and overlapping of institutional mandates, making implementation and enforcement of plans difficult. The lack of effective planning and land-use controls have encouraged sprawl in all Indian cities - mega, big and small (Gupta, 2014)(Gogoi, 2013). There is a need for the plans to align with each other in time, space, and objectives, in order to ensure tangible benefits (CSTEP, 2014)²².

Urban Finance Flows: Growing Role of Private Sector

The financial resources flowing into ULBs typically consist of its own tax and non-tax revenues, shared revenues, grants and loans from the state government, and market borrowings. While the types of taxes collected by ULBs are not specified by the 74th CAA, their revenue base is decided by the state government. Generally, Property Tax is the single most important source of revenue for ULBs. 'User-charges' significantly contribute towards non-tax revenues. As a part of the urban reform agenda, a portion of funding from GoI has been made available to cities through schemes like Viability Gap Funding (VGF). Since economic liberalisation, multilateral agencies (such as World Bank, Asian Development Bank) have been playing an important role in funding as well as structuring key reform-driven urban development programmes. Private sector participation has also emerged as a source of funding in the urban sector through various forms of project structuring and Public-Private-Partnership (PPP) agreements.

Important References as Planning Guides for Indian Cities

Since the 10th FYP period and especially post launch of JNNURM Phase-I, a few important set of documents came to exist which provide useful guidance and crucial insights on planning for urban areas in India. These are as mentioned below.


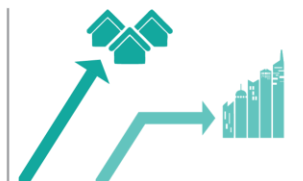


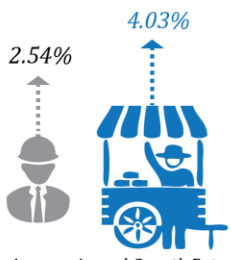

1. Toolkit for preparation of City Development Plans under JnNURM- latest revised version in 2013
2. Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines- latest revised version in 2015
3. Report of the Working Group on Urban Strategic Planning, 12th Five-year plan, Steering committee on Urban Development & Management, October 4, 2011
4. National Urban Spatial Planning and Development Guidelines- submitted to MoUD in 2013

There is a need for drawing necessary convergence between these guides with specific and non-overlapping scope and making them easily accessible reference for cities and institutions.

²² Can Bangalore's planners solve its commuter woes?- India Together, March 2014

3.2. State of Urbanisation in India

The state of urbanisation in India is briefly described through the following major trends and characteristics:

<div style="text-align: center;"> 1 2 </div>  <p>Steady Growth of Urban Population to Continue</p> <p><i>Urban population in India will continue to grow over next few decades¹ and by 2050, will comprise about 58% of the total global population</i></p>	<div style="text-align: center;"> 3 4 </div>  <p>Bigger Cities Stabilising, the Next Tier Growing Faster</p> <p><i>Within Class I category of cities (Population > 0.1 million), those in the 1–5 million population range are growing faster, whereas the growth rate in the bands above and below are slowing down(IUT and CSTEP, 2014).</i></p>
<div style="text-align: center;"> 5 6 </div>  <p>Deficient Urban Infrastructure Conditions</p> <p><i>A gap of INR 1.45 lakh crore in the annual investment in infrastructure service delivery in Indian cities based on a comparison between investments made in 2011-12 and 2012-13 (HPEC, 2011).</i></p>	<div style="text-align: center;"> 7 8 </div>  <p>Two-Third contribution of urban sector in national economy</p> <p><i>Approximately 62-63% of India's Gross Domestic Product (GDP) is contributed by urban areas, and the same is estimated to reach 75% by 2030 (HPEC, 2011).</i></p>
 <p>The share of informal workers in urban areas is high</p> <p><i>The share of the informal sector is about 70% of the total urban working population with an average annual growth rate (4.03%), higher than that of the formal sector (2.54%) in urban areas¹ (Naik, 2003).</i></p>	 <p>Urban environmental conditions raising sustainability concerns</p> <p><i>India is the fourth largest emitter of Green House Gases (GHG) in the world. Indian cities are becoming more vulnerable to climate change due to high share of urban poor¹, improper land-use, high population density in flood-prone areas, improper infrastructure and planning practices, and competing use of scarce resources, etc.)</i></p>

3.3. Smart City as an Opportunity to Address India's Urban Aspirations

Discussions in the previous section indicate that the share of 'urban' in India is expected to grow, both in terms of population and economy. However there are gaps in attaining the required conditions of liveability, fostering equity and inclusiveness and building urban resilience. Formidable challenges exist in setting the urban trajectory on a path which is sustainable in the long term. The positioning of the Smart Cities Mission can be seized as an opportunity to address these challenges and attain the larger goals of urbanisation in the national development agenda. The areas of interventions that the Mission needs to focus on include:

Establishing an Efficient Urban Management Systems

Indian cities are not equipped with any comprehensive monitoring and evaluation platforms for measuring the performance of projects and plans. Better data availability and analytical platforms with the help of technology to continuously track changes in city-level indicators could be a large step forward in improving the performance of urban sector programmes.

Building Adequate Capacity of Urban Institutions and Local Governments

The technology domain and its application in cities are developing at a fast pace. This is generating additional requirement for adequate training and capacity building in ULBs and across urban sector institutions. At the same time, technology application itself can substantially enhance the capacity of ULBs by bridging gaps in knowledge and skills. Further, there is scope for enhancing the efficiency of institutions that will enable them to deliver their mandate and further the agenda of good governance.

Achieving the Decentralisation Agenda

Furthering the decentralisation agenda — as intended by the 74th CAA — needs creation of enabling conditions. This includes the creation of platforms for citizen engagement in identifying, planning and implementing city-level programmes and projects. A smart city must address this by not only applying technology, but also by adequately altering institutionalised decision-making processes.

Minimising Conflicts in the Urban Environment

There is an absence of frameworks for ensuring compatibility among sector policies, plans and regulations. Further, the essential linkages between project identification, monitoring and evaluation of project performance and using the same in future programme formulation are also not practiced. This leads to ad-hoc decision making, resulting in increased conflicts in urban spaces pertaining to aspects such as land acquisition, energy demand and availability of natural resources such as water. A holistic decision-support platform will allow cities to be treated as spaces and as a system of systems, while minimising conflicts.

Creating Enabling Conditions for Inclusive and Equitable Urbanisation

Gaps in income, opportunity, and quality of life standards need be addressed through better access to infrastructure, facilities and information. Also, there is need for conceptualising and evaluating urban development initiatives from a regional growth perspective. The city selection process under the Smart Cities Mission can be an effective way to address this.

The Mission needs to equip itself to deliver on minimising these challenges. A clear urbanisation policy for India can also be built through this programme while working towards achieving India's growth targets and addressing sustainability concerns.

Key Messages:

1. The Smart Cities Scheme is positioned to deliver on India's urban development agenda.
2. There is need for better strategic articulation of the Scheme to address India's urban challenges by orienting itself on a more **process-oriented path rather than a project-oriented path.**
3. A reference framework based on a set of guiding principles is needed to enable governments to implement the Scheme and maintain consistency across different stages of development involving different stakeholders.

A Reference Framework for the Smart Cities Mission in India is proposed in the next chapter based on imperatives drawn from the discussion so far.

4. Proposed Reference Framework for the Smart Cities Mission

The imperatives emerging from the last three chapters for conceptualising smart cities in the Indian context can be articulated as follows:

- a) A city needs to be sustainable to become smart
- b) Principles of good governance need to be fostered as they are important for achieving sustainability
- c) Technology is an important enabler in achieving the above (a, b), along with a supportive policy environment, long-term vision and domestic stability. Innovation will follow as a result
- d) Urban institutions need capacity to achieve and/or nurture a), b), through c)
- e) India needs to build its own terms of reference for developing smart cities, being cognisant of the four imperatives (a, b, c, d,) mentioned above.

This chapter proposes a set of terms of reference in the form of a 'Smart City Reference Framework' (SCRF) for India. This is envisaged to be the point of departure from other urban development initiatives. The Smart Cities Mission needs to initiate this in order to have both short-term (such as meaningful utilisation of investments under the Mission) and long-term benefits (such as initiating important structural reforms in the urban planning and management processes, empowered by technology).

SCRF has been conceived as a set of action steps that governments and relevant agencies need to follow while making decisions for a city. These are referred to as Smart City Action Stages (SCAS) in this report. SCASs need to be supplemented with points of references (enabling factors) like standards, processes, etc., that will guide governments to implement the action stages. These will henceforth be referred to as Smart City Reference Guides (SCRG) in this report.

The proposed SCRF is illustrated in Figure 4 along with the constituent SCASs and SCRGs. The process is not a linear flow, but rather a loop, suggesting a continuous and incremental nature to making cities smart with adequate feedback mechanism.

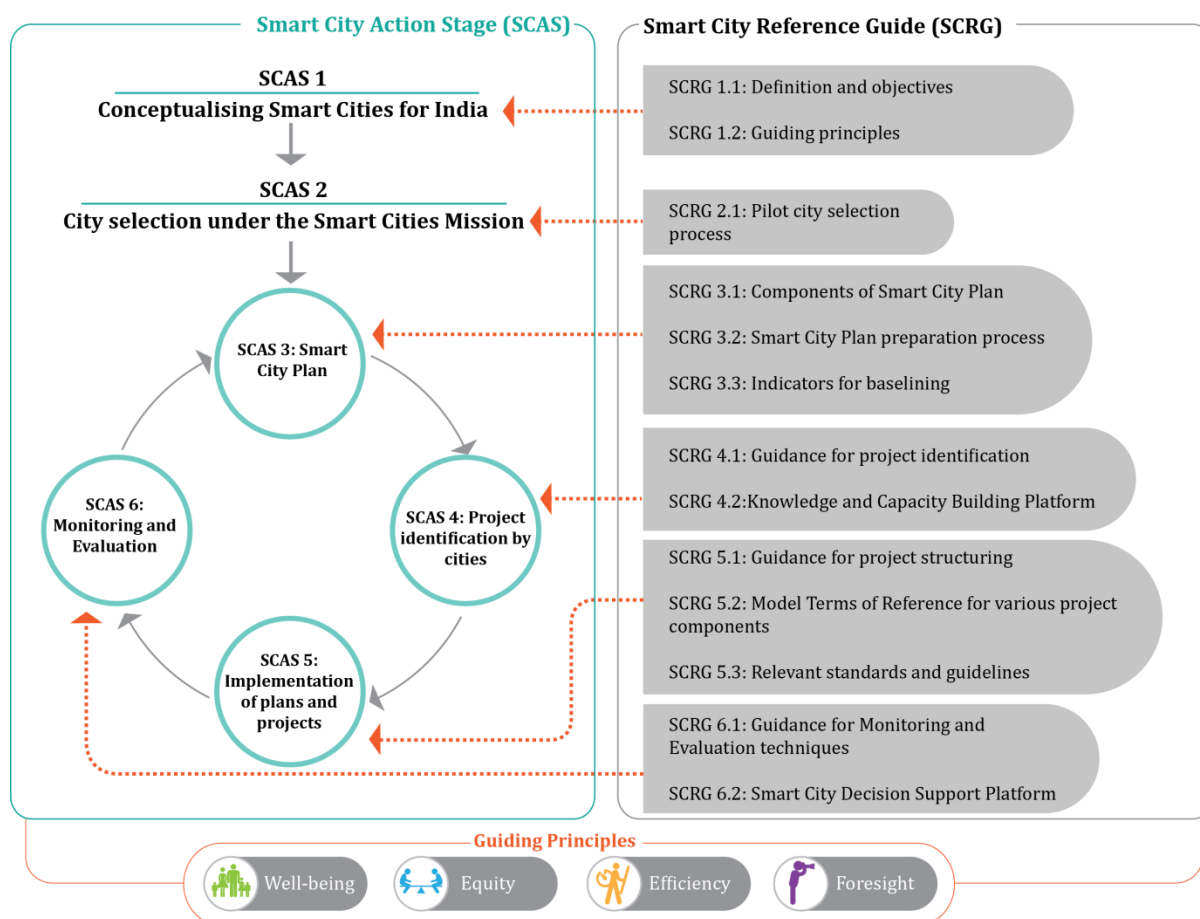


Figure 4: Proposed Smart City Reference Framework for India

Source: CSTEP Analysis

The first two action stages are meant for national-level and state-level agencies and governments. Post the city selection stage, the onus of carrying out the actions shifts to the ULBs. SCRGs associated with all the action stages however need to be formulated by competent agencies and experts at the national level through a process of deliberations. This framework can guide those states and cities planning to participate in the ‘City Challenge’ programme, announced by GoI under the Smart Cities Mission.

It is to be noted that irrespective of whether a city is selected under the Mission, SCRF can guide the management of cities across different classes based on size. SCRF can also provide insights for cities undergoing the existing protocol of planning processes, through the SCRGs mentioned beyond the City Selection stage.

The following section provides brief descriptions of SCASs and SCRGs for each stage. Further elaboration and recommendations for specific SCRGs have also been provided, as mentioned below, based on CSTEP’s research:

- SCRG 1.1 - Definition and Objectives
- SCRG 1.2 - Guiding Principles
- SCRG 2.1 - Pilot City Selection Process
- SCRG 3.3 - Indicators for Baselineing

4.1. SCAS 1: Conceptualising Smart Cities for India

This stage involves the conceptualisation of smart cities for India and arriving at a set of guiding principles. These principles are envisaged to be helpful in maintaining consistency throughout all the stages of SCRF, in order to achieve a converging set of objectives for various domains. The two SCRGs under this SCAS are elaborated in the following sections.

SCRG 1.1: Smart City Definition and Objectives

The suggested definition of a smart city in the Indian context is:

A Smart City would be the one which plans judiciously to meet its aspirations and challenges in a sustainable manner while fostering principles of good governance. These are achieved in a Smart City by utilising the enhanced power of technology, engaging with a more aware and informed citizenry and creating a more competent and capacitated set of people working within an accountable framework (Figure 5).



Figure 5: Approach for Smart City Development in India

Source: CSTEP Analysis

The definition sets broad goals for smart cities. The objectives of the Smart Cities Mission that would contribute towards achieving the definition could be articulated as:

1. Strengthening urban management systems through an effective monitoring and evaluation platform
2. Enhancing the capacity of urban institutions through easily accessible tools and guidance
3. Pushing a decentralisation agenda by strengthening avenues for citizen participation

4. Reducing conflict in the urban environment by treating cities as spaces through a seamless and responsive planning and policy framework
5. Targeting inclusive and equitable urbanisation by enhancing liveability conditions across all segments of a city.

These objectives also attempt to address the opportunities identified in Section 3.3. Smart City as an Opportunity to Address India’s Urban Aspirations

SCRG 1.2: Smart City Guiding Principles

Indian cities, as global entities, must chalk out their growth path based on the principles of sustainable development²³ to ensure their long-term existence (Figure 6). The intention of the draft Sustainable Development Goals (SDGs) and their targets (Refer Annexure 4: Sustainable Development Goals for details on SDGs) could be divided into the following four major thematic principles of attainment:²⁴

1. *Well-being* – refers to the overall liveability conditions in a city which includes hard and soft infrastructure, aesthetics, functionality and safety aspects, which build an image of a city thus enhancing its competitiveness.
2. *Equity* – refers to the availability of the well-being conditions across all segments of a city
3. *Efficiency* – refers to the performance of a city with respect to resources, finances and human power to produce the desired outcomes (i.e., city goals)
4. *Foresight* – signifies a commitment to address long-term challenges and aspirations of a city

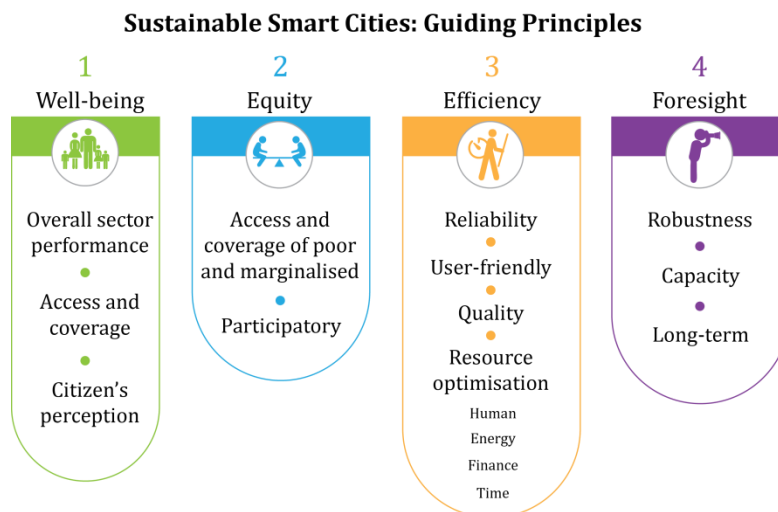


Figure 6: Guiding Principles for the Smart City Reference Framework

Source: CSTEP Analysis

The proposed SCRF is based on these guiding principles because adhering to these principles in all the processes and outcomes of a smart city will enable good governance.

²³ Refer Chapter 1, Section 1.3 for details

²⁴ The study has extensively referred to literature published by UN on sustainable development in order to arrive at the guiding principles.

4.2. SCAS 2: City Selection under the Smart Cities Mission

A set of pilot cities will be selected to launch the first phase of the Mission. There is a need for a process of selection based on the guiding principles. The adoption of an objective process would entail transparency and accomplishment of good governance. This study assumes that the broad focus of the Smart Cities Mission will be on small and medium cities.

The proposed Reference Guide for the selection process of pilot cities is elaborated in the following sub-section.

SCRG 2.1: Pilot City Selection Process

The process of selecting pilot cities should entail both top-down and bottom-up approaches. A top-down approach ensures the replicability and scalability of the process, adherence to larger development goals, and also specific physical and socio-economic characteristics of a region (such as vulnerability issues). A bottom-up approach focuses on determining the economic potential of a city and its preparedness for adoption of the Reference Framework. The proposed process is illustrated in Figure 7²⁵. Details of the selection criteria and indicators associated with Step-2 of the illustration are elaborated in Annexure 5: Proposed Indicators under Four Principles for City Selection.

²⁵ Refer to CSTEP's Policy Brief on 'Building Smart Cities in Karnataka: An opportunity for spatially inclusive growth' and Bhattacharya et.al. (2015).

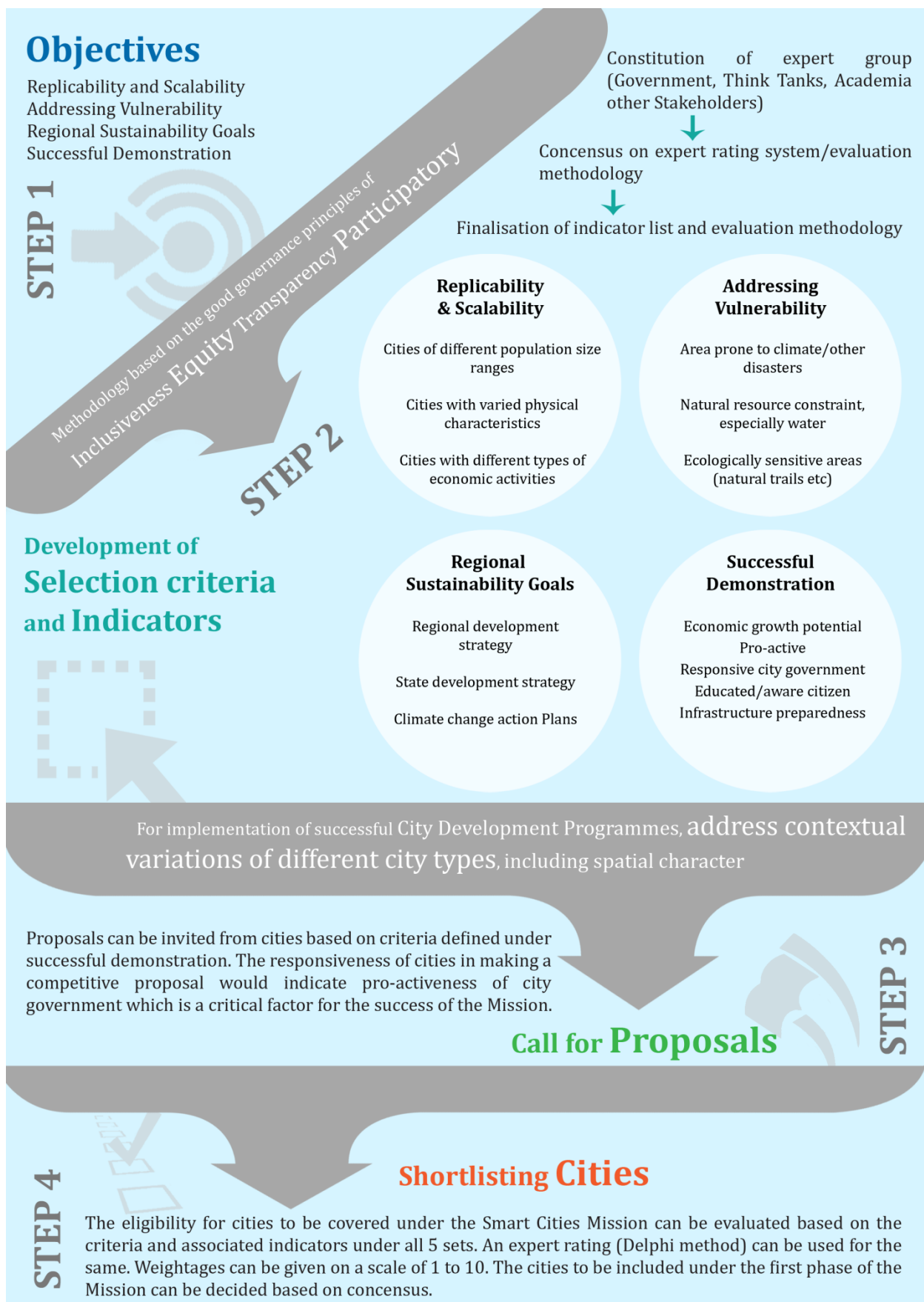


Figure 7: Proposed Selection Methodology for Pilot Cities under Smart Cities Mission

Source: CSTEP Analysis

4.3. SCAS 3: Smart City Plan

The Smart City Plan is perceived as an opportunity to treat cities as spaces; they are not intended to be an extra source of burden of plan-making on the already resource-constrained ULBs. It is meant to be one common plan for the city, encompassing both spatial and non-spatial aspects covering attributes such as land-use plan and a socio-economic-environmental sustainability plan.

A maturing smart city will increasingly plan and deliver services within an integrated system (i.e., mobility and accessibility) as opposed to elements within the system (bus, rail, and car). This would need a systems approach that is enabled by increasing use of data and technologies that aim to transform governance and service delivery models, along with stakeholder engagement.

The Smart City Plan will focus on the status of ULBs with respect to levels of integration in strategy development and planning, partnership modes of working and investments across sectors, including shared-technology platforms and data assets. The plan will include baselining of the city, i.e., assessing the existing situation in a city against a set of indicators across a wide range of sectors. Based on the baseline, future goals for the city need to be set, while being cognisant of the opportunities, constraints and relative priorities.

The preparation of a Smart City Plan needs to be supplemented with the following SCRGs:

SCRG 3.1: Components of Smart City Plan

This shall make sure that the plans cover all essential components which are chosen based on the shortcomings of existing plans. The components also need to adhere to the four guiding principles.

SCRG 3.3: Process for Preparation of Smart City Plan

Like the city selection process, the Smart City Plan preparation process should be based on the principles of good governance. The process must entail the participation of citizens and stakeholders in a planned manner. The level of outputs at each step also needs to be framed.

SCRG 3.3: Indicators for Baselining

There is a plethora of indicators from various sources to assess a city and its services. However, an analysis done by CSTEP on a number of those indicators suggest that the existing set of indicators are not comprehensive enough to do justice to all the four guiding principles, i.e., well-being, equity, efficiency and forward-looking (refer to Annexure 6: Sources for Gap Analysis of Different Sectoral Indicators). The analysis suggests the following imperatives for designing base-lining indicators for aspiring 'smart cities' in India:

1. There is a need for a set of overarching questions, the answers to which should be based on the four guiding principles. These can further guide the designing of baselining indicators. A suggested list of questions is shown in Figure 8.
2. There is a need for a shift from asset-based indicators to a more outcome-based set of indicators²⁶

²⁶ For example, the number of school buildings per 1000 population may not truly reflect the status of learning. The conventional ways and means of delivering education is going through substantial changes owing to fast advancing

3. There is a need to consider indicators which are aspirational in nature, not being constrained by data availability.²⁷



Figure 8: Suggested Generic Set of Guidance Questions for Designing Indicators

Source: CSTEP Analysis

An example of indicators for baselining city-level mobility conditions that have been designed guided by these questions is appended in ‘Annexure 7: Indicators for Baselining using Mobility Indicators as an Example’. The indicators suggested could be categorised into different groups based on their availability over a specific time frame. These could also be categorised into subsets of primary, secondary and tertiary indicators where the secondary set would be an

technological solutions and increased engagement of the private sector through corporate social initiatives. Instead, the literacy rate among a set of population and/ or levels of education may give better indications of educational attainments within the group.

²⁷ As the concept of smart city focuses on better data availability, a city will have to strive to measure certain data in the future which may not be available now.

input for arriving at the primary indicators and the tertiary set would be input for the secondary set.

Notably, these are indicators and not indices. For the purpose of ranking cities or arriving at a composite value for a city, these indicators need to be further given weightage. A methodology needs to be arrived at for designing indices.

4.4. SCAS 4: Project Identification by Cities

The project identification stage should aim at identifying measures for achieving the goals set in the City Maturity Plan, in a time-bound manner. There needs to be a shift from projects aiming only to create new assets. Instead, projects need to span across the following categories:

1. Improvement of existing infrastructure
2. Creating new infrastructure
3. Changing processes
4. Impacting behavioural aspects such as awareness building.

This stage needs to be supplemented with the following two reference guides:

SCRG 4.1: Process for Project Identification

Like the City Maturity Plan, the project identification stage should also be based on the principles of good governance, with robust citizen participation. This stage should also entail project prioritisation as an outcome. In order to achieve this, a logical process will have to be followed and documented by cities in order to avoid ad-hoc decision making.

SCRG 4.2: Knowledge and Capacity Building Platform

A wider approach for project identification is suggested through this Framework, rather than selecting typical projects. This needs to be facilitated through access to required knowledge at the city-level in an easily graspable manner. This can be done by designing a Knowledge Support Platform - a virtual platform with well-researched examples, options, case studies and best practices for city-level adoption. This open platform can be continuously built upon by sharing newer examples. Guidelines identified in Chapter 3 may be a good starting point to draw reference.

Further, this platform can be enhanced to a decision-support platform, with an easy user-interface as discussed in *SCRG 6.2: Smart City Decision Support Platform*. This will enable city stakeholders to upload city-specific conditions as inputs and get a variety of suitable options as well as see the impact of a particular intervention across a range of cross-sectoral indicators.

The National Association of Software and Service Companies (NASSCOM) in India has developed a framework for 'Integrated ICT and Geospatial Technologies' for the Smart Cities Scheme. The framework identifies links in a city's system where ICT can be used as an intervention to improve its present performance. Similar pieces of work need to supplement the Smart Cities Scheme, as identified in this report as SCRGs. Specifications on technology parameters available from ITU can also be referred to as international standards.

4.5. SCAS 5: Project Implementation

The implementation stage should include a range of activities including detailed project planning, preparing financial operating plans, partnerships with stakeholders and so on. Important reference guides required for this stage are:

SCRG 5.1: Guidance for Project Structuring

This should cover guidance for all essential elements such as:

- Project phasing
- Financial structuring
- Implementation of partnerships including beneficiaries and citizens.

SCRG 5.2: Model Terms of Reference for Projects

The objective of having a model Terms of Reference (ToR) is to ensure that the project outcomes contribute towards achieving the four guiding principles, as well as the city-level goals set in the Maturity Plan. This can be achieved by incorporating a set of checks and balances as a part of ToR for the implementation of a project, even when it is outsourced.

SCRG 5.3: Applicable Standards and Guidelines

There are a number of guidelines and standards that are available or are being developed, which are applicable to a city and/or its specific sectors. It is essential that a project is implemented in accordance with these guidelines and meet the desired standards. Cities will need guidance in identifying relevant standards and their applicability for a certain project. This is specifically important for projects involving technological intervention, where both experience and capacity of ULBs are limited.

4.6. SCAS 6: Monitoring and Evaluation of Plans and Projects

Monitoring and Evaluation (M&E) is a continuous process through which any changes in the baseline indicators are captured. It is important for cities to have knowledge about M&E techniques for effective evaluation of not only projects but also policies, plans, regulations, etc.

This stage needs to be supplemented with the following reference guides:

SCRG 6.1: Guidance to Monitoring and Evaluation Techniques

This reference guide needs to include the following:

- Techniques on how to monitor and evaluate projects/programmes/decisions
- How to evaluate results from monitoring
- How to take forward decisions based on M&E results.

SCRG 6.2: Smart City Decision Support Platform

For a city to be smart, it needs to complete the loop of logical decision making, starting from continuous data capturing and monitoring, to analysis so as to provide an indication on the impact of relevant indices, and building of scenarios with multiple options. This process will facilitate decision making in a well-informed manner. The interventions in a smart city need to ideally culminate in such a decision-support platform, allowing different drivers, enablers and components of a city system to interact with each other.

For example, how a certain economic investment impacts land-use, demographics, physical and social infrastructure conditions and movements within a city can be visualised through such a platform. The three main aspects of the decision theatre should include:

- Data repository
- Powerful analytics
- Visualisation.

While the ICT-related technical aspects such as ‘interoperability’²⁸ should be ensured by technology companies and research organisations, finer research needs to be carried out to meaningfully understand the relationships between the enablers and drivers of a city.

“A smart Decision Support Platform enables much needed logical flow between data analysis results and decision making. It instils transparent and equitable city planning and management rather than ad-hoc arrangements. Identifying the right points of intervention within established protocols in city planning and governance is important to start embedding smart-city thinking while minimising frictions.”(CSTEP 2014)²⁹

4.7. Institutional Responsibility for the Reference Framework

The agencies that are primarily responsible for carrying out specific action stages are mentioned in Table 2. The preparation of SCRGs needs to be initiated by GoI with inputs from states, ULBs and active engagements with research and academic institutions, Think Tanks, citizens and citizen groups, individual experts, civil societies and other non-governmental organisations. These need to be further made available to ULBs in various languages as required. ULBs also need to be trained to make effective use of SCRGs, which can be spearheaded by the state governments.

Table 2: Agencies/Stakeholders Involved in Smart City Reference Framework

Smart City Action Stages	Smart City Reference Guide	Agencies/Stakeholders to be involved
SCAS 1: Contextualise Indian Smart City concept	SCRG 1.1: Definition and objectives SCRG 1.2: Guiding principles	<ul style="list-style-type: none"> • All central and state government/line agencies concerned with urban planning • Ministry of Finance • Centres of learning familiar with the concept of smart cities (universities, educational institutions) • Civil Society Organisations • Business Organisations • Consultancies • ULBs (through the respective state governments)

²⁸ Interoperability ensures that products and services from disparate providers can exchange information and work together seamlessly. There are three interoperability targets: 1) Adhere to open standards, 2) use open integration architectures and loosely coupled interfaces, 3) prioritise legacy investments (Smart Cities Council, 2014)

²⁹ Source: ‘Smart Decisions for a Sustainable City’ published in Sustainability Next, November 2014

<p>SCAS 2: City selection under the Smart Cities Mission</p>	<p>SCRG 2.1: Pilot City selection process</p>	<ul style="list-style-type: none"> • Central government • Respective state governments • ULBs (through the respective state governments) • A nodal agency which can anchor the proceedings and ensure impartiality and transparency (National Institute of Urban Affairs [NIUA] in the current context)
<p>SCAS 3: Smart City Plan</p>	<p>SCRG 3.1: Smart City Plan components</p>	<ul style="list-style-type: none"> • Respective State government/line departments which deal with urban issues • ULBs (elected/parastatal) • Central government in an advisory capacity
	<p>SCRG 3.2: Smart City Plan preparation process</p>	<ul style="list-style-type: none"> • ULBs (elected/parastatal) to take the lead in this process • Consultants who will prepare the maturity plan • Expert Committee to review the process • State government agencies which will also review and approve • Civil Society Organisations in an advisory capacity • Business Organisations/Chamber of Commerce in an advisory capacity
	<p>SCRG 3.3: Indicators for Baselineing</p>	<ul style="list-style-type: none"> • Respective line/domain agency identified by ULB • ULBs (elected/parastatal) to oversee the process • Civil Society Organisations in an advisory capacity • Business Organisations/Chamber of Commerce in an advisory capacity • Centres of learning which have knowledge in subject matter (advisory capacity) • Expert Committee to review indicators
<p>SCAS 4: Project identification by cities</p>	<p>SCRG 4.1: Guidance for Project identification SCRG 4.2: Knowledge and Capacity Building Platform</p>	<ul style="list-style-type: none"> • State government agencies (specifically UDD and specific line department) in an advisory capacity • ULBs (elected/parastatal) • Civil Society Organisations in an advisory capacity • Business Organisations/Chamber of Commerce in an advisory capacity • Centres of learning which have knowledge in subject matter (advisory capacity) • Technical agency which will prepare decision-support platform (E.g. NIC)
<p>SCAS 5: Implementation of</p>	<p>SCRG 5.1: Guidance for Project Structuring</p>	<ul style="list-style-type: none"> • Specific agency in-charge of project • ULB in an advisory capacity • Structuring experts (business, civil society, centres of learning)

plans and projects	SCRG 5.2: Model Terms of Reference for various project components	<ul style="list-style-type: none"> Referencing expert agencies (E.g. World Bank, ADB, United Nations) ULB in an advisory capacity
	SCRG 5.3: Relevant standards and guidelines	<ul style="list-style-type: none"> Standards and guidelines experts (e.g. ISO) ULB in an advisory capacity
SCAS 6: Monitoring and Evaluation	<p>SCRG 6.1: Guidance for Monitoring and Evaluation Techniques</p> <p>SCRG 6.2: Smart City Decision Support Platform</p>	<ul style="list-style-type: none"> Sectoral experts on monitoring and guidance (business organisations, civil society, centres of learning) State government as a hands-off overseer. ULBs as part of monitoring and evaluation committee

5. Conclusion and Recommendations

Making cities smart will take time and effort. It is critical to create an enabling policy and regulatory environment. This will allow a nuanced approach to a smart, and yet sustainable roadmap for urban development. Smart cities need to be sustainable as well in order to ensure successful returns on investments made in developing them. Many countries are interested in partnering with Indian firms on smart city ventures. Foreign investment is crucial and required. However cities need to be empowered and capacitated to decide on the specific aspect to invest upon, along with the modalities and timing of that investment. It is important to show some actions happening on the ground to win investors' confidence. Equal impetus also needs to be given to advanced research in Urban Planning to encourage innovation and make investments sustainable. Each city has its established functional cycle of people-economy-enterprises-culture. Using technology to improve quality of life within this functional cycle will be challenging, but will be the most desirable form of a smart city in India. (Rathi & Bhattacharya, 2015)

The way forward has already been identified in the form of a Smart City Reference Framework, which needs to be adopted by the government. This study recommends the following action points in order to facilitate the building of a robust Smart City Reference Framework:

- 1. Create a catalogued platform for Smart City knowledge resources:** There is a vast pool of knowledge resources consisting of the different aspects of city planning and smart cities, both in India and internationally. For example the planning guides mentioned in chapter-3 could be an important set of resource. However these need to be made available over a common platform in a way so they make for easy reference, clearly indicating their scope and which aspect of urban planning and management they provide guidance. More importantly, all these need to have necessary cross referencing to avoid confusion. Apart from these guides, an inventory of other resources, which is accessible by all, would make way for an informed deliberation and also help academics, Think Tanks and corporate agencies to identify relevant research areas. The Reference Guides relating to Smart City Planning components and processes can be substantially drawn from already existing guidelines.
- 2. Bring together ongoing efforts on relevant research:** There are considerable efforts and research work already initiated by various organisations related to smart cities as well as urban planning in general in India. These efforts need to be brought to a common platform from to identify convergence, deliberate and also to leverage on key findings from them. These will substantially contribute towards some of the reference guides. For example, there are efforts towards arriving at smart city indicators and smart city standardisation in India, which can supplement each other. However, there needs to be consistency across initiatives to attain a set of common goals and there emerges the need for having a set of overarching principles. The four guiding principles identified in chapter-4 can provide easy reference in this regard.
- 3. Ensure mechanisms for convergence of programme and projects:** The Mission Statement and Guidelines emphasises on drawing convergence with various other related programmes. The key outcome suggested by the 12th Plan Working Group is "to place a framework for effective planning in all the states, with some level of consistency in processes and principles across the country. The above reference framework is recommended to

ensure a coherent and consistent process for strategic urban planning. The different guidelines, mechanisms that form part of the process identified in the SCRF, can be integrated in an easy-to-use Toolbox, to achieve technical convergence. A national level capacity building programme (Planning Commission, 2011b)(Planning Commission, 2011a), is vital to scale up the plan-making and implementation processes. The suggestions of the Working Group can be taken up in this aspect.

Further, institutional and financial convergence across sectors and schemes/programmes need to happen. To avoid multiplicity of parastatal bodies that exist today and ensure coordination between different institutions, various administrative models can be explored (Planning Commission, 2011). Incentivising the convergence of different programmes that are closely connected to it will be vital. Moreover, it will require adequate mechanism with necessary checks and balances at various stages to ensure convergence of programmes and projects.

4. **Initiate an assessment of the smart city planning and regulatory framework in India:** An assessment needs to be conducted to identify the changes needed in India's urban planning acts and regulations and the provisions of different plans. The planning stages suggested in the Reference Framework, regardless of its relevance, cannot be implemented as a streamlined process unless supported by legal mandates. Also, technology application-related domains need to be assessed with respect to the guiding principles.
5. **Constitute an expert group on Smart Cities at the national level, supplemented by expert groups at the state level:** These groups need to be supported further by a Smart City Working Group under the Department of Urban Development in each state. The Working Group should have representatives from all relevant departments and work as a secretariat to the national-level Smart City Expert Group. Involving different government departments from the initial stages of this activity will instil a sense of ownership in the stakeholder departments and will ease the process of implementation at later stages. departments from the initial stages of this activity will instil a sense of ownership in the stakeholder departments and will ease the process of implementation at later stages.

Excerpts from the Recommendations of the 12th Plan Working Group on Urban Strategic Planning- Capacity Building

- Setting up Indian Institutes of Urban Management
- Create a Reform and Performance Management Cell (RPMC) in the Government of India (and at state level and in large cities) with a multidisciplinary team undertaking activities like:
 - Promote think tank initiatives in urban policy
 - Declare leading institutions as Centers of Excellence
 - Create a Scheme for funding Strategic (Spatial) Planning Research through Centers of Excellence
- Create an annual forum for sharing of research outcomes
- Establish new schools of planning and enhance capacity of existing ones
- Producing new breed of professionals and training the resources who are already carrying out these functions.
- Funding for training & certification of in-service personnel as well as for producing more planning professionals
- Central funding for creation of state level data infrastructure for planning

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Annexure 1: Smart City Indices

Some of the prominent indexing methodologies for smart cities that are available in the public domain³⁰ are mentioned below:

i. **Smart Cities Readiness Guide by Smart Cities Council**

The Guide gives a description of smart cities and the impact of technology on future cities. It provides guidance to achieve these future cities by suggesting appropriate aspirational goals based on features and functions that reduce the risk factor and are able to achieve maximum benefits from minimum cost. The purpose of this Guide is to help decision makers like mayors, city managers, city planners and their staff to develop objectives and vendor-neutral information to enable them to make educated choices about the technologies that can transform a city.

ii. **Smart City Wheel by Boyd Cohen**

This model of a smart city is based on identifying six important aspects, namely, smart people, smart environment, smart mobility, smart living, smart economy and smart governance. In order to achieve these aspects, various drivers are considered for each component as well as numerous indicators to track their performances. Boyd Cohen's Smart City Wheel is an attempt to create a model which can be applied to any city, of varied scale, irrespective of population density, topography, existing infrastructure, etc. This model emphasises the need to integrate citizen participation in defining the vision of a city. Accordingly, realistic targets can be set and pursued taking into account best practices from around the globe.

iii. **Six ICT-enhanced Dimensions of the Smart City**

This model is an outcome of a research titled 'Expanded urban planning as a vehicle for smart cities'. It provides a revised version of existing smart city models (Adapted from (Giffinger et al., 2007)(Boyd Cohen, 2015) from an integrative and holistic perspective with a special focus on people and liveability aspects. It takes planning as a participatory knowledge-building and coordination process which strives to pull together scattered information from digital and non-digital sources intertwined with community development and local co-governance.

iv. **Ranking of European Medium-sized Cities by European Union**

According to this report³¹, the ranking of cities is a central instrument for assessing the attractiveness of urban regions. Cities are evaluated and ranked with regards to different economic, social and geographical characteristics in order to reveal the best (and the worst) places for certain activities. City rankings are mostly done either for companies which have to relocate executives (expatriates) or (future) expatriates, or for political leaders of cities and communes, and therefore differ based on the target audience. In addition to the spatial scope, the chosen factors (and corresponding indicators) are bound to the actual aim and target audience of a ranking. Refer to Annexure 3 for an inventory of smart cities indices as well as other city-level indices including the ones for specific city infrastructure and services.

³⁰ The International Organization for Standards (ISO) is also working towards developing indices for smart cities as a part of Smart City standardisation.

³¹ Source: http://www.smart-cities.eu/download/smart_cities_final_report.pdf

There are a number of smart city rankings by various organisations which use different attributes for measuring the smartness of a city. The methodology and outcome of each of these exercises however do not match with each other as can be seen in Table 3.

Table 3: Smart City Rankings by Various Organisations

Organisation/ Institute	Methodology/ Criteria	City List
Fast Co Exist	City rankings in Innovation, Quality of Life, Sustainability, Digital Community and Digital Governance	1. Vienna 2. Toronto 3. Paris 4. New York 5. London 6. Tokyo 7. Berlin 8. Copenhagen 9. Hong Kong 10. Barcelona
Institution of Mechanical Engineers (IMechE)	Smart City Initiative, Innovation, Indigenous Development Strategies, Sustainability	1. Chicago 2. Rio de Janeiro 3. Stockholm 4. London 5. Boston 6. Barcelona 7. Hong Kong 8. Singapore 9. San Francisco 10. Seoul
ACCIONA (Sustainability for All)	Governance, Urban planning, Public management, Technology, environment, International projection, Social cohesion, Mobility and transportation, Human capital and economy	1. Tokyo 2. London 3. New York 4. Zurich 5. Paris 6. Tokyo 7. Singapore 8. Los Angeles 9. Hong Kong 10. Toronto
Institute of Information Sciences, Shanghai Academy of Social Sciences	Internet space, Physical space, Economic space, Digital creativity, Content originality, Smart service, Smart management	1. New York 2. London 3. Paris 4. Berlin 5. Seoul
Global Smart City – 2015 (Juniper Research)	Use of smart grids, smart traffic management and smart street lighting, alongside aspects such as technological capability and social cohesion, among others.	1. Barcelona 2. New York 3. London 4. Nice 5. Singapore

Source: Various, CSTEP Analysis

A review of criteria and indicators used for ranking ‘Smart Cities’ vis-à-vis ‘Liveable Cities’ by various organisations indicates several overlaps; in many cases, the criteria used in one set are the subset of other (refer to Annexure 4 for Liveable City criteria and rankings). Interestingly, the cities ranked as smart are also ranked as the most liveable and vice-versa. Overall, the criteria defining a smart city contribute towards achieving sustainability in various sectors as well.

There is a substantial amount of variation between the indicator sets and the methodology applied by the various organisations. Therefore there is a need for standardising smart city indices across the globe. Various standardisation tools that are available and ongoing projects with respect to smart cities by internationally recognised organisations are discussed in Annexure 2.

Annexure 2: Standards and Certifications for Smart Cities

Presently, three important resources which may remotely qualify as a standardisation framework for Smart Cities³² include:

International Organization for Standards (ISO)

Most of ISO's smart cities related work falls under the Technical Committee 268 (TC 268) - Sustainable Development in Communities, which was constituted in March 2012³³. The primary objective of TC 268 is to build consensus among international communities on sustainable development standards. It focuses on the development of the following standards:

- a. ISO 37120: Sustainable development and resilience of communities – provides metrics for Smart Community Infrastructure based on *Global City indicators for City Services and Quality of Life*, which will help harmonise performance indicators in these fields.
- b. ISO/TR 37150 and ISO 37151 - This is a technical report on Smart Urban Infrastructures around the world, which will serve as a base for the development of the future ISO 37151 standards on harmonised metrics for benchmarking smartness of infrastructures.
- c. ISO 37101: Sustainable development and resilience of communities – Management systems – General principles and requirements - this is an output which is built on ISO 26000:2010, Guidance on Social Responsibility.

Apart from the standards mentioned above, there are other standards in ISO, which can be linked to a city's environment but are outside the purview of TC 268, such as:

- ISO 15686- Buildings and Construction Assets
- ISO 13153- Framework and Design Process for Energy Saving Single Family Residential and Small Commercial Buildings
- ISO 14001- Environmental Management System
- ISO 50001- Energy Management System
- ISO 27001- Information Security Management
- ISO 20121- Sustainable Events

³² There are more relevant standardisation activities being carried out by various organisations such as:

ITU-T – Focus Group on Smart Sustainable Cities,
 IEC – System Evaluation Group on Smart Cities,
 IEEE Standards Association – Smart Interoperability, Smart Grid Network,
 European Commission – Smart Cities and Communities European Partnership,
 CEN/CENELEC and ETSI – Coordination Group for Smart and Sustainable Cities and Communities,
 NIST - Framework and Roadmap for Smart Grid Interoperability,
 ANSI – National and International Smart City Initiative,
 BSI – Standard strategy for Smart Cities,
 ACR NEMA – Digital Imaging and Communication of Medicines ,
 China – China National IT Standardisation TC,
 Korea – U-City intrinsic lifecycle management process,
 Germany – European innovation Partnership for Smart cities and Communities, etc.

Source: ISO/IEC Joint Technical Committee Report, 2015

³³ The city-level indicators developed under TC 268 can be found in http://www.iso.org/iso/home/standards_development/list_of_iso_technical_committees/iso_technical_committee.htm?commid=656967

In September 2013, a Task Force on Smart Cities was constituted by the Technical Management Board (TMB) of ISO to develop a strategic approach to smart city development and to coordinate activities with the International Electrotechnical Commission (IEC).

International Electrotechnical Commission (IEC)

IEC publishes consensus-based International Standards and manages conformity assessment systems for electric and electronic products, systems and services aiming to serve as a reference for national and international standardisation.

IEC has so far published a White Paper on 'Orchestrating Infrastructure for Sustainable Smart Cities'. It has a set of standards and publications related to smart electrification, smart telecommunication systems, transmission protocols, etc. which can be integrated as part of smart city systems.

In June 2013, a **Systems Evaluation Group (SEG) on Smart Cities** was formed by IEC's Standardization Management Board (SMB). This group is evaluating relevant work on this aspect and proposes to establish a Systems Committee (SyC) with regards to smart cities and conduct a mapping of smart city related activities in cooperation with ISO and other organisations.

ISO/IEC Joint Technical Committee (JTC-1): Formed in November 2013, the scope of JTC-1 includes international standardisation of business and consumer applications in the field of Information Technology. There are Special Working Groups (SWG) and Joint Sub-committees working under JTC-1 on various aspects of IT standardisation, from vocabulary to sensor networks. The **Smart Cities - Preliminary Report 2014** released by ISO/IEC JTC-1 highlights the following aspects:

- Smart city characteristics, identified as: instrumentation, data aggregation, visualisation and access, measurable and real-time knowledge, analytics and decision-making systems, automation, network of collaborative spaces, more inclusive and open decision making process.
- The need for developing new indicators for the performance of ICT within smart cities in technological, market and societal terms. It also identifies the requirement, outcome and output of ICT standardisation for smart cities.

Source: 'Smart Cities: Preliminary Report 2014', released by ISO/IEC JTC-1

International Telecommunication Union (ITU)

ITU is the UN's specialised agency for ICT. ITU releases normative recommendations on standards relating to telecommunication networks, which are non-mandatory until adopted by the legal system of a particular country (apart from technical papers, regulations and resolutions and handbooks).

ITU-T Study Group 5 (SG5) established a Focus Group on Sustainable Smart Cities (FG-SSC) in February 2013. A report published by this group in 2014 called '**Smart Sustainable Cities: An Analysis of Definitions**³⁴' aims to introduce ICT as a remedy to economic and environmental problems in urban areas. FG-SSC has four main Working Groups (WGs):

³⁴ Source: http://www.itu.int/en/ITU-T/focusgroups/ssc/Documents/Approved_Deliverables/TR-Definitions.docx

- a. WG1 – ICT and roadmap for smart sustainable cities
- b. WG2 – ICT infrastructure
- c. WG3 – Standardisation gaps, KPIs and metrics
- d. WG4 – Policy and positioning

One of the key deliverables for WG1 in the Focus Group is to develop a standardised definition and attributes for ‘Smart Sustainable Cities’, especially in terms of ICT infrastructure.

The FG-SSC report identifies the following four core pillars of a smart sustainable city:

- a. Economy
- b. Governance
- c. Environment
- d. Society

The report highlights the role of ICT as crucial in delivering smart city solutions including disaster management. It recognises that “to become a smart city it is essential to adopt a holistic approach that may involve the creation of multiple infrastructures (as discussed above), as well as strengthening the motivation for government participation, the application of technology, and the integration of various smart infrastructure management systems combined with citizen collaboration” (ITU, 2014). ICT is an enabler in achieving this integration.

Source: An overview of smart sustainable cities and the role of information and communication technologies, ITU 2014

To summarise, while there are important pieces of work related to various aspects of smart cities that are being pursued, there is no single standard till date which is accepted globally as the standard method to certify a city as ‘smart’. There are standardisations for various components of a city system such as ICT and various physical and social infrastructure facilities. However many of these are in isolation. Thus there are bound to be tensions in viewing cities as a sum of products or services vis-à-vis a single dynamic entity within which the products and services are in a constant mode of interaction to deliver on the ever-changing expectations.

Annexure 3: Smart City Projects

In the context of a non-standardised eco-system for smart cities, some of the projects named as ‘Smart City’ which are being developed in different parts of the world are mentioned in Table 4.

Table 4: Examples of Smart City Projects across the World

Country	Smart City Project	Description and Status of Project	Investment Made / Planned	Area	Population
South Korea	Songdo Smart City	Smart apps, video-conferencing facilities in every apartment, daily energy consumption tracking. 40% Green space, water taxi, bicycle hire scheme, LED traffic lights, renewable energy for transportation, solid waste management pipe network, grey water and rain water collected for irrigation and recycled, automated traffic signals through public travel patterns to remove traffic jams.	\$35 billion	6.10 sq. km	65000 and increasing (300000 daily commuters)
Japan	Yokohama Smart City	Smart houses and electric vehicles, Energy management systems by involving members of public and commercial customers, CO2 emission reduction, introducing photovoltaic systems, Smart Homes, electric vehicles, etc.	Approx. 74 billion JPY	60 sq. km	420000 (about 170000 households)
India	GIFT City	Command centre for city management using the ICT, Utility tunnels, Central solid waste management system and building cooling systems	Rs. 70,000 crore	3.59 sq. km	60000-80000 (by2024)
Japan	Kashiwanoha Campus City	Public - Private -Academic partnership		2.73 sq. km	400000
Russia	Skolkovo	Smart Grids, Transportation, Education and Health Care	\$ 2 billion	-	Upto 300000
Japan	Nagama City	Reduction of ICT cost and enhance network operation and management efficiency	-	539.48 sq. km	123071
Japan	Yokohama Smart City	Renewable energy(solar), smart homes, CO ₂ emission reduction	74 billion JPY	60 sq. km	420000
Japan	Kitakyushu Smart Community Creation Project	Private homes and solar parks, using conventional energy sources like wind and geothermal, CO ₂ emission reduction	16.3 billion JPY	1.2 sq. km	600(200 households)

Japan	Toyota City Low-Carbon Verification Project	Houses with renewable energy (solar), smart homes, CO ₂ emission reduction	22.72 billion JPY	918 sq. km	420000 (160000 households)
Japan	Keihanna Eco-City (Kansai Science Park)	Using renewable energy (solar), smart homes, CO ₂ emission reduction	13.5 JPY	154 sq. km	170000 (60000 households)

Source: CSTEP Analysis

Table 4 shows that there are a wide range of examples and models being pursued as smart cities which substantially vary in their scale, objectives and the geo-political context in which they are built. Thus the suitability of these smart city examples for replication in the Indian context demands a careful examination and necessary alterations and contextualisation.

Annexure 4: Sustainable Development Goals

One of the main outcomes of the Rio+20 Conference was the agreement by member States to launch a process to develop a set of Sustainable Development Goals (SDGs), which will build upon the Millennium Development Goals and converge with the ‘post-2015 Development Agenda’. In the Rio+20 outcome document, it was agreed that SDGs must:

- Be based on Agenda 21 and the Johannesburg Plan of Implementation
- Fully respect all the Rio Principles
- Be consistent with international law
- Build upon commitments already made
- Contribute to the full implementation of the outcomes of all major summits in the economic, social and environmental fields
- Focus on priority areas for the achievement of sustainable development, being guided by the outcome document
- Address and incorporate in a balanced way all three dimensions of sustainable development and their inter-linkages
- Be coherent, and integrated into UN’s development agenda beyond 2015
- Not divert focus or effort from the achievement of the Millennium Development Goals
- Include active involvement of all relevant stakeholders, as appropriate, in the process (United Nations – Sustainable Development Knowledge Platform).

Sustainable Development Goals	
Goal 1	End poverty in all its forms everywhere
Goal 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3	Ensure healthy lives and promote well-being for all at all ages
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5	Achieve gender equality and empower all women and girls
Goal 6	Ensure availability and sustainable management of water and sanitation for all
Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10	Reduce inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts
Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17	Strengthen the means of implementation and revitalize the global partnership for sustainable development

For details and further information, go to United Nations – Sustainable Development Knowledge Platform <https://sustainabledevelopment.un.org/focussdgs.html>

Annexure 5: Proposed Indicators under Four Principles for City Selection

Larger regional development agenda	<p>The city selection parameters should converge with larger sustainability goals like:</p> <ul style="list-style-type: none"> • Regional development strategy • State development strategy • Climate Change Action Plan
Replicability and scalability	<p>Each city is different, however the initiatives need to be scaled-up and processes replicated, if the pilot cities are such that it demonstrates contextual variation. Thus, the selection should include:</p> <ul style="list-style-type: none"> • Cities of different population size ranges • Cities with varied physical characteristics • Cities with different types of economic activities
Addressing vulnerability	<p>Some cities are more vulnerable, due to their location constraints and so prioritisation of the challenges become necessary. Vulnerability constraints that should be addressed are:</p> <ul style="list-style-type: none"> • Area prone to climate/other disasters • Natural resource constraint, especially water • Ecologically sensitive areas (natural trails, etc.)
Probability of Success	<p>The pilot smart city initiatives should have a positive impact to ensure stakeholder confidence. The major parameters that determine this are as follows:</p> <ul style="list-style-type: none"> • Economic growth potential - location with respect to growth corridors, committed investments, etc. • Infrastructure preparedness - Physical infrastructure and facilities such as roads, water supply, sewerage, drainage, sanitation, etc., and social infrastructure such as education institutions, and health care facilities • Educated/ aware citizens - education level, presence of knowledge institutions, participation in governance, use of internet-based services • Proactive city government - timely preparation of required plans and their revision, responsiveness to reforms, efficiency of citizen services and grievance redressal • ICT intervention preparedness - database, GIS-based map, etc.

Annexure 6: Sources for Gap Analysis of Different Sectoral Indicators

Sector	Indicator Sources				
Environment	World Bank Indicators	Eco Cities (China)	OECD Indicators		
Housing	Sustainable Measures	Global City Indicators	Smart Cities-Ranking of European medium sized cities	Report on trend and progress of housing in India-National Housing Bank	Affordable Housing Performance Indicators for Landed houses in the Central region of Malaysia
Health	ISO Indicators	World Bank	URDPFI Guidelines	OECD Indicators	World health Organisation
Water	ISO Indicators	Global City Indicator	Handbook of Service Level Benchmarking	Performance indicators for water supply-International water association	PAS-Performance measurement for Urban Water supply and sanitation
	Result and indicators for the water and sanitation sector: European Commission	The California Water sustainability indicators framework			
Solid Waste Management	ISO Indicators	Global City Indicators	Handbook of Service Level Benchmarking, MoUD	PAS	
	UNEP, Solid Waste Management Performance Indicators for Solid Services	Professor David C. Wilson, Waste and Resources Management Consultant - Waste Management; an indicator of urban governance	Resources, Conservation and Recycling Assessment of factors influencing the performance of solid waste recycling programmes		
Sanitation	ISO Indicators	Global City Indicators	Handbook of Service Level Benchmarking, MoUD	Water and Wastewater Utilities Indicators	Outcome and Impact Level Indicators, Water and Sanitation Sector

Sanitation	Revised Draft, Goals, Targets, Indicators, and Definitions for Post-2015 Sanitation Monitoring	City Sanitation Plans	Performance Assessment System		
Education	OECD	World Bank	UNESCO	ISO Indicators	Global City Indicators
	URDPFI Guidelines	SSA Guidelines	NCERT	Smart City Study- International Study on the situation on ICT, innovation and knowledge	
Transport	ISO Indicators	Global City Indicators	Service Level Benchmarks for Urban Transport at a glance, MOUD	Ministry of Transport, New Zealand	Developing Indicators for comprehensive and sustainable transport planning, Victoria Transport Policy Institute
	Indicators to assess sustainability of transport activities	Sustainable measures	Sustainable Urban Transport in Asia, Making the Vision a reality-project report	Tool kit for Gender Equality results and indicators	Worldwide trends in Energy Use and Efficiency, IEA
Energy	End-use of electricity in households of Karnataka State, India	ISO Indicators	Global City Indicators	Global Tracking Framework	Energy Indicators for Sustainable Development-Guidelines and Methodologies
	High Performance Commercial Building System-California Energy Commission	Worldwide Trends in Energy Use and Efficiency-International Energy Agency	International Energy Agency-World Energy Outlook	Indicators for the framework for action on energy security in the pacific - Gerthard Zieroth energy consultant	Monitoring Performance of Electric Utilities: The World Bank

Annexure 7: Indicators for Baseline using Mobility Indicators as an Example

Transport: Well-being		
Questions	Indicators	Formula/Input
What is the average travel time for commute?	Average travel time	Travel Time
	Maximum travel time for the longest trip	Travel Time
	Average travel time to amenities/work/recreation	Travel Time from residential area to work/amenities/recreation areas
What is the contribution of this sector on pollution levels, and health?	Passenger Transport CO2 Emissions per Capita	CO ₂ emissions from passenger vehicles(Bus, Cars, Two Wheelers, Three Wheelers)/ Total Population
	CO ₂ , SO ₂ , SPM, RSPM, NOx Emissions from transport sector	Emission factor of vehicles multiplied by VKMs travelled (µg/m ³)
	Test samples exceeding permissible limit for air and noise	Number of test samples exceeding permissible limit for air and noise/ Total number of samples collected for air and noise*100
	Total vehicle emissions	Emission factor of vehicles multiplied by VKMs travelled (µg/m ³)
	Road traffic noise measurement	Noise levels in decibel
What is the average distance travelled for services, work, and recreation?	Largest distance between two points within city limits	City radius
	Average commuting distance to services, work, and recreation	Average distance from residential areas to services, work, and recreation
What is the per capita availability of transport options?	Kilometres of high capacity public transport system per 100000 population	Total length of public transit system/ Total population*100000
	Availability of public transport/ 1000 population	Ratio of Total no. of buses/train coaches available in the city on any day to total population of the city*1000
	Kilometres of bicycle paths and footpath lanes per 100000 population	Total length of bicycle and pedestrian path/lane in the city / Total population*100000
	Number of bus stops/metro stations/ BRT stations per 1000 population	Total no of bus stops/metro stations/ BRT stations / total population*1000
	Rapid Transit to Resident Ratio	(Ratio of kilometres of Mass Rapid Transit to Millions of Urban Resident)
	Number of personal automobiles per capita	Total number of passenger vehicles registered/ Total population
How is the average accessibility to different modes of transit?	Percentage of the population who can get to key locations door-to-door by public transport, walking and cycling	Total population - Population using private vehicles for commuting
	Percentage of households with access to a motor vehicle	Number of households with access to a motor vehicle / Total number of households*100
	Percent of population taking public transportation to work	Total number of trips to work by public transport / Total number of trips to work *100
What is the spatial reach of transport options?	Availability of high quality and high frequency mass transport within 800m(10-15 minute	yes/no

	walking distance) of all residences in areas over 175 persons / ha of built area	
	Service coverage of public transport	Ratio of Total length in kilometres of public transport systems in the city to Area of the urban limits of the city
	Access to Intermediate Public Transit within 300m walking distance	yes/no
	Percentage of road-based short trips of less than 5 kilometres by bicycle	Number of trip legs by bicycle with 5 km / total no. of trips legs within 5 km
	Percentage of short trips of less than 2 kilometres on foot	Number of trip legs by foot with 2 km / total no. of trips legs within 2 km
	Percentage of population with commute time 25 minutes or less	Population with average travel time less than 25 minutes / Total population*100
What is the comfort level?	Availability of accessible information about public transport services	yes/no
	Percentage of fully accessible bus/metro/BRT stops and train stations	Number of bus/metro/BRT stops designed as per universal accessibility standards / total no. of bus / metro/BRT stops *100
	Number of minutes between buses/metro/BRT on scheduled routes	Frequency of buses/metro/BRT buses within a specified interval
	Footpath quality	Compliance with Universal accessibility standards, design standards/guidelines - yes/no
	Road quality – Percentage of paved roads, fair/good condition	Total Length of Paved Roads / Total length of Roads*100
	Bus stop and metro station quality	Compliance with Universal accessibility standards, design standards/guidelines - yes/no
	Bus stops/metro stations/ BRT stations having feeder services	Number of bus stops/metro stations/ BRT stations having feeder services / Total number of bus stops/metro stations/ BRT stations*100
	Percentage of bus stops having roof and sitting arrangement	Total number of bus stops with roof and sitting arrangement / Total number of bus stops*100
How safe is it to travel by different modes?	Perceptions of safety when using modes of public transport, by sex and age	Safe/ Partially Safe/ Unsafe
	Traveller crime and assault rates	Number of case reported for crime/assault in public transport +walking +cycling +IPT / Total number of crime/assault cases reported

Transport: Equity		
Questions	Indicators	Formula/Input
Do specific groups (minority/slum population/BPL/different age groups/gender/differently-abled) within the city have access (physical, social and economic) to different transport options?	Availability of streets and pedestrian pathways with universal access	yes/no
	Portion of destinations accessible by people with disabilities and low incomes	Number/ length of streets having compliance with universal accessible standards and any specific design guidelines for disadvantaged people / total number/length of streets in the city
	Number of completed gender-responsive design features that facilitate access for female transport users, people with disability, and the elderly	Number
	Portion of low income households that spend more than 20% of budgets on transport.	Total number of slum HH that spend more than 20% of budget on transport / total number of slum HH*100
	Changes in the number of women using public transport services due to improved transport facilities and services	Total number of female passenger boarding in public transport
	Number and percentage of women and men who access employment or better income opportunities due to improved transport infrastructure and services	
	The proportion of income spent on public transport by women and men	Average fare of all public transport modes for maximum distance / Average income of women/men*100
	Quality of transport for disadvantaged people (disabled, low incomes, children)	Compliance with universal accessible standards and any specific design guidelines for disadvantaged people - yes/no
	Number and percentage of female and male security staff on public transport	
	Percentage of transport staff trained in preventing sexual harassment and appropriate responses	Number of transport staff trained in preventing sexual harassment and appropriate responses / Total number of transport staff*100
	Average travel time to employment by women	Travel Time
	Number of physical and sexual assaults on public transport reported by women and girls (including by female staff)	Number
What is the gap between the well-being indicator performances, with the equity indicator performance?	Average travel time in Slum areas	Travel Time
	Average travel time from slum area to city centre(CBD)	Travel Time
	Average travel time to services, work, and recreation, in slum areas	Travel Time
	Percentage/number of test samples collected from slum areas exceeding permissible limit for air and noise	Number of test samples collected from slum areas exceeding permissible limit for air and noise/Total number of test samples collected from the whole

		city*100
	Road traffic noise measurement in slum areas	Noise levels in decibel
	Availability of public transport/ 1000 population in slum areas	Ratio of Total no. of buses/train coaches available in the for slum population on any day to total slum population of the city *1000
	Kilometres of bicycle paths and lanes per 10000 slum population in slum areas	Total length of bicycle and pedestrian path/lane in the slum areas/ Total slum population*100000
	Number of bus stops/metro stations/ BRT stations per 1000 slum population	Total no of bus stops/metro stations/ BRT stations in or near by slum areas / total slum population*1000
	Number of personal automobiles per capita slum population	Number of registered personal automobiles owned by slum population/ Total slum population
	Percentage of slum population who can get to key locations door-to-door by public transport, walking and cycling	
	Percentage of slum households with access to a motor vehicle	Number of registered personal automobiles owned by slum population/ Total slum population*100
	Percent of slum population taking public transportation to work	Total number of trips by slum population to work by public transport / Total number of trips by slum population to work *100
	Access to Intermediate Public Transit within 300m walking distance of slum areas	yes/no
	Percentage of slum population with commute time 25 minutes or less	Slum population with commute time 25 minutes or less / Total slum population *100
	Road quality –Percentage of paved roads, fair/good condition in slum areas	Total length of paved roads in good condition in slum areas / total length of roads in slum areas *100
	Traveller crime and assault rates in slum areas	Number of case reported for crime/assault in public transport +walking +cycling + IPT / Total number of crime/assault cases reported in slum areas
Do citizens participate in decision making?	Stakeholder Consultations in preparation of master plan/ mobility plan/ development plan/ transit oriented design	yes/no
	Perception study/survey for safety/comfort of public transit	yes/no

Transport: Efficiency		
Questions	Indicators	Formula/Input
What is the city's carbon footprint?	Per capita impervious surface area due to transport	(Total area of roads + Total area devoted to transport facilities)/Total Population
	Per capita land devoted to transport facilities	Total Area Devoted to Transport Facilities/Total Population
What are the consequent emission levels?	Passenger Transport CO ₂ Emissions per Capita	Co2 emissions from passenger vehicles(Bus, Cars, Two Wheelers, Three Wheelers, Metro rails)/ Total Population
	Freight Transport CO ₂ Emissions per Capita	CO2 emission from freight transport(LCV, HCV)/ Total Population
	Number of days of exposure per year	Number of days where emission level is higher than permissible limit/ 365 days
	CO ₂ , SO ₂ , SPM, RSPM, NO _x Emissions	Emission factor of vehicles multiplied by KMs travelled (µg/m ³)
What is the overall energy efficiency level?	Per capita transport energy consumption	Total fuel, electricity, gas, consumed by different modes of transport/Total Population
	Ratio of fuel-efficient/fuel-inefficient vehicles (Litre/km - Average fuel consumed to undertake a number of journeys of a total distance measured by km (fuel consumption per distance travelled))	Number of vehicles with fuel efficiency equal to or more than Corporate Average Fuel Consumption(CAFC) standards as per Bureau of Energy Efficiency guideline/ Number of vehicles with lesser fuel efficiency than CAFC Standards
	Percent of city fleet converted to reduced emission fuels	(Number of Vehicles using petrol and diesel converted to CNG and electric energy sources/ Total number of vehicles in city)*100
	Energy Use per Passenger-Kilometre Aggregated for All Modes	Total energy consumption by all modes/(total passenger*Total KM)
	Average Fuel Intensity of the Car Stock	Total emissions(CO ₂ , SO ₂ , SPM, RSPM, Nox) from car stock/ total number of Cars
	Passenger Transport Energy Use per passenger-vehicle kilometre by Mode	Total energy consumption by modes(Bus or Car or Two Wheeler or Three Wheeler or Van, Metro etc)/(total passenger by mode(Bus or Car or Two Wheeler or Three Wheeler or Van, Metro etc)*Total km)
	Freight Transport Energy Use per Tonne-Kilometre by Mod	Total Energy consumption for freight transport/Total FTKM(Total Load * Total Distance)
	Per capita use of imported fuels	Total imported fuel/ Total population
Overall resource efficiency levels? (bus	Total public transport boarding per capita	Total passenger using public transport/ Total population

mileage, car mileage- an indicator of congestion levels)	Per capita congestion delay (Congestion: Minutes lost per person or per kilometre per day)	<ul style="list-style-type: none"> Hourly Delay(HD)=Estimated travel time under actual (often congested) conditions - Estimated travel time under uncongested conditions(for each road segment and each hour of the day) Daily Vehicle Hours of Delay(DVHD) = HD per vehicle * annual average hourly traffic for each hour Total Daily Vehicle Hours of Delay(TDVHD)= Sum of all DVHD of all road segments Total person hours of delay = TDVHD * vehicle occupancy Per capita Congestion delay = Total person hours of delay/Total Population
	Vehicle kilometres travelled	Total number of Vehicles * Total Distance covered by those vehicles
	Average age of vehicle fleet of public transport	Sum of ages of all vehicle fleet/Total number of vehicles
	Per capita congestion cost	Additional travel time costs divided by area population
Overall financial viability of public transit authorities?	Extent of Non fare Revenue (%)	(Total revenue from sources apart from fares(Private Investors, Earmarked Charges, General Budget, Secondary Revenue)/Total transport Revenue)*100
	Percentage contribution to GDP	(Total GDP contribution from Transport/Total GDP from all sectors)*100
	Total municipal road and transit expenditures per capita (include capital and operating expenditures)	Expenditure on municipal roads and transit/Total population
	Operating Ratio	Total Expenditure on Public Transport/Total Public Transport Revenue from all sources
	Transit revenues per transit-rider trip, inflation adjusted	(Total revenue from sources apart from fares(Private Investors, Earmarked Charges, General Budget, Secondary Revenue + Fare Revenue)/Total Transit Rider
How much employment is generated vis-a-vis per capita investment?	Contribution of transport sector to employment	Total Employment in transport Sector/Total Employment
What is the efficiency in transport operation?	Average Waiting time at intersections with traffic signals	Total waiting time interval of all Traffic Signals/ Total Number of Traffic Signals
	Cost of Travel Per Km per person	Total Cost of Travel/(Total km Travelled*Number of Person)
	Average Cost of public transport per capita	Total Cost of Travel/(Total km Travelled*Number of Person)
	Percentage of people choosing public transit over car	(Total number of public transit boardings/Total Population travelling in cars)*100
	Fatality rate / 100000 population (Total no. of fatalities recorded in road accidents in a year)	Total no. of fatalities recorded in road accidents in a year/100000 population

	Fatality rate for NMT (%) (Total no. of fatalities recorded of people using NMT/ Total no. of fatalities recorded in road accidents*100)	(Total no. of fatalities recorded of people using NMT/ Total no. of fatalities recorded in road accidents)*100
	Consumer expenditures on transport	Expenditure spent on Transport/Total expenditure(Household or Individual)
	Encroachment on NMT paths by vehicle parking (%) (Total length of parking encroachment/ Total length of NMT path *100)	(Total length of parking encroachment/ Total length of NMT path)*100
	Cycle parking facilities at interchanges (Total no. of interchanges having bicycle parking / Total no. of interchanges *100)	(Total no. of interchanges having bicycle parking / Total no. of interchanges)*100
	Occupancy rate of passenger vehicles	Total number of Passengers/Total carrying capacity of Vehicles
	Percentage of population with commute time of 25 minutes or less	Population with commute time 25 minutes or less/Total population

Transport: Foresight		
Questions	Indicators	Formula/Input
Does the city have a transport and public transit plan in alignment with the land-use plan for the city?	Link between planning and implementation at the onset of the physical development process	yes/no
	Policies to protect high value farmlands and habitat	yes/no
	Percentage of area under mixed land use	Total area under mixed land-use/Total area of the municipality*100
	Intensity of development FSI	Average FSI applicable to most parts of the city as per Master Plan/ Development Plan
	Intensity of development FSI along transit corridors	Average FSI along transit corridors/ Average FSI applicable to most parts of the city as per Master Plan or Development Plan
Are the plans updated periodically to capture the change in urban form, density, etc.?	Periodic revision/upgradation of master plan, city development plan, development plan, city mobility plan, integrated mobility plan etc	yes/no
Does it consider climate change, resilience building, and energy efficiency?	Use of zero-emission vehicles – percentage	Number of registered electric vehicles/ total number of registered*100
	Availability of air quality standards and management plans.	yes/no
	R &D expenditure on “eco-vehicles” and clean transport fuels	In lakh rupees
	Total expenditure on pollution prevention and clean-up	In lakh rupees
	Use of renewable fuels (alternative-fuelled vehicles) use of biofuel	Number of registered biofuel or CNG vehicles/ total number of registered*100

Does the city have a framework for knowledge and capacity building?	Availability of capacity Building plan for transport sector	yes/no
	No of think tanks/research institutes working in transport sector	Number
	Workshops and training programmes for personnel engaged in transport sector	Number of workshops/ training sessions held in a year
	Gender safety awareness in public transport	Number of awareness campaigns in a year
	Number of publications related to transport development	
Does it have a resource management plan?	Management of used oil, leaks and storm water	yes/no
	Taxation of vehicles	Total tax collected from transport sector/ total tax collected*100
	Availability of transport funds for alternative modes and demand management	yes/no
	Subsidies to public transport	yes/no
	Share of Government investment in transport related to gender issue	Investment on transport related to gender issues/ total investment in transport sector+100
Does it have a disaster preparedness plan?	Presence of sustainable, innovative and safe transport system	yes/no
	Presence of security framework	yes/no
	Presence of evacuation plan during disaster for various transport modes	yes/no
	Compliance with fire safety standards for transport infrastructure and logistics	yes/no
Is it capturing and storing data? Is it updated periodically? Is data analysis done?	Presence of citywide data management, transparency and sharing policy	yes/no
	Have access to a central GIS	yes/no
	Presence of data of transport routes: quantitative and map data	yes/no
	Presence of transport logistics data	yes/no
	Periodic upgradation of data	Interval for periodic upgradation for data
	Availability of planning information and documents	yes/no
Does it follow a specific decision making process?	Portion of population engaged in planning decisions	percentage
	Presence of clearly defined goals, objectives and indicators	yes/no
	Enable dynamic, demand-based pricing	yes/no
How does it use technology for efficiency in operations, and governance?	Integration of all transport modes for multi-modal transportation optimisation	yes/no
	Availability of ICT - infrastructure	yes/no
	Presence of Integrated Ticketing System	yes/no

	Multi-channel access to an integrated customer transportation account	yes/no
	Implementation of cyber security	yes/no
	Have access to comprehensive device management	yes/no
	Access to Passenger Information System (PIS) %	Total no. of bus stops, terminals, metro stations having PIS/ Total no. of bus stops, terminals, metro stations*100
	Access to Global Positioning System (GPS) %	No. of PT vehicles and IPTs with GPS/GPRS connected to common control centre/Total No. of PT vehicles and IPTs
	Availability of Traffic surveillance (%)	total no. of bus stops, metro stations, terminals and signalised intersections having CCTV/ total no. of bus stops, metro stations, terminals and signalised intersections*100
	Support for smart growth development	yes/no



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