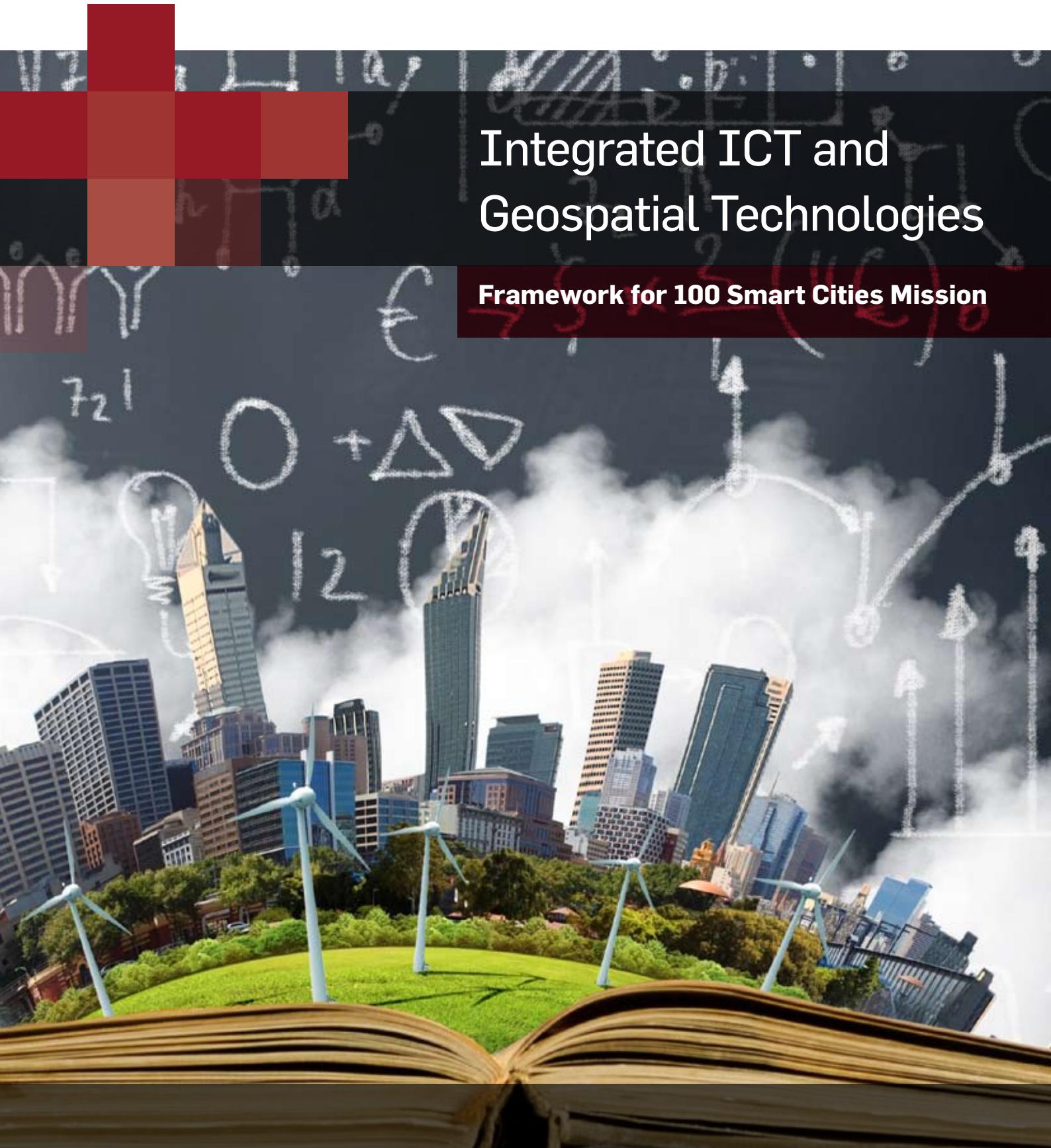


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Integrated ICT and Geospatial Technologies

Framework for 100 Smart Cities Mission



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Foreword

Smart Cities - Transforming Life - Transforming India

India's economy is expanding rapidly and is making a steady shift from 'rural' to 'urban'. India is anticipated to witness a rise in urban population from 377 million in 2011 to 600 million in 2031. By 2031 India is also expected to have grown its economy by five times, sustained largely by the country's urban centers. Given this rapid rate of urbanization, India is likely to have around 68 cities with population of more than 1 million by 2030.

Government has rightly anticipated the emergence of the "neo middle class" which has aspiration of better living standards. To revive the urban landscape of the country, to make them more livable and inclusive, besides driving economic growth, Government of India has embarked on an ambitious Smart Cities programme. Taking the Smart Cities Mission further, the Union Cabinet chaired by Honorable Prime Minister, cleared the Smart Cities Mission and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) for 500 cities with significant budget outlays in April 2015. The focus will be on core infrastructure services like adequate and clean water supply, sanitation and solid waste management, efficient urban mobility and public transportation, affordable housing for the poor, power supply, robust IT connectivity, governance, especially e-governance and citizen participation.

A key challenge in developing smart cities is the complexity of how cities are planned, operated, and financed. As population in India surges, it places greater stress on the city infrastructure such as transportation, healthcare, education and public safety. The urban migration challenge in India is far more unprecedented than anywhere in the globe and hence India needs to innovate and develop its unique smart cities programme enabled by ICT.

The solution is to develop new cities and modernize existing Indian cities leveraging the efficiencies and effectiveness enabled by implementing city specific ICT solutions.

The Integrated ICT and Geospatial Technologies Framework for the 100 Smart Cities Mission has been developed with the aim to demystify the role of ICT in developing Smart Cities. The framework tries to capture and address the issues & needs of all stakeholders including citizens and businesses. The ICT interventions will enable management of cities in a manner that is sustainable, transparent and efficient. The framework also proposes the ICT Governance model, organizational requirements, conceptual architecture, implementation approach and performance management approach over and above drawing reference to already existing investments in ICT, under various MMP's, wherever applicable.

We trust that you will find the report useful and we welcome your feedback and comments.



R. Chandrashekhar
President, NASSCOM



Avinash Vashistha,
Chairman and Managing
Director, Accenture India

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The Integrated ICT and Geospatial Technologies Framework for 100 Smart Cities Mission is an endeavor to demystify the role of ICT in developing Smart Cities.

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The role of the NIUA deserves a special mention for their guiding hand and thoughtful and timely inputs during the course of the development of this framework.

Special Thanks to:



Smart Cities Executive Overview

1. Smart Cities Executive Overview

Background

India is expected to witness an increase in urban population from 377 million in 2011 to 600 million (roughly twice the current population of the United States) in 2031. Given these numbers, the country is expected to have around 68 cities with population of more than 1 million by 2030. This rapid urbanisation is putting up additional pressure on Indian cities which are already struggling to deliver basic city services and infrastructure to citizens and businesses due to lack of robust urban planning mechanism, infrastructure development and investments.

There is a growing need to embrace innovative approaches to new city development and city management. Rapid advances in technology will only make it more feasible.

How do we define smart cities?

A smart city effectively delivers public services to citizens and businesses wherever they may be located, in an integrated and resource-efficient way while enabling innovative collaborations to improve the quality of life, reduce any detrimental impact on environment, grow the local and national economy and ensure safety and emergency compliances.

For creating smart cities, India needs a balanced focus in terms of modernising city infrastructure and leveraging technology to improve efficiency and capacity of city services. In terms of city infrastructure, investments are required to modernise city services like water, energy, public transportation, roads, sewage, etc. In terms of technology, investments are required to take up technology initiatives in core city subsystems like energy, water, transportation, public safety, citizen services, city governance, healthcare, education, etc. and overall at city level to improve collaboration amongst these city subsystems, improve citizen's participation and to wring out efficiencies from the infrastructure assets.

Essence of smartness in a city lies in integration of the core city subsystems and a deep analysis of the resultant data in ways meaningful to all the stakeholders. All of this can be facilitated by leveraging advances in technologies as well as by synergising with several investments already made in creating technology infrastructure, all across.

The Integrated ICT and Geospatial Technologies Framework for 100 Smart Cities Mission

The Integrated ICT and Geospatial Technologies Framework for 100 Smart Cities Mission is developed with an aim to define the role and impact of Information Communication Technologies (ICTs) and Geospatial Technologies (GTs) in developing smart cities.

The core elements of framework include:

- **Value chain and issues/Need analysis of city core subsystems:** Value chain analysis is conducted to map the core city subsystems. As a part of this, issues, pain points and needs of stakeholders in the value chain of the specific city core subsystems are identified
- **Define smart for each city core subsystems:** Identify smart technology solutions for each of the city core subsystems to address issues, pain points and needs of the stakeholders
- **ICT governance, organisational requirements, change and capability development at city levels:** This section deals with suggested governance and organisational structures at a city level and also addresses the change and capability development aspects

- **Smart city conceptual architecture:** This section provides an overview on the conceptual architecture, architecture principles to be followed to create deployment architecture and smart cities-specific standards to be adhered to while defining and developing the technology solutions. It also provides the overall architecture framework
- **Implementation framework and approach:** Provides a framework and approach for implementation of the technology solutions and suggested next steps
- **Performance management framework:** Provides a framework to assess and benchmark the performance of the city

This framework will not only demystify the adoption of technology in various domains and sub-domains of a city but also serve as a ready reckoner for state/local administration including Urban Local Bodies (ULBs) and regional development authorities for any ICT-related interventions which would be required in the journey of a city to become a smart city.

The framework also provides a high level overview of various ICT-related investments already made in cities/states under various Mission Mode Projects (MMPs) of Department of Electronics and Information Technology (DeitY), Government of India and several other line ministries, which could be leveraged upon by the state/local administration.

Overview of Global Smart Cities Initiatives

2. Overview of Global Smart Cities Initiatives

Urbanisation is one of the key socio-economic trends of the next decade. It is predicted that by 2050 about 64 per cent of the developing world and 86 per cent of the developed world will be urbanised. This rapid urbanisation has cities at the core of the world growth agenda. Competitiveness of nations is turning into competitiveness of cities. Attractiveness of cities depends on effectiveness of city's economic, environmental and social services. With burning need to improve a nation and a city's competitiveness, many nations around the world have taken up smart cities initiatives to improve competitiveness of its cities. Some of the examples of global smart cities initiatives are:

Singapore

Long-term planning and strategic partnerships with leading universities and corporations, and substantial government investments in both money and manpower have enabled Singapore to transform the city into one of the most innovative, sustainable and tech-savvy cities on the planet. Every 10 years since 1971, Singapore issues a concept plan with a 40-50-year time frame. Every five years, most recently in 2008, it issued more detailed plans on smart growth. On the city's streets, a network of sensors, cameras and GPS devices embedded in taxi cabs track traffic, predict future congestion alerting all downtown drivers to alternate routes. Singapore's advanced system on congestion pricing utilises traffic data to adjust prices in real-time and drivers' accounts are automatically deducted as they glide beneath electronic gantries. The city's water management system is among the world's most advanced, and the government is testing a new desalination technology for seawater that would be 50 percent more energy efficient than any current method. A super-fast, next-generation broadband network already reaches 95 percent of homes and businesses in Singapore.

Dubai

After focusing the initial 10 years on physical infrastructure and its modernisation, Dubai embarked on a smart city programme across three tracks – smart life, smart economy and smart tourism. The six key initiatives included: 1) Open and easy access to data shared among residents and institutions with smart boards for residents to obtain information about the city; 2) A central control centre to monitor and manage traffic throughout the city; 3) 'Smart Electrical Grid' programme to encourage residents to use solar energy and sell the surplus to the Authority; 4) Smart parks and beaches that will provide relevant information such as safety instructions, weather and sea conditions, temperature and more; 5) Police smartphone to enable residents to make reports and enquiries without having to travel down to a police station; 6) World's largest 5D control room, which will be the central operation centre to oversee all government projects and monitor real-time situations in the city, including emergencies, road conditions, weather, etc.

Amsterdam

Amsterdam Smart City (ASC) started in 2009 as a collaboration project between Amsterdam Innovation Motor and the grid operator Liander, in close collaboration with the municipality of Amsterdam. Today, the project involves over 70 different partners. Amsterdam is focusing on the challenge of saving energy to reduce CO₂ emissions. To do this, ASC has introduced and tested a vast amount of energy saving projects, divided into four areas: sustainable public space, sustainable mobility, sustainable living and sustainable working. Some of the key projects included smart meters, energy sensors, use of electrical vehicles, etc.

Birmingham

Birmingham Smart City Programme is led by the Birmingham Smart City Commission, a body created by the city council which includes leading figures from the business, academic and public sector. It is a collective ambition by city stakeholders to deliver real change by developing intelligent and integrated services through the use of digital technologies, data and open collaboration, driven by the citizens and communities that are core to the city's future growth. The roadmap comprises 39 proposed actions like free community Wi-Fi, eHealth services, smart metering, etc., to be delivered over the next three years, by identifying funding through European, national and regional programmes.

Smart Cities Framework for India

3. Smart Cities Framework for India

India's population in towns and cities is expected to reach 600 million by 2031¹. Urban infrastructure in these towns and cities will need to keep pace with the growing requirements in the years to come. India is also a diverse country with varied geographic, socio-economic and cultural differences across the country. Within this context there is no one-size-fits-all solution that is feasible to be developed for India.

We propose a smart city framework for India which is driven by the unique challenges faced by the Indian cities. It covers the physical, social, environmental and institutional (governance) infrastructure requirements for a smart city driven by stakeholder collaboration and one which extensively leverages the advances made in the domain of Information and Communication Technologies (ICTs).

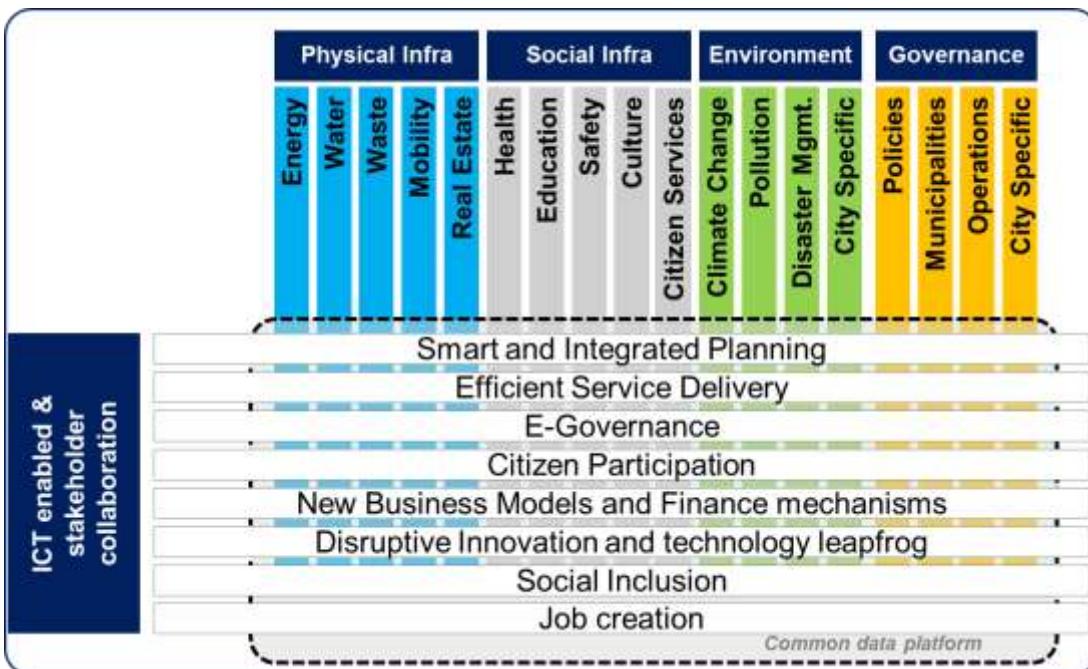


Figure 1: Overall smart city framework for India

The framework covers physical and social infrastructure, environment and governance systems required to design a smart city. Each of the parameters has been further elaborated to layout the components.

- **Physical infrastructure:** Physical infrastructure illustrates requirements within various layers of energy, water, waste, mobility and real estate necessary for a robust smart city infrastructure. The objective here is to provide cost-efficient and intelligent physical infrastructure such as electricity supply, transport and traffic infrastructure, water supply system, sewerage system, sanitation facilities, drainage system and building energy, security systems, etc.
- **Social infrastructure:** Social infrastructure relates to provisions of healthcare, education, safety, cultural requirements and establishments for citizen services required by the city. Smart social infrastructure aims to ensure intelligent and better connected infrastructure for various social needs and services for citizens
- **Environment :** Smart cities need to be sustainable and environment-friendly. There need to be systems and processes in place to address climate change, pollution, disaster management and any city specific issues.
- **Governance:** Smart city should comprise governance mechanisms to ensure proper functioning of all other systems and processes. This begins with having requisite policies and regulatory mechanisms, an urban local body to execute processes along with an execution mechanism

¹<http://www.firstpost.com/india/indiast-urban-population-reach-600-mn-2031-un-backed-report-1716149.html>

Synergies With Key National Programs

4. Synergies with Key National Programmes

The 100 smart cities programme is taken up by the Government of India to develop selected 100 cities in India on smart cities concept to improve the quality of life of citizens, spur economic development and reduce impact on environment.

Smart cities concept is relevant and important for Ministry of Urban Development programmes like 100 smart cities programme, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Heritage City Development & Augmentation Yojana (HRIDAY) and Swachh Bharat Mission (SBM). Visible areas of synergy exists amongst these ambitious and nationally-important initiatives.

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

About the programme

Inadequate infrastructure, rising population rates as well as rising urban poverty are major causes of degradation in cities. The Government of India has therefore taken up AMRUT initiative to redevelop urban towns and cities by developing infrastructure, carrying out municipal reforms and providing aid to the state governments and the ULBs.

AMRUT is a city-modernisation scheme launched by the Government of India under the Ministry of Urban Development. AMRUT aims at creating ‘economically productive, efficient, equitable and responsive cities’ by upgrading the social and economic infrastructure in cities.

Relevance and importance of smart cities concept

India needs balanced focus in terms of creating/upgrading city infrastructure and leveraging ICT and Geospatial technologies to improve efficiency and capacity of city services. In terms of city infrastructure, investments are required to create/upgrade city services like water/energy/public transportation/roads/sewage, etc. In terms of technology, cities need to take up technology initiatives in core city subsystems like energy/water/transportation/public safety/citizen services/city governance/healthcare/education, etc. and overall at city level to improve collaboration among these city subsystems.

While infrastructure development understandably takes a long time, technology adoption can be much quicker and lead to quick and noticeable improvement in city services.

Considering the role and impact of technology on improving/modernising city services, technology is going to be a key pillar for modernising cities in India. You can refer to various sections in this document to know more about the role of technology in improving city subsystems like water/energy/transportation, etc.

Heritage City Development and Augmentation Yojana (HRIDAY)

About the programme

India is endowed with rich and diverse resources. However, it is yet to explore the full potential of such resources. Past efforts of conserving historic and cultural resources in Indian cities and towns have often been carried out in isolation from the needs and aspirations of the local communities as well as the main urban development issues, such as local economy, urban planning, livelihoods, service delivery, and infrastructure provisioning in the areas.

The heritage development of city is not about development and conservation of few monuments, but development of the entire city, its planning, its basic services, quality of life to its communities, its economy and livelihoods, cleanliness, security, reinvigoration of its soul and explicit manifestation of its character.

12 cities selected for development under HRIDAY includes Ajmer, Amrawati, Amritsar, Badami, Dwarka, Gaya, Kanchipuram, Mathura, Puri, Varanasi, Velankanni and Warangal.

Relevance and importance of smart cities concept

The objective of HRIDAY is the holistic development of an entire city, its planning, its basic services, quality of life of its communities, its economy and livelihoods, cleanliness, security, reinvigoration of its soul and explicit manifestation of its character. The smart cities concept plays an important role in holistic improvement of cities. Advances in technologies can be leveraged for improvement of city subsystems to improve quality of life of stakeholders, improve cleanliness, etc. You can refer this document and various sections to know more about how Information, Communication and Geospatial technologies can impact in improving city service delivery and bring in improved efficiencies in other dimensions.

Swachh Bharat Mission (SBM)

About the programme

Swachh Bharat Mission is a national campaign by the Government of India, covering 4,041 statutory towns, to clean the streets, roads and infrastructure of the country. SBM includes focus on provisioning of household toilets, community toilets, public toilets, solid waste management and bringing in behavioural change in people regarding healthy sanitation practices.

Relevance and importance of smart cities concept

ICT and geospatial technologies can help improve the waste management and sanitation operations & governance in a city to enable Swachh Bharat Mission. Technology plays an important role by providing visibility on city sanitation, resource optimisation, efficient asset/fleet management, efficient maintenance management, visibility of waste bins, route planning for waste management, segregation planning, air quality measurements etc.

City needs to redefine the waste management process based on circular economy concepts to reduce impact on environment and leverage waste to generate value.

Technology can also help in involving citizens in city sanitation using mobile and web channels. Please refer to the solid waste management section to know more about the technologies relevant for Swachh Bharat Mission.



Integrated ICT and Geospatial Technologies Framework For 100 Smart Cities Mission

5. Integrated ICT and Geospatial Technologies Framework for 100 Smart Cities Mission

ICT and Geospatial Technologies(GT)plays a crucial role in improving quality of life of citizens, improving business infrastructure and reducing impact on environment. ICT-GT technologies have the ability to improve performance, capacity and efficiency of physical, social, environmental and institutional (governance) infrastructure. Considering the role that ICT and geospatial technologies can play in improving city performance, Integrated ICT and Geospatial Technologies Framework for 100 Smart Cities Mission is designed in alignment with the overall smart city framework for India.

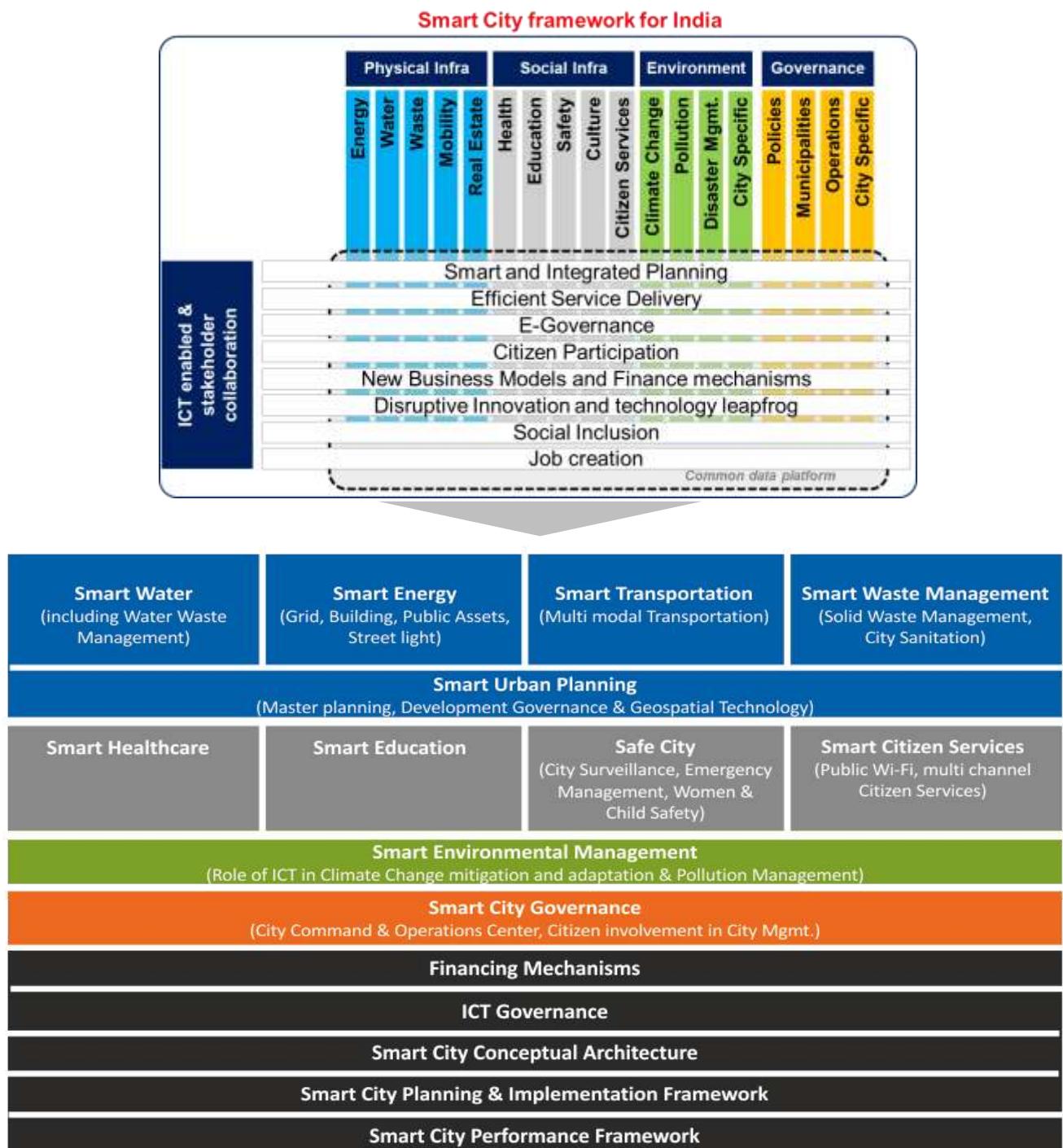


Figure 2: Smart city ICT and geospatial technologies framework

5.1 Smart physical infrastructure

5.1.1. Smart energy

Electricity

Background:

There are various forms of energy available in India: electricity, CNG, LPG and fossil fuels and its usage are all-pervasive. Energy supply is controlled by the centre and state along with private players in some cities. It is not under the purview of ULBs.

The main components of the energy ecosystem are:

1. **Power generation:** Electricity generation is the process of generating electric power from other sources of primary energy. In India, about 70 per cent of electricity consumed is generated by thermal power plants, 16 per cent from hydro power plants and 13 per cent from renewable energy. The centre and the state account for 29 per cent and 38 per cent of power generation respectively while private players account for 33 per cent of the total electricity generation². A key limitation of electric power is that, with minor exceptions, electrical energy cannot be stored and therefore must be generated as needed.
2. **Transmission:** Electric power transmission is the bulk transfer of electrical energy, from generating power plants to electrical substations located near demand centres. Electricity is transmitted at high voltages (500kV HVDC, 400kV, 220kV, 132kV and 66kV) to reduce the energy losses in long distance transmission. This transmission happens through overhead power lines.
3. **Distribution:** India's distribution network starts at the 33kV substation and ends at the customer's doorstep. Distribution substations connect to the transmission system and lower the transmission voltage to medium voltage ranging between 2kV and 33kV with the use of transformers. Primary distribution lines carry this medium voltage power to distribution transformers located near the customer's premises. Distribution transformers again lower the voltage to the utilisation voltage of household appliances and typically feed several customers through secondary distribution lines at this voltage. Commercial and residential customers are connected to the secondary distribution lines through service drops. Customers demanding a much larger amount of power may be connected directly to the primary distribution level or the sub-transmission level.
4. **Consumption:** Industries, commercial establishments and households are the main consumer types in urban areas in India. Electricity is consumed for the purposes of lighting, air-conditioning in buildings, modern day equipment, industrial equipment, etc.

Key issues:

Some of the key issues in providing electricity are demand-supply gap, reliable 24x7 energy supplies, reliable metering, and poor customer service for citizens and business in cities. Distribution firms are struggling with key issues like huge under recovery due to theft/losses, supply constraints from generating units, unpredictable variance in demand, under recovery and huge public energy uses like street lighting/public buildings, poor asset management and planning. The next section covers the issues in detail.

²<http://www.cea.nic.in/reports/monthly/executive rep/feb14.pdf>(Ministry of Power, Government of India, 2014)

Energy - 1: Electricity

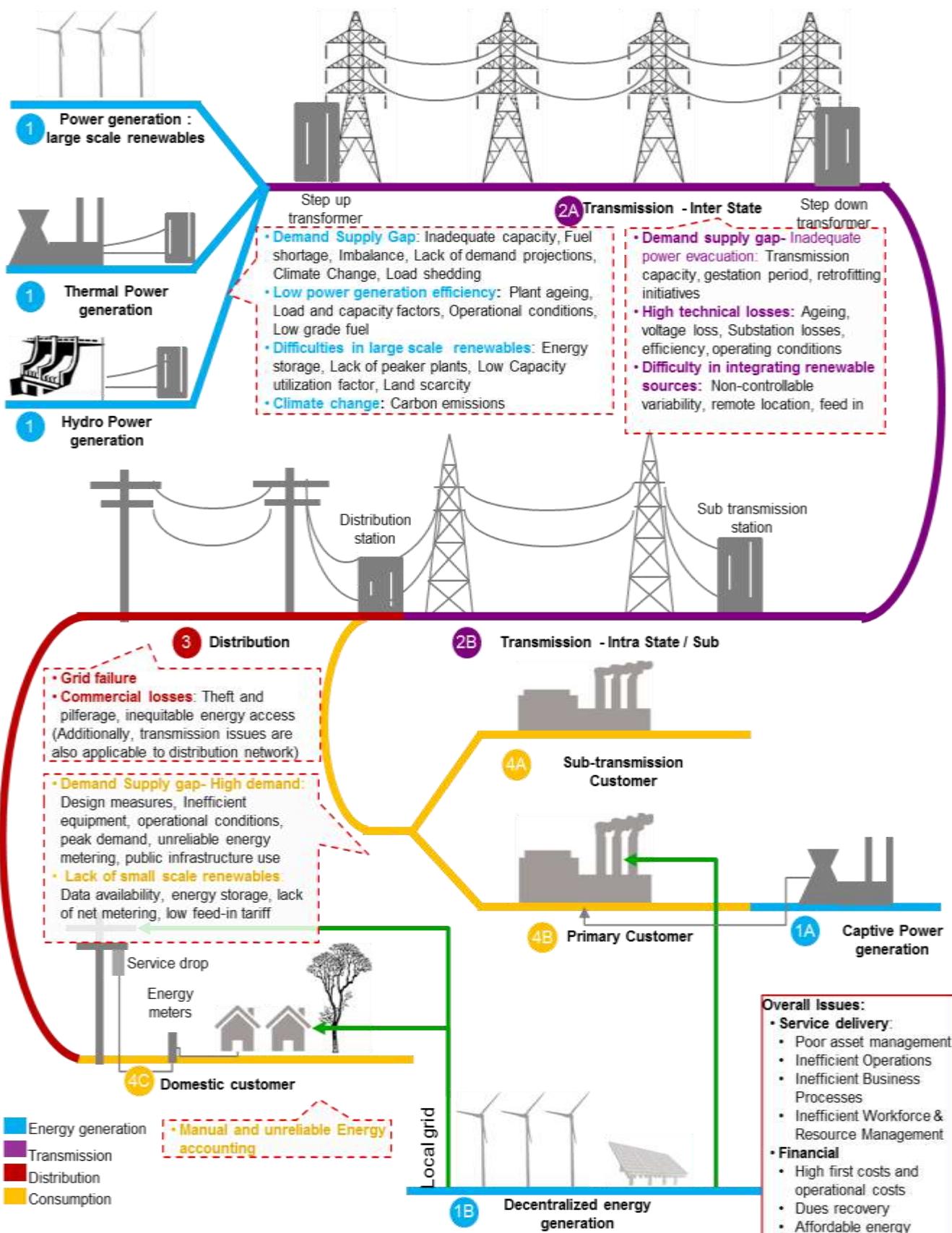


Figure 3: Current state of energy management in cities (electricity)

Detailed description of the key issues and challenges across the value chain:

- Power generation:** For the past two decades, India has had to face increasing deficit in power supply, both for meeting its normal energy requirements as well as its peak load demand. The problem is acute during peak hours and summers, and necessitates planned load shedding by many utilities to maintain the grid in a healthy state. The average all-India shortages in 2009-10 were at 10 per cent in terms of normal energy requirement and about 13 per cent in terms of peak load(Sparta Strategy , 2011).The overall efficiency of coal-based power plants is low, ranging from 28-35 per cent depending upon size, operational practices and capacity utilisation.³Large scale renewables usage, while increasing, is facing hurdles in terms of accelerated implementation.

Table 1: Issues and challenges in power generation

Issue	Sub-issue	Description
i. Demand-supply gap: Supply side	Inadequate capacity	The total installed capacity as on August 2014 is 253 GW ⁴ . There is still a 10 per cent gap in capacity and around 13 per cent in peak time capacity.
	Fuel shortage	The total installed capacity in India faces shortages in fuel for power generation.
	Imbalance between distribution of power demand and supply centres	The power generation capacities are unevenly dispersed across the country creating an imbalance between the distribution of power demand and supply centres. Based on the current supply position, the national grid region is surplus to the extent of 2.3 per cent of the total regional demand during peak hours; while, the Southern region is anticipated to face a peak time shortage of 26 per cent of regional demand in 2013-14 ⁵ .
	Lack of demand projections	Conventional planning entails separate estimates of a city's needs for each form of energy. However, most cities don't have energy requirement projections, leading to shortages.
	Load shedding leading to increase in local diesel generators	Commercial establishments respond to power cuts by using diesel generators, which not only increase costs but also contribute significantly to air and noise pollution. 40 per cent of the firms generate their own electricity due to erratic power supply ⁶ .
ii. Low power generation efficiency	Plant ageing	Since most of the power plants were installed immediately after independence, they have become old and inefficient. Only about 6 percent of the coal-fired power plants use super-critical boiler technologies, which are much cleaner than older systems ⁷ .
	Load and capacity factors	Power plants are designed and run at suboptimum load and capacity factors due to factors such as unavailability of demand projections, etc.
	Operational conditions	Plants are often not run at their rated design conditions (for e.g. steam pressure, etc.) thus impacting the efficiency of power generation.
	Low grade fuel	Low grade coal used in India leads to higher emission of dust in the form of fly ash which occupies most of the thermal boilers and further reduces their efficiency.

³http://www.beeindia.in/energy_managers_auditors/documents/guide_books/3Ch1.pdf(Bureau of Energy Efficiency)

⁴List of power stations in India. (2014). Retrieved January 9, 2014, from www.wikipedia.org:

http://en.wikipedia.org/wiki/List_of_power_stations_in_India

⁵ Power Transmission: The Real Bottleneck, FICCI(FICCI).

⁶<http://indioclimatedialogue.net/2014/08/14/india-trails-energy-efficiency/>(India trails in energy efficiency, August 2014)

⁷<http://www.bloombergview.com/articles/2014-11-30/indias-climate-change-opportunity>

Issue	Sub-issue	Description
iii. Difficulties in large scale renewables	Energy storage	Renewable energy sources normally produce power when the demand is low thus requiring high energy storage. Alternatively, dispatchable loads are needed to soak up the excess energy.
	Lack of peaker plants	The availability of wind and sunlight is partially unpredictable. Renewables are not only seasonal but also have diurnal fluctuation necessitating additional peaker plants. Peaker plants are power plants that generally run only when there is a high demand, known as peak demand, for electricity.
	Low capacity utilisation factor	The Capacity utilisation Factors (CUFs) (i.e. how much of the total capacity is actually used) of solar Photovoltaic (PV) plants in India range from 11-31% ⁸ .
	Land scarcity	Renewable projects require large land pieces which are often difficult to find closer to the demand centres.
iv. Climate change	Carbon emissions	CO ₂ emissions from power plants have been of major social and environmental concerns, at national and international levels.

2. **Transmission and distribution:** While there has been around 50 per cent growth in the installed power in the last five years, the transmission capacity has increased only by around 30 per cent. Plants supplying electricity to State Electricity Boards (SEBs) under long-term power purchase agreements lost 1.93 billion units of generation due to transmission capacity bottlenecks (FICCI, p. 06). In addition, financial investments in India are more inclined towards power generation than transmission which will lead to aggravating the situation further.

Table 2: Issues and challenges in transmission and distribution

Issue	Sub-issue	Description
a) Demand-supply gap: Inadequate power evacuation	Transmission capacity	The installed transmission capacity in 2011-12 was only 13 per cent of the total installed generation capacity ⁹ .
	Long gestation period	Typical transmission projects have a long (4-5 years) gestation period (versus three year for large gas fired power plant) which would mean that additional power capacity faces the risk of power not being evacuated.
	Lack of retrofitting initiatives	Retrofitting existing lines with more efficient transmission is normally not considered as back up facilities are not easily available.
b) High technical losses	Ageing T&D infrastructure	Since most of the T&D grid was installed immediately after independence, it has become old and inefficient.
	Power outages	Power outages due to unreliable gas distribution mechanism, inaccurate configuration of field devices, etc.
	Voltage loss	Electricity transmission at higher voltages is more efficient. Extra high voltage and high voltage lines have efficiency of 98-99 per cent while low voltage sub transmission and distribution lines have an efficiency of 95-96 per cent ¹⁰ .
	Substation losses/transformer losses	Energy losses due to conversion from high voltage to low voltage are minimal and range within 1 per cent but can add up significantly with number of conversions.
	Low efficiency of	Poor conducting materials i.e. materials with relatively higher

⁸<https://firstgreenconsulting.wordpress.com/2013/06/26/capacity-utilization-factor-of-solar-pv-plants-in-india-11-31/>

⁹http://www.ijareeie.com/upload/march/18_Indian%20power.pdf(Omer, 2013)

¹⁰http://www.beeindia.in/energy_managers_auditors/documents/guide_books/3Ch1.pdf

Issue	Sub-issue	Description
	lines	resistance used in transmission lines lead to high losses.
	Operating conditions	The grid is most efficient when in operation at designed conditions. However, weather conditions, and demand-supply conditions further determine the efficiency of the transmission and distribution.
c) Difficulty in integrating renewable sources	Large scale: Non-controllable variability	Wind and solar output varies in a way that generation operators cannot control, because wind speeds and available sunlight may vary every moment resulting in varying output. This fluctuation necessitates additional energy to balance demand and supply instantaneously as well as ancillary services such as frequency regulation and voltage support.
	Large scale: Remote location	Renewable sources of wind and solar energy may be available only in remote areas which may not be within the reach of existing transmission and distribution lines.
	Small scale: Feed-in power	Feeding excess energy from renewables from consumer installed generation units is not technically feasible at all places. However, a few states such as Tamil Nadu, Uttarakhand, Karnataka and Maharashtra have taken measures to encourage this.
d) Grid failure	Grid overload and failure	Increasing demand from urban areas leads to strain on the grid resulting in the local grid failure.
e) Commercial losses	Theft and pilferage	Theft and pilferage account for a substantial part of the high transmission and distribution losses in India.
	Dues recovery	Huge gaps in dues recoveries due to defective meters and reading errors.
f) Inequitable access to energy	Inequitable access to energy	Many urban poor and those in the outskirts in India still do not have official access to electricity.

3. **Consumption:** High energy demand and consumption in India is characterised by lack of appropriate design measures, use of inefficient equipment, varying and unmonitored operational conditions, high peak demand, ineffective energy metering and high use of energy for public infrastructure. While small scale renewables at consumer ends such as solar panels, solar PV and small scale wind mills have been on the rise, the uptake can be accelerated further.

Table 3: Issues and challenges in consumption

Issue	Sub-issue	Description
a) Demand-supply gap: High demand	Lack of appropriate design measures	Lack of daylighting in buildings, overheating in buildings due to inappropriate orientation and excessive glazing, oversized systems, etc. lead to increased demand on the energy system.
	Inefficient equipment	Energy labelling has been relatively new in the Indian market. While efficient equipment are available, demand uptake requires additional regulatory support.
	Operational conditions	Operational conditions of systems (industrial systems, HVACs, etc.) are not closely monitored. Deviations from design parameters result in the equipment drawing excessive energy.
	Peak demand	Demand for electricity peaks during afternoons when office occupancy is the highest and industries are working full swing.
	Unreliable energy metering	Unreliable energy metering has made it difficult to estimate the appropriate energy demand for urban centres.

Issue	Sub-issue	Description
	Public infrastructure use	Public infrastructure draws a large amount of energy for water pumping, street lights, government buildings, etc. which goes unaccounted for.
	Manual and unreliable energy accounting	Inaccurate accounting of energy usage by customer and inefficient metering.
b) Lack of small scale renewables	Data availability	Exact data for local sites is often not available for consumers to install small scale renewables on site.
	Energy storage	Renewable energy is variable and unpredictable and hence, energy storage at consumer end is required.
	Lack of net metering	Outdated energy meters do not allow measurement of net energy (total energy consumption minus the local renewable energy consumed). Hence, two meters have to be installed.
	Low feed-in tariff	Low feed-in tariff is a major hurdle in uptake of small scale renewable.

ICT-GT enablers:

Technology plays an important role in improving demand and supply by integrating decentralised renewable energy sources like solar/wind, etc. Technology can provide visibility in demand and supply. Smart metering technology can provide reliable metering and data can be used for real-time demand visibility. Smart grid can help in reducing energy losses. Public uses of energy can be reduced by leveraging smart street lighting, smart building solutions, etc. Technology can also help in improving energy asset management, energy operations and customer service. Smart solutions are discussed in detail in the next section.

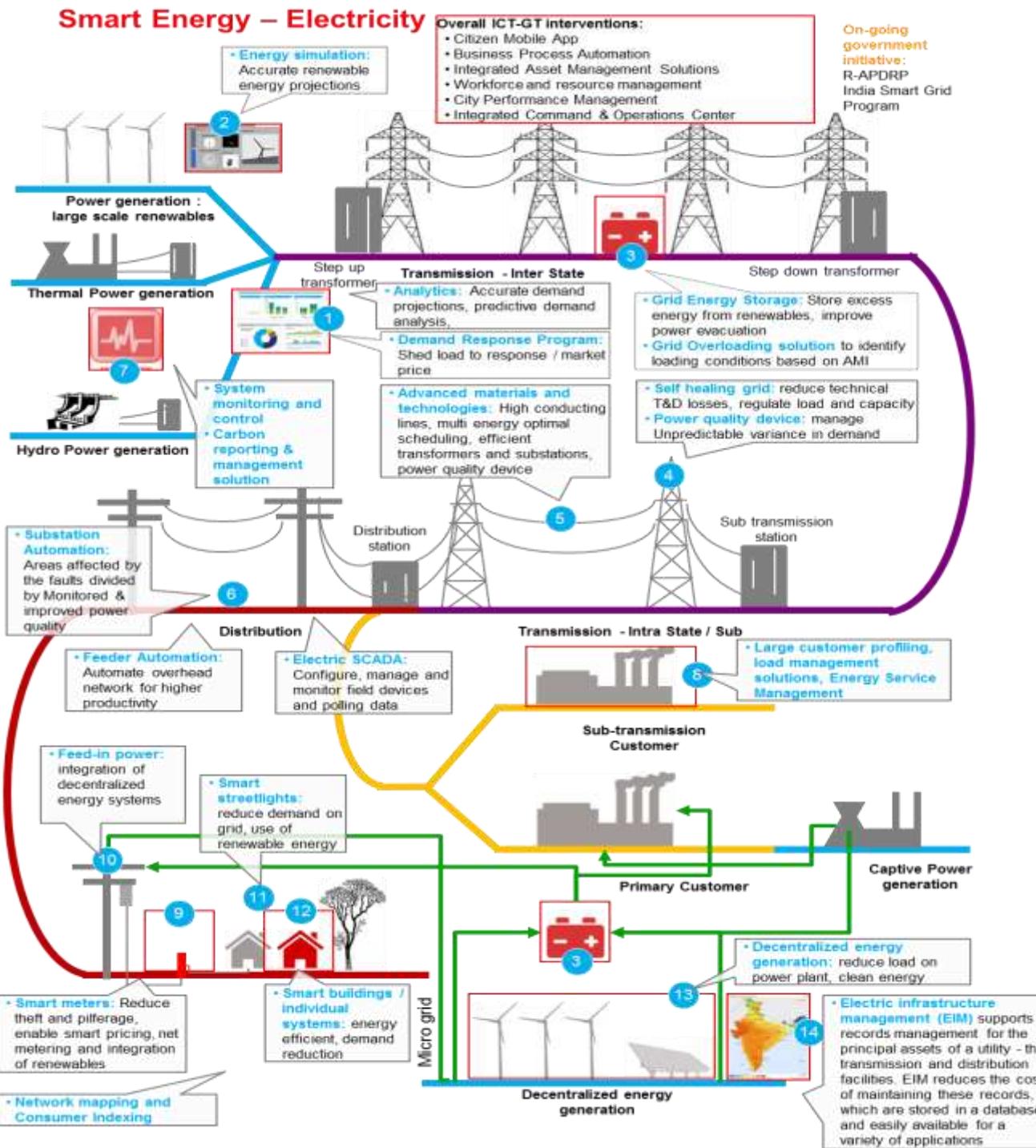


Figure 4: Smart energy management

ICT-GT enablers to overcome key challenges in electricity sector:

Table 4: Smart energy: Mapping ICT-GT enablers to challenges

Issue	Sub-issue	ICT-GT enablers
1. Power generation		
a) Demand-supply gap: Supply side	Inadequate capacity	Decentralised energy generation: Use of renewable decentralised energy systems to supplement grid power.
	Fuel shortage	<i>Requires non-ICT interventions.</i>
	Imbalance between	Analytics: Use of analytics to balance power distribution and

Issue	Sub-issue	ICT-GT enablers
	distribution of power demand and supply centres	supply centres. This should be executed at the centre or state level to drive informed decision-making.
	Lack of demand projections	Demand response programme: Dedicated control systems to shed loads in response to a request by the energy supplier or market price conditions. Analytics: Utility firms can use analytics for accurate demand projections.
	Load shedding leading to increase in local diesel generators	Grid energy storage: Grid storage devices can store the excess energy and supply it when required. Decentralised energy generation: Renewable decentralised energy systems provide power when available and are complemented by power plant supply when required.
b) Low power generation efficiency	Plant ageing	<i>Requires non-ICT interventions.</i>
	Power outage	Electric SCADA: Manages polling data, exception reports and field devices while generating alarms, replicating values to other systems, etc. Substation automation: Scalable and customisable solution for energy automation which includes protection devices, measurement centres, bay controllers, communication devices, analysis tools, etc. Feeder automation: Feeder automation solution helps decrease the number and duration of outages, reduces the size of zones affected by the faults and thus optimises the network's reliability of supply.
	Load and capacity factors	Self-healing grid: Grid is technology-enabled to regulate the load and capacity factors to maintain stability.
	Operational conditions	Plant monitoring and controls: Monitor and control operational conditions such as steam pressure to optimise the plant performance.
	Low grade fuel	<i>Requires non-ICT interventions.</i>
c) Difficulties in large scale renewables	Inadequate energy storage	Grid energy storage: Grid storage devices can store the excess energy and supply it when required.
	Lack of peaker plants	Grid energy storage: Grid storage devices can store the energy from renewables when produced and supply it when required. Controlled decentralised energy generation: Renewable energy from sources such as biogas plant can be produced in a controlled manner.
	Low capacity utilisation factor	Grid energy storage: Grid storage devices can store the excess energy and supply when required. Energy simulation: Energy simulation software provides accurate projections of power generation in varying weather scenarios to aid decision-making by the authorities.
	Land scarcity	<i>Requires non-ICT interventions.</i>
d) Climate change	Carbon emissions	Carbon reporting and management: Appropriate carbon reporting and management software can inform owners and policymakers in decision-making.
2. Transmission and Distribution		
a) Demand-supply gap:	Low transmission capacity	High conducting lines: Use of HVDC and other technologies can increase the capacity of the existing grid.

Issue	Sub-issue	ICT-GT enablers
Inadequate power evacuation	Long gestation period	High conducting lines: Use of HVDC and other technologies can increase the capacity of the existing grid without the need for greenfield transmission projects.
	Lack of retrofitting initiatives	High conducting lines: Use of HVDC and other technologies can increase the capacity of the existing grid by reducing the downtime for retrofits.
b) High technical losses	Ageing T&D infrastructure	<i>Requires non-ICT interventions like modernising T&D infrastructure.</i>
	Voltage loss	Self-healing grid: Grid is technology-enabled to regulate the load and capacity factors to maintain stability.
	Substation losses/transformer losses	Self-healing grid: Grid is technology enabled to regulate the load and capacity factors to maintain stability.
	Low efficiency of lines	<i>Requires non-ICT interventions such as advanced materials.</i>
	Operating conditions	Self-healing grid: Grid is technology-enabled to regulate the load and capacity factors to maintain stability.
c) Difficulty in integrating renewable sources	Large scale: Non-controllable variability	Analytics: Use of predictive analytics can enable the controller or automated system to integrate unpredictable energy production.
	Large scale: Remote location	<i>Requires non-ICT interventions.</i>
	Small scale	Power quality device: Monitors and maintains the power quality in the grid enabling integration of decentralised sources of power.
d) Grid failure	Grid overload and failure	Grid equipment overloading solution: This solution can identify and isolate the overloading conditions. Power quality device: Monitors and maintains the power quality in the grid.
e) Commercial losses	Theft and pilferage	Smart metering: Smart meters provide real-time monitoring of energy consumption and help identify theft and pilferage.
	Dues recovery	Smart metering: Smart meters provide accurate data of consumers and help track defaulters.
f) Inequitable access to energy	Inequitable access to energy	<i>Requires non-ICT interventions.</i>
3. Consumption		
a) Demand-supply gap: High demand	Lack of appropriate strategy and design measures	Smart buildings: Smart buildings can significantly reduce energy demand. Energy Service Management (ESM): Using ESM utilities can monitor the overall energy consumption, drill down to each customer, analyse typical usage, identify target customers and define strategies for effective energy management. Large customer profiling: This solution provides customer load profiling and helps utilities to identify the major load contributors.
	Inefficient equipment	Energy efficient equipment: Use of energy efficient equipment and devices such as CFL lights, BEE-rated HVAC and other equipment and efficient industrial machinery can significantly reduce energy demand.
	Operational	Smart systems: Individual smart systems such as smart buildings,

Issue	Sub-issue	ICT-GT enablers
	conditions	industrial plant monitoring can monitor and control the operational conditions and help optimise performance and reduce energy demand.
	Peak demand	Smart metering and smart pricing: Policy intervention through smart pricing can inform the consumer the impact of their choices; thereby encouraging behavioural change. Large customer profiling: This solution provides customer load profiling and helps utilities to identify the major load contributors.
	Unreliable energy metering	Smart metering: Smart meters provide accurate information on energy usage. Real-time monitoring reduces the need for human reading of meters and thus reduces the chances of human error.
	Public infrastructure use	Smart metering: Smart metering on public infrastructure can drive accountability and responsibility. Energy efficient equipment: Use of energy efficient infrastructure can reduce energy demand. Smart streetlights: Smart streetlights reduce the grid energy demand.
	Manual and unreliable energy accounting systems	Network mapping and consumer indexing: Digital mapping and geo referencing of substations, feeders and indexing of all the consumers in all categories so that the consumers can be segregated feeder-wise and DT-wise using GIS. The consumers are mapped using GIS technology and identified based on their unique electrical address, called Consumer Index Number (CIN).
b) Lack of small scale renewables	Inadequate data availability	GIS mapping: GIS maps with solar and wind data can enable design and innovation of small scale renewables.
	Inadequate/high costs of energy storage	Grid based storage: Common grid-based storage can reduce individual costs.
	Lack of net metering	Smart metering: Smart meters enable measuring the energy consumed by the consumer and renewable energy fed into the grid. Consumers are only charged for net usage of energy.
	Low feed-in tariff	<i>Smart metering: Policy intervention required.</i>

Description of ICT-GT enablers /smart solutions:

- **Analytics:** Advanced capabilities of predictive analytics can predict future energy demand, optimise rates and pricing programmes, help plan for power purchases, and foresee the availability of excess energy and gauge the likelihood and location of power outages. It can also provide insights into changing demands, preferences and behaviours of energy consumers
- **Demand response programme:** Demand response programmes are implemented through the use of dedicated control systems to shed loads in response to a request by the energy supplier or market price conditions
- **Electric SCADA:** Manages polling data, exception reports and field devices while generating alarms, replicating values to other systems, etc.
- **Substation automation:** Scalable and customisable solution for energy automation which includes protection devices, measurement centres, bay controllers, communication devices, analysis tools, etc.
- **Feeder automation:** Feeder automation solution helps decrease the number and duration of outages, reduce the size of zones affected by the faults and thus optimises the network's reliability of supply
- **Energy simulation for renewables:** Energy simulation software use historical weather data to provide accurate projections of renewable energy generation

- **Grid energy storage:** Grid-based storage refers to the methods used to store electricity on a large scale within an electrical power grid. Electrical energy is stored during times when production exceeds consumption and when additional discretionary load is turned on but consumption is still insufficient to absorb it
- **Self-healing grid:** Self-healing grid keeps itself stable during normal conditions and is also able to recover in the event of disturbance, hence, reducing frequency of blackouts and cost of electricity
- **System monitoring and control:** System monitoring and automation ensure that the system is running at most optimum operational conditions. It reduces the need for human intervention and hence, reduces chances of human errors
- **Large customer profiling and load management solutions or energy service management:** Load profiling is done to identify the peak load contributors and optimise load management for each customer involved
- **Smart meters:** Leverage the smart meters for piped gas to ensure accurate billing and remote management
- **Network mapping and consumer indexing:** Digital mapping and geo referencing of substations, feeders and Indexing of all the consumers in all categories so that the consumers can be segregated feeder-wise and DT-wise using GIS. The consumers are mapped using GIS technology and identified based on their unique electrical address, called Consumer Index Number (CIN).
- **Feed-in mechanism:** Use of ICT can enable demand-supply predictions and enable smooth integration of decentralised energy systems with the grid
- **Smart systems:** Individual energy efficient and smart systems such as smart buildings, smart street lighting and smart industrial processes can reduce the energy demand
- **Decentralised energy generation:** Decentralised energy is produced close to where it will be used, rather than at a large plant elsewhere and sent through the national grid. Local generation reduces transmission losses and lowers carbon emissions. It increases security of supply nationally as customers don't have to share a supply or rely on relatively few, large and remote power stations. Long-term decentralised energy also offers more competitive pricing than traditional energy and options to leverage renewable energy sources like solar/wind, etc. Integration of decentralised sources with grid allows the sources to feed into the main power grid reducing the need for individual storage capacity
- **Electric Infrastructure Management (EIM)** supports records management for the principal assets of a utility - the transmission and distribution facilities. EIM reduces the cost of maintaining these records, which are stored in a database and easily available for a variety of applications
- **Grid equipment overloading solution:** A grid overloading solution helps to identify loading conditions based on Advanced Metering Infrastructure (AMI) data to find out real causes of overloading and find solutions to relieve the overload
- **Smart streetlights:** Smart streetlights are isolated systems which use renewable energy and have inbuilt daylight sensors to automate the lighting system
- **Power quality device:** Usage of smart grid features like sensors which are distributed throughout the network to monitor power quality and in some cases also respond automatically to them, promises to bring higher quality power and less downtime while simultaneously supporting power from intermittent power sources and distributed generation

Overall ICT-GT enablers:

- **Integrated asset management solutions:** Integrated asset management of all safety infrastructure assets including the associated data, processes, information systems and governance for manageable operations and higher sustainability
- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools

- **City performance management:** Monitor the performance of city subsystems through the use of digital technologies and big data analytics to manage city governance, efficient performance and proactive crisis management
- **Integrated command and operations centre:** Leverage integrated command and operations centre to monitor city services on real-time. Improve/synchronise maintenance activities to reduce downtime and improve maintenance effectiveness

Ongoing government initiatives

Initiatives	Brief Description
R-APDRP	<p>The focus of R-APDRP is on actual, demonstrable performance in terms of sustained loss reduction. This is proposed to be achieved in two parts:</p> <p>Part A of the scheme envisages establishment of base line data which includes consumer indexing, GIS mapping and metering of distribution transformers and feeders and SCADA/DMS (Supervisory Control and Data Acquisition System/Data Management System) in project areas having a population of 4 lakh and annual input energy of 350 MU. This part of the scheme also includes IT applications for energy accounting/auditing and IT-based consumer service.</p> <p>Part B of the scheme is for renovation, modernisation and strengthening of distribution systems.</p>
India Smart Grid Programme	<p>The programme aims to implement smart grids to transform the Indian power sector into a secure, adaptive, sustainable and digitally-enabled ecosystem that provides reliable and quality energy for all with active participation of stakeholders. Some of the key initiatives include smart grid roll outs including micro-grids, automation, etc., streamlining of policies and tariffs, renewable energy generation, electrical vehicles, increasing efficiency, reducing losses and enabling access and availability of quality power to all.</p>

Natural gas

Background:

Natural gas for urban areas includes Liquefied Petroleum Gas (LPG) and Compressed Natural Gas (CNG). LPG also referred to as simply propane or butane, are flammable mixtures of hydrocarbon gases used as fuel in heating appliances, cooking equipment, and vehicles. In India, of recently, CNG is being used for fueling of vehicles.

The main components of the energy ecosystem are:

1. **Extraction:** Natural gas is extracted and is provided to customers in the form of LPG and CNG. Gas is filled in cylinders for the purpose of transportation and usage.
2. **Transportation:** Gas cylinders are transported from refineries to the storage point in large vehicles.
3. **Storage:** Gas cylinders are stored in large storage sheds.
4. **Distribution:** Cylinders are distributed to customers by small vehicles such as tempos, etc.
5. **Consumed:** Gas is consumed for domestic and commercial purposes of cooking, water heating, etc. Gas may also be used for industrial applications.

Key issues:

Inadequate gas supply, demand supply gap, no visibility on demand, low piped gas grid coverage and lack of energy conservation are some of the key issues. The next section discussed these issues in detail.

Energy - 2: Gas

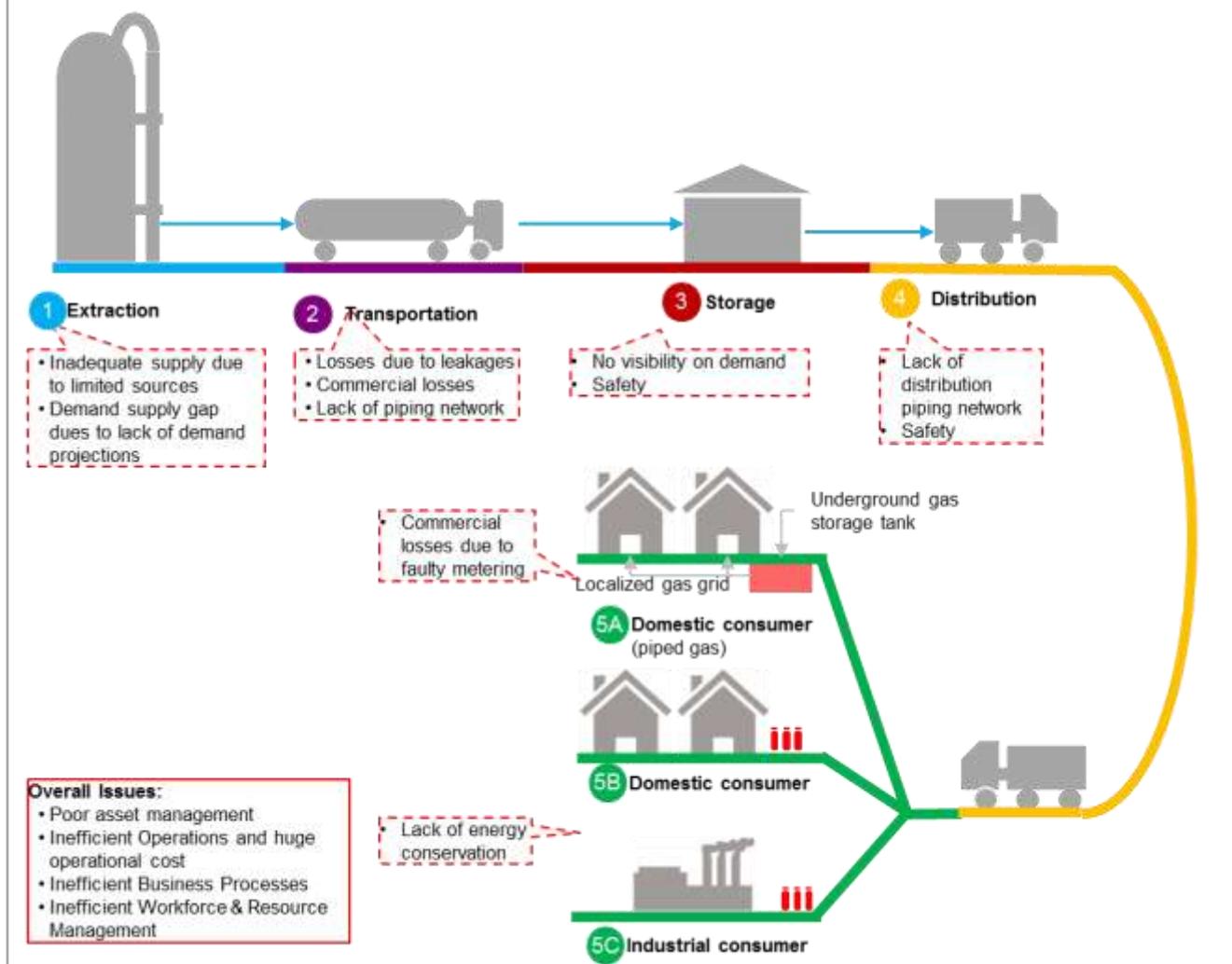


Figure 5: Current state of energy management in cities (natural gas)

Detailed description of key issues and challenges in the gas sector:

Table 5: Issues and challenges in energy: natural gas system

Value chain component	Issue	Description
a) Source	Inadequate supply due to limited sources	India has limited reserves of natural gas and is mostly located on the western shore of India.
	Demand-supply gap due to lack of demand projections	Supply is often not in tune with the demand as there are no actual projections of gas demand.
b) Transportation	Losses due to leakages	Filled LPG cylinders which are intended to be utilised in the upright position should preferably be transported upright with the valves protected against any impact. Deviation from best practices and manhandling can lead to losses and in extreme cases accidents.
	Commercial losses	Commercial losses due to theft are high.
	Lack of piped gas grid	A national grid for gas transportation and distribution is

Value chain component	Issue	Description
	network	lacking.
c) Storage	No visibility on demand	Storage is often not in tune with the demand as there are no actual projections of gas demand.
	Safety	Safety during storage of gas cylinders is a major issue.
d) Distribution	Lack of distribution piping network	Only a few cities in India, such as Surat, have piped gas distribution network for supply of gas.
	Unreliable gas distribution and measurement	Gas distribution devices are not efficiently configured, monitored and tracked which leads to poor operations and inaccurate measurement data
	Commercial losses	Where piped gas is provided, faulty metering leads to loss of dues recovery.
	Safety	Safety during distribution of gas cylinders could be an issue.
e) Consumption	Lack of energy conservation	Energy conservation is not a priority for consumers leading to non-responsible consumption of gas energy.

ICT-GT enablers:

Smart Energy - Gas

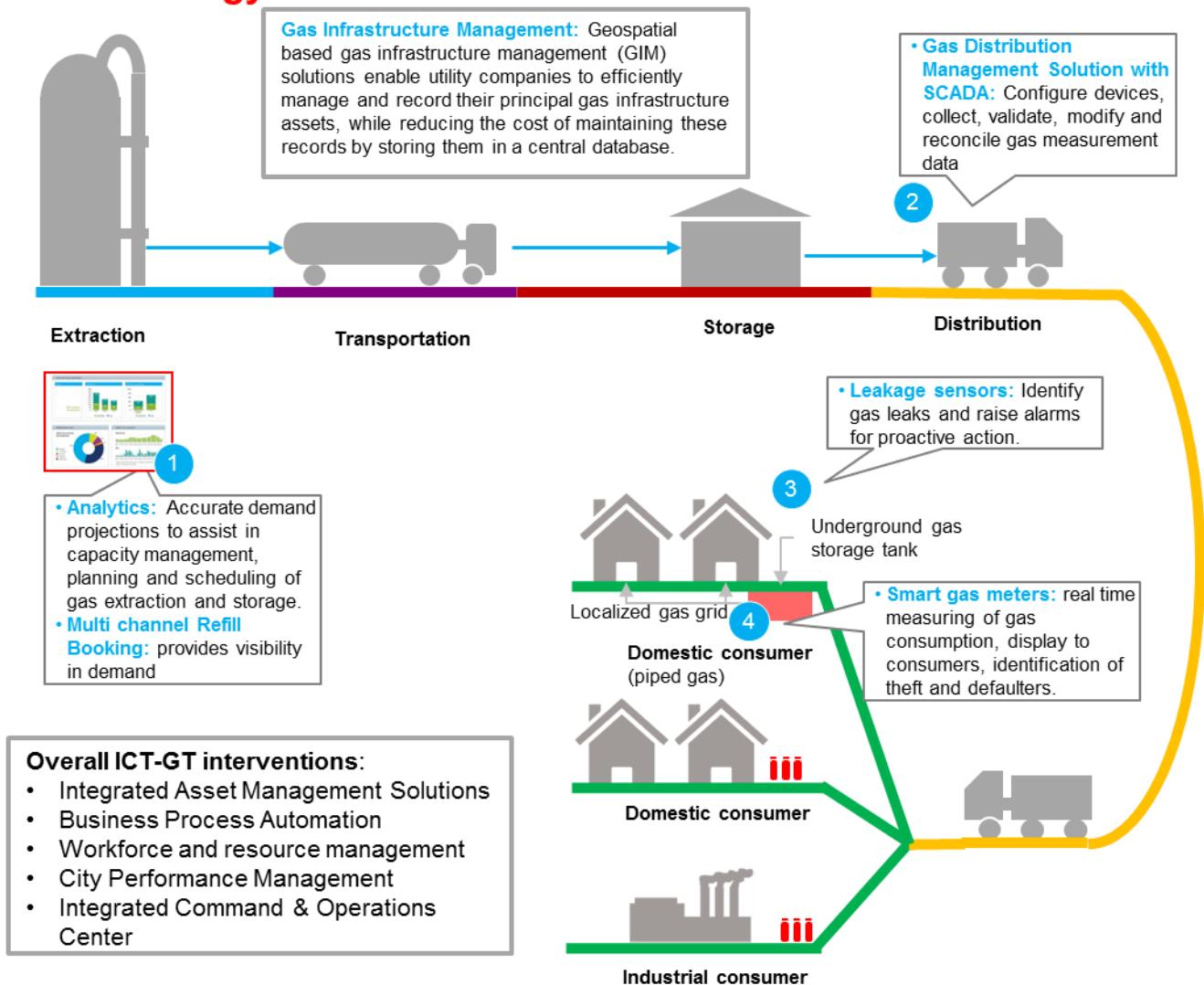


Figure 6: Smart energy management in cities (gas)

ICT-GT enablers and smart solutions to overcome challenges in gas sector:

Table 6: Smart energy (natural gas): Mapping ICT-GT enablers to challenges

Value chain component	Challenges	ICT -GT enablers
a) Source	Inadequate supply due to limited sources	<i>Requires non-ICT interventions.</i>
	Demand-supply gap dues to lack of demand projections	Analytics: Use of analytics to balance demand and supply of gas. Multi-channel refill booking: Can enable online refill booking and provide visibility on demand.
b) Transportation	Losses due to leakages	Leakage sensors: Leakage sensors identify and raise alarms in case of any gas leakages (applicable on gas grid).
	Commercial losses	Smart meters on gas grid: Gas grids installed with smart meters help in minimising commercial losses.
	Lack of piped gas grid network	<i>Requires non-ICT interventions like laying gas pipeline in cities.</i>
c) Storage	No visibility on demand	Analytics: Use of analytics to balance demand and supply of gas.
	Safety	Leakage sensors: Leakage sensors identify and raise alarms in case of any gas leakages (applicable on gas grid).
d) Distribution	Lack of distribution piping network	<i>Requires non-ICT interventions like laying gas pipeline in cities.</i>
	Unreliable gas distribution and measurement	Gas distribution management solution with SCADA: Manages configuration of devices, collection, validation, modification and reconciliation of gas measurement data.
	Commercial losses	Smart meters: Gas grids installed with smart meters help in minimising commercial losses.
	Safety	Leakage sensors: Leakage sensors identify and raise alarms in case of any gas leakages. This can be implemented for piped gas and cylinder-based connection.
e) Consumption	Lack of energy conservation	Smart meters: Smart meters provide user with real-time consumption and can propel behavioural change in consumers.

Description of ICT-GT enablers and smart solutions:

- **Analytics:** Data analytics is an efficient and inexpensive way to improve gas demand-supply management strategies. It helps in determining in real-time when, how much and where gas is being used. Predictive analytics helps in understanding gas demand pattern and forecasting to ensure adequate supply
- **Gas distribution management solution with SCADA (Supervisory Control and Data Acquisition):** Manages configuration of devices, collection, validation, modification and reconciliation of gas measurement data. GAS SCADA solution manages polling data, receive exception reports from field devices while generating alarms, replicating values to other systems, displaying tabular data and dynamic fields on operator displays, generating reports and collecting values for time-series historical recording
- **Leakage sensors:** Gas leakage sensors identify any gas leaks and raise alarm for authorities to take an action

- **Smart meters on gas grid:** Smart gas meters measure the amount of gas usage and provide a real-time view on the consumption of gas
- **Multi-channel refill booking:** Multi-channel platform enable refill booking at anytime from anywhere and track dealer performance to ensure timely supply
- **Gas infrastructure management:** Geospatial-based gas infrastructure management (GIM) solutions enable utility firms to efficiently manage and record their principal gas infrastructure assets, while reducing the cost of maintaining these records by storing them in a central database

5.1.2 Smart water

Background:

Water management is a basic as well as essential service provided by the city government to its citizens and businesses. Most of the cities have a vast water distributions network running for thousands of kilometres.

The main components of the ecosystem are:

1. **Water source and extraction:** Most of the cities in India depend on nearby lakes, dams or rivers for supply of water. Groundwater is also extracted where it is feasible. Some of the coastal cities, such as Chennai are now depending on desalination of sea water to provide water for urban centres.
2. **Storage and purification:** Water is stored in reservoirs. Retention time in reservoirs leads to settling of the sediments forming the first stage of purification. Water is then treated to make it usable for human consumption.
3. **Distribution network:** Distribution network consists of water mains, branches and service connectors and a number of pumps and valves to allow and control flow of water.
4. **Consumption:** Urban water consumption includes domestic and commercial use for cooking, cleaning, etc. as well as for industrial uses for various processes.
5. **Discharge and treatment:** Water is discharged into the sewerage network and carried to treatment plants. Treated water is finally discharged to the water body.

Key issues:

Most cities depend on a few key sources like rivers and ponds for water supply. Groundwater management does not exist in most of the cities. Water resources in India are depleting due to increasing consumption because of rising population and increased water consumption in urban areas. In 2010, India ranked 120th among the 122 nations in terms of quality of water available to its citizens¹¹. Most cities are unable to tap rain water up to its maximum potential. There is no water metering in most of cities, leading to irresponsible use of water and high non-revenue water and under recovery. For e.g., in Delhi, as much as 40 per cent of water is lost due to leaking pipes and many households go without water.¹² It is estimated that 27 per cent of homes in Delhi receive tap water for less than three hours a day. In order to improve water management, India needs an integrated approach for water and wastewater management to meet the various needs to citizens and businesses.

¹¹<http://www.deccanherald.com/content/63740/poor-water-quality-serious-threat.html>

¹²<http://www.thehindu.com/news/cities/Delhi/40-per-cent-of-water-supply-gets-wasted-study/article76718.ece>

Water and wastewater

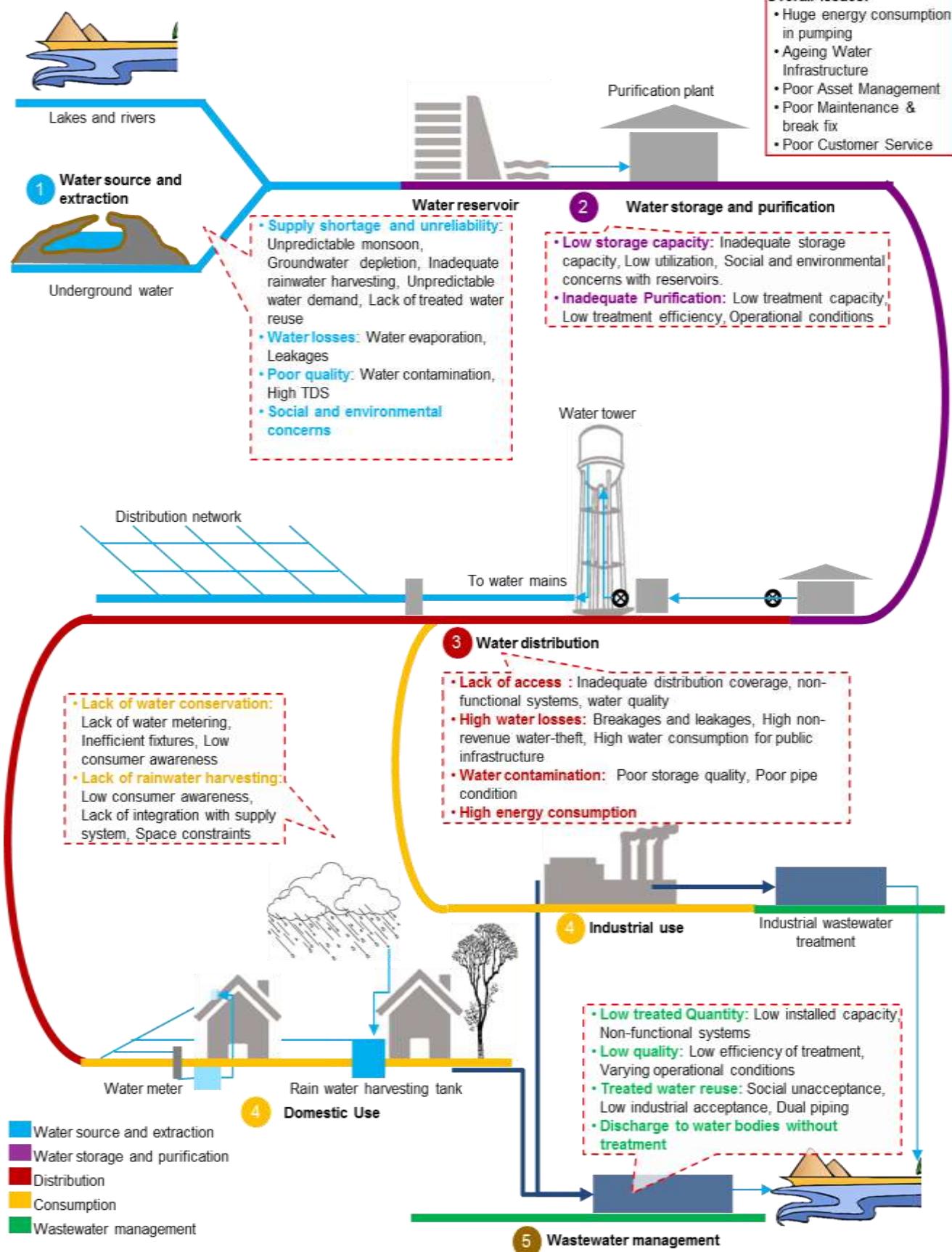


Figure 7: Current state of water management in cities

Detailed description of the key issues and sub issues across the value chain:

Table 7: Issues and sub-issues in water subsystem

Issue	Sub-issue	Description
1. Water source and extraction		
a) Supply shortage and unreliability	Unpredictable monsoon	In the recent years, monsoon has played havoc with instances of flood and draughts within the same season. Supply systems are not able to handle the unpredictable variations in the monsoon patterns.
	Groundwater depletion	All across India, trends show that groundwater is depleting and threatening the sustainability of urban water systems.
	Inadequate rainwater harvesting at catchment areas	There is a lack of enough rainwater harvesting and watershed systems in catchment areas.
	Unpredictable water demand	Water demand calculations are based on crude ways using thumb rules (135 litres per person per day) which fail to provide the appropriate demand projections required for managing the supply.
	Lack of treated water reuse	Large scale application of treated water reuse is not practiced in India.
b) Water losses	Water evaporation	Water from open canals evaporate resulting in net loss of water in the supply system.
	Leakages	Unattended breakages and leakages in long distance piping result in large water loss.
c) Poor quality of water	Water contamination	Contamination and pollution levels have increased in groundwater as well as surface water sources. At many places untreated sewage is discharged into rivers and lakes, polluting them and imposing health risks to users through water-borne diseases. About 70 per cent of India's water supply is polluted with sewage effluents. Many a times, water from agricultural lands flow into rivers carrying pesticides and other toxic chemicals along with it.
	High TDS	Groundwater level depletion has led to increase in Total Dissolved Solids(TDS)levels requiring further treatment of water before consumption or even industrial use.
d) Social and environmental concerns	Equitable distribution	Equitable distribution of water is a key issues in most of the cities. Available water is not distributed to all areas in cities based on demand leading to water shortage in some areas.
	Environmental issues	Environmental concerns with excessive extraction of water include impact on biodiversity and flora and fauna of the region.
2. Water storage and purification		
a) Low storage capacity	Inadequate storage capacity	Reservoirs built decades ago are not adequate and cannot meet the needs of the current urban population.
	Low utilisation	Full capacity of reservoirs or storage equipment is not utilised.
b) Inadequate purification	Low treatment capacity	Low water purification capacity hampers the distribution of available water to the city.
	Low treatment	Potable water treatment plants at times do not remove all the

Issue	Sub-issue	Description
	efficiency	contaminants leading to health risks.
	Varying operational conditions	Operational conditions such as retention time, etc. play a major role in the purification process. Varying conditions hinder the process.
3. Water distribution		
a) Lack of access	Inadequate distribution coverage	According to the 2011 Census, 70 per cent of urban households are being served by tap and 21 per cent by tube well or hand pump. 66 per cent of urban households reported having their principal access point of water within their premises; 32 per cent had it within 0.2 kilometres. Only 41 per cent had sole access to their principal source of drinking water and 59 per cent were sharing a public source.
	Non-functional systems	In some parts of the cities, even if water distribution pipeline is laid down, water is not provided due to shortage of water.
b) High water losses	Breakages and leakages	City water distribution network in some cities is thousands of kilometers long and breakages/leakages may lead to significant loss of water.
	High non-revenue water theft	Ghost pipes and water theft are major causes of water loss leading to high non-revenue water.
	Huge water consumption for public infrastructure	Public infrastructure uses large amount of water for purposes of landscape/gardening of public spaces, government buildings and other purposes. Non-metered usage results in commercial losses.
	Slow response to outage	Slow response to water outage leads to inconvenience to customers.
	Leakage due to high pressure	High water pressure increases the water leakage in case of pipe breakage.
	Obsolete distribution system	Old and inefficient distribution system resulting in issues like loss of water, low water quality and low pressure.
	Inefficient monitoring of water infrastructure	Traditional method of monitoring water infrastructure leads to slow response to issues like pipe breakages, water quality degradation, maintenance need, etc.
c) Contamination of water	Poor storage quality	Poor water storage conditions at the water tower or intermediate storage tanks lead to water contamination.
	Poor pipe condition	Underground piping network does not undergo any maintenance thus posing a risk of water contamination.
d) High energy consumption	High energy consumption in pumping water to water distribution network	Water pumped through large water distribution network require high amount of energy.
4. Water consumption		
e) Lack of water conservation	Lack of water metering	Lack of water metering has led to irresponsible water usage and wastages.
	Inefficient fixtures	Conventional water fixtures use relatively higher quantities of water compared to the latest technology which leverages high pressure techniques.
	Low consumer awareness	Low consumer awareness on water conservation results in irresponsible behaviour and water wastages

Issue	Sub-issue	Description
		.
f) Lack of rainwater harvesting	Low consumer awareness	Despite many efforts, consumers are not fully aware of rainwater harvesting systems.
	Lack of integration with supply system	Rainwater harvesting is normally designed as an add-on and hence, not integrated within the core design and water system.
	Space constraints	Storage systems for rainwater consume significant amount of space and may not be a feasible option in dense urban areas.
5. Water discharge and treatment		
a) Inefficient collection system	Leakages and breakages	Leakages and breakages go undetected and lead to health issues in case of water contamination.
	Insufficient capacity	Some areas do not have full coverage of sewerage lines leading to health issues.
b) Insufficient treatment capacity	Low installed capacity	In 2008, Class I cities had 32 per cent of the total required capacity while Class II towns had only 8 per cent of the required capacity of water treatment plants installed ¹³ .
	Non-functional systems	Many plants are non-functional due to operational or other reasons.
c) Low quality	Low efficiency of treatment	Old plants use outdated technologies and have a very low efficiency of treatment.
	Varying operational conditions	Operational conditions such as pump speed, weather, etc. play a significant role in the quality of the treated water.
d) Treated water reuse	Social unacceptance	Reuse of treated water is still not socially acceptable in India at many places.
	Low industrial acceptance	Natural hazards and weather risks have encouraged industries to consider treated water as a resource and reuse for appropriate functions, especially thermal power plants where health risks are not a major issue. However, acceptance and uptake in other industries remains fairly low.
	Dual piping	Reuse of treated water for indoor purposes requires dual piping. Hence, it may not be feasible in existing buildings.

ICT-GT enablers:

Technology plays an important role by providing visibility in demand/supply to ensure equitable water distributions and optimise energy use to pump water in vast water distribution network, reducing the non-revenue water by detecting leakages faster and reducing theft by detecting ghost pipes. Smart meter technology shapes behaviour of citizens and businesses by providing visibility in consumption and reduces under recovery by accurate metering. Water asset management, water management operations and customer services can be improvised significantly using technology.

¹³India Infrastructure Report 2011 (3iNetwork, p. 287)

Smart Water Management

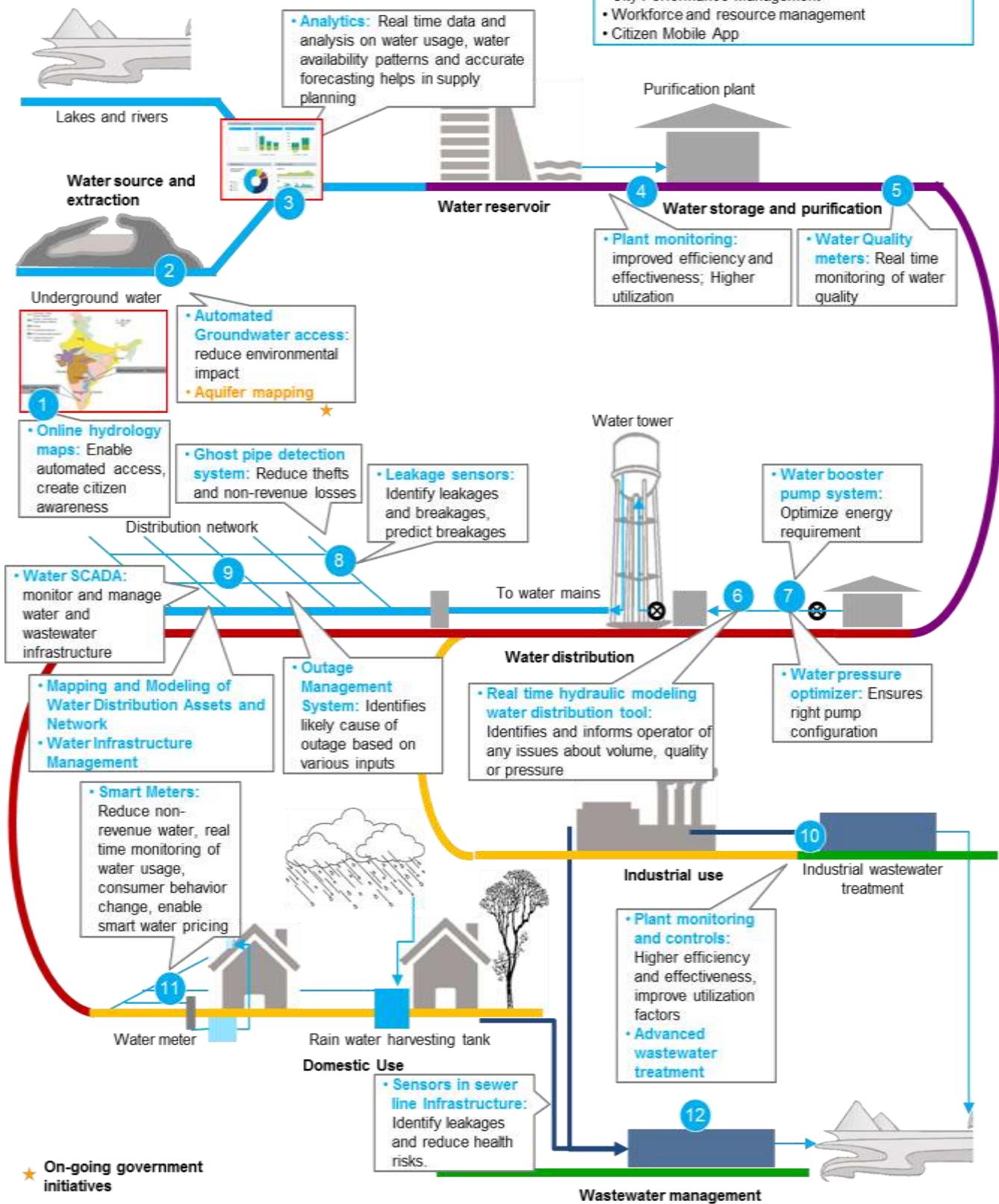


Figure 8: Smart water management

ICT-GT enablers to overcome key challenges in water and wastewater value chain:

Table 8: Smart water: Mapping ICT-GT enablers to challenges

Issue	Sub-issue	ICT -GT enablers
1. Water source and extraction		
a) Supply shortage and unreliability	Unpredictable monsoon	Weather forecasting: More accurate weather forecasting can assist city managers to handle the unpredictability in the monsoons more efficiently.
	Groundwater depletion	Online hydrology maps: Online hydrology maps can map groundwater levels and help identify groundwater storages. Automate ground water access approval process: Automated access based on groundwater levels and quality can ensure environmental protection of groundwater.
	Inadequate rainwater harvesting at catchment areas	<i>Requires non-ICT technological interventions such as advanced rainwater harvesting equipment.</i>
	Unpredictable water demand	Analytics: Predictive analytics can assist managing the supply to minimise the demand-supply gaps. Monitoring consumer usage can provide more granular data and accurate forecasts.
	Lack of treated water reuse	Advanced wastewater treatment: Improves treatment efficiencies and capacity. <i>Policy interventions are required to promote use of treated water for industrial and other uses.</i>
b) Water losses	Water evaporation	<i>Requires non-ICT interventions.</i>
	Leakages	Leakage sensors: Leakage sensors can automatically detect leakages in water distribution network to raise alert for quick resolution.
c) Poor quality of water	Water contamination	Water quality meters: Measure the water quality on real-time basis to take corrective action in case of any degradation of water quality.
	High TDS	Water quality meters: Measure the water quality on real-time basis to take corrective action in case of any degradation of water quality.
d) Social and environmental concerns	Equitable distribution	Analytics: Water supply analytics can be used to ensure equitable water distribution.
	Environmental issues	Automate groundwater access approval process: Automated access based on groundwater levels and quality can ensure environmental protection of groundwater.
2. Water storage and purification		
c) Insufficient treatment capacity	Inadequate storage capacity	<i>Requires additional non-ICT interventions like developing new storage tanks to meet local demands, etc.</i>
	Low utilisation	Asset management: Asset management and improved business processes can help ensure appropriate utilisation of current capacities.
d) Inadequate purification	Low treatment capacity	<i>Requires non-ICT interventions such as new technologies to increase capacity of water treatment plants.</i>
	Low treatment efficiency	<i>Requires non-ICT interventions such as new technologies to increase treatment efficiency of water treatment plants.</i>

Issue	Sub-issue	ICT -GT enablers
	Varying operational conditions	Plant monitoring and controls: Plant monitoring and controls can ensure that the plant is running at optimum conditions at higher efficiencies.
3. Water distribution		
g) Lack of access	Inadequate distribution coverage	Analytics: Analytics done by integration of demographic data can help prioritise areas for higher distribution coverage.
	Non-functional systems	Citizen services: Multi-channel citizen services interface can capture data related to non-functional systems.
h) High water losses	Breakages and leakages	Leakage sensors: Leakage sensors can help identify breakages and leakages and can also help predict breakages.
	High non-revenue water-theft	Ghost pipe detection system: Advanced technology and sensors to detect the ghost pipes to ensure zero theft. Smart meters: Smart meters provide real-time information and enable identifying water theft.
	Slow response to outage	Outage management system: Identifies the likely cause of an outage based on inputs from the call centre, field crews, etc. and speeds outage resolution .Water supply is more rapidly restored and outage costs are contained.
	Leakage due to high pressure	Water pressure optimiser: Ensures that the pump with the most appropriate configurations are running at the right time – all the times, at the right efficiency. For instance it can optimize the pressure. This minimizes the water lost in existing leakages and reduces the risk of new burst and breaks.
	Obsolete distribution tools	Real-time hydraulic modelling water distributions tool: Informs the operator of any issues about volume, quality or pressure providing immediate knowledge about actions made.
	Inefficient monitoring of water infrastructure	Water and wastewater SCADA: Helps to manage water and wastewater infrastructure by measuring, collecting and analysing network data, making it available to operators. Mapping and modelling of water distribution assets and network: Global data models and a suite of integrated applications that are fundamental to geospatial management of a water distribution network.
	Huge water consumption for public infrastructure	Water supply analytics: Analytics can help identify large consumers as well as abnormalities in water consumption. Smart meters: Smart meters provide real-time information and enable identifying abnormalities in water consumption.
i) Contamination in water	Poor storage quality	Water quality meters: Quality meters to measure the water quality on real-time basis to take corrective action in case of any degradation of water quality.
	Poor pipe condition	Predictive failure detection: Failure detection system can predict pipe failures and enable pro-active action.
j) High energy consumption	High energy consumption in pumping water to water distribution network	Water booster pump system: Water booster pump systems take advantage of technology to optimise energy requirement of water pumping.

Issue	Sub-issue	ICT -GT enablers
4. Water consumption		
k) Lack of water conservation	Lack of water metering	Smart meters: Smart metering enables near real-time information enabling customers to understand, monitor and control their water usage.
	Inefficient fixtures	<i>Non-ICT interventions such as water efficient fixtures.</i>
	Low consumer awareness	Smart meters: Smart metering enables near real-time information enabling customers to understand, monitor and control their water usage.
l) Lack of rainwater harvesting	Low consumer awareness	Citizen services: Online information services through government portals can increase awareness.
	Lack of integration with supply system	<i>Requires non-ICT interventions.</i>
	Space constraints	<i>Requires non-ICT interventions.</i>
5. Water discharge and treatment		
a) Inefficient collection system	Leakages and breakages	Sensors in sewer line infrastructure: Sensors can help identify leakages and breakages in sewer lines.
	Insufficient capacity	<i>Requires non-ICT interventions.</i>
b) Insufficient treatment capacity	Low installed capacity	Analytics: Water supply and discharge analytics provide accurate wastewater projections to design plant capacities.
	Non-functional systems	Plant monitoring and controls: Plant monitoring and controls can identify non-functional systems for authorities to take further action.
c) Low quality	Low efficiency of treatment	<i>Requires non-ICT interventions such as new technologies to increase treatment efficiency of water treatment plants.</i>
	Varying operational conditions	Plant monitoring and controls: Plant monitoring and controls ensure that the plant is running under optimum conditions.
d) Treated water reuse	Social unacceptance	<i>Requires policy intervention in terms of guidelines for treated water usage for industrial and other purposes.</i>
	Low industrial acceptance	<i>Requires policy intervention in terms of guidelines for treated water usage for industrial and other purposes.</i>
	Dual piping	<i>Requires policy intervention like change in building code to include dual piping to promote usage of treated water.</i>

Description of ICT-GT enablers /smart solutions:

- **Analytics:** Data analytics is an efficient and inexpensive way to improve water management strategies. It helps in determining in real-time when, how much and where water is being used. Predictive analytics helps in understanding water availability pattern and forecasting to ensure adequate supply
- **Water infrastructure management:** Geospatial-based water infrastructure management (WIM) solution can provide all the details of a municipal or private water and wastewater distribution system. It helps to plan, conduct engineering analysis, design work orders and manage mapping, asset and maintenance records. It helps engineers, planners, designers, dispatchers, accountants and crews do a better job of utilising and managing the facilities
- **Automate groundwater access approval process:** BPM solutions help in designing and building automated end-to-end business processes (starting with water rights administration) that coordinate the interactions among people, systems and information; increase transparency and performance of business processes and enhance business agility
- **Ghost pipe detection system:** Advanced technology and sensors to detect the ghost pipes to ensure zero theft

- **Leakage sensors:** Leakage sensors to automatically detect water leakages. Water leakage detection sensors can be used in a variety of applications. Once they detect water leakage they can raise alerts to shut-off the water flow to the leaky area in water distribution network
- **Outage management system:** Identifies the likely cause of an outage based on inputs from the call centre, field crews, etc. and reduces outage resolution time and outage costs are contained
- **Water pressure optimiser:** Ensures that the right pump configuration are running at the right time – all the time, at the right efficiency. For instance it can optimize the pressure. This minimizes the water lost in existing leakages and reduces the risk of new burst and breaks.
- **Real-time hydraulic modelling water distributions tool:** Informs the operator of any issues about volume, quality or pressure providing immediate knowledge about actions made
- **Water and wastewater SCADA:** Helps to manage water and wastewater infrastructure by measuring, collecting and analysing network data, making it available to operators
- **Mapping and modelling of water distribution assets and network:** Global data models and a suite of integrated applications that are fundamental to geospatial management of a water distribution network
- **Online hydrology maps:** Hydrogeological maps can estimate reserves of underground waters and determine the watering capacity of mineral deposits and determine the interrelationship of geological structure, terrain and underground water, hence, giving citizens a view of the current groundwater levels. Making hydrology maps available online can help citizens to identify right locations for groundwater
- **Smart meters:** Smart metering provisions near real-time information enabling customers to understand and monitor their water usage and assists the water utility in managing its network and provide better customer service. Smart meters also provide a more detailed understanding of where water is being used, and in what quantities, enhancing the ability to pinpoint and tackle leakage
- **Water booster pump system:** Assess energy saving opportunities in the existing pumping systems and upgrade where necessary to the water booster pumping system so as to reduce annual energy consumption, improved system reliability and lower maintenance requirements
- **Water quality meters:** Leverage water quality meters to measure the water quality on real-time basis to take corrective action in case of any degradation of water quality
- **Water supply analytics:** Use of predictive analysis to better understand how the citizens use water, how this affects a city's water network and how can it be optimised to ensure adequate supply of water
- **Sensors in sewer line infrastructure:** Help in quick detection of leakages and blockages in sewer lines to avoid flooding and overflow

Overall ICT-GT enablers:

- **Integrated asset management solutions:** Integrated asset management of all safety infrastructure assets including the associated data, processes, information systems and governance for manageable operations and higher sustainability
- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools
- **City performance management:** Monitor the performance of city subsystems through the use of digital technologies and big data analytics to manage city governance, efficient performance and proactive crisis management
- **Integrated command and operations centre:** Leverage integrated command and operations centre to monitor city services on real-time. Improve/synchronise maintenance activities to reduce downtime and improve maintenance effectiveness

On-going government initiatives:

Initiatives	Brief Description
Aquifer mapping	The National Project on Aquifer Management (NAQUIM) is an initiative of the Ministry of Water Resources for mapping and managing the entire aquifer systems in the country. The vision of the project is to identify and map aquifers at the micro level, to quantify the available groundwater resources, and to propose plans appropriate to the scale of demand and aquifer characteristics and institutional arrangements for participatory management.

5.1.3. Smart mobility/transportation

Background:

City transportation is an important pillar for quality of life of citizens. Currently, in most of the cities, public and private road transportation are the key mode of commuting and logistics. Some large and mega cities have metro and local train network as the backbone transportation mode.

The main components of the transportation ecosystem are:

- Consumer demand:** People travelling to offices, schools, religious places etc for every day necessities such as groceries, stationary and other needs, creates a demand for travel. Changing urban patterns, moving to suburban areas, setting up of IT or industrial parks away from city limits has led to increase in ridership.
- Last mile connectivity:** "Last mile" is the connectivity to get people from a transport hub, especially railway stations, bus depots, or ferry ships, to their final destination. Alternatively, this is also called as "first mile". In India, issues such as inappropriate walkways or small internal roads pose challenges to last mile connectivity.
- Traffic management:** Traffic management is the method of increasing peak capacity and smoothing traffic flows on busy highways and intersections.
- Transit stations:** Transit stations connect last mile to the transport hub such as metro station or bus depot.
- Backbone transport system:** Transport systems include the city bus service, BRTs, local trains or metro service which transports people from one place to another over longer distances within the city.
- Backbone infrastructure:** Backbone infrastructure lays the foundation for mass transit systems and longer travel routes in form of railway (metro) or roadways.

Key issues:

Lack of quality and safe public transportation, inadequate capacity of public transportation, road safety concerns, overcrowded road network, poor traffic management, parking issues, theft, poor road conditions, lack of modal options, etc. remain the key issues in most of the cities. Most cities also lack the integrated transportation plans leading to huge demand-supply gap and poor transportation network. For transport operators, huge demand-supply gap, under recovery and poor asset management remain the key issues.

Transportation

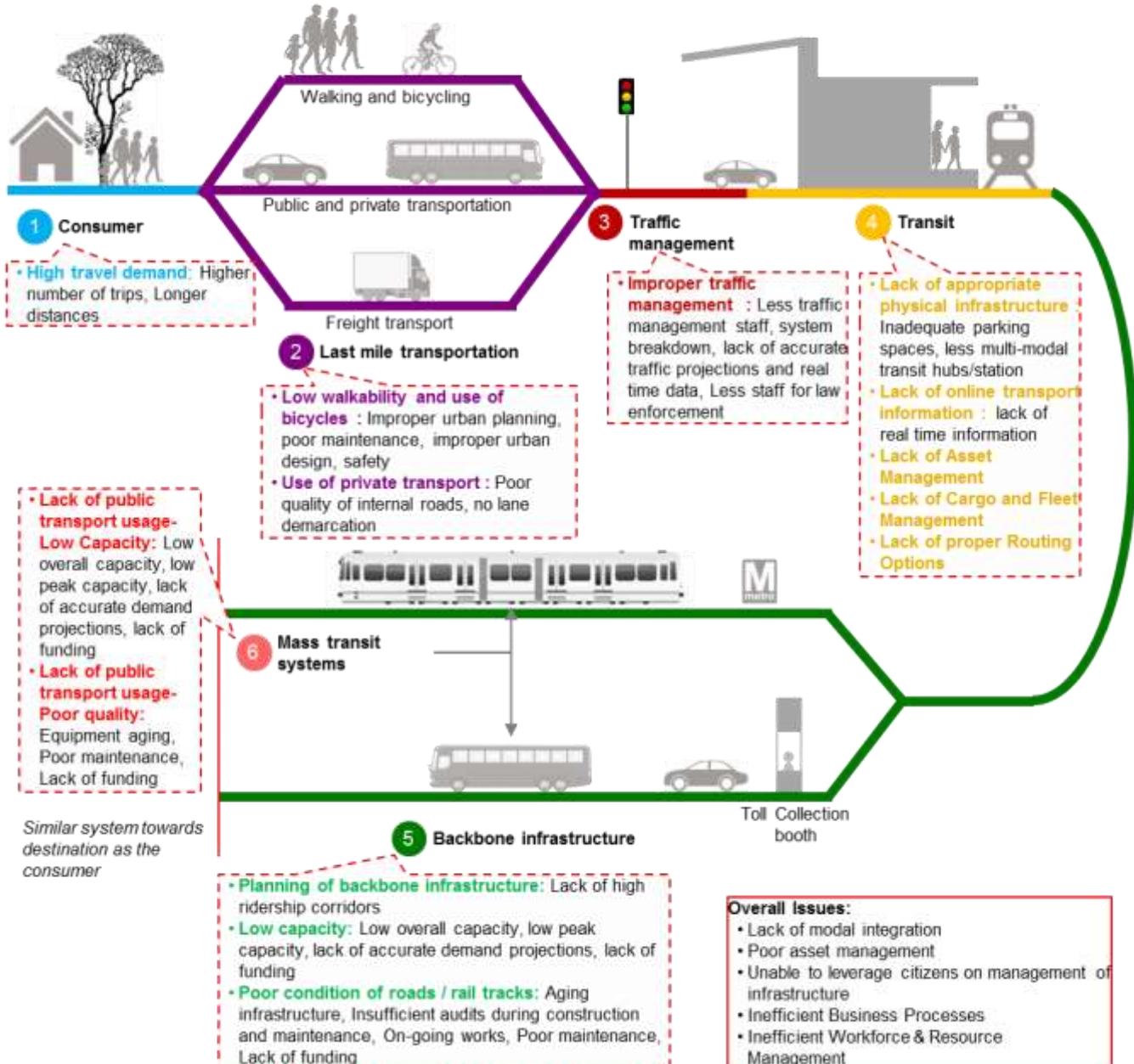


Figure 9: Current state of transportation in cities

Detailed description of the key issues and sub issues across the value chain:

Table 9: Issues and challenges in transportation subsystem

Issue	Sub-issue	Description
1. Travel demand/consumption		
a) High travel demand	Higher number of trips	Large population in cities. Lack of integrated commercial, residential, social and office infrastructure leads to movement of people for daily needs and office travel.
	Longer distances	Larger urban areas and movement to suburbs also leads to longer distances of commute. For instance, Delhi's urban area has almost doubled in the last 20 years. This has led to

Issue	Sub-issue	Description
		an increase in average trip length from 8.5 kilometres to 10.4 kilometres, and this commuting distance is projected to increase further in the coming years. ¹⁴
2. Last mile connectivity		
a) Low walk ability and use of bicycles	Improper urban planning	Most of the cities in India do not include plans for walkways and related details in the city master planning. More often, while walkways are designed on paper, the construction does not happen.
	Poor maintenance	Existing walkways or bicycle pathways are poorly maintained due to lack of capacity of cleaning staff.
	Improper urban design	Support infrastructure to encourage walking and bicycling such as proper walkways, weather protections, rest places or appropriate street lighting is not designed and/or constructed.
	Safety	Pedestrian safety is a major concern in most of the cities.
b) Use of private transport	Lower occupancy	Lack of systems to coordinate carpooling has resulted in higher number of single occupancy trips resulting in more number of vehicles on the roads.
	Lack of public transport	Lack of efficient public transport system leads to larger number of private vehicles on the road.
c) Lack of public transport	Narrow internal roads	Small internal roads in most of the core areas in cities make it difficult to plan for buses for last mile connectivity.
(Issues listed in #6 – Public transport systems are applicable here)		
3. Transit		
a) Lack of appropriate physical infrastructure and management of assets and resources	Lack of bicycle, motor and four wheeler parking	There is a lack of safe bicycle parking areas. Two wheeler and four wheeler parking capacities are not adequate.
	Lack of integration	There are less number of multi modal transit hubs/stations connecting metros to city buses and a single fare card system integrated across all modes of transport is not available.
	Lack of asset management	Need to improve asset management by standardizing processes, procedure, protocols and tools to manage the transport assets.
	Lack of cargo and fleet management	Mechanism to track and monitor cargo and fleets are not deployed.
	Lack of proper routing options	Most of the cities do not have tools for creating routes based on traveller needs.
b) Lack of online transport information	Lack of online access to information	Most of the cities do not have online access to all the necessary information regarding bus routes, timings and travel time.
	Lack of real-time information	Real-time information like wait times of buses, metros, etc. is not available; thus leading to inconvenience and longer travel time.
4. Traffic management		
a) Improper traffic	Low capacity of	The resources of the traffic police department are not

¹⁴Challenges of Urbanisation in India , 2013(Secretariat, 2013)

Issue	Sub-issue	Description
management	traffic personnel (police, support staff, etc.)	adequate to handle peak hour traffic. Often junctions are left unattended leading to congestion.
	No lane demarcation	Internal roads in India do not have identified lanes thus leading to unorganised traffic.
	System breakdown	Non-functioning traffic signals also contribute to congestion.
	Lack of accurate traffic projections/scenario simulations	In the absence of sophisticated methods of traffic projections, getting a real picture of the traffic scenario and creating simulations for planning purposes is missing.
	Lack of real-time data or monitoring	Real-time traffic monitoring solutions are not deployed due to lack of resources.
	Lack of enforcement of traffic rules	Violating traffic rules is a serious offence; however, there is lack of systems to track the offender in most of the cities.
5. Development and operation of backbone infrastructure		
a) Planning of backbone infrastructure	Lack of high ridership corridors	Given the structure of Indian cities which have organically evolved as an urban form around economic centres, trips are distributed in multiple directions and it is difficult to find high ridership corridors to justify the metro rail system ¹⁵ or other mass transit systems.
	Organic growth	Majority of the cities in India have grown organically making it challenging to undertake works for backbone infrastructure including expansion of roads.
b) Low capacity	Low overall capacity – Improper planning	Narrow road widths and lack of integrated planning leads to gap in road/metro capacity.
	Low peak capacity	In many of the cities, capacity of infrastructure to support the traffic is barely met at off-peak hours and is badly stretched during peak hours.
	Lack of accurate demand projections	Lack of long-term demand projections, makes it challenging to plan for increasing population.
	Insufficient funding	Governance issues and lack of private players has resulted in inadequate finance and funding in this sector.
c) Poor condition of roads/rail tracks	Ageing infrastructure	Large part of the infrastructure had been laid during the post independence era and is now in a poor condition.
	Insufficient audits during construction and maintenance	Use of poor quality construction materials causes roads to get damaged easily and require re-enforcement.
	On-going un-coordinated works	Roads are dug up for electrical, water, sewage and ICT works. These are handled by different departments at the local or state levels. Lack of integration amongst these departments' leads to repetitive work resulting in digging and re-digging of roads.
	Poor maintenance	Maintenance of roads is usually taken up as reactive work and in patches rather than in a pro-active and comprehensive way. For e.g. filling up potholes after the monsoon season.
	Insufficient funding	Governance issues (municipal government depend on state transfers for finance), commercial issues (such as losses in

¹⁵Challenges of Urbanisation in India , 2013(Secretariat, 2013)

Issue	Sub-issue	Description
		fare collection), and lack of private players has resulted in the lack of adequate funding in this sector.
6. Backbone transport systems		
a) Lack of public transport usage: Low capacity	Low overall capacity	Lack of adequate buses, parking areas, metro systems and lack of institutional capacities results in a major under capacity in the public transport system.
	Lack of demand projections	Lack of long-term demand projections, makes it challenging to plan for increasing population.
	Low peak capacity	In many of the cities, capacity of public transport is barely met at off-peak hours and is badly stretched during peak hours.
	Insufficient funding	Governance issues (municipal government depend on state transfers for finance), commercial issues (such as losses in fare collection), and lack of private players has resulted in lack of adequate funding in this sector.
b) Lack of public transport usage: Poor quality	Equipment ageing	Buses or local trains in the cities are usually old with outdated systems.
	Poor maintenance	Poor maintenance due to lack of staff and other reasons of buses or local trains.
	Insufficient funding	Governance issues and lack of private players has resulted in lack of adequate funding in this sector.
c) Lower occupancy	Lack of carpooling	Lack of systems to coordinate carpooling has resulted in higher number of single occupancy trips leading to more number of vehicles on the roads.
7. Polluting vehicles		
a) Fuel-based private and public vehicles	Polluting vehicles	Fuel-based private and public vehicles cause a lot of air pollution

ICT-GT enablers:

Technology plays an important role by predicting demand and supply data to feed into transportation planning. Technology can also help in improving reliability of public transportation network by providing visibility on arrivals/departures/route information for travellers for hassle-free journey. Multi modal fare integration can help citizens to use multiple modal options without hassle of purchasing different tickets. Intelligent traffic management can aid efficient traffic flow.

Transportation

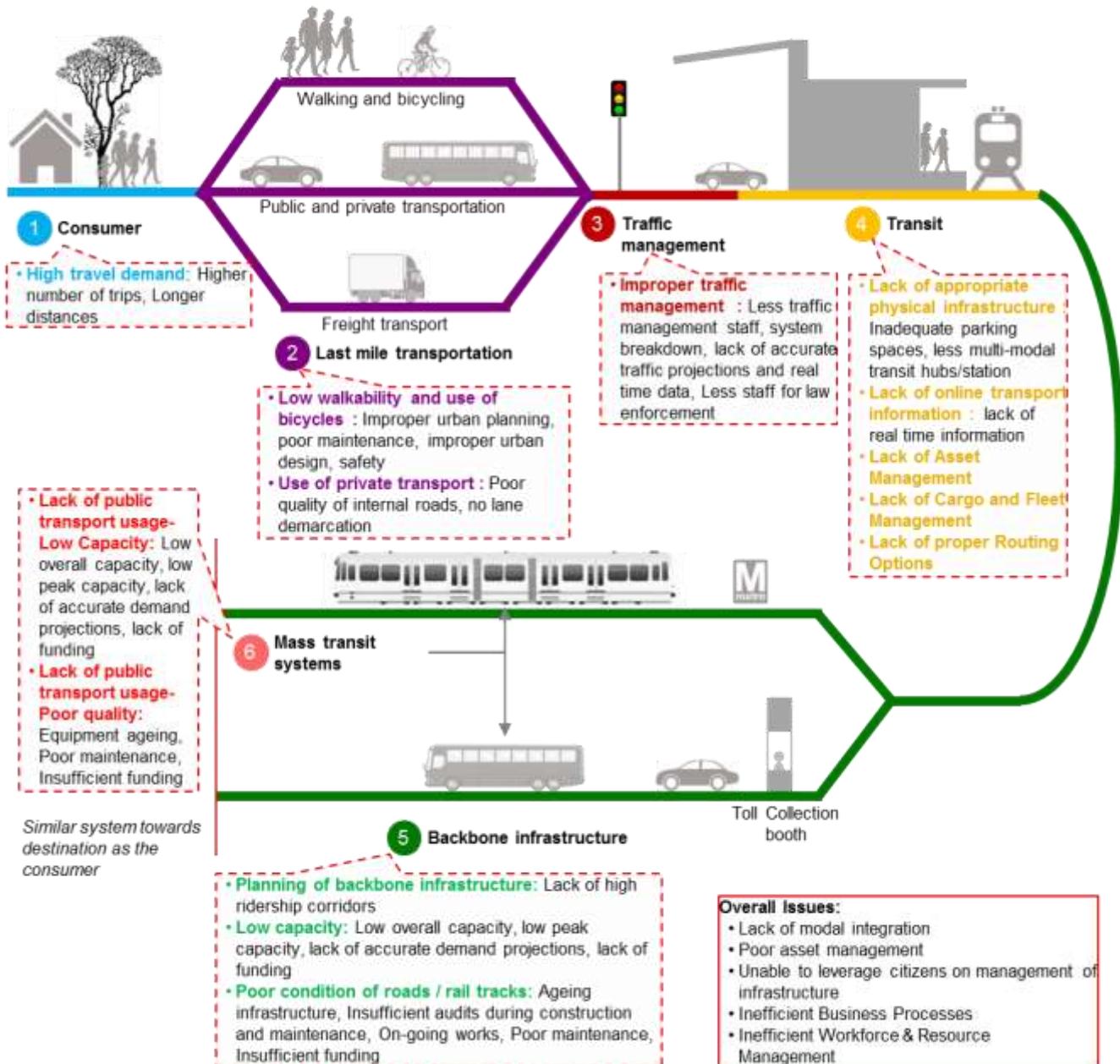


Figure 10: Smart transportation

ICT-GT enablers to overcome key challenges in transportation value chain:

Table 10: Smart transportation: Mapping ICT-GT enablers to challenges

Issue	Sub-issue	ICT-GT enablers
1. Travel demand/consumption		
b) High travel demand	Higher number of trips	Online services: Online services and telecommuting can reduce the need for travel.
	Longer distances	<i>Requires non-ICT interventions like mixed use land use plans for integrated commercial, residential, social and office layouts.</i>
2. Last mile connectivity		
d) Low walkability and use of bicycles	Improper urban planning	<i>Refer urban planning section.</i>
	Poor maintenance	Asset management: ICT-enabled asset management systems can enable proactive and regular maintenance. Multi-channel citizen services: Citizen services can enable citizens to report maintenance issues in their areas via multiple channels like mobile, web, face-to-face, kiosk, social, etc.
	Improper urban design	<i>Requires primarily non-ICT interventions.</i> Bicycle sharing system: Bike sharing programmes have effectively increased usage of bicycles in cities across the world.
	Safety	<i>Refer safe city section.</i>
e) Use of private transport	Lower occupancy	Dynamic carpooling/car sharing: Carpooling applications link drivers and passengers in real-time, thus enabling dynamic carpooling.
	Lack of public transport	GPS-based tracking and route information of public transport: Provides single point access to all real-time information. <i>Requires additional non-ICT interventions with respect to capacity and quality issues.</i>
f) Lack of public transport	Narrow internal roads	<i>Requires non-ICT interventions like road widening.</i>
<i>(Issues listed in #6 – Public transport systems are applicable here)</i>		
3. Transit		
c) Lack of appropriate physical infrastructure	Lack of bicycle, motor and four wheeler parking	Smart parking: Smart parking systems provide real-time information on availability. These systems can also effectively improve peak parking capacity.
	Lack of integration	Single fare card: Convenience to traveller by enabling cash less payment for multiple mode of transportation.
d) Lack of online transport information	Lack of online access to information	Geospatial-based tracking and route information of public transport: Provides single point access to all real-time information.
	Lack of real-time information	
4. Traffic management		
b) Improper traffic management	Low capacity of traffic personnel (police, staff, etc.)	Smart traffic lights: Smart traffic lights have the ability to regulate traffic based on real-time traffic conditions. Video analytics-based surveillance: Video analytics provide real-time analysis of video feeds. It helps in detecting threats on real-

Issue	Sub-issue	ICT-GT enablers
		time basis without much manual interventions. Smart tolls: Smart tolls can efficiently reduce the queues while effectively collecting user charges.
	No lane demarcation	<i>Requires non-ICT interventions.</i>
	System breakdown	Smart traffic lights: Smart traffic lights have the ability to regulate traffic based on real-time traffic conditions. Real-time information on functioning of the lights is received at the command centre to take quick actions.
	Lack of accurate traffic projections/scenario simulations	Video analytics-based surveillance: Traffic data and real-time information can be used to create scenarios and simulate various situations.
	Lack of real-time data or monitoring	Smart traffic lights: Smart traffic lights have the ability to regulate traffic based on real-time traffic conditions. Efficient incident management: System can assist in detecting incidents early and responding to them in a timely fashion to ensure smooth movement of traffic on the road.
	Lack of punishment for violating traffic rules	GPS-based vehicle tracking: GPS-based vehicle tracking can enable identification of violators. Online fine and dues payment: Online payment of fine can reduce the incidences of corruption.

5. Development and operation of backbone infrastructure

d) Planning of backbone infrastructure	Lack of high ridership corridors	<i>Covered under urban planning.</i>
	Organic growth	<i>Covered under urban planning.</i>
e) Low Capacity	Low overall capacity – Improper planning	<i>Requires non-ICT interventions.</i>
	Low peak capacity	Online services: Online services, remote working and coordination of work hours can reduce the peak hour traffic.
	Lack of accurate demand projections	Analytics: Traffic data and real-time information integrated with other demographic database can be used to create demand projections.
	Insufficient Funding	Road user charges: Road user charges are direct charges levied for the use of roads, including road tolls; distance or time-based fees and can help the provider recover the investment.
f) Poor condition of roads/rail tracks	Ageing infrastructure	<i>Requires non-ICT interventions.</i>
	Insufficient audits during construction and maintenance	<i>Requires non-ICT interventions.</i>
	On-going un-coordinated works	Integrated asset management: Integrated asset management can assist in conducting proactive maintenance and increase the life of the fleet.
	Poor maintenance	
	Lack of finance/funding	<i>Refer to financing mechanism section.</i>

6. Backbone transport systems

d) Lack of public	Low overall capacity	<i>Requires non-ICT interventions.</i>
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Issue	Sub-issue	ICT-GT enablers
transport usage: Low capacity	Lack of demand projections	Analytics: Traffic data and real-time information integrated with other demographic database can be used to create demand projections.
	Low peak capacity	<i>Requires non-ICT interventions.</i>
	Insufficient funding	Usage charges: Usage charges and other models can help recover the investment with appropriate returns.
e) Lack of public transport usage: Poor quality	Equipment ageing	Integrated asset management: Integrated asset management can assist in conducting proactive maintenance.
	Poor maintenance	
	Insufficient funding	Usage charges: Usage charges and other models can help recover the investment with appropriate returns.
f) Lower occupancy	Lack of carpooling	Dynamic carpooling/car sharing: Enables carpooling which leads to reduction of private cars on the road.
7. Polluting vehicles		
b) Fuel-based private and public vehicles	Polluting vehicles	Electric vehicles charging stations and management platforms will encourage users to use electric vehicles which will in turn reduce air pollution.

Description of ICT-GT enablers /smart solutions:

- **Bicycle sharing system:** A bicycle sharing system, public bicycle system, or bike share scheme, is a service in which bicycles are made available for shared use to individuals on a very short-term basis. For many systems, smartphone mapping apps show nearby stations. They show how many bikes and how many open docks are available at each station, increasing convenience for users
- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **Geospatial-enabled efficient transportation system:** Geospatial-enabled services provide periodic traffic forecast, journey planning mobile applications based on real-time data, etc.
- **Dynamic carpooling/car sharing:** Carpooling applications link drivers and passengers in real-time, thus enabling dynamic carpooling. Drivers wishing to profit from their journeys can find people situated on the same route via a smartphone app and vice versa. Passengers can also directly debit his or her fare to app, eliminating the need for any money exchange. The costs of travel would typically be capped
- **GPS-based tracking and route information of public transport:** Advanced vehicle tracking solutions enhances operations and optimises public transportation and ridership. These solutions offer real-time GPS tracking from mobile devices thus increasing the reliability of public transportation
- **Integrated asset management solutions:** Integrated asset management of all transport infrastructure assets including the associated data, processes, information systems and governance for manageable operations and higher sustainability
- **Integrated command and operations centre:** Leverage integrated command and operations centre to monitor city services on real-time. Improve/synchronise maintenance activities to reduce downtime and improve maintenance effectiveness
- **Integrated transit hubs:** Integrated transport hubs seamlessly connect multiple modes of transportation like bus system, metro system, etc.
- **Public transport surveillance:** As the public transit population grows, it becomes increasingly important to launch surveillance system on the public transport, for e.g. buses, mass transit railway, underground, and trains to secure public transportation. The administrators can monitor the public transport remotely and take action against any accidents/incidents. The video footage can also be used as legal evidence against damage or criminal action on the public transport

- **Road user charging:** Road user charges are direct charges levied for the use of roads, including road tolls, distance or time-based fees, congestion charges and charges designed to discourage use of certain classes of vehicle, fuel sources or more polluting vehicles. These charges help to reduce peak hour travel and the associated traffic congestion or other social and environmental negative externalities associated with road travel such as air pollution, greenhouse gas emissions, and visual intrusion, noise and road accidents. It can be leveraged in certain busy areas or selected cities to discourage private transport usage.
- **Single fare card:** Single fare card for fare payment on the various participating public transportation systems. The cards can be recharged by mobile applications/internet/retail outlets. Potential extension of the cards could also be for street parking
- **Smart parking:** A smart parking leverages parking sensors, cameras, smart parking solution, etc. to provide efficient management of on street and off street parking spaces
- **Smart toll:** Smart toll leverages technology like number plate detection, RFID, etc. to charge toll fees to user account so that vehicles do not have to wait at toll gates on local, national and state highway
- **Smart traffic lights:** Smart traffic lights leverages technology to sense traffic condition to tune traffic lights which enable smooth flow of traffic
- **Video analytics-based surveillance:** Video analytics enhances video surveillance systems by performing the tasks of real-time event detection, post event analysis and extraction of statistical data while saving manpower costs and increasing the effectiveness of the surveillance system operation
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools
- **Efficient incident management:** Detecting incidents early and responding to them effectively with a quick response time for emergency services makes the roads safer, congestion-free and allow smoother traffic flow
- **Freight ICT services:** Freight ICT applications can help save time and energy by improving the efficiency of freight vehicle operations including processes at entry and exit and making better use of the freight network. ICT brings the potential for virtually unlimited data collection, greatly enhanced predictive capabilities, and real-time, dynamic decision-making and implementation which lead to a more efficient freight system based on completely visible and accessible physical and digital networks

Overall ICT-GT enablers:

- **Integrated asset management solutions:** Integrated asset management of all transportation infrastructure assets including the associated data, processes, information systems and governance for manageable operations and higher sustainability
- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools
- **City performance management:** Monitor the performance of city sub-systems through the use of digital technologies and big data analytics to manage city governance, efficient performance and proactive crisis management
- **Integrated command and operations centre:** Leverage integrated command and operations centre to monitor city services on real-time. Improve/synchronise maintenance activities to reduce downtime and improve maintenance effectiveness
- **Electric vehicles:** Support electricity and renewable energy operated cars with the required infrastructure. Make a few cities as pilot for “Plug-in” ready cities by facilitating the expansion of a Public Electric Vehicle (EV) infrastructure that ensures the safe, reliable, and efficient integration of EV charging loads with the power grid ongoing government initiatives:

<i>Initiatives</i>	<i>Brief Description</i>
Ongoing government initiative: Sustainable urban transport	The project aims to strengthen capacities of government agencies, national/state urban transport departments, municipal corporations and transport experts engaged in urban transport planning and regulations to reduce urban transport emissions causing environmental damage. The project will also demonstrate sustainable urban transport models in 10 cities in the country.
Ongoing government initiative: Bus Rapid Transit (BRT, BRTS)	Bus Rapid Transit (BRT, BRTS) is a bus-based mass transit system with specialised design, services and infrastructure to improve system quality and remove the typical causes of delay. The idea of a BRT concept in India - based on the successful system in Curitiba, Brazil - was first introduced in the year 2000 in the form of a feasibility study for Bengaluru. Today, however, the concept has caught on and Bus Rapid Transit systems already exists in Pune, Delhi, Ahmedabad, Surat, Rajkot, Mumbai and Jaipur with new ones coming up in Kolkata, Hyderabad, Lucknow, Bengaluru and Hubli-Dharwad. High capacity buses can be found in cities like Mumbai, Bengaluru, Nagpur, Indore and Chennai.

5.1.4. Smart waste management

Background:

Increase in population and change in lifestyles has led to increase in waste generation. Municipal solid waste includes residential and commercial wastes generated in city areas in either solid or semi-solid form¹⁶. This excludes industrial hazardous wastes but includes treated bio-medical wastes. Safe and cost-effective management of municipal solid waste is a significant environmental challenge for modern society. Inadequately managed waste disposal has the potential to affect the health and environment.

The main components of the solid waste management value chain are:

1. **Waste generation:** Waste generation encompasses activities, in which materials (in their present form) are identified valueless and are either thrown away or gathered for disposal.
2. **Waste handling, sorting and storage:** Waste handling and sorting involves the activities associated with management of wastes until they are placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection. For streets and other public spaces, street sweepers clean the streets and collect the garbage in the containers.
3. **Waste collection and transportation:** In most average density cities, primary collection is managed door-to-door on a daily basis by waste collectors using hand carts or tricycles. Households are encouraged to segregate their waste in two fractions – biodegradable and non-biodegradable. Further, the waste collectors make an initial separation into recyclable, inert and biodegradable waste before storing the waste in his or her cart or tricycle. The waste in primary collection is stored and separated. Regular collection of waste avoids a problem of leachate and odor; as the fresh organic waste does not start to decompose un-anaerobically. From the primary collection carts or tricycles waste is transferred directly to trucks or tractor trolleys. This waste is then transferred to waste processing centres for composting, recycling and ultimately disposal. Typically, throughout the secondary collection system biodegradable, recyclable and inert waste is managed separately.
4. **Waste segregation:** The recovery of sorted materials, processing of solid waste and transformation of solid waste that occurs primarily in locations away from the source of waste generation form this functional element. Sorting of mixed wastes usually occurs at a materials recovery facility, transfer stations, combustion facilities, and disposal sites. Sorting often includes the separation of bulky items, separation of waste components by size using screens, manual separation of waste components, and separation of ferrous and non-ferrous metals.
5. **Waste disposal:** The final functional element in the solid waste management system is disposal. Typically the disposal of wastes is by land filling or incineration. Waste which is recyclable is recycled.

Key issues:

Indian cities alone generate more than 100 million tonnes of solid waste a year. It is estimated that up to 40 percent of municipal waste in India remains simply uncollected¹⁷. A large number of cities do not have any processing facilities and the municipalities tend to haphazardly dump wastes all over the dumpsite(s). Lack of storage and collection facilities, segregation of waste, pollution and contamination due to dumping of garbage on roads, open transportation in trucks, space constraints with landfills, social and environmental issues associated with landfills and lack of reusable and recyclables are the key issues in solid waste management.

¹⁶www.environmentclearance.nic.in

¹⁷http://en.wikipedia.org/wiki/Environmental_issues_in_India#Solid_waste_pollution

Solid Waste Management

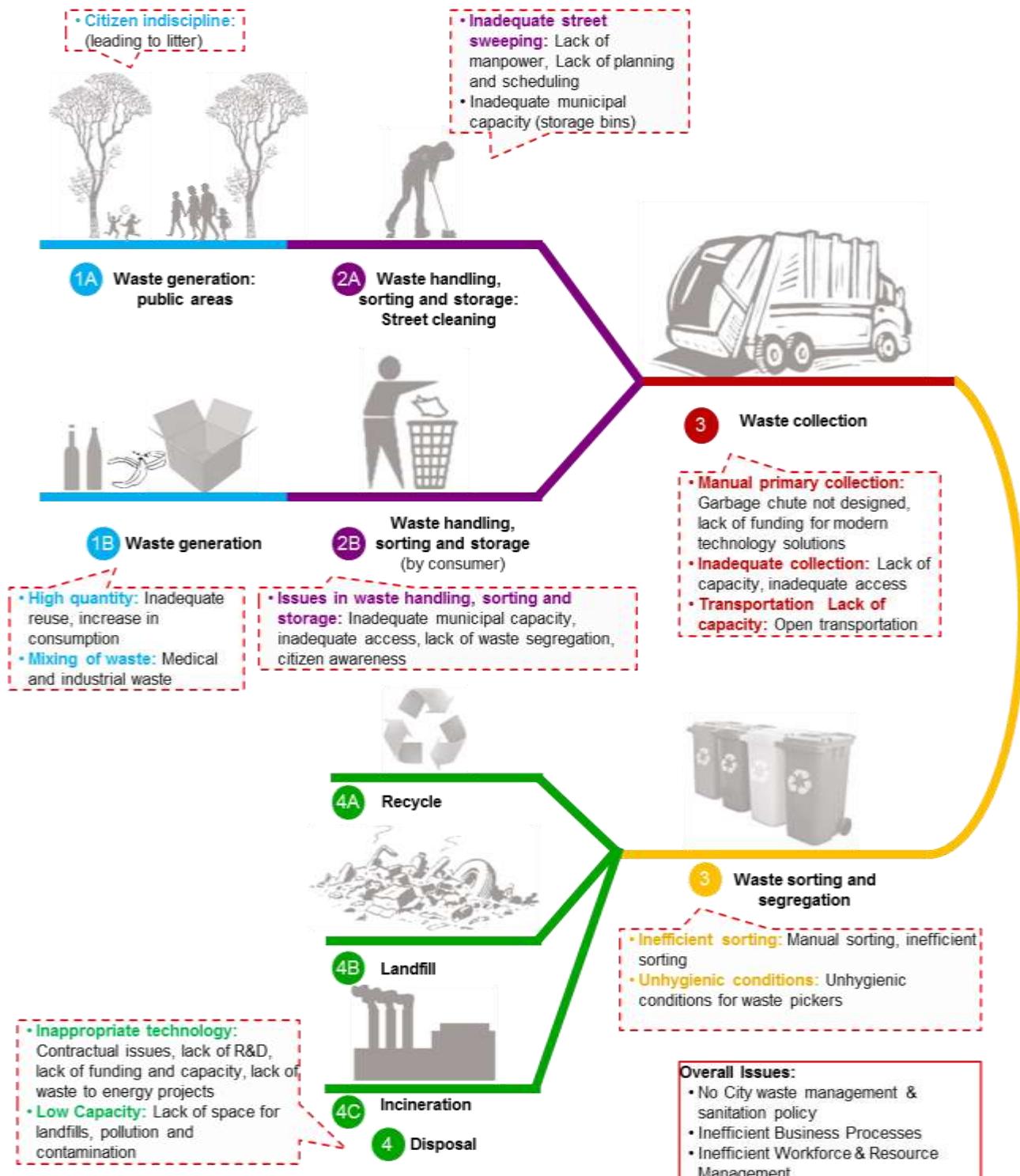


Figure 11: Current state of solid waste management

Description of the key issues and challenges across the value chain:

Table 11: Issues and challenges in solid waste management

Issue	Sub-issue	Description
1. Waste generation		
a) High quantity	Inadequate reuse	There is an overall reduction in realising reuse opportunity before discarding the material.
	Increase in consumption	Increase in disposable income, easy availability of packaged products and consumerism has led to increase in consumption and thus increase in waste generation.
b) Mixing of waste	Medical and industrial waste	Medical and industrial waste is often mixed with municipal waste due to lack of appropriate disposal systems.
2. Waste handling, sorting and storage		
a) Issues in waste handling, sorting and storage	Inadequate municipal capacity	Many public places do not have garbage bins leading to dumping of garbage on streets and open areas.
	Inadequate access	Illegal settlements have no access to municipal solid waste services, again leading to dumping on streets and open areas.
	Lack of waste segregation	Segregation at source is lacking in Indian cities. Some cities, such as Pune and Bengaluru, have mandated segregation of waste into organic and inorganic; however, most of the cities do not have systems for collection of segregated waste.
	Citizen indiscipline	Citizen discipline and awareness is critically lacking. The Swachh Bharat mission is aimed at creating awareness and behavioral change.
b) Inadequate street sweeping	Lack of manpower	Lack of resources often leads to main streets not cleaned in a timely manner.
	Lack of planning and scheduling	Street cleaning must be strategised based on the traffic, use and citizen behaviour in the areas. However, planning and scheduling often happens in an adhoc manner.
3. Waste collection and transportation		
a) Manual primary collection	Garbage chute not designed	Providing a garbage chute is not a common practice in residential complexes.
	Lack of funding for modern technology solutions	Lack of sufficient budgets are primary reasons for inadequate up-gradation of technologies.
b) Inadequate collection	Lack of capacity	Municipal corporations lack capacity and areas in which service is provided often do not have a 100 per cent collection rate.
	Inadequate access	Houses and other facilities in slums do not have any access to garbage collection systems leading to dumping on the roads. This further leads to unhygienic conditions and poses a major health risk to the city.
c) Transportation	Lack of capacity	Municipalities do not have sufficient and proper garbage collection trucks, other equipment, drivers and staff.
	Open transportation	Open transportation leads to spillage and stink on the roads.
4. Waste sorting and segregation		
a) Inefficient	Manual sorting	Cities rely on manual sorting methods which are crude and

Issue	Sub-issue	Description
sorting		inefficient.
	Low ease of sorting	Sorting is best done at the source of waste generation.
b) Unhygienic conditions	Unhygienic conditions for waste pickers	Waste pickers pick reusable or recyclables waste; this poses a major health risk.
5. Waste disposal		
a) Inappropriate technology	Contractual issues	Selection of appropriate technology for handling and disposal of solid waste is often ignored in the tenders due to lack of funds.
	Lack of R&D	Minimal investments from the public as well as private sector have gone into R&D in solid waste disposal.
	Lack of funding and capacity	Lack of funding and capacity are the prime reasons for old and outdated technologies.
	Lack of waste to energy projects	While some cities have undertaken implementation of waste to energy plants, scalability of these projects is a big issue.
b) Low capacity	Lack of space for landfills	Cities are running out of space and are unable to provide sufficiently big landfill areas. As per 2008 statistics, it is estimated that India needed to manage 0.573 MMT of municipal solid waste per day of which about 60 per cent was organic waste amounting to 0.292 MMT/d. There are only 110 facilities in the country for treating which accounts for hardly 50 per cent of the organic waste generated. ¹⁸
	Pollution and contamination	Pollution and contamination from the landfills has been a major cause of social and environmental concern. Citizens have held protests asking government to shut down landfills due to health risks.

ICT-GT enablers:

Technology plays an important role by providing visibility on city sanitation, route planning for garbage collection, resource optimisation, efficient asset management, efficient maintenance, visibility of waste bins, air quality measurements etc. City needs to redefine the waste management processes based on circular economy concepts to reduce impact on environment and leverage waste to generate value. Technology can also help involving citizens in city sanitation using mobile and web channels.

¹⁸<http://www.moef.nic.in/sites/default/files/Roadmap-Mgmt-Waste.pdf>(Ministry of Environment and Forests, 2010)

Solid Waste Management

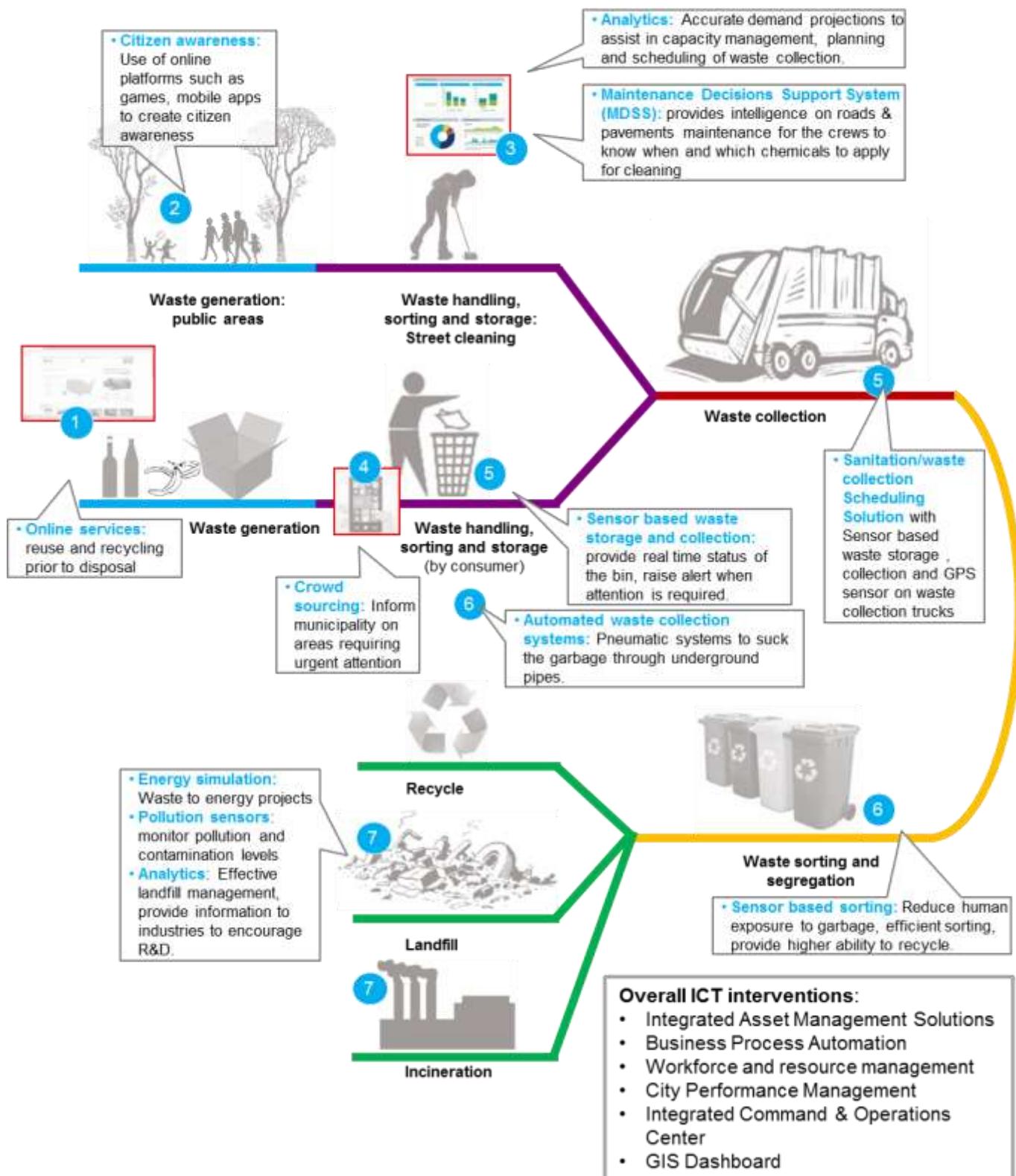


Figure 12: Smart solid waste management

ICT-GT enablers to overcome key challenges in solid waste management:

Table 12: Smart waste management: Mapping ICT-GT enablers to challenges

Issue	Sub-issue	ICT-GT enablers
1. Waste generation		
a) High quantity	Inadequate reuse	Online platforms: Online platforms can connect users and sellers and allow reuse of the products before disposing off as garbage.
	Increase in consumption	<i>Requires policy intervention and citizen awareness to use recyclable products.</i>
b) Mixing of waste	Medical and industrial waste	<i>Non-ICT solutions such as colour coded waste bins can be implemented.</i>
2. Waste handling, sorting and storage		
a) Issues in waste handling, sorting and storage	Inadequate municipal capacity	Analytics: Matching demand and supply can help in effective planning and design of solid waste management. Crowd-sourcing: Citizens can be encouraged to provide feedback regarding the status of the garbage bins in their areas. Prioritisation can happen accordingly.
	Inadequate access	<i>Requires policy intervention.</i>
	Lack of waste segregation	<i>Non-ICT solutions such as colour coded waste bins can be implemented.</i>
	Citizen indiscipline	Citizen awareness portals: Use of online platforms for creating citizen awareness on waste segregation and recycling.
b) Inadequate street sweeping	Lack of manpower	<i>Non-ICT technologies such as sweeper machines can reduce need for manpower.</i>
	Lack of planning and scheduling	Analytics-based waste collection scheduling solution: Real-time monitoring can assist in developing effective schedules.
3. Waste collection and transportation		
d) Manual primary collection	Garbage chute not designed	<i>Requires non-ICT interventions in building design and bye-laws.</i>
	Lack of funding for modern technology solutions	<i>Covered under financing mechanisms.</i>
e) Inadequate collection	Lack of capacity	Sensor-based collection scheduling solution: Sensors identify the status of bin as full/empty and can optimise the pick-up routes and schedules. Automated waste collection system: Automated waste collection systems reduce the need for manpower
	Inadequate access	<i>Requires policy interventions.</i>
f) Transportation	Lack of capacity	GPS devices and sensors on waste trucks: Efficient routing of trucks to maximise collection.
	Open transportation	<i>Requires other technology solutions.</i>
4. Waste sorting and segregation		
c) Inefficient sorting	Manual sorting	Sensor-based sorting: Sensor-based sorting reduces the need for manual sorting. Improves recycling efficiency and capacity.
	Low ease of sorting	

Issue	Sub-issue	ICT-GT enablers
d) Unhygienic conditions	Unhygienic conditions for waste pickers	
5. Waste disposal		
c) Inappropriate technology	Contractual issues	<i>Requires non-ICT intervention.</i>
	Lack of R&D	
	Lack of funding and capacity	<i>Covered under financing mechanisms.</i>
	Lack of waste to energy projects	Energy simulation: Energy simulation using software can provide accurate projections of the energy generation from city waste and enable developing a business case.
d) Low capacity	Lack of space for landfills	<i>Requires non-ICT interventions and policy interventions.</i>
	Pollution and contamination	Pollution sensors: Monitors pollution and contamination Analytics: Analytics can aid in smart management of landfills based on projections of waste generated in the city.

Description of ICT-GT enablers /smart solutions:

- **Online platforms:** Online platforms provide options and alternatives to the user to look into reusing old stuff. The existing user is also encouraged to look for options to sell and regain value from the product before discarding the product as waste.
- **Analytics:** Accurate projections on total waste generated, waste type and identification of high waste generation areas enable effective planning and management of solid waste management services. Use of analytics during events with large citizen involvement such as festivals and fairs can ensure smooth collection and transport of waste
- **Crowd-sourcing:** Citizens can be encouraged to report waste-related activities which need urgent attention from the authorities
- **Sensor-based waste collection:** Sensor-based waste bins to identify status of waste bins if it is empty or filled so as to customise the waste collection schedule accordingly and save costs
- **Automated waste collection system:** Automated Waste Collection System (ACS) is a long-term solution and can take care the conventional methods like door-to-door, curb-side, block, community bins collections and transportation via chute system from high rise buildings with waste sucked through pipes and minimal human intervention
- **GPS devices and sensors on waste truck:** GPS technology to route the waste collection trucks to optimise the collection efficiency and ensure contractors dump waste in designated places. It will also give a clear picture of waste generated per ward
- **Sensor-based sorting:** Sorting waste material with the use of sensor technology helps in smart sorting. The sensor technology can recognise materials based on their visible spectrum or colour with infrared/ultraviolet spectra or based on their specific and unique spectral properties of reflected light, or atomic density or conductivity/permeability or atomic characteristics
- **Pollution sensors:** Leverage the pollution sensors to gauge pollution levels at landfills
- **Energy simulation (waste to energy):** Use of energy simulation software and analytics can provide accurate projections of waste generation and energy production from waste
- **Analytics-based landfill management:** Accurate waste generation and collection projections along-with break-up of type of waste can enable smart landfill management

Overall ICT-GT enablers:

- **Integrated asset management solutions:** Integrated asset management of all waste infrastructure assets including the associated data, processes, information systems and governance for manageable operations and higher sustainability
- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools
- **City performance management:** Monitor the performance of city subsystems through the use of digital technologies and big data analytics to manage city governance, efficient performance and proactive crisis management
- **Integrated command and operations centre:** Leverage integrated command and operations centre to monitor city services on real-time. Improve/synchronise maintenance activities to reduce downtime and improve maintenance effectiveness
- **Geospatial dashboard:** Bin locations, landfill locations, waste management assets need to be mapped in geospatial system

5.1.5. Smart urban planning

Background:

Urban planning is a key pillar for predictable growth and quality of life in any city. Cities have been focusing on infrastructure plans based on future projections to plan for city infrastructure like road, transportation, land use, etc. Traditionally, urban planning was done manually which leads to inefficiency in planning process.

The main components of urban planning ecosystem are:

1. **Land use planning:** Land use planning encompasses various disciplines which seek to order and regulate land use in an efficient and ethical way, thus preventing land use conflicts. Land use planning is used to manage the development of land. In doing so, the governmental unit can plan for the needs of the community while safeguarding natural resources. Often one element of a comprehensive plan, a land use plan provides a vision for the future possibilities of development in neighbourhoods, districts, cities, or any defined planning area.
2. **Development planning:** Development planning includes development of urban planning and design along with planning for infrastructure and facilities such as water and wastewater, sewerage, drainage, solid waste management, electricity, gas and public infra lighting.
3. **Governance:** Approvals of the layout plans, building plans, NOCs and the other necessary processes thereby.

Key issues:

Currently master plans are available for only 1,500 towns out of 5,161 urban centres. The growth of Indian cities is largely organic in the sense that existing urban centres are expanding and exploding economically, geographically and demographically rather than new planned cities emerging from scratch(Planning Commission). Integration of plans is lacking and peri-urban areas are not considered during planning process. Large parts of cities today completely 'escape' mainstream planning. Half the population of Delhi and Mumbai lives in unauthorised areas. The considerable 'illegal development' (illegal layouts, un-authorised constructions, slums) in many towns threatens the future of urban areas and the credibility of main plan documents and regulations.

The dissemination of the data has been severely restricted by the government under Official Secrets Act 1923. Planners and agencies related with planning and development works have to depend on obsolete spatial data. In addition, the real lies in lack of technical competence to handle complex spatial data. The real challenge revolves around the issues of integration and inter-operability of different systems. Also, consistent socio-economic data is not available. Information required for urban studies usually comes from the Census of India, which though extensive, often does not meet specific data requirements(Press, 2006). Integration of urban planning with city growth strategy has been conventionally not considered.

Urban Planning

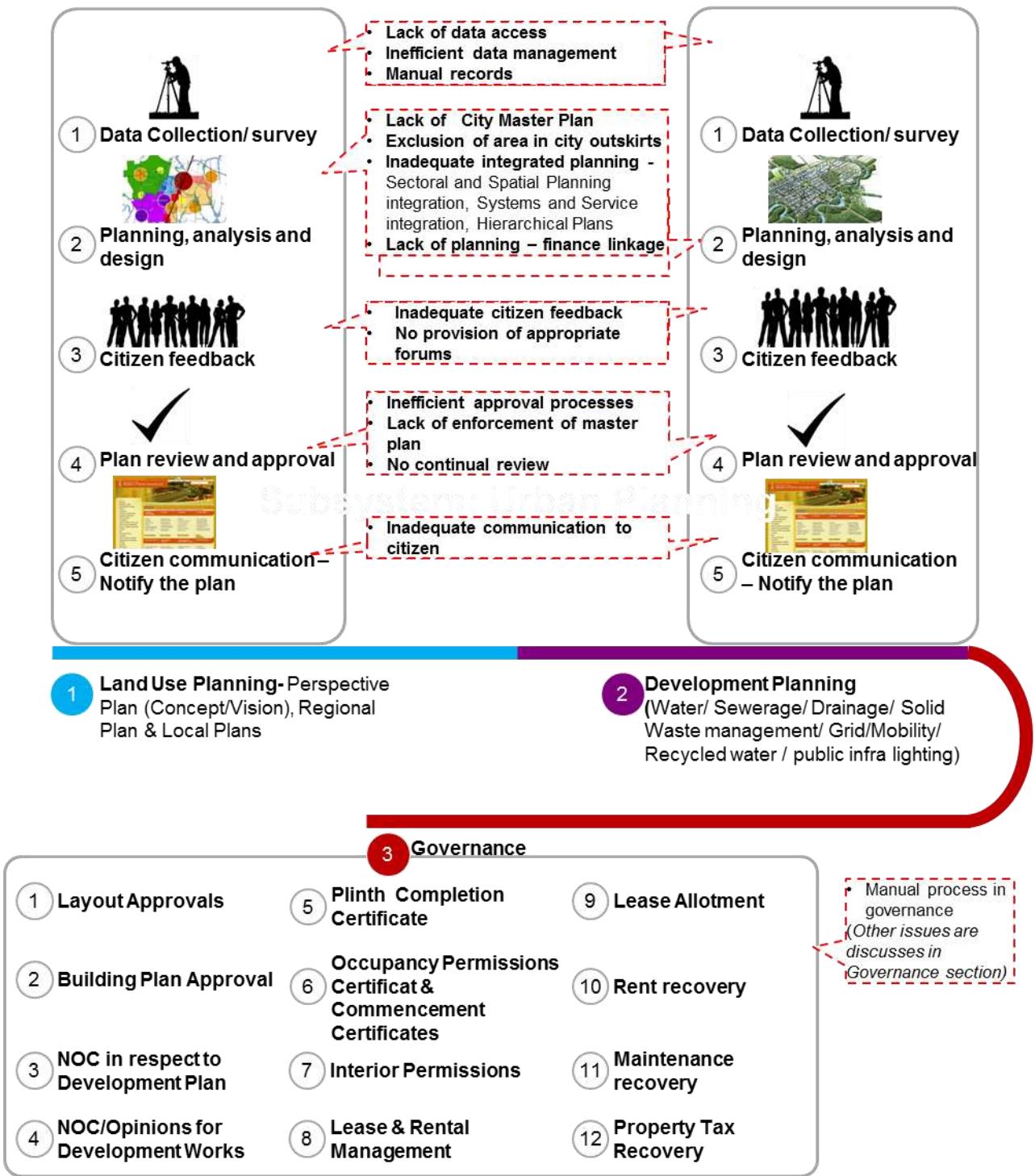


Figure 13: Current state of urban planning in cities

Detailed description of the key issues and sub issues in the ecosystem:

Table 13: Issues and challenges in urban planning

Issue	Subissue	Description
Land use planning and development planning		
1. Data collection and survey		
a) Inefficient data management	Lack of data access manual records	The dissemination of the data has been severely restricted by the government under Official Secrets Act 1923. Planners and agencies related with planning and development works have to depend on obsolete spatial data.
	Lack of technical competence	There is a lack of technical competence to handle complex spatial data. The real challenge revolves around the issues of integration and inter-operability of different systems. Also, consistent socio-economic data is not available. Information required for urban studies usually comes from the Census of India, which though extensive, often does not meet specific data requirements.
2. Planning, analysis and design		
a) Lack of city master plan	Not all cities have a master plan	Currently master plans are available for only 1,500 towns out of 5,161 urban centres. The growth of Indian cities is largely organic in the sense that existing urban centres are expanding and exploding economically, geographically and demographically rather than new planned cities emerging from scratch. Existing large cities and new towns should have 40-year and 20-year strategic and master plans.
b) Haphazard development	Exclusion of city outskirts	The present planning approach focuses on only the core area of the city, without proper vision and strategy to integrate the peri-urban and rural areas within a regional framework. Consequently most cities and their regions are facing serious issues of haphazard development in the urban periphery.
c) Lack of planning hierarchy	No plan hierarchy	Hierarchy of plans is required— Regional plan, master plan, zonal and town planning schemes, and local plan (Neighbourhood)
d) Inadequate integrated planning	No sectorial and spatial planning integration	Spatial planning in many states in India is carried out by town planning departments or development authorities. These plans define the road network, land use zoning and development control regulations for entire urban area. As a parallel process, the state governments undertake planning for many sectors of development (social and economic) at the state, district and city level. Most of the sectorial (socio-economic) planning efforts are focused on program and project formulation and have very weak spatial planning components.
	No systems and service integration	Lack of integrated planning of various services and systems, including, but not limited to surface water drainage, water management, electrical and power systems, transport and mobility, lack of integration of BRTS with other modes of transportation. A multitude of authorities are involved in planning of different systems and services leading to isolated planning and conflicts.
e) Lack of	No integration with	Master plans in the past have been utopian, without linkage to

Issue	Subissue	Description
planning – Finance linkage	financing and operating strategy	any financing and operating strategy. Planned urban development leads to increases in tax bases, especially those related to land. Master plans did not address the financing issues in a meaningful manner as a result of which plan implementation has lagged behind plan targets significantly.
3. Citizen feedback		
a) Lack of citizen feedback	Inadequate citizen feedback	The plan process is often not participatory. The lack of accountability and participation of the people and elected local government representatives in the planning process also hinders the effectiveness of the plan-making and implementation processes.
	No provision of appropriate forums	There are very few forums, if any, through which the government can engage with citizens to obtain their feedback.
4. Plan review and approval		
a) Inefficient approval processes	Inefficient approval processes	The regulatory framework is inadequate and inefficiencies exist in the approval process. Infrastructure projects require multiple sequential clearances at various levels of government; the perspectives of the different ministries/departments vary and coordination remains inefficient; bureaucratic complexities and the protracted procedure for securing approvals are often considered serious disincentives for developers and contractors.
b) Lack of enforcement of master plan	Lack of enforcement of master plan	Only 4 of the requisite 10 states and 20 of the 29 states have constituted Metropolitan Planning Committee and District Planning Committee respectively. The metropolitan master plans created by these MPCs are not binding on city development plans, negating the benefits of metropolitan planning.
c) No continual review	No continual review	Currently master plans are available for only 1,500 towns out of 5,161 urban centres many of which are not reviewed and are outdated.
5. Citizen communication		
a) Unplanned communication	Inadequate communication to citizen	Information regarding the city planning is rarely communicated to the citizens through a user-friendly platform.
Governance		
a) Inefficient governance process	Manual process in governance	Manual processes lead to delay in governance-related issues. There is also an increased chance of human error. <i>(Other issues are discussed in the governance section)</i>

ICT-GT enablers:

ICT-GT master plan needs to be created for each city to define roadmap. Geospatial technology should be leveraged in urban planning to effectively plan for city expansion, land use, building permits, etc.

Smart Urban Planning

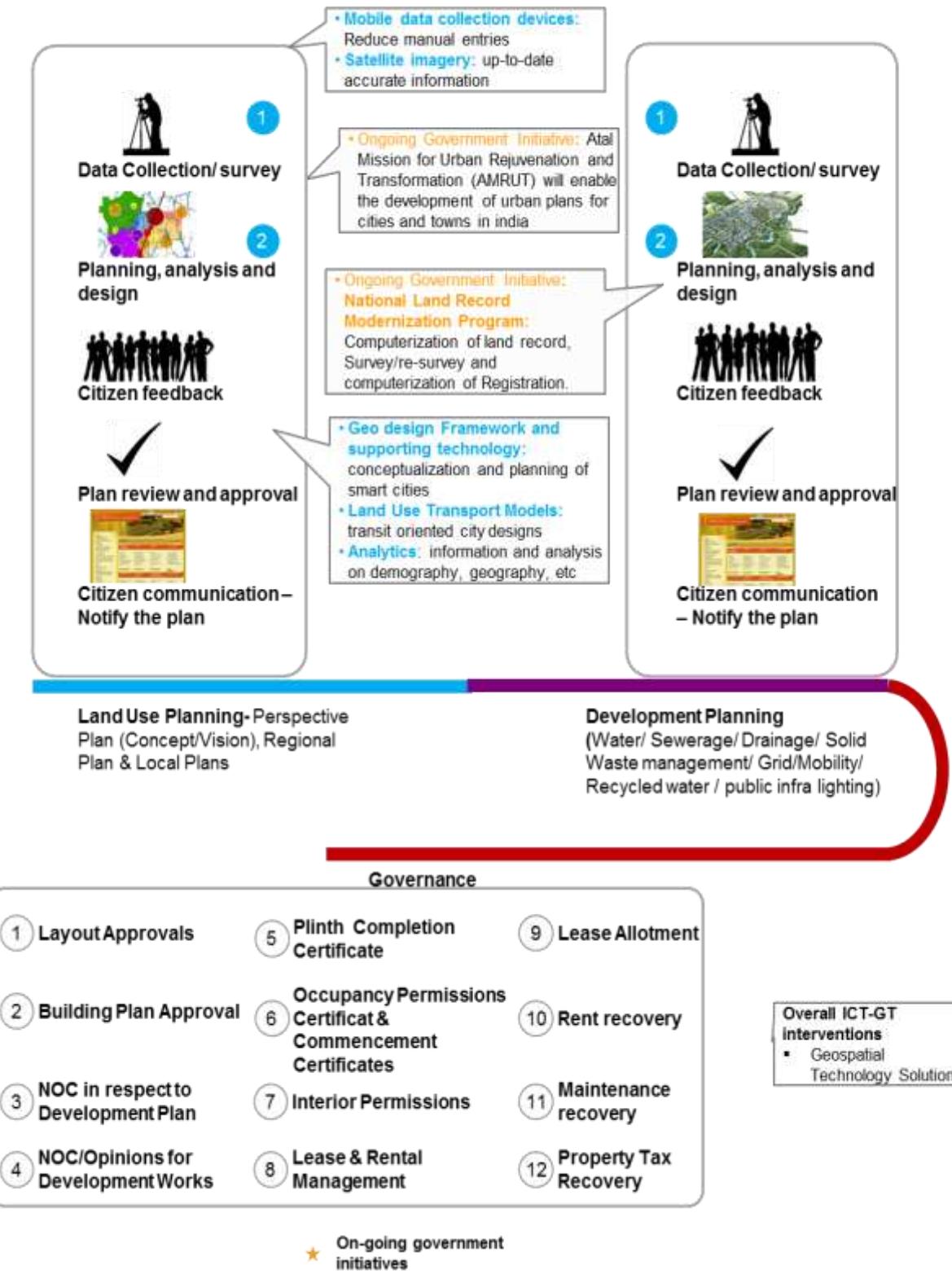


Figure 14: Smart urban planning

ICT-GT enablers to overcome key challenges in urban planning:

Table 14: Urban planning: Mapping ICT-GT enablers to challenges

Issue	Sub-issue	ICT-GT enablers
Land use planning and development planning		
1. Data collection and survey		
b) Inefficient data management	Lack of data access manual records	Mobile data collection devices: To collect, share and visualise geographically tagged data in real-time giving valuable insights to urban planners.
	Lack of technical competence	Satellite imagery: Satellite data and images helps to obtain an up-to-date view of the physical world thus enabling better use and management of land, resources and mitigation of risks.
2. Planning, analysis and design		
f) Lack of city master plan	Not all cities have a master plan	Geo design framework and supporting technology: For conceptualising and planning for smart cities. Analytics: Enables planners to decide on the basis of evidence rather than intuition. Land use transport models: Transportation models that aims to estimate how cities will develop on a long-term basis (typically over a period of 30 to 50-years) through the interaction of three main factors: population, land use and transport services.
g) Haphazard development	Exclusion of city outskirts	
h) Lack of planning hierarchy	No plan hierarchy	
i) Inadequate integrated planning	No sectorial and spatial planning integration No Systems and Service integration	
j) Lack of planning – Finance linkage	No integration with financing and operating strategy	Online payments: By digitizing payments cities can realise cost reductions while creating new conveniences for users. With advanced revenue collection and payments systems, individuals and companies can pay for taxes and apply for permits online without having to stand in long queues. <i>*Also requires non-ICT intervention.</i>
3. Citizen feedback		
b) Lack of citizen feedback	Inadequate citizen feedback	Multi-channel citizen communications: Enables citizens communication over multiple channels like web, face-to-face, phone, social, etc.
	No provision of appropriate forums	
4. Plan review and approval		
d) Inefficient approval processes	Inefficient approval processes	BPM: Business process re-engineering followed by business process automation can be used to improve efficiency of manual process and reduce turnaround time.
e) Lack of enforcement of master plan	Lack of enforcement of master plan	<i>Non-ICT intervention.</i>

Issue	Sub-issue	ICT-GT enablers
f) No continual review	No continual review	<i>Non-ICT intervention.</i>
5. Citizen communication		
b) Unplanned communication	Inadequate communication to citizen	Multi-channel citizen communication: Enables citizens communication over multiple channels like web, face-to-face, phone, social, etc.
6. Overall		
All issues		<p>Geospatial technology is a key enabler which combines spatial data (maps, aerial photographs, satellite images) with other quantitative, qualitative and descriptive information databases. It can be used for multiple areas like:</p> <ul style="list-style-type: none"> - Increase routing efficiency for solid waste collection, landfill location selection, site assessment of illegal dump sites and monitoring waste pick performance - A surveillance system for monitoring the movement of the vehicles using GPS/geospatial to manage traffic as well as give traffic reports to citizens via multiple channels - Monitoring of the vehicle in real time to improve per vehicle productivity & decrease non-compliance - Monitor water utilisation, tracking water waste and also to locate new sources of water - Land use planning, zoning and inspection - Property valuation and taxation - Transportation and infrastructure planning - Predict extreme weather conditions, unforeseen events and take preventive actions

Geospatial technology– Key ICT enabler:

Geospatial technology is designed to capture, store, manipulate, analyse, manage, and present all types of spatial or geographical data. Geospatial technologies are focused on use of geospatial data to reduce the cost of programmes, carry out informed decision-making, and at the same time provide improved services to citizens, thereby enhancing various business processes with location intelligence. Following are some of the key areas geospatial technology should be used as the key enabler:

- **Infrastructure management:** Geospatial-enabled infrastructure management solution provides tools to build and maintain digital spatial data infrastructure models for water, wastewater, and storm water systems, as well as digital infrastructure models for municipal transportation systems
- **Critical infrastructure protection:**
 - Protection for
 - Airports and transit security
 - Utilities – to ensure uninterrupted (24x7) supply of electricity, water, telecom, etc.
 - Sensitive installations both government and private
 - Large/crowded venues such as stadiums, markets, religious places, monuments, tourism spots, etc.
 - Geospatial technology-based applications can enable early
 - Detection and warning
 - Assessment and rapid response

during unplanned catastrophic incidents by integrating the safety and surveillance systems with location-enabled spatial data and applications

- **Geospatial-enabled efficient transportation system:** Geospatial-enabled services provide periodic traffic forecast, journey planning mobile applications based on real-time data, etc.
- **Electric Infrastructure Management (EIM):** Electric infrastructure management (EIM) supports records management for the principal assets of a utility - the transmission and distribution facilities. EIM reduces the cost of maintaining these records, which are stored in a database and easily available for a variety of applications
- **Gas infrastructure management:** Geospatial-based gas infrastructure management (GIM) solutions enable utility firms to efficiently manage and record their principal gas infrastructure assets, while reducing the cost of maintaining these records by storing them in a central database
- **Pipeline infrastructure management:** Geospatial-based pipeline infrastructure management (GIM) solutions reduce the cost of maintaining a utility firm's key assets - transmission and distribution facilities which represents a significant portion of their annual operating budgets
- **Water infrastructure management:** Geospatial-based water infrastructure management (WIM) solution can provide all the details of a municipal or private water and wastewater distribution system. It helps to plan, conduct engineering analysis, design work orders, and manage mapping, asset, and maintenance records. It helps engineers, planners, designers, dispatchers, accountants, and crews do a better job of utilising and managing the facilities
- **Reporting and analysis:** Public safety applications generate volumes of useful data. CAD (Computer-aided Dispatch) system collects vital call information. Records management system logs accidents, arrests, citations, gang activity, and more
- **Incident management:** Incident management solution helps to process calls, gain insight into incidents, coordinate with other agencies, access business intelligence data and respond quickly to save lives. The resultant analysis allows decision makers to ensure resources are effectively deployed by targeting areas based on spatial patterns and tactical analysis
- **Motion video exploitation:** Motion video exploitation solution, built on geospatial content management, forensic video analysis, and image fusion and exploitation capabilities, provides end-to-end management and exploitation of full motion video streaming of UAVs
- **Mobile workforce management:** Mobile GIS and Mobile Workforce Management (MWFM) solution supports the display of maps in the field, and coordinates routing, dispatch tracking, and reporting the status of utility field personnel
- **Law enforcement records management:** Law enforcement records management solution combines data management with the benefits of web-based operations – with no need to load software on individual workstations. It can be deployed anywhere, not just on fixed PCs, so you have flexibility while reducing cost of ownership
- **Disaster management:** Identify areas that are disaster prone, categorised by risk magnitudes, inventory of populations, assets, etc. at risk. Simulate damage scenarios and develop mitigation strategies and post disaster scenarios to assess the extent of damage for compensation and for remedial and rebuilding measures
- **Air quality check:** Providing information on spatial variability of air pollutants relative to source and quantify in-situ emissions both for local and distributed sources
- **Water quality check:** Allow users to assess water quality at selected sites or in entire water body
- **Climate change:** Scoping and monitoring climate change impacts as well as decision support tools applied in planning for adaptation and mitigation

Geospatial technology implementation:

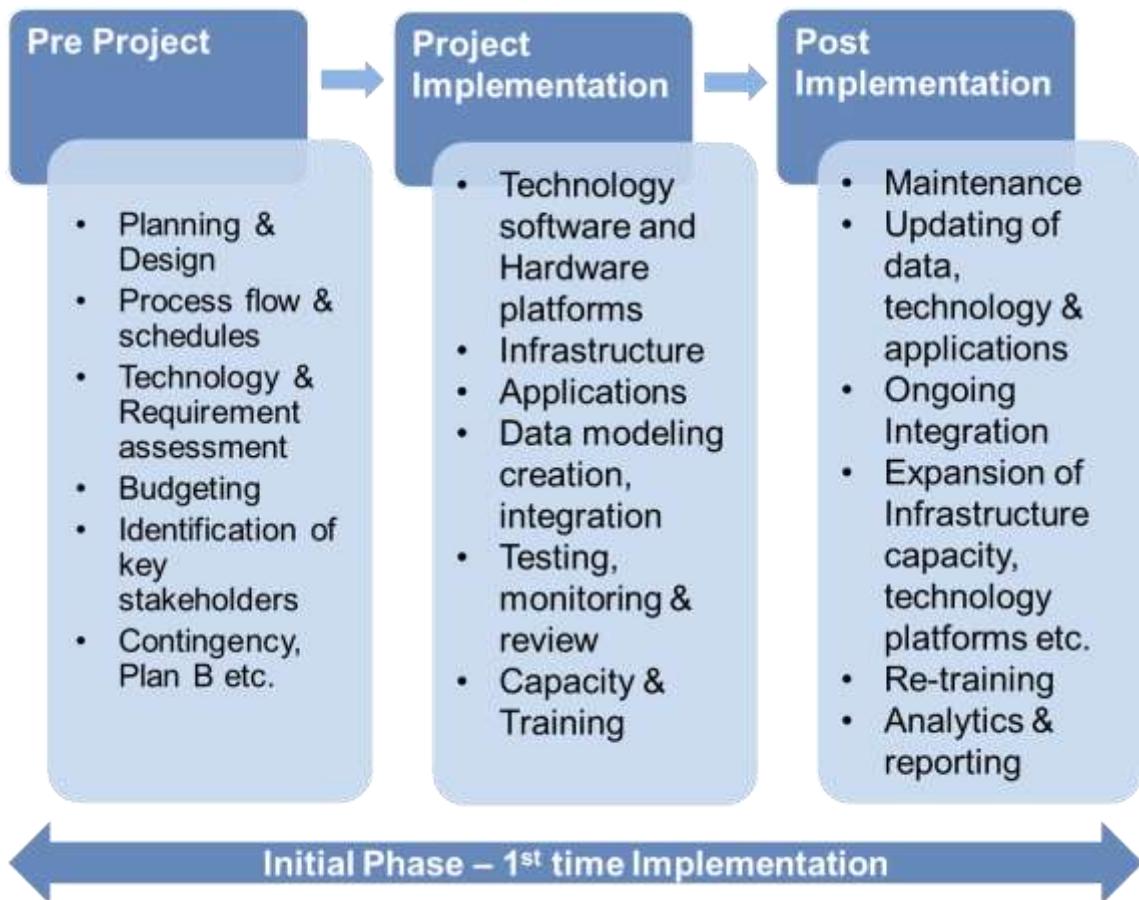


Figure 15: Geospatial technology implementation

*** For more details on geospatial technology, please refer to 'Geospatially enabled Urban-infrastructure and Governance Information System (UGIS) for 100 Smart Cities Mission, available on www.nasscom.in*

Other ICT-GT enablers /smart solutions:

- **Mobile data collection devices:** Mobile devices to collect, share, and visualise geographically tagged data in real-time giving valuable insights to urban planners. Wireless operators have access to an unprecedented volume of information about users' real-world activities for instance where people live, work and play, population density at specific public places, preferred modes of transport to various places, etc. these help city planners to design sustainable new ecosystems
- **Satellite imagery:** Satellite data and images helps to obtain an up-to-date view of the physical world thus enabling better use and management of land, resources and mitigation of risks
- **Land use transport models:** Transportation models that aims to estimate how cities will develop on a long term basis (typically over a period of 30 to 50-years) through the interaction of three main factors: population, land use and transport services. This reflects the influence of land use patterns on mobility patterns and the evolution of transport infrastructure in one direction, and in the other direction, how transport systems have an impact on how urban form evolves and how people engage in various land use activities. Typical plans evaluated using this family of models include the estimation of the impacts around a change in transport infrastructure, for e.g. a new railway line between two areas, or the building of a new development in the region, for e.g. a new industrial estate

- **Analytics:** Analytics enables planners to decide on the basis of evidence rather than intuition. The vast amount of integrated data provides a holistic model of highly complex systems – like social housing – and is able to support a broad spectrum of planning decisions in a smart yet simple manner. In addition, data on how many vehicles, how much garbage, how much energy consumption also helps in rationalising development across areas
- **Mobile data collection devices:** Mobile devices to collect, share, and visualise geographically tagged data in real-time giving valuable insights to urban planners. Wireless operators have access to an unprecedented volume of information about users' real world activities for instance where people live, work and play, population density at specific public places, preferred modes of transport to various places, etc. these help city planners to design sustainable new ecosystems
- **Lease management solutions:** It enables control, report, track and manage owned and leased real estate and make better decisions on leases and related information
- **Online payment:** By digitizing payments cities can realize cost reductions while creating new conveniences for users. With advanced revenue collection and payments systems, individuals and companies can pay for taxes and permits online without having to stand in long queues. Direct credit of salaries and benefits to bank accounts will bring down costs significantly, eliminating the need for intermediaries. Digital wallets and online payments for utility bills, parking, public transport, etc. also adds to the list
- **Case management:** Advanced case management solutions enable coordination of service requests in finance, health, legal, citizen or human resources-related matters. It offers the ability to monitor, update, understand and interpret every piece of work as it is processed, enhancing both efficiency and security and providing a smarter, more integrated way to handle increasingly complex caseloads

On-going government initiatives

Initiatives	Brief Description
Atal Mission for Rejuvenation and Urban Transformation (AMRUT)	Atal Mission for Rejuvenation and Urban Transformation (AMRUT) is the scheme to rejuvenate India's 500 cities and towns. AMRUT will be a 10-year programme with total investment of about Rs 2 lakh crore.
National Land Record Modernisation Programme	The National Land Records Modernisation Programme (NLRMP) is aimed to modernise management of land records, minimise scope of land/property disputes, enhance transparency in the land records maintenance system, and facilitate moving eventually towards guaranteed conclusive titles to immovable properties in the country. The major components of the programme are computerisation of all land records including mutations, digitisation of maps and integration of textual and spatial data, survey/re-survey and updation of all survey and settlement records including creation of original cadastral records wherever necessary, computerisation of registration and its integration with the land records maintenance system, development of core Geospatial Information System (GIS) and capacity building.

5.2 Smart social infrastructure

5.2.1 Smart healthcare

Background:

There has been tremendous progress in the healthcare sector in India since independence - infant mortality rate (IMR) has dropped from 150 to 50 (a three-fold reduction), the Maternal Mortality Ratio (MMR) declined 10 folds to 200 per 100,000 live births and the life expectancy at birth has gone up from 31 to 65 years¹⁹. Healthcare in India includes public as well as private sectors. The healthcare delivery segment is dominated by the private sector in India; 75 per cent of service delivery for dental health, mental health, orthopedics, vascular and cancer diseases and about 40 per cent of communicable diseases and deliveries are provided by the private sector²⁰. However, most of the organised private infrastructure is confined to the state capitals or Tier I cities. Very few have made inroads in Tier II and Tier III cities. Given that the private sector is highly unregulated, the issues faced across both the systems vary tremendously. The healthcare industry comprises hospitals, health insurance, medical equipment, medical devices, clinical trials, outsourcing, telemedicine and medical tourism facilities.

The main components of the healthcare value chain are:

1. **Urban society and public health:** Lifestyle changes, demographic changes, and epidemiological transition constitute the fabric of public health of the society.
2. **Primary healthcare:** The primary healthcare infrastructure provides the first level of contact between the population and healthcare providers. The services provided by U-PHC include OPD (consultation), basic lab diagnosis, drug/contraceptive dispensing and delivery of Reproductive and Child Health (RCH) services, as well as preventive aspects of all communicable and non-communicable diseases²¹.
3. **Secondary healthcare:** Secondary healthcare refers to a second tier of health system, in which patients from primary health care are referred to specialists in higher hospitals for treatment.
4. **Tertiary healthcare:** Tertiary healthcare refers to a third level of health system, in which specialised consultative care is provided usually on referral from primary and secondary medical care. Specialised intensive care units, advanced diagnostic support services and specialised medical personnel are the key features of tertiary health care. In India, under public health system, tertiary care service is provided by medical colleges and advanced medical research institutes.

Key issues:

India faces the twin epidemic of continuing/emerging infectious diseases as well as chronic degenerative diseases. High rates of infectious diseases compete with a large and growing burden of chronic illness. India's disease profile has undergone significant change with Non-Communicable Diseases (NCDs) currently accounting for 53 per cent of the total mortality and 44 per cent of the Disability Adjusted Life Years (DALYs)²² lost. Rise in NCDs such as cardiovascular disease, diabetes, cancer and hypertension is attributed to lifestyle changes, demographic changes, and epidemiological transition. Cardiovascular disease has become a major cause of morbidity and mortality, more than a million deaths a year are attributed to smoking, and nearly 65 million²³ Indians are known to have diabetes.

¹⁹<http://medind.nic.in/iby/t13/i4/ibyt13i4p632.pdf>(Deo, 2013)

²⁰<http://medind.nic.in/iby/t13/i4/ibyt13i4p632.pdf>(Deo, 2013)

²¹http://nrhm.gov.in/images/pdf/NUHM/NUHM_PIP_Guidelines_2013-14.pdf

²² The Disability-Adjusted Life Year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death.

²³<http://www.livemint.com/Opinion/pl58bANi9zaF0AR2MkUYuN/Fixing-Indias-healthcare-system.html>

Spread of infectious diseases is related to poor implementation of the public health programmes. Delivering primary healthcare services, immunisation of children, focus on women's health, delivering quality services at health centres, ability to handle medical emergencies in case of mass incidents and availability of medicines are some of the key issues in this area. Most Indians seeking care are confronted by two unpalatable choices—a public health system that is almost entirely free but of poor quality if it is accessible, and a largely unregulated private-sector system that provides world-class service to some but too often charges ruinous prices, dispenses inappropriate or unnecessary care, and is riddled with practitioners with little or no formal training²⁴. The health system in India, despite the epidemiological transition, is yet to re-orient itself to adequately address the rising burden of NCDs, as the focus is still largely on providing acute care and not in providing chronic care. The expansion of private sector in healthcare has been accompanied by a shift towards curative care with marginalisation of the preventive care systems, neglect of primary care, and growth of tertiary care facilities with a strong commercial focus, resulting in a high dependence on clinical investigations, over diagnosis and over treatment. The level of private healthcare spending is among the highest in the world and places a disproportionate economic burden on people²⁵. The key issues are discussed in detail in the next section.

²⁴<http://www.livemint.com/Opinion/pl58bANi9zaFOAR2MkUYuN/Fixing-Indias-healthcare-system.html>

²⁵<http://www.idfc.com/pdf/report/2013-14/IIR-2013-14.pdf>(IDFC, 2014)

Healthcare

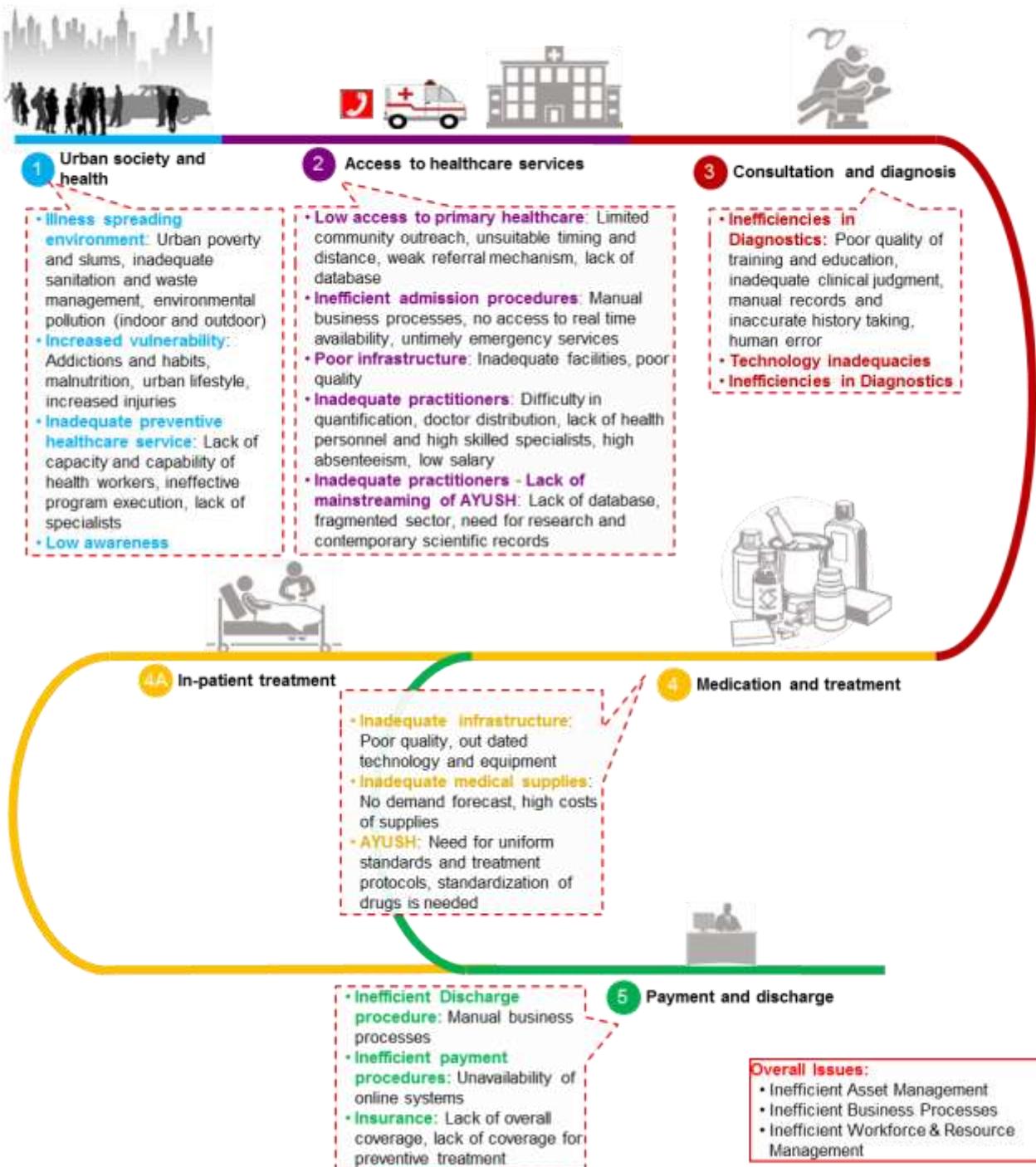


Figure 16: Current state of healthcare in cities

Detailed description of the key issues and sub issues in the ecosystem:

Table 15: Issues and challenges in public healthcare system

Issue	Sub-issue	Description
1. Urban society and public health		
c) Illness spreading environment	Urban poverty and slums	The rate of infectious diseases is high in slums and regions with high urban poverty.
	Inadequate sanitation and solid waste management	Lack of efficient solid waste management and sanitation leads to contaminated environment. In 2008, Class I cities had 32 per cent of the total required capacity while Class II towns had only 8 per cent of the required capacity water treatment plants installed ²⁶ .
	Environmental pollution (indoor and outdoor)	Poor qualities of indoor air due to lack of fresh air, contaminants from upholstery and carpets, Volatile Organic Compounds (VOCs) from paints have adverse health impacts.
d) Increased vulnerability	Addictions and habits	Alcoholism, addiction to tobacco and drug abuse adversely impact health and well-being of the person. People who suffer from addiction often have one or more accompanying medical issues, which may include lung or cardiovascular disease, stroke, cancer and mental disorders ²⁷ .
	Diet and nutrition	Nutrition is a basic human need and a prerequisite to a healthy life. A proper diet is essential from the very early stages of life for proper growth, development and to remain active. The World Bank estimates that India is one of the highest ranking countries in the world for the number of children suffering from malnutrition ²⁸ .
	Urban lifestyle	Sedentary lifestyle adversely impacts health and immune system of the body. However, this is often neglected. There is very little awareness on health impacts (mental and physical) of work and urban lifestyle related stress.
	Increased injuries	Increased traffic and improper traffic management has resulted in increased road accidents and deaths. Currently, about 2.8 million people are hospitalised due to road traffic accidents ²⁹ . Domestic violence is also found to be a cause of injuries mainly amongst the urban poor.
e) Low awareness	Low awareness	Poor awareness is a top reason why some studies show only around half of people with hypertension are aware of their condition and about 50 per cent of diabetics are diagnosed ³⁰ . Lack of preventive health check-ups hinders many urban Indians from seeking regular checkups or early treatment, resulting in higher long-term healthcare costs. Various contemporary packaging materials as well as usable products are found to be cancerous in nature. However, publishing information is not mandatory, thus leading to mass unawareness.

²⁶India Infrastructure Report 2011 (3iNetwork, p. 287)

²⁷<http://www.drugabuse.gov/publications/drugs-brains-behavior-science-addiction/addiction-health>

²⁸http://en.wikipedia.org/wiki/Malnutrition_in_India

²⁹[\(IDFC, 2014, p. 216\)](http://www.idfc.com/pdf/report/2013-14/IIR-2013-14.pdf)

³⁰http://articles.economictimes.indiatimes.com/2014-03-05/news/47933750_1_rs-20-lakh-healthcare-narayana-health

Issue	Sub-issue	Description
f) Inadequate preventive healthcare services	Lack of capacity and capability of health workers	Primary healthcare facilities have limited capacities and capabilities to conduct preventive healthcare activities and programs. Moreover, there is no database of health workers.
	Ineffective programme execution	Capacities and capabilities in programme management skills are lacking in the public healthcare sector.
	Lack of specialists	Management of lifestyle disorders needs continuous long term interaction of patients with highly skilled trained doctors and not just a primary health worker ³¹ .
2. Access to healthcare services		
c) Low access to primary healthcare	Limited community outreach	Health check-up camps include screening for birth defects, diseases, disability and deficiency.
	Unsuitable timing and distance	While the urban public primary healthcare system is not as structured as the rural one, healthcare centres in urban areas are not accessible to the urban poor who need it the most.
	Weak referral mechanism ³²	A community healthcare worker is typically the first contact referring the patient to the primary healthcare unit. However, urban settlements have a weak referral mechanism.
	Lack of database	There is no central database of all primary health centres.
	No or difficult access to emergency services	Poor emergency services lead to no treatment.
d) Inefficient admission procedures	Manual business processes	Manual processes for registration, information collection, transmission to appropriate centers, data entries can take hours adding to the patient's and caretaker's trauma.
	No access to real time availability	Lack of real-time availability results in rejection from health centres and increase in travel time to another health centre.
	Untimely emergency services	Emergency services not provided in-time lead to fatal outcomes. Untimely emergency services can be attributed to apathy at hospitals, mismanagement, heavy traffic on roads, etc.
e) Poor infrastructure	Inadequate facilities such as laboratories, latest technology, etc.	Public primary healthcare facilities lack the basic facilities due to poor funding, management as well as maintenance.
	Poor quality	Not even 5 per cent of private hospitals in 2012 were NABH accredited, and for state facilities, the figure was 0.1 per cent. So, ensuring acceptable healthcare standards for the urban masses, not just high quality facilities for the well-to-do, should be less arduous ³³ .
f) Inadequate practitioners	Difficulty in quantification	Mixed reports exist on the actual number of health workers in India. While there is no shortage in the aggregate number of doctors and nurses in the country ³⁴ other reports list over 10 per cent shortages across various health workers ³⁵ .
	Imbalance of doctors in primary	There is a major imbalance of doctors. 30 per cent primary health centres have two or more doctors and equal number

³¹ <http://medind.nic.in/iby/t13/i4/ibyt13i4p632.pdf>(Deo, 2013)

³² Referral is a process by which a health worker/facility transfers the responsibility of care to another higher/lateral health worker/facility.

³³ http://articles.economictimes.indiatimes.com/2014-03-05/news/47933750_1_rs-20-lakh-healthcare-narayana-health

³⁴ <http://pib.nic.in/newsite/ererelease.aspx?relid=30771>

³⁵ <http://www.idfc.com/pdf/report/2013-14/IIR-2013-14.pdf>

Issue	Sub-issue	Description
	healthcare	provides 24x7 services. States like Maharashtra are now producing surplus MBBS doctors ³⁶ .
	Lack of nurses and other health personnel	The nurse to population ratio found in India stood at 0.80 nurses per 1,000 in 2004 ³⁷ , the same ratio stood at 9.37 for US in 2000 and 12.12 for UK in 1997 ³⁸ . Emigration of nurses, low status to the profession, poor working conditions have only exacerbated this problem further.
	Lack of high skilled specialists	India faces severe shortage of specialists in urban areas ³⁹ . Even as cancer is fast turning into an epidemic in India, with about two million registered patients, the country is facing an acute shortage of oncologists, surgical oncologists and radiotherapists. Official data show there are only about 1,000 trained oncologists in the country and the ratio of oncologists to cancer patients is about 1:2,000. In other countries, such as US, this ratio is 1:100 ⁴⁰ . Moreover, the private sector employs 75 per cent of specialists in their facilities ⁴¹ .
	High absenteeism at public centers	There is a high rate of absenteeism of the medical practitioners or support staff at the primary healthcare centre.
	Low salary at public institutions	Low salary leads to high staff turnover, issues with career progression, etc.
g) Inadequate practitioners: Lack of mainstreaming of AYUSH ⁴²	Lack of database	A significantly high amount of Indian masses reverts to alternative medicine such as Ayurveda and Homeopathy as the first resort. However, no database of these practitioners is maintained.
	Fragmented sector	The AYUSH sector is mostly fragmented and limited to small scale sole practitioners or family units.
	Need for research and contemporary scientific records	Lack of proven scientific evidence of contemporary treated cases is a major hindrance in integrating AYUSH with mainstream primary healthcare.
h) Adverse impact on the healthcare system	Inefficient services adversely impact the healthcare system	Due to lack of effective and efficient primary healthcare services, people resort to secondary and tertiary healthcare institutes for minor ailments leading to a stressed healthcare system.
3. Consultation and diagnosis		
a) Inefficiencies in diagnostics	Poor quality of training and education	Medical professionals in public sector are either untrained or minimally trained in any system of medicine or trained in one system and practicing another. It is estimated that these untrained, unlicensed practitioners in the country outnumber qualified medical doctors by at least 10:1 ⁴³ . India is already facing gross shortages of medical teachers ⁴⁴ . There has been a 30-fold increase in enrolment in medical colleges since independence. This fast expansion of medical colleges has

³⁶ <http://medind.nic.in/iby/t13/i4/ibyt13i4p632.pdf>(Deo, 2013)

³⁷ [file:///C:/Users/reshma.kulkarni/Downloads/517-2769-1-PB%20\(1\).pdf](file:///C:/Users/reshma.kulkarni/Downloads/517-2769-1-PB%20(1).pdf)

³⁸ http://en.wikipedia.org/wiki/Nursing_shortage

³⁹ <http://medind.nic.in/iby/t13/i4/ibyt13i4p632.pdf>(Deo, 2013)

⁴⁰ http://www.business-standard.com/article/current-affairs/india-has-1-8-mn-cancer-patients-but-only-one-oncologist-to-treat-every-2-000-114052401140_1.html

⁴¹(Ministry of Health and Family Welfare, Government of India, 2013)

⁴² AYUSH stands for Indian systems of medicine: Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy

⁴³(Ministry of Health and Family Welfare, Government of India, 2013)

⁴⁴ <http://medind.nic.in/iby/t13/i4/ibyt13i4p632.pdf>(Deo, 2013)

Issue	Sub-issue	Description
		resulted in gross shortage of teachers estimated to be currently 40 per cent. ⁴⁵
	Inadequate clinical judgement	Inadequate experience and clinical judgement has led to misdiagnosis as well as high dependence on medical tests and technology for diagnostics. For e.g. practitioners in India are often found facing difficulties in differentiating asthma from the rest of the respiratory illnesses, consequently leaving out a large burden of the disease untreated ⁴⁶ .
	Manual records and inaccurate history taking	Registration, issue of case papers, appointment, past prescriptions are maintained as manual records and often are not available with the patient at the required time. Clinicians fail to collect information through an accurate history-taking and looking for the harmful exposures.
	Human error	Long working hours, high stress and low work satisfaction lead to human errors in diagnosis.
b) Technology inadequacies	Technology inadequacies	There is a lack of sophisticated medical equipment and technology necessary for accurate diagnosis especially at secondary and tertiary healthcare centres.
c) Inefficiencies in diagnostics: AYUSH	Need for quality assurance methods	There is little, or moreover no quality audit or assurance system in place for AYUSH health clinics.
4. Medication and treatment (includes in-patient treatment)		
a) Inadequate infrastructure	Poor quality	Poor quality of infrastructure for in-patients is primarily due to lack of funding, poor maintenance and governance issues.
	Outdated technology and equipment	Outdated technology and medical devices result in poor treatment and low satisfaction of the patients.
b) Inadequate medical supplies	No demand forecast	Lack of any demand supply forecast leads to inadequate medical supplies.
	High costs of supplies	High cost of medical supplies is a major issue at the public institutions. This is contrary to the fact that, India is the third-largest exporter of pharmaceutical products in terms of volume. Around 80 per cent of the market is composed of generic low-cost drugs which seem to be the major driver of this industry ⁴⁷ .
c) AYUSH	Need for uniform standards and treatment protocols	There is a need to develop contemporary uniform standards and treatment protocols for AYUSH treatment.
	Standardisation of drugs is needed	There is a need to develop contemporary uniform standards for AYUSH drugs.
5. Payment and discharge		
a) Inefficient discharge procedures	Manual business processes	Creating discharge papers, doctor's approvals, collecting reports from various departments can often take hours.
b) Inefficient payment procedures	Unavailability of online systems	Government hospitals, including secondary and tertiary health centers will often ask for cash payments and do not support online transactions.
c) Insurance	Lack of overall	Most Indian patients pay for their hospital visits and doctors'

⁴⁵<http://medind.nic.in/by/t13/i4/ibvt13i4p632.pdf>(Deo, 2013)

⁴⁶<http://www.idfc.com/pdf/report/2013-14/IIR-2013-14.pdf>(IDFC, 2014, p. 243)

⁴⁷<http://forbesindia.com/blog/health/5-things-to-know-about-the-indias-healthcare-system/#ixzz3PU7WBXm9>

Issue	Sub-issue	Description
	coverage	appointments with straight up cash after care with no payment arrangements. According to the World Bank and National Commission's report on Macroeconomics, only 5 per cent of Indians are covered by health insurance policies ⁴⁸ . Only a quarter of India's population has health insurance, and for middle-class Indians, the figure is less than 10 Per cent. Insurance penetration is greater at both ends of the socioeconomic spectrum — the bottom part, thanks to central and state government-led efforts.
	Lack of coverage for preventive treatment	The lack of coverage hinders many urban Indians from seeking regular checkups or early treatment, resulting in higher long-term healthcare costs ⁴⁹ .

ICT-GT enablers:

Information insights, coupled with clinical collaboration, can dramatically improve quality of care, patient safety and outcomes, while also improving the cost-effectiveness of care. Use of analytics can help stratify population into high risk to low risk and deploy health workers and doctors more effectively. Other solutions include electronic health records, smart health card, online database with real-time information on availability, medical simulation, etc. can improve the effectiveness and efficiency of healthcare services in urban India.

⁴⁸<http://forbesindia.com/blog/health/5-things-to-know-about-the-indias-healthcare-system/#ixzz3PW0GpMno>

⁴⁹http://articles.economictimes.indiatimes.com/2014-03-05/news/47933750_1_rs-20-lakh-healthcare-narayana-health

Smart Healthcare



• Smart Health Card and Electronic Health record: Easy access to patient information and medical history, effective admission procedures.

• GPS enabled Emergency Medical Services (EMS): Timely and high quality emergency medical services, specialty care, prevention services, disaster preparedness and response



Urban society and health



• Health Portal: Create awareness, single point source for all health information.



• Tele-medicine: Provide preventive healthcare, aid with shortage of doctors and health workers



• Analytics: Accurate demand projections, predictive demand analysis, effective deployment of health workers and doctors.



In-patient treatment

Access to healthcare services



• Online Health portal, online database with real time monitoring: Information and access to health care providers. Easy decision making based on real time information.
• Electronic Health records and Patient portal which is digital collection of patient health information

• Diagnostic Analytics: Accurate demand projections, match demand – supply for medicines and drugs.



Medication and treatment

Consultation and diagnosis

• Medical simulation: avoid human errors, aid clinical judgment, effective and quality training of doctors.



Payment and discharge

• Business Process Automation: Online processes, online payment and discharge systems, reduce human error, increase effectiveness

• Smart Health Card: Effective discharge procedures land automatic linkage with insurance information



Overall ICT-GT Interventions:

- Integrated Asset Management Solutions
- Business Process Automation
- Workforce and resource management

Figure 17: Smart healthcare

ICT-GT enablers to overcome key challenges in healthcare sector:

Table 16: Smart healthcare: Mapping ICT-GT enablers to challenges

Issue	Sub-issue	ICT-GT enablers
1. Urban society and public health		

Issue	Sub-issue	ICT-GT enablers
g) Illness spreading environment	Urban poverty and slums	<i>Covered under the urban planning section.</i>
	Inadequate sanitation and solid waste management	<i>Covered under the solid waste management and sanitation section.</i>
	Environmental pollution (indoor and outdoor)	<i>Requires non-ICT interventions.</i>
h) Increased vulnerability	Addictions and habits	Online health portal: Online health portal can be a single point of source for all health related information to create awareness on health and well-being.
	Diet and nutrition	Tele-medicine: Preventive healthcare such as diet plans and nutrition information can be easily provided over tele-medicine.
	Urban lifestyle	<i>Requires non-ICT interventions.</i>
	Increased injuries	<i>Covered under the smart transportation section.</i>
i) Low awareness	Low awareness	Online health portal: Online health portal can be a single point of source for all health-related information.
j) Inadequate preventive healthcare services	Lack of capacity and capability of health workers	Population health management/analytics: Analytics can predict and assist effective deployment of healthcare workers in the areas with high demand. Tele-medicine/remote consultation: Tele-medicine/remote consultation solutions can be used to enable consultation over telephone/internet/video conferencing to overcome the shortage of health workers.
	Ineffective programme execution	<i>Requires non-ICT interventions.</i>
	Lack of specialists	<i>Requires non-ICT interventions.</i>

2. Access to healthcare services

i) Low access to primary healthcare	Limited community outreach	Online database: Online database can provide a single point source for all information on healthcare centres in the locality.
	Unsuitable timing and distance	Tele-medicine/remote consultation: Tele-medicine/remote consultation solutions can be used to enable consultation over telephone/internet/video conferencing to overcome the shortage of health workers.
	Weak referral mechanism ⁵⁰	Online database: Patients can refer to an online database to locate the appropriate healthcare centre.
	Lack of database	Online database: A single point database can connect patients with various doctors.
	No or difficult access to emergency services	Emergency medical services solution: To ensure citizens receive timely and high quality emergency medical services, specialty care, prevention services, disaster preparedness and response.
j) Inefficient admission procedures	Manual business processes	Business process automation: Business process automation can increase effectiveness and efficiency of healthcare operations. Smart health card and electronic health record: Smart health card and electronic health record can provide all necessary information of the patient to speed up the admission processes.
	No access to real-	Online database with real-time information: Online database

⁵⁰ Referral is a process by which a health worker/facility transfers the responsibility of care to another higher/lateral health worker/facility.

Issue	Sub-issue	ICT-GT enablers
	time availability	with real-time information can help patients in choosing the right healthcare centre or hospital.
	Untimely emergency services	Online database with real-time information: Online database with real-time information can help patients in choosing the right healthcare centre or hospital. It can also enable hospitals to collaboratively deliver efficient services.
k) Poor infrastructure	Inadequate facilities such as laboratories, latest technology, etc.	<i>Requires non-ICT interventions.</i>
	Poor quality	<i>Requires non-ICT interventions.</i>
l) Inadequate practitioners	Difficulty in quantification	Online database: Online database of social workers can effectively help in quantification of health workers in any particular area. Analytics: Analytics can be used to effectively plan deployment of health workers to high demand areas.
	Imbalance of doctors in primary healthcare	Spatial analytics: Analytics can be used to effectively plan deployment of doctors to high demand areas. Tele-medicine: Patients in areas with low density of doctors can take advantage of tele-medicine to gain access to doctors from other parts of the country.
	Lack of nurses and other health personnel	Tele-medicine: <i>Requires additional non-ICT interventions.</i>
	Lack of high skilled specialists	<i>Requires non-ICT interventions.</i>
	High absenteeism at public centers	Business process transformation: Use of biometric-based attendance systems.
	Low salary at public institutions	<i>Requires non-ICT interventions.</i>
m) Inadequate practitioners: Lack of mainstreaming of AYUSH⁵¹	Lack of database	Online database: A single point online database can provide information and access to the AYUSH practitioners.
	Fragmented sector	<i>Requires non-ICT interventions.</i>
	Need for research and contemporary scientific records	<i>Requires non-ICT interventions.</i>
n) Adverse impact on the healthcare system	Inefficient services adversely impact the healthcare system	Online database: Online database can provide information on primary healthcare and AYUSH centres to direct citizens to these institutions and reduce the unnecessary load on secondary and tertiary centres. <i>Requires additional non-ICT interventions.</i>
3. Consultation and diagnosis		
d) Inefficiencies in diagnostics	Poor quality of training and education	<i>Requires non-ICT interventions.</i>
	Inadequate clinical judgement	Medical simulation: Simulation software can be used in medical training to enhance learning effectiveness.
	Manual records and	Electronic health records: Electronic health records provide

⁵¹ AYUSH stands for Indian systems of medicine: Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy

Issue	Sub-issue	ICT-GT enablers
	inaccurate history taking	complete information regarding the patients' health history.
	Human error	Electronic health records: Electronic health records can help avoid human errors. <i>Requires additional non-ICT interventions.</i>
e) Technology inadequacies	Technology inadequacies	<i>Requires additional non-ICT technology interventions.</i>
f) Inefficiencies in Diagnostics: AYUSH	Need for quality assurance methods	<i>Requires additional non-ICT technology interventions.</i>
4. Medication and treatment (includes in-patient treatment)		
d) Inadequate infrastructure	Poor quality	<i>Requires non-ICT interventions.</i>
	Outdated technology and equipment	<i>Requires additional non-ICT hi-tech interventions.</i>
e) Inadequate medical supplies	No demand forecast	Diagnostic analytics: Use of big data and analytics can provide accurate demand projections.
	High costs of supplies	<i>Requires non-ICT interventions.</i>
f) AYUSH	Need for uniform standards and treatment protocols	<i>Requires non-ICT interventions.</i>
	Standardisation of drugs is needed	<i>Requires non-ICT interventions.</i>
5. Payment and discharge		
d) Inefficient discharge procedures	Manual business processes	Business process automation: Automated business processes can increase the efficiency of hospital operations. Smart health card: Smart health cards with linked to insurance information can increase effectiveness of the discharge procedures.
e) Inefficient payment procedures	Unavailability of online systems	Business process automation: Automated business processes can increase the efficiency of hospital operations.
f) Insurance	Lack of overall coverage	<i>Requires non-ICT interventions.</i>
	Lack of coverage for preventive treatment	<i>Requires non-ICT interventions.</i>

Description of ICT-GT enablers /smart solutions:

- **Analytics:** Big data analytics help the industry address problems related to variability in healthcare quality and escalating healthcare spend for e.g. researchers can find most effective solutions for a particular condition, identify drug side effects patterns, etc.
- **Geospatial technology-based database:** Access to healthcare and hospitals via geo-based services as well as locations of various types of healthcare services such as doctors' offices, hospitals and old peoples' homes helps citizens in availing the right services in time
- **Electronic health record:** An electronic health record is a digital collection of patient health information which typically includes patient demographics, progress notes, problems and medications, vital signs, past medical history, immunizations, laboratory data and radiology reports

- **Online database:** Access to healthcare and hospitals via geo-based services as well as locations of various types of health services such as doctors' offices, hospitals and old peoples' homes helps citizens in availing the right services in time
- **Online database with real-time information:** An online database can be enabled with real-time information regarding the availability of beds, waiting times, doctor appointments, etc.
- **Emergency medical services solution:** To ensure citizens receive timely and high quality emergency medical services, specialty care, prevention services, disaster preparedness and response
- **Patient portal:** Patients can connect with their healthcare providers and/or doctors through a convenient, safe, and secure environment over a patient portal
- **Smart healthcare card:** Smart health cards improve the security and privacy of patient information, provide a secure carrier for portable medical records, reduce healthcare fraud, support new processes for portable medical records, provide secure access to emergency medical information, enable compliance with government initiatives and mandates, and provide the platform to implement other applications as needed by the healthcare organisation
- **Tele-medicine:** Remote consultation removes the burden of distance in procedure-specific consultation of specialists. Such a service has particular benefits in the rural setting, where medical staff do not have immediate access to specialists and in areas which have shortage of doctors
- **Medical simulation:** Medical simulation is the modern day methodology for training healthcare professionals through the use of advanced educational technology. Simply put, medical simulation is the experiential learning every healthcare professional will need, but cannot always engage in during real-life patient care. Medical simulation has also been called healthcare simulation, simulation in healthcare, patient simulation, nursing simulation, surgical simulation and clinical simulation⁵²
- **Population health management:** Population health and disease management involves stratification of patients into well-defined risk groups and the creation of differential care strategies based on each group's needs. Its goal is to reduce costs by preventing those who are well from becoming ill and improving quality of life and enhancing health outcomes for those who have developed one or more chronic condition

Overall ICT-GT interventions:

- **Integrated asset management solutions:** Smart and integrated asset management ensures all infrastructure data is available to asset management applications in a seamless manner using a common message bus in an integrated environment that leverages data across the enterprise
- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools

On-going government initiatives:

Initiatives	Brief Description
National Health Portal	The Ministry of Health and Family Welfare, Government of India has set up the National Health Portal in pursuance to the decisions of the National Knowledge Commission, to provide healthcare-related information to the citizens of India and to serve as a single point of access for consolidated health information. The National Institute of Health and Family Welfare (NIHFW) have established Centre for Health Informatics to be the secretariat for managing the activities of the National Health Portal.

⁵²<http://healthysimulation.com/medical-simulation/>

5.2.2 Smart education

Background:

Education is the key factor for social inequality and poses a significant challenge to provide equal learning opportunities. Education in India is provided by the public sector as well as the private sector, with control and funding coming from three levels: central, state and local governments. Under various articles of the Indian Constitution, free and compulsory education is provided as a fundamental right to children between the ages of 6 and 14. At the primary and secondary level, India has a large private school system complementing the government run schools. Certain post-secondary technical schools are also private. It is important to clarify that while there are private schools in India, they are highly regulated in terms of what they can teach, in what form they can operate and all other aspects of operation⁵³.

Education structure in India:



Figure 18: Education structure in India

The main components of the education ecosystem are:

- Setting up school infrastructure:** Setting up school infrastructure includes setting up the hard and soft infrastructure. Hard infrastructure includes the school building, libraries, laboratories, playground, etc. Soft infrastructure includes governance, finance, etc.
- Curriculum adoption:** The National Council of Educational Research and Training (NCERT) is the apex body for curriculum-related matters for school education in India. NCERT provides support and technical assistance to a number of schools in India and oversees many aspects of enforcement of education policies.
- Teacher recruitment:** School teachers are recruited either directly by the school or by state boards through interview process.
- Student enrollment:** Student enrollment happens mostly once a year or twice depending on state and school policies.
- Teaching and learning:** The teaching and learning methodologies (pedagogy) are highly regulated through the curriculum development and are in need of major revision.
- Learning outcomes:** While assessment of learning is primarily done through theoretical exams, these have turned out to be ineffective in the contemporary education system.

Key issues:

Non-availability of teachers, lack of teachers training, overcrowded classrooms, outdated resources, lack of professional/skill development education, rundown buildings, non-availability of clean toilets and insufficient funding are the key issues faced by most of the cities in India. The total number of teachers engaged in teaching in schools imparting elementary education has increased from 5.2 million in 2006-07 to 7.7 million in 2013-14. The Pupil-Teacher Ratio (PTR) at the primary level has improved from 36:1 in 2006-07 to 25:1 in 2013-14. Various schemes implemented by the government have led to a sharp improvement in PTR at the primary level from 36:1 in 2006-07 to 25:1 in 2013-14. This achievement brings the national average at par with the norms set under the Right to Education Act 2009. However, this varies across the states; thus leaving many states with high pupil-teacher ratio. The shortages intensity also varies across the states with Uttar Pradesh and Bihar facing the maximum shortage of over 2 lakh teachers. Between 2009-10 and 2012-13, the

⁵³<http://startup.nujs.edu/blog/indian-education-system-what-needs-to-change/>

annual average dropout rate in primary education declined from 9.1 per cent to 4.7 per cent⁵⁴. The dropout rate, though declining from year to year, still remains a major challenge. While there has been a steady decline in the percentage of out-of-school children across gender and social categories, and nationally the proportion of out-of-school has been brought down to 4.2 per cent of the population age 6-13 years in 2009-10, the proportion of out-of-school children remain much higher than the national average in a few states for e.g. Uttar Pradesh at 34 per cent. In terms of digital infrastructure, more than 30,000 schools in India have a digital classroom now. However, that does not ensure meaningful learning. There is an urgent need for meaningful, engaging, curiosity evoking, application-oriented and stimulating content⁵⁵.

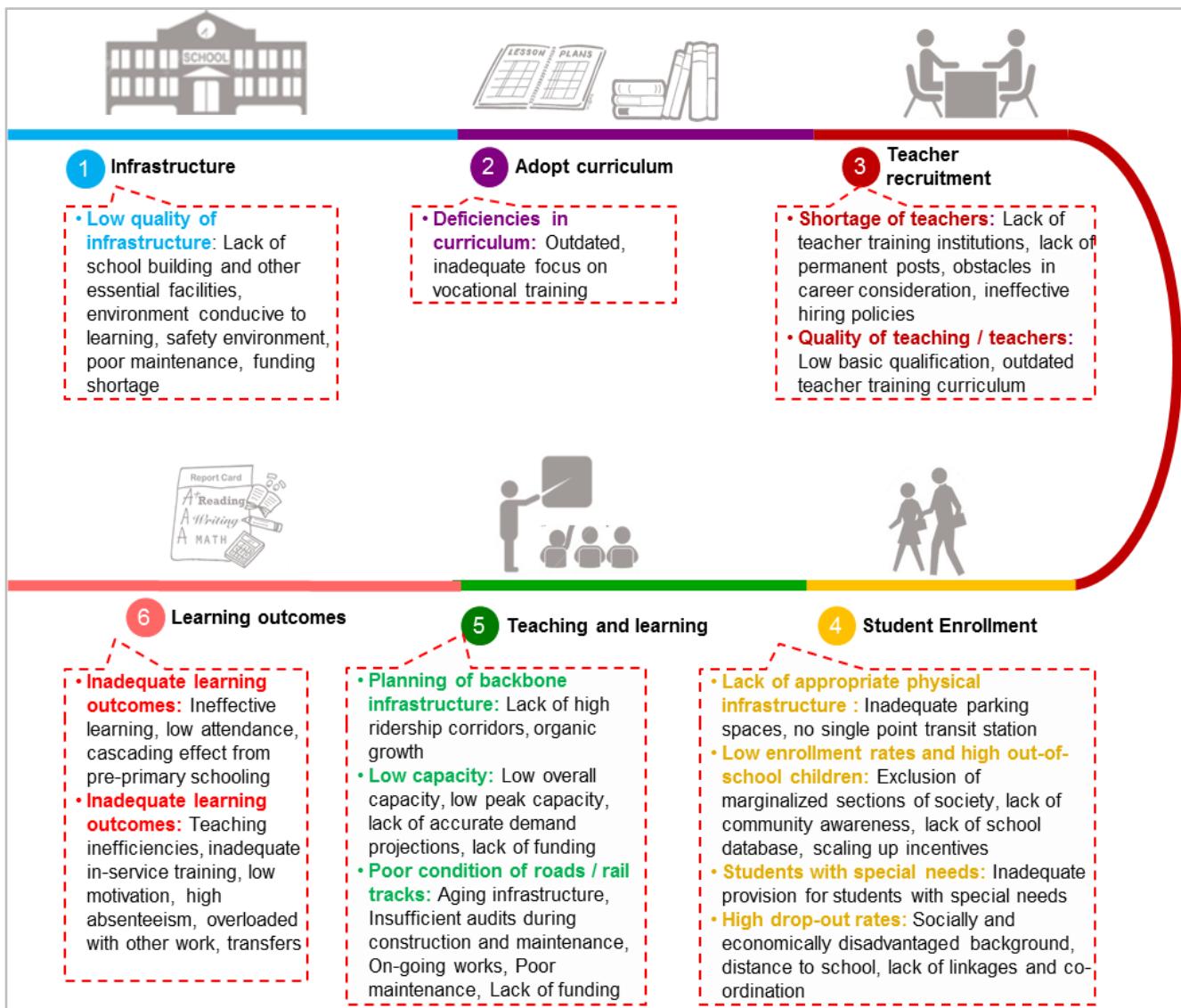


Figure 19: Current state of education in cities

Detailed description of the key issues and challenges across the value chain:

Table 17: Issues and challenges in education sector

Issue	Sub-issue	Description
1. Infrastructure		

⁵⁴(National University of Educational Planning and Administration, 2014, p. xviii)

⁵⁵<http://www.indiaeducationreview.com/article/problems-school-education-india>

Issue	Sub-issue	Description
a) Low quality of infrastructure	Lack of school building and other essential facilities	An analysis of Unified District Information System for Education data related to schools by Right to Education Act (RTE) compliance (10 indicators) indicates that only 8.3 per cent of government schools had complied with all 10 parameters stipulated in the RTE Act, 2009 ⁵⁶ .
	Environment conducive to learning	Good daylight, no noise pollution, cleanliness are few factors which contribute to developing a conducive learning environment. However, these are missing at most of the schools.
	Safety environment	Safety has been a major issue in India where child abuse is on a rise in many states. This includes on-the-campus safety and safety during travelling from/to home.
	Poor maintenance	Lack of monitoring of physical infrastructure results in poor maintenance.
	Funding shortage	There has been substantial shortfall in funding for RTE of about Rs 155 billion ⁵⁷ .
2. Curriculum adoption		
a) Deficiencies in curriculum	Outdated	While curriculum revisions are undertaken every 10 years by state boards, a radical transformation in curriculum is required.
	Inadequate focus on vocational training	There is lack of focus on vocational training through the elementary and secondary schools.
3. Teacher recruitment		
a) Shortage of teachers	Lack of teacher training institutes	There is a shortage of good quality teacher training institutes in India.
	Lack of permanent posts	There is a lack of permanent posts available to teachers.
	Obstacles in career consideration	Low social status accorded to teaching creates obstacles in consideration of teaching as a bright career option.
	Ineffective hiring policies	Teachers are recruited by the state boards and allocated to schools. Lack of communication leads to ineffective hiring of teachers.
b) Poor quality of teaching /teachers	Low basic qualification	The proportion of trained contract teachers was only 49.37 per cent in 2010-11. About 640,000 teachers in the government schools across the country are yet to acquire the qualifications prescribed by NCTE ⁵⁸ .
	Outdated teacher training curriculum	Curriculum for Bachelor of Education (B.Ed.) and Master of Education (M.Ed.) programmes is outdated.
4. Student enrollment		
c) Low enrollment rates and high out-of-school children	Exclusion of marginalised sections of society	It is necessary to create conditions in which disadvantaged sections of the society can participate in education.
	Lack of community awareness	There is an overall lack of awareness of the importance of education. This is more pronounced in case of girls and minorities.

⁵⁶(National University of Educational Planning and Administration, 2014, p. 113)

⁵⁷(National University of Educational Planning and Administration, 2014, p. 99)

⁵⁸(National University of Educational Planning and Administration, 2014, p. 85)

Issue	Sub-issue	Description
	Lack of school database	There is no database of schools with information on vacancies which people can easily refer to.
	Scaling up incentives	Government programmes such as mid-day-meals have focused on incentives such as everyday free meals in school to attract and retain students. However, these need to be scaled up along with other incentives.
d) Students with special needs	Inadequate provision for students with special needs	Sufficient consideration is not given to students with special needs; thus, keeping them out of the mainstream school system.
e) High drop-out rates	Socially and economically disadvantaged background	Even though the drop-out rates at elementary and secondary stages of education have been declining, the progress has not been satisfactory. Higher drop-out rates are observed in elementary and secondary education, especially among children belonging to socially and economically disadvantaged population groups.
	Distance to school	A majority of primary schools do not have upper primary sections attached to them; consequently, many children have been dropping out after completing primary education. Opening of new upper primary sections/schools within reasonable walking distance from the habitations of residence of children has enabled children to continue their education beyond the primary stage ⁵⁹ .
	Lack of linkages and coordination	Greater linkages and integration between pre-school, elementary education, secondary education and adult education; also between ministries and departments at the centre and state government handling these issues is required.
5. Teaching – learning		
a) Deficiencies in pedagogy	High focus on rote learning	The current focus is more on rote learning. Teaching-learning processes that would promote a learner-centered approach to education involving active learning approaches, cooperative learning, and methodologies which would stimulate independent thinking, develop critical thinking and problem-solving skills are required.
	Classroom structure	The current Indian classrooms consist of multi-age, multi-grade and multi-level contexts, and making teachers' professional development a needs-driven process as opposed to top-down decision wherein curriculum design and delivery is centrally-driven.
	No experiential learning	Teaching methodologies are theory and text book-based. Experiential learning methods are not considered.
6. Learning outcomes		
a) Inadequate learning outcomes: Ineffective learning	Low attendance	There is no monitoring and action-based on student attendance.
	Cascading effect from pre-primary schooling	Lack of motivation on the teacher's part leads to low learning outcomes in the students.

⁵⁹(National University of Educational Planning and Administration, 2014, p. 48)

Issue	Sub-issue	Description
b) Inadequate learning outcomes: Teaching inefficiencies	Inadequate in-service training	There is no in-service training provided to teachers. Where training is provided it is not adequate to have any significant impact on teaching quality.
	Low motivation	Low status of teaching as a profession results in low motivation.
	High absenteeism	High teacher absenteeism has been observed in majority of the public schools. There is no accountability and teacher absenteeism is not linked to measures such as salary deduction.
	Overloaded with other work	Teachers in public schools are overloaded with other work such as election duties, conducting medical camps, etc.
	Transfers	Teachers are hired by the State Board and allocated to a school.

While many issues in the elementary and secondary education system, such as inclusion of marginalised sections of society, shortage and poor quality of teachers, deficiencies in pedagogy are also applicable to higher education, some of the issues specific to higher education are mentioned below:

- a) **Low capacity utilisation:** The capacity utilisation of colleges and universities is low in India. For e.g. in case of MBA it is about 57 per cent in Maharashtra and 72 per cent in Haryana⁶⁰. In case of certain states, there are a lot of vacant seats in institutions. It is necessary to ensure that institutions/colleges/schools created for providing higher education fully utilise the capacity created
- b) **Curriculum – Lack of industry connection:** The syllabus and curriculum for higher education courses is focused more on theory than practical understanding. The connection with industry, through internships and projects, is quite low. Wherever undertaken, meaningful engagement is lacking
- c) **Learning outcomes – Lack of quality:** The lack of quality education results in qualified but not employable category of candidates

⁶⁰http://rbi.org.in/scripts/BS_SpeechesView.aspx?Id=588

ICT-GT enablers:

Smart Education

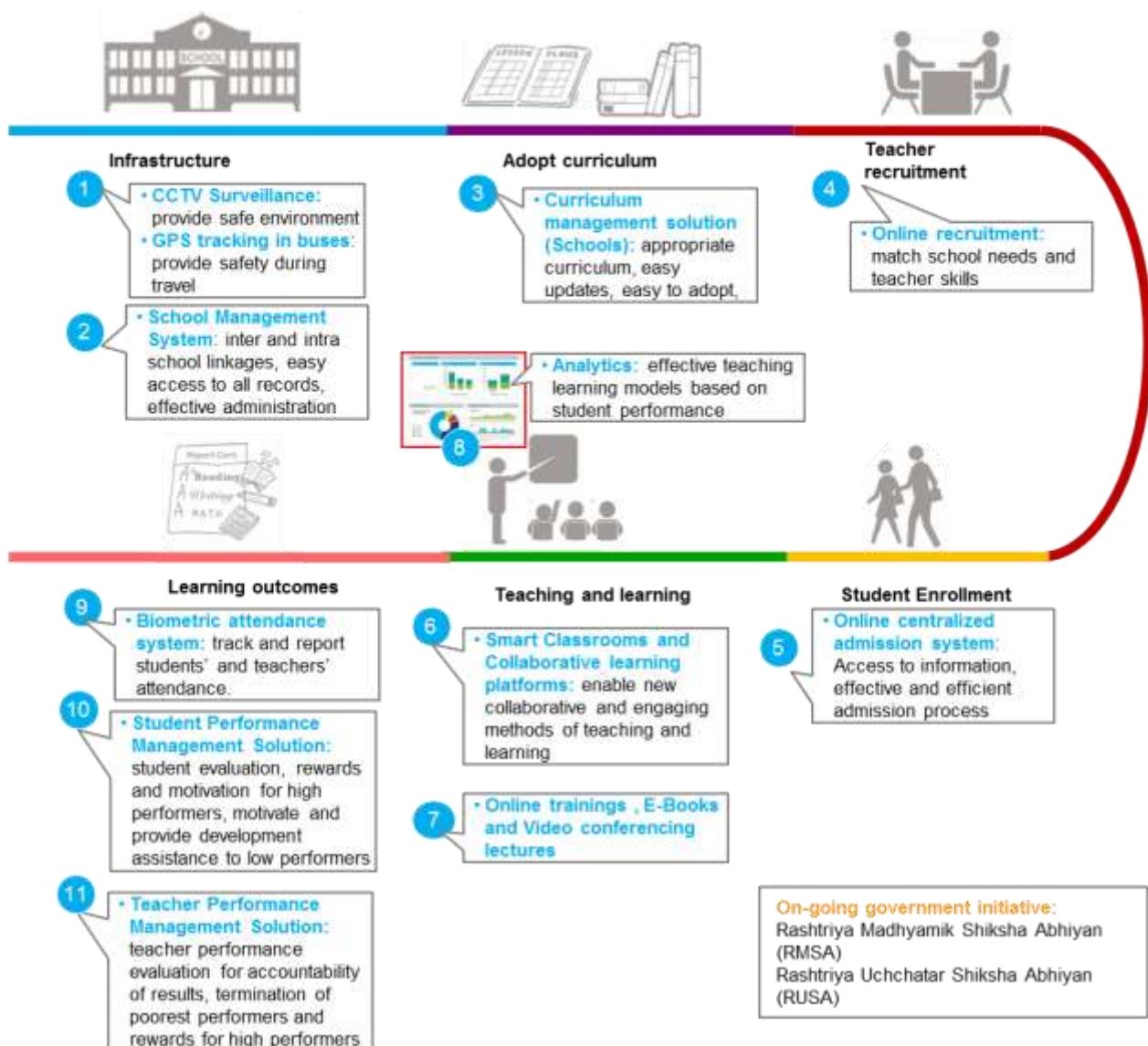


Figure 20: Smart education

ICT-GT enablers to overcome key challenges in education sector:

Table 18: Smart education: Mapping ICT-GT enablers to challenges

Issue	Sub-issue	ICT-GT enablers
1. Infrastructure		
b) Low quality of infrastructure	Lack of school building and other essential facilities	<i>Requires non-ICT interventions.</i>
	Environment conducive to learning	<i>Requires non-ICT interventions.</i>
	Safety environment	CCTV-based surveillance: Surveillance systems can monitor school environments. GPS tracking system in buses: Tracking of buses can assist in providing safety during transport.
	Poor maintenance	Integrated asset management: Integrated asset management solutions can assist in regular maintenance of school infrastructure.
	Funding shortage	<i>Requires non-ICT interventions.</i>
2. Curriculum adoption		
b) Deficiencies in curriculum	Outdated	
	Inadequate focus on vocational training	Curriculum management solution: Increased efficiency and effectiveness in curriculum development, updates and adoption. e-Books: e-Books can enable regular and more frequent changes to curriculum.
3. Teacher recruitment		
f) Shortage of teachers	Lack of teacher training institutes	Online trainings (e-Learning): Online trainings can be used to increase the capacity of teacher training institutions. Video conferencing lectures: Video conferences can help bring in the best-in-class expertise to train teachers.
	Lack of permanent posts	<i>Requires non-ICT interventions.</i>
	Obstacles in career consideration	<i>Requires non-ICT interventions.</i>
	Ineffective hiring policies	Online recruitment: Smart staffing solutions can connect school needs with teacher skills.
g) Poor quality of teaching/teachers	Low basic qualification	Online trainings (e-Learning): Online trainings can be used to provide additional trainings to teachers.
	Outdated teacher training curriculum	Curriculum management solution: Increased efficiency and effectiveness in development, updates and adoption of curriculum for B.Ed. and M.Ed. programmes. e-Books: e-Books can enable regular and more frequent changes to curriculum.
4. Student enrollment		
h) Low enrollment rates and high	Exclusion of marginalised sections of society	Online trainings (e-Learning): Online training programmes can remove the barriers of access to education. e-Books: e-Books can provide access to knowledge to the

Issue	Sub-issue	ICT-GT enablers
out-of-school children		marginalised sections. <i>Requires additional policy and non-ICT interventions.</i>
	Lack of community awareness	<i>Requires non-ICT interventions.</i>
	Lack of school database	Online centralised admission system: A centralised admission system can provide a single point of source for school database.
	Scaling up incentives	<i>Requires non-ICT interventions.</i>
i) Students with special needs	Inadequate provision for students with special needs	<i>Requires non-ICT interventions.</i>
j) High drop-out rates	Socially and economically disadvantaged background	<i>Requires non-ICT interventions.</i>
	Distance to school	Online trainings (e-Learning): Online training programmes can remove the barriers of access to education. e-Books: e-Books can provide access to knowledge to the marginalised sections. <i>Requires additional policy and non-ICT interventions.</i>
	Lack of linkages and coordination	School management system: School management systems can provide inter and intra school linkages to track student performances.

5. Teaching – Learning

b) Deficiencies in pedagogy	High focus on rote learning	Smart classroom: Smart classrooms can enable a more collaborative approach towards learning and increase the effectiveness of the teaching and learning processes. Smart classrooms can provide individually customised programmes based on the pupil's needs. Education analytics: Education analytics can help track student's data over time, link them to behavioral models, and then combine those data to provide the most appropriate teaching-learning models for students. Collaborative learning platforms: Collaborative learning is a new approach to learning and substitutes the old approaches of rote learning etc.
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6. Learning outcomes

c) Inadequate learning outcomes: Ineffective learning	Low attendance	Biometric attendance system with SMS alerts to parents: The solution can monitor attendance and inform the parents regarding the same.
	Cascading effect from pre-primary schooling	Student performance management solution: The solution can assist teachers with objective evaluation process, rewards for high performers, relevant professional development, interventions to assist low performers and improvement programmes for the poorest performers.
d) Inadequate learning outcomes: Teaching inefficiencies	Poor quality of teachers	Teachers performance management solution: A teacher performance management system encompasses a foundational theory of accountability for results, an objective evaluation process, rewards for high performers, relevant professional development, interventions to assist low performers and
	Inadequate in-service training	

Issue	Sub-issue	ICT-GT enablers
		termination of the poorest performers. Online trainings (e-Learning): On-the-job training can be provided to teachers to improve the quality. Video conferencing lectures: Video conferences can help bring in the best-in-class expertise to the schools.
	Low motivation	<i>Requires additional policy and non-ICT interventions.</i>
	High absenteeism	Biometric attendance system: Biometric attendance system can track teachers' attendance.
	Overloaded with other work	<i>Requires additional policy and non-ICT interventions.</i>
	Transfers	Online recruitment: Smart staffing solutions can state the visibility regarding the specific needs of schools while hiring or during transfers. <i>Requires additional non-ICT interventions.</i>

Description of ICT-GT enablers /smart solutions

- **Education analytics:** Predictive tracking and sensing technologies including learning analytics platforms can track students data over time, link them to behavioural models, and then combine those data to project likely future progress, actions, and outcomes
- **Teachers performance management solution:** A teacher performance management system encompasses a foundational theory of accountability for results, an objective evaluation process, rewards for high performers, relevant professional development, interventions to assist low performers and termination of the poorest performers
- **Online trainings (e-Learning):** e-learning platforms supported by knowledge management systems and digital libraries to be availed in all education institutes to be leveraged by students as well as teachers
- **Teachers performance management solution:** A teacher performance management system encompasses a foundational theory of accountability for results, an objective evaluation process, rewards for high performers, relevant professional development, interventions to assist low performers and termination of the poorest performers
- **Curriculum management solution:** Comprehensive, easy-to-use online curriculum management software for managing the design, delivery, publication, cost-effectiveness and quality of education courses throughout all stages of the curriculum lifecycle
- **Smart classroom:** Technology enhanced classrooms that foster opportunities for teaching and learning by integrating learning technology, such as computers, specialised software, audience response technology, assistive listening devices, networking, and audio/visual capabilities
- **Biometric attendance system:** Biometric attendance system for monitoring student attendance and activity in schools and colleges using any of the mechanisms like palm vein scanning, eye scan, fingerprint scan, etc.
- **Biometric attendance system with SMS alerts to parents:** Biometric identification system for monitoring student attendance and activity in schools and colleges using any of the mechanisms like palm vein scanning, eye scan, fingerprint scan, etc.
- **Student performance management solution:** An objective evaluation process, rewards for high performers, relevant professional development, interventions to assist low performers and improvement programs for the poorest performers
- **e-Books:** e-Learning platforms supported by knowledge management systems and digital libraries to be available in all education institutes to be leveraged by students as well as teachers
- **CCTV-based surveillance:** Setting up of IP-based security cameras at various places in the school to ensure real-time monitoring and event resolution
- **GPS tracking system in buses:** Advanced vehicle tracking solutions optimises transportation and ridership. These solutions offer real-time GPS tracking from mobile devices thus increasing the reliability

- **Online centralised admission system:** Online admission system for all colleges and universities right from filling in the application form to evaluation of the application and communication of results
- **Video conferencing lectures:** Maximise the reach of presentations delivered from a lecture hall with a video conferencing solution providing scalable and cost-effective solutions. It helps in reaching out to more people, in more places, with a minimal amount of resources
- **Collaborative learning platforms:** Collaborative Learning is a process in which two or more individuals obtain knowledge together, or in a group setting with technologies such as blogs, knowledge repositories and social networks. Unlike individual learning, people engaged in collaborative learning capitalise on one another's resources and skills (asking one another for information, evaluating one another's ideas, monitoring one another's work, etc.)⁶¹
- **School management system:** Advanced solutions to control all school activities online, manage assignments online, send digital announcements, use performance management solutions for both teachers and students
- **Online recruitment:** Smart staffing solutions to recruit the right skills for schools ensuring best-in-class teachers and support staff

Overall smart solutions:

- **Integrated asset management solutions:** Smart and integrated asset management ensures all infrastructure data is available to asset management applications in a seamless manner using a common message bus in an integrated environment that leverages data across the enterprise
- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools

On-going government initiatives

Initiatives	Brief Description
Rashtriya Madhyamik Shiksha Abhiyan (RMSA)	Provision of opportunities to secondary stage students to mainly build their capacity on ICT skills and make them learn through computer-aided learning process. Smart schools are also being established in the districts by conversion of one of the existing State Government schools to serve as a role model and technology demonstrator among the neighbourhood schools.
Rashtriya Uchchatar Shiksha Abhiyan (RUSA)	Rashtriya Uchchatar Shiksha Abhiyan (RUSA) is a Centrally Sponsored Scheme (CSS) launched in 2013 it aims at providing strategic funding to eligible state higher educational institutions. The funding to states would be made on the basis of critical appraisal of state higher education plans, which would describe each state's strategy to address issues of equality, access and excellence in higher education.

⁶¹ http://en.wikipedia.org/wiki/Collaborative_learning

5.2.3 Safe city

Background:

Urban safety and security is vital for overall development of cities and it is time the challenge of securing our cities is taken up in the right earnest. The UN and the World Bank both rank high crime rate as one of obstacles to a country's development⁶². Crime has this capacity to generate vicious cycles causing unemployment, economic downturns and instability. Poverty and crime combined together leave people with two choices: either take part in criminal activities or try to find legal but quite limited sources of income. Thus India faces the dual mandate of urban poverty eradication and providing safe and secured environment in all of its cities.

The main components of the ecosystem are:

1. **Urban society and planning:** Urban society and city planning play a huge role in a person's thinking and behaviour and hence impact criminal tendencies.
2. **City surveillance, incidence detection and analysis:** Surveillance is the monitoring of the behaviour, activities or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them⁶³. This can include observation from a distance by means of electronic equipment (such as CCTV cameras) or interception of electronically transmitted information (such as Internet traffic or phone calls); and it can include simple methods such as human intelligence agents and postal interception.
3. **Response to incidence:** Incident response is an organized approach to addressing and managing the aftermath of a security breach or attack (also known as an incident). The goal is to handle the situation in a way that limits damage and reduces recovery time and costs. An incident response plan includes a policy that defines, in specific terms, what constitutes an incident and provides a step-by-step process that should be followed when an incident occurs⁶⁴.
4. **Recover and rehabilitate:** In the recovery phase the victim is provided necessary support to recover from the loss e.g. hospitalisation in case of violence or physical abuse. In the rehabilitation phase the victim is provided with further support to be able to integrate with the society with dignity.
5. **Case registration and investigation:** Registering an FIR with the police is the first step. Investigation is carried out by the police with help and assistance of other teams to identify the victim, gather witnesses and proofs and submit to court.

Key issues:

Providing a safe environment to live and work for citizens and business is the key responsibility of city government. In India, we have multiple public safety agencies like police for citizen safety and security, fire agency for fire safety; some cities have disaster management agencies to handle disaster. We have multiple public and private emergency management services to handle medical emergencies. We have NGOs and other agencies for women & child safety. All agencies at national, state and local levels need to work together in close collaboration to ensure safe environment to citizen and business. Cities in India need an integrated approach towards public safety. The police force in India is constrained by the lack of adequate manpower, equipment, technology and technical know-how and to some extent political will⁶⁵ and apathy.

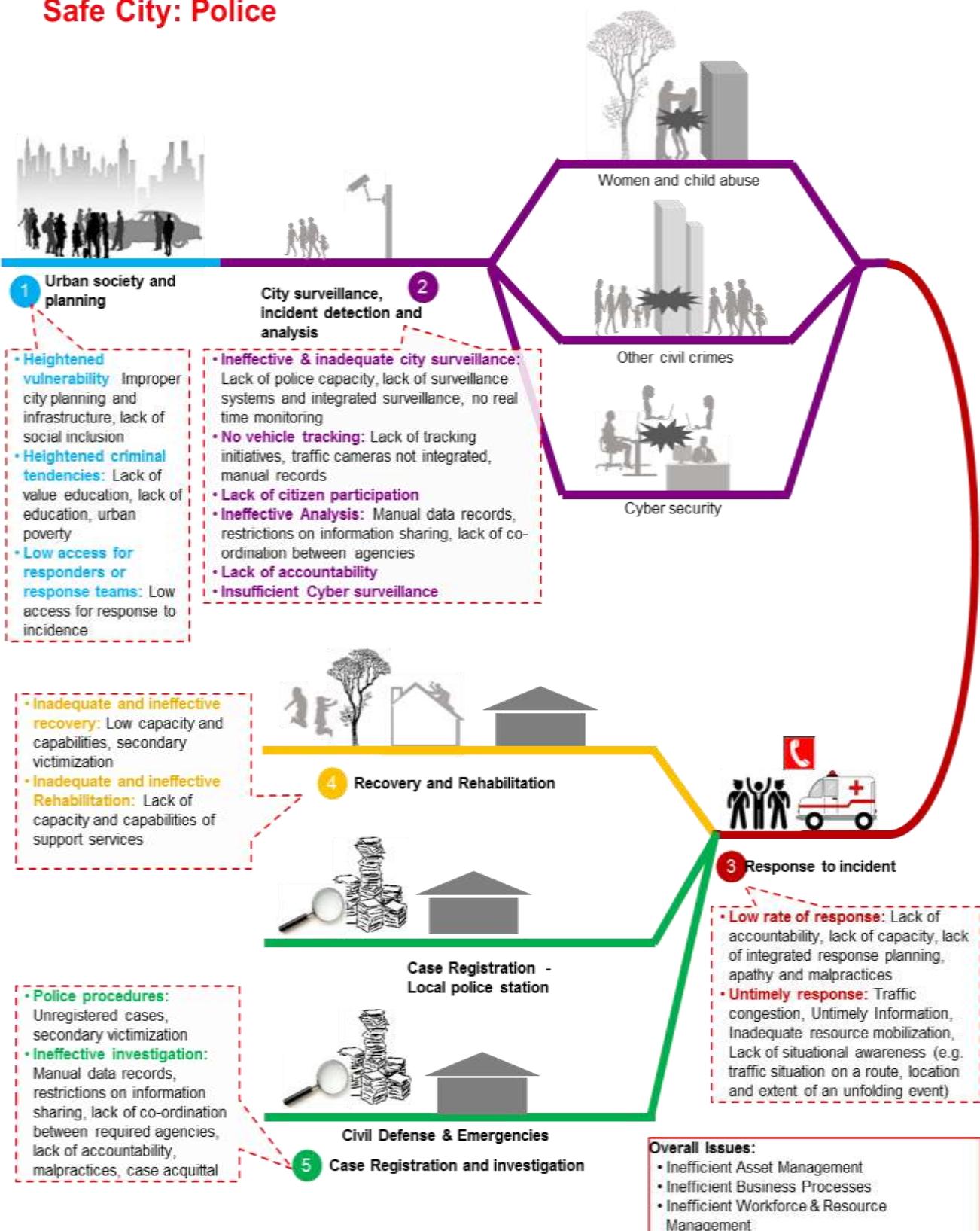
⁶²<http://www.poverties.org/poverty-and-crime.html#sthash.2aYhlqly.dpuf>

⁶³Lyon, David. 2007. Surveillance Studies: An Overview. Cambridge: Polity Press

⁶⁴<http://searchsecurity.techtarget.com/definition/incident-response>

⁶⁵<http://blog.ficci.com/rising-crime-india/1028/>(Mukhopadhyay, 2012)

Safe City: Police



Note: Case registration and investigation often runs in parallel with recovery and rehabilitation and must not be considered exclusive choices

Figure 21: Current state of public safety in cities – Police

Detailed description of the key issues and sub issues across the value chain:

Table 19: Issues and challenges in safe city

Issue	Sub-issue	Description
1. Urban society and planning		
a) Heightened vulnerability	Improper city planning and infrastructure	Narrow desolated lanes, dark corridors and subway stations; lack of daylighting, lack of street lighting provides more opportunity for crime.
	Lack of social inclusion	Urban planning and strategic planning often exclude the minorities and urban poor, forcing them towards illegal habitation and more vulnerable to crime.
b) Heightened criminal tendencies	Lack of value education	Good parenting, value education in schools and colleges form the foundation of safety and security in the society; however, lacks attention from local, state and national authorities.
	Lack of education	Less education leads to more criminal offenses ranging from property crime to casual theft and drug-related offenses ⁶⁶ .
	Urban poverty	Studies show that poverty is more tied with violence, criminal damage and also drug use - as a catalyst for violence ⁶⁷ .
c) Low access for response	Low access for response to incident	Narrow lanes hamper easy access to ambulances or fire brigade.
2. City surveillance, incidence detection and analysis		
a) Ineffective city surveillance	Lack of police personnel capacity	With just one policeman for 761 people translating into approximately 131 policemen per lakh population, India has fewer cops per capita than most other countries ⁶⁸ .
	Lack of surveillance systems	Lack of CCTV systems, perimeter security systems and network equipment required for state-of-the-art city surveillance.
	Lack of integrated surveillance	Data from surveillance and detection system such as high definition CCTV cameras, Infrared Radars (IRs), lasers and handheld devices are not integrated. Moreover, CCTVs across the city, such as those in ATMs are not integrated in the overall system.
	No real-time monitoring	There is no real-time monitoring of the data received from the surveillance and detection systems.
b) No vehicle tracking	Lack of tracking initiatives	There is no vehicle tracking system implemented across the country. While some of the states and cities, such as Maharashtra and Chennai have taken initiatives ⁶⁹ in this direction, they are still in initial phases.
	Traffic cameras not integrated	Inter-city or inter-state integration of traffic cameras is not implemented leading to isolation of episodes.
	Manual records	Vehicle records of existing old vehicles are in manual database and hence, difficult to access.
c) Difficulty in citizen participation	No helpline number	Most of the cities do not have a helpline number for citizens to report any suspicious activities.
	Citizen apathy	In many cases, citizens are apathetic towards the safety and

⁶⁶<http://www.poverties.org/poverty-and-crime.html>

⁶⁷<http://www.poverties.org/poverty-and-crime.html>

⁶⁸<http://www.dnaindia.com/india/report-police-to-people-ratio-3-cops-for-every-vip-but-just-1-for-761-commoners-1879695>

⁶⁹<http://cis-india.org/internet-governance/blog/driving-in-the-surveillance-society-cameras-rfid-black-boxes>

Issue	Sub-issue	Description
		security issues of their own cities and hence do not report any suspicious activities.
	Police apathy	While some aware citizens would responsibly want to report suspicious activities often they are met with the apathy of the police personnel.
d) Ineffective analysis	Manual data records	A majority of the cities in India have manual records, for current and/or past situations. Retrieving appropriate data can be a painstaking process.
	Restrictions on information sharing	Different departments and agencies involved in an incidence may show resistance to sharing of information.
	Lack of coordination between required agencies	The required agencies, such as weather, police, fire, medical lack coordination to drive to an appropriate analysis of the situation.
e) Lack of accountability	Lack of accountability	There is a lack of accountability in majority of the city police stations.
f) Insufficient cyber surveillance	Insufficient cyber surveillance	There has been an annual increase of more than 40 per cent in cybercrime cases registered in the country during the past couple of years ⁷⁰ . Cyber security teams are not available at all cities to monitor and investigate cybercrimes.
3. Response to incidence		
a) Low rate of response	Lack of accountability or ownership	While an incidence has been detected and analysed, state and local governments officials are not held accountable for lapse of response.
	Lack of capacity	In 2011 the actual strength of police force was 12,81,317 against the sanctioned strength of 16, 60,953.
	Lack of integrated response planning	Isolation and lack of integrated efforts across various departments, i.e. police, medical, fire, bomb disposal, etc. and lack of integrated planning to incidence leads to low rate of response.
	Apathy and malpractices	Apathy and malpractices such as corruption are significant factors in low response to incidences.
b) Untimely response	Many factors like traffic, untimely information, etc.	Untimely response could be due to traffic congestion, untimely information, inadequate resource mobilisation, lack of situational awareness.
4. Recover and rehabilitate		
a) Inadequate and ineffective recovery	Low capacity and capabilities	There is a shortage of capacity and capabilities at municipal hospitals to handle emergencies such as accidents, burns, etc.
	Secondary victimisation ⁷¹	Intrusive or inappropriate conduct by medical officers and other staff leads to secondary victimisation.
b) Inadequate and ineffective rehabilitation	Lack of capacity and capabilities of support services	There is an acute shortage of health and rehabilitation centres. Legal and psychological counselling services also face an acute shortage of capacity and capability to handle complete rehabilitation of the victims.
5. Case registration and investigation		

⁷⁰<http://www.firstpost.com/business/cyber-crime-india-rise-govt-reports-40-increase-online-fraud-cases-2020329.html>

⁷¹Secondary victimisation refers to the victimisation that occurs not as a direct result of the criminal act but through the response of institutions and individuals to the victim. (Legal Services India, 2012)

Issue	Sub-issue	Description
a) Police procedures	Unregistered cases	There have been situations where police have refused to register the case; often, cases such as rape go unregistered ⁷² .
	Secondary victimisation	Intrusive or inappropriate conduct by police or other staff leads to secondary victimisation.
b) Ineffective investigation	Manual data records	A majority of the cities in India have manual records, for current and/or past situations. Retrieving appropriate data can be a pain staking process.
	Restrictions on information sharing	Different departments and agencies involved in case investigation may show resistance to sharing of information.
	Lack of coordination between required agencies	The required agencies, such as police, fire and/or medical lack coordination to drive the investigation.
	Lack of accountability	There is a lack of accountability in majority of the city police stations and/or other departments.
	Malpractices	Malpractices such as corruption lead to distortion of facts hindering the investigation process.
	Case acquittal	Harassment of survivors and witnesses by perpetrators leading to acquittal of cases.

ICT-GT enablers:

A smart city must enhance performance on safety and security for citizens to thrive as a city. A ‘Safe’ city is a pre-requisite to create an attractive economic and social environment for the citizens, and to attract the investments for the growth of smart city. With the integration of smart citizen-centric services with the safety and security infrastructure, the city would be able to ensure sustainability and socio-economic growth. Safe city services include policing services, traffic management and mass transportation system, incident response, community policing, emergency and disaster management, surveillance and monitoring, safety and security of critical infrastructure and security of public places.⁷³

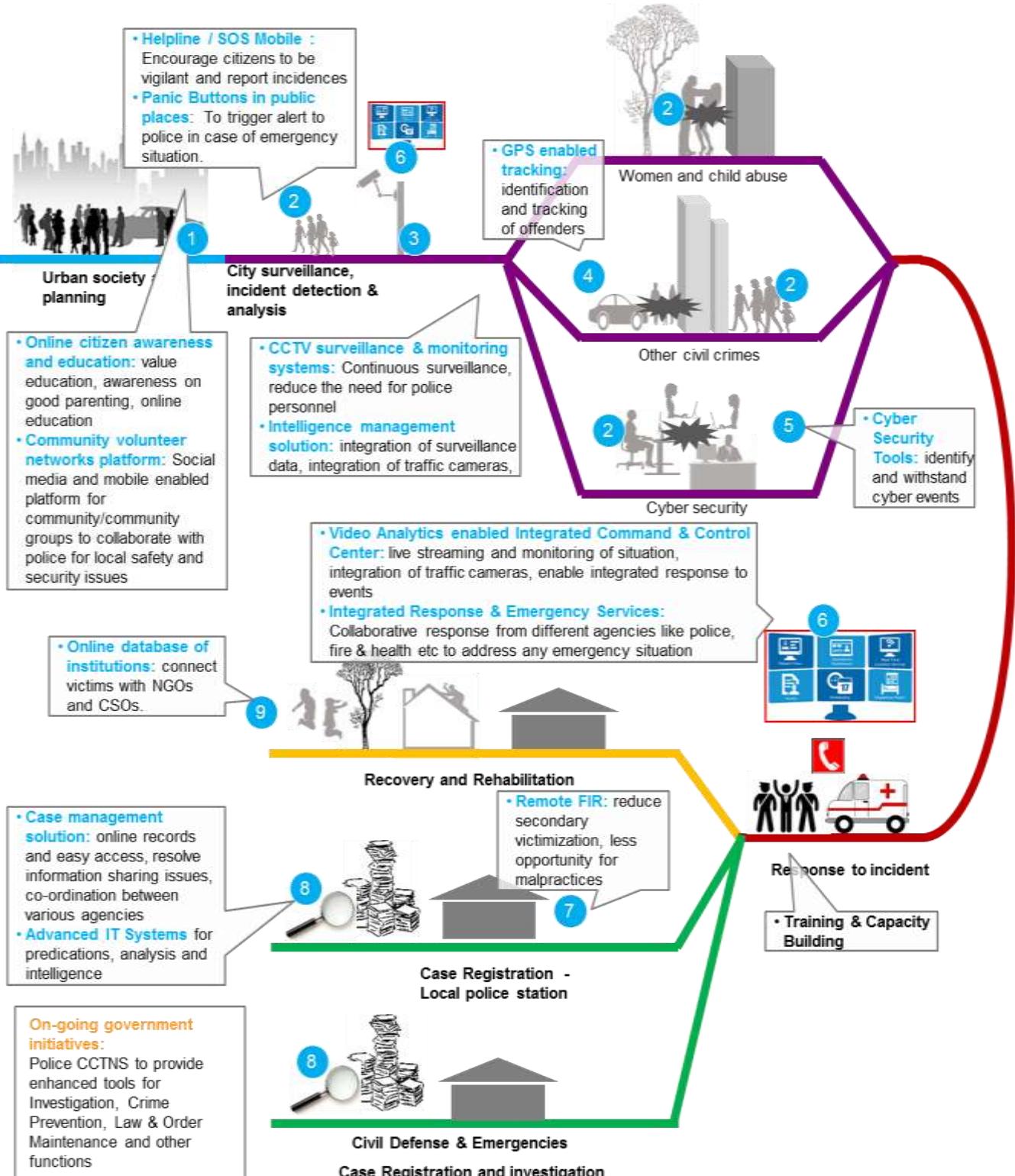
⁷²<https://www.osac.gov/pages/ContentReportDetails.aspx?cid=13695>

⁷³NASSCOM & ORKASH study – Safe City Architecture for Smart Cities

Smart Public Safety and Security

Overall ICT-GT interventions:

- Integrated Asset Management Solutions
- Business Process Automation
- Workforce and resource management
- City Performance Management
- Integrated Command & Operations Center



Note: Case registration and investigation often runs in parallel with recovery and rehabilitation and must not be considered exclusive choices

Figure 22: Smart public safety

ICT-GT enablers to overcome key challenges in safe city:

Table 20: Smart public safety: Mapping ICT-GT enablers to challenges

Issue	Sub-issue	ICT-GT enablers
1. Urban society and planning		
d) Heightened vulnerability	Improper city planning and infrastructure	<i>Covered under urban planning.</i>
	Lack of social inclusion	<i>Requires non-ICT interventions.</i>
e) Heightened criminal tendencies	Lack of value education	Online citizen awareness and education: Use of online platforms and services for citizen awareness and education. <i>Requires additional non-ICT interventions.</i>
	Lack of education	Online citizen awareness and education: Use of online platforms and services for citizen awareness and education. (<i>Also covered under smart education</i>) <i>Requires additional non-ICT interventions.</i>
	Urban poverty	<i>Requires non-ICT interventions.</i>
f) Low access for response	Low access for response to incident	<i>Covered under urban planning.</i>
2. City surveillance, incidence detection and analysis		
g) Ineffective and inadequate city surveillance	Lack of police personnel capacity	CCTV surveillance: Electronic surveillance systems reduce the need for police personnel in surveillance. Citizen helpline: Single point service to report any suspicious activity. Note that this can happen through multiple channels such as helpline number, social media, etc.
	Lack of surveillance systems	CCTV surveillance: Installation of electronic surveillance systems.
	Lack of integrated surveillance	Intelligence management solution: Monitor and record intelligence from devices and networks which are connected and allow seamless flow of information. Video analytics-enabled command centre: Video analytics triggered by street cameras. Live video is streamed to the command centre and field supervisor is alerted to a potential threat.
	No real-time monitoring	Video analytics-enabled command centre: Video analytics triggered by street cameras. Live video is streamed to the command centre and field supervisor is alerted to a potential threat.
h) No vehicle tracking	Lack of tracking initiatives	GPS-based vehicle tracking: GPS-based tracking can track vehicles and offenders.
	Traffic cameras not integrated	Video analytics-enabled command centre: Video analytics triggered by street cameras. Live video is streamed to the command centre and field supervisor is alerted to a potential threat.
	Manual records	Business process automation: Online records with ease of access as required.
i) Difficulty in	No helpline number	Citizen helpline: Single point service to report any suspicious

Issue	Sub-issue	ICT-GT enablers
citizen participation		activity. Note that this can happen through multiple channels such as helpline number, social media, etc.
	Citizen apathy	<i>Requires non-ICT interventions.</i>
	Police apathy	Remote FIR centers: Kiosks/systems to help citizens file a First Information Report (FIR) remotely.
j) Ineffective analysis	Manual data records	Business process automation: Online records with ease of access as required.
	Restrictions on information sharing	<i>Requires non-ICT interventions.</i>
	Lack of coordination between required agencies	<i>Covered under governance and operations.</i>
k) Lack of accountability	Lack of accountability	<i>Requires non-ICT interventions.</i>
l) Insufficient cyber surveillance	Insufficient cyber surveillance	Cyber security tools: Cyber security tools to build an ability to withstand cyber events.
3. Response to incidence		
c) Low rate of response	Lack of accountability or ownership	<i>Requires non-ICT interventions.</i>
	Lack of capacity	Video analytics-enabled command centre: Video analytics triggered by street cameras. Live video is streamed to the command centre and field supervisor is alerted to a potential threat.
	Lack of integrated response planning	Video analytics-enabled command centre: Video analytics triggered by street cameras. Live video is streamed to the command centre and field supervisor is alerted to a potential threat.
	Apathy and malpractices	<i>Requires non-ICT interventions.</i>
d) Untimely response	Traffic congestion	<i>Covered under smart transport.</i>
	Apathy and malpractices	<i>Requires non-ICT interventions.</i>
4. Recover and rehabilitate		
c) Inadequate and ineffective recovery	Low capacity and capabilities	<i>Covered under smart healthcare.</i>
	Secondary victimisation ⁷⁴	<i>Requires non-ICT interventions.</i>
d) Inadequate and ineffective rehabilitation	Lack of capacity and capabilities of support services	Online database: Online database of NGOs and rehabilitation services.
5. Case registration and investigation		

⁷⁴Secondary victimisation refers to the victimisation that occurs not as a direct result of the criminal act but through the response of institutions and individuals to the victim. (Legal Services India, 2012)

Issue	Sub-issue	ICT-GT enablers
c) Police procedures	Unregistered cases	Remote FIR centres: Kiosks/systems to help citizens file a First Information Report (FIR) remotely.
	Secondary victimisation	Remote FIR centres: Kiosks/systems to help citizens file a First Information Report (FIR) remotely.
d) Ineffective investigation	Manual data records	Business process automation: Online records with ease of access as required. Case management solution: End-to-end enterprise solution for managing cases.
	Restrictions on information sharing	Case management solution: End-to-end enterprise solution for managing cases. <i>Requires additional non-ICT interventions.</i>
	Lack of coordination between required agencies	Case management solution: End-to-end enterprise solution for managing cases. <i>Requires additional non-ICT interventions.</i>
	Lack of accountability	<i>Requires non-ICT interventions.</i>
	Malpractices	<i>Requires non-ICT interventions.</i>
	Case acquittal	<i>Requires non-ICT interventions.</i>

Description of ICT-GT enablers/smart solutions:

- **CCTV surveillance:** Setting up of IP-based outdoor security cameras across the city with video surveillance data being stored and monitored at command control centres.
- **Cyber security tools:** Cyber security tools (to build an ability to withstand cyber events measured by the mean time to failure and mean time to recovery) along with a cybersecurity command centre to monitor cyber security risks and take reactive/preventive actions
- **Online database:** Online database of NGOs and CSOs can help victims, especially women and children to access these services for physical and mental recovery and rehabilitation
- **Intelligence management solution:** Leverage the intelligence management solution to monitor and record intelligence from devices and networks which are connected and allow seamless flow of information
- **Advanced IT systems:** Enables predictions, analysis and intelligence
- **Community volunteer networks platform:** Social media and mobile enabled platform for community/community groups to collaborate with police for local safety and security issues
- **Panic buttons in public places:** To trigger alert to police in case of emergency situation
- **Remote FIR centres:** Kiosks/systems to help citizens file a First Information Report (FIR) remotely, irrespective of the location of the jurisdiction where the offence has occurred in the city. The complainant can sign, print and scan documents virtually as part of the experience
- **Video analytics-enabled integrated command and control centre:** Video analytics triggered by street cameras. Live video is streamed to the command centre and field supervisor is alerted to a potential threat. Video analytics enhances video surveillance systems by performing the tasks of real-time event detection, post event analysis and extraction of statistical data while saving manpower costs and increasing the effectiveness of the surveillance system operation
- **Integrated response and emergency services:** Collaborative response from different agencies to address any emergency situation
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools

- **Integrated command and operations centre:** Integrated city command and operations centre to monitor emergencies and disasters to provide effective response when needed
- **SoS mobile application:** SoS mobile application to trigger alerts and incident reporting with geo location to provide effective response during an emergency situation. The alerts could not just be routed to the Police Control Room but also to certain selected numbers from the phone book
- **Helpline:** 24x7 emergency helpline number to raise any events/issues/concerns to a centralised/localised call centre which is integrated with police stations, hospitals, etc.
- **Training and capability building** to consistently improve forces

Overall ICT-GT enablers:

- **Integrated asset management solutions:** Integrated asset management of all safety infrastructure assets including the associated data, processes, information systems and governance for manageable operations and higher sustainability
- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools
- **City performance management:** Monitor the performance of city subsystems through the use of digital technologies and big data analytics to manage city governance, efficient performance and proactive crisis management

For more details, please refer to '[NASSCOM & ORKASH Study- Safe City Architecture for Citizen Centric Services for Smart Cities in India](#)' available at www.nasscom.in

Ongoing government initiatives

Initiatives	Brief Description
Police CCTNS	Provide enhanced tools for investigation, crime prevention, law & order maintenance and other functions like traffic management, emergency response, etc. Create platforms at state and central levels for sharing crime and criminal information/databases across states and across the country. Improve service delivery to the public/citizens/stakeholders. The project aims to provision and streamline services like National Crime Record Bureau (NCRB) citizen interface, crime and criminal records &query management service, police email & messaging service, complaint and FIR management services, etc.

5.2.4 Smart citizen services

Background:

Shaping citizen behaviour, educating citizens and reducing digital divide is important to achieve India's objective to create smart and inclusive cities.

The main components of the ecosystem are:

1. **Access to internet and online services:** Access to internet at public places and provision of online services such as utility bill payment, tax payment are the stepping stone towards smart citizen services.
2. **Citizen engagement and participatory process:** A functional democracy needs informed citizens, active citizen participation in policymaking, a responsive state and governing processes that are open, transparent and inclusive to all. Improving relationships between citizens and their government means working simultaneously on state responsiveness and effectiveness, citizen empowerment, and the accountability of elected and selected authorities. The state alone cannot solve society's many problems or provide the remedies for democracy's deficits—this also requires citizen action.
3. **Citizen service delivery:** Delivering various municipal citizens services like birth certificate of birth, death, caste certificate, income certificate, property tax payments, grievance/complaint registration, utilities connection, utilities bill payment, etc.

Key issues:

Very few places in India have free access to public Wi-Fi. While one of the world's largest public Wi-Fi zone is located in Patna, many other cities have no public Wi-Fi services at all. Access to information, responsible use of internet/resources and increasing digital divide are the key issues faced by our country. While there are many firms and agencies-both government and private, participating in delivery of urban services, the IT potential of the country has not been leveraged to provide better citizen interface.

Smart Citizen Services

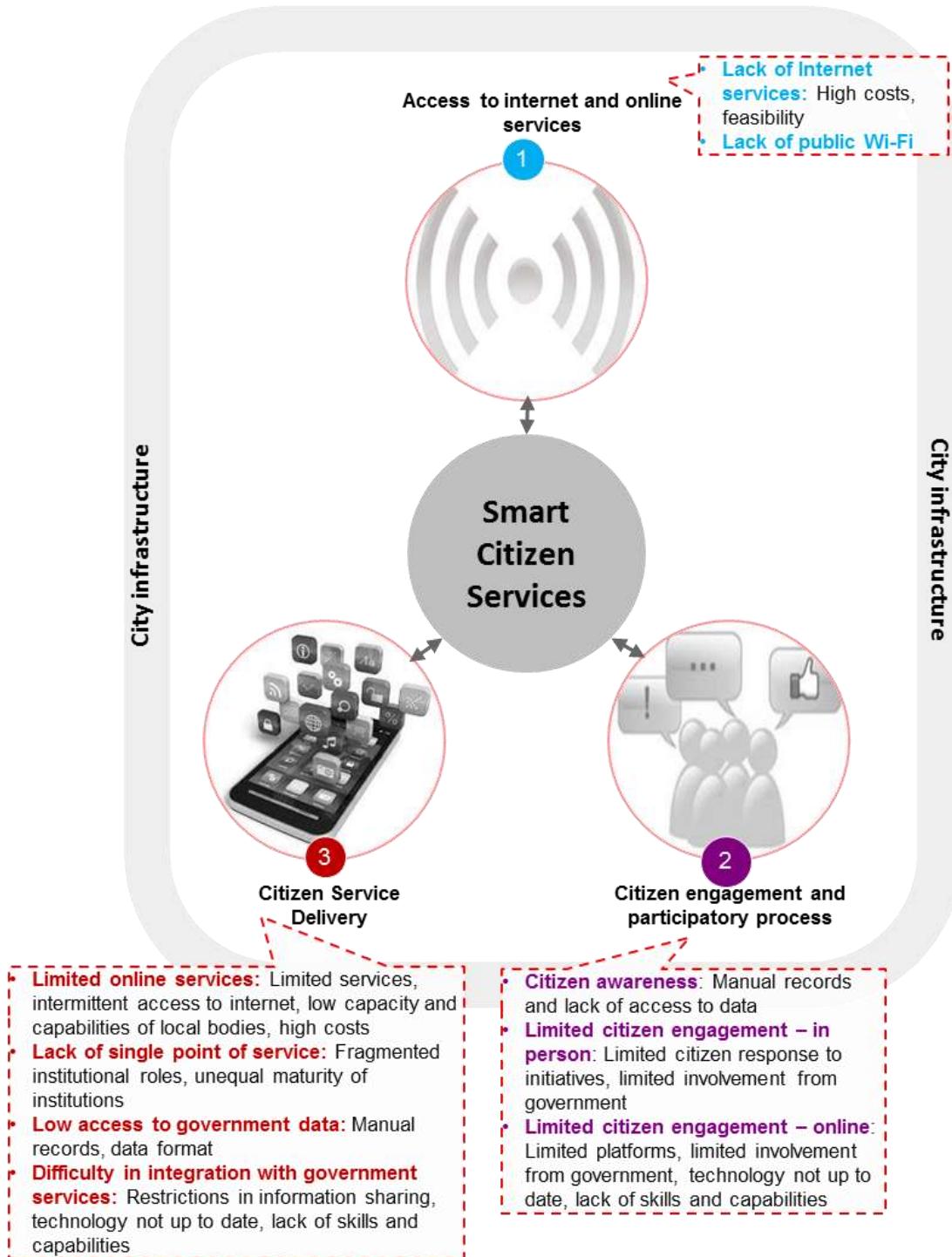


Figure 23: Current state of citizen services in India

Description of the key issues and challenges across the value chain:

Table 21: Issues and challenges in smart citizen ecosystem

Issue	Sub-issue	Description
1. Access to internet and online services		
a) Lack of public	High costs	Covered under new business models.

Issue	Sub-issue	Description
Wi-Fi	Feasibility	Providing additional ICT infrastructure for public Wi-Fi requires retrofitting .Installing Wi-Fi infrastructure in public places while keeping them functional is challenging.
2. Citizen engagement and participatory process		
a) Citizen awareness	Manual records and lack of access to data	Access to information can assist in citizen awareness. However, currently information is not easily accessible.
b) Limited citizen engagement – In person	Limited citizen response to initiatives	While the government attempts to hold workshops for consultation, the response rate for these initiatives is very low.
	Limited involvement from government	High ranking government officials do not willingly get involved in such initiatives further discouraging the citizens.
c) Limited citizen engagement – Online	Limited platforms	There are currently very limited platforms, and nearly no platforms by the local bodies to engage with citizens and take feedback on public initiatives.
	Limited involvement from government	High ranking government officials do not willingly get involved in initiatives based on online platforms. This discourages citizen participation.
	Lack of skills and capabilities	Government bodies do not have the necessary skills and capabilities to handle such engagements.
3. Citizen service delivery		
a) Low access to government data	Manual records	Age old government data which may be required for research is mostly in manual format and hence, difficult to use.
	Data format	While online data may be available, legacy data is in reality scanned version of manual records and hence not very useful for direct applications.
b) Difficulty in integration with government services	Restrictions in information sharing	Restrictions on information sharing hinder entrepreneurs from building private services and apps-related to public services.
	Lack of skills and capabilities	Government bodies do not have the necessary skills and capabilities to handle such engagements.
c) Limited online services	Limited services	Major metros in India offer online bill payment and tax payment services; however, Tier II and Tier III cities do not provide online options for all public services.
	Intermittent access to internet	Intermittent access to internet at the government offices leads to issues with servers being down and sites being inaccessible for prolonged periods of time. This necessitates a back-up of manual processes which is more tedious.
	Low capacity and capabilities of local bodies	Low capacity and capabilities of local bodies to provide and maintain online services or related customer service.
	High costs	Costs of providing smart infrastructure in public places are very high.
d) Lack of single point of service	Fragmented institutional roles	Fragmentation in institutional roles is reflected in online services as there is no single point of access to avail these services.

ICT-GT enablers:

Providing access to information and internet at no/affordable cost to citizens via a channel which is accessible anywhere from any device can be achieved by public Wi-Fi. Responsible use of internet can be achieved by leveraging internet security tools; restricting free usage and affordable charge back mechanisms. Citizens' access to city services can be improved significantly by providing multi-channel (web, mobile, kiosks, and face-to-face) citizens services facilities.

Smart Citizen Services

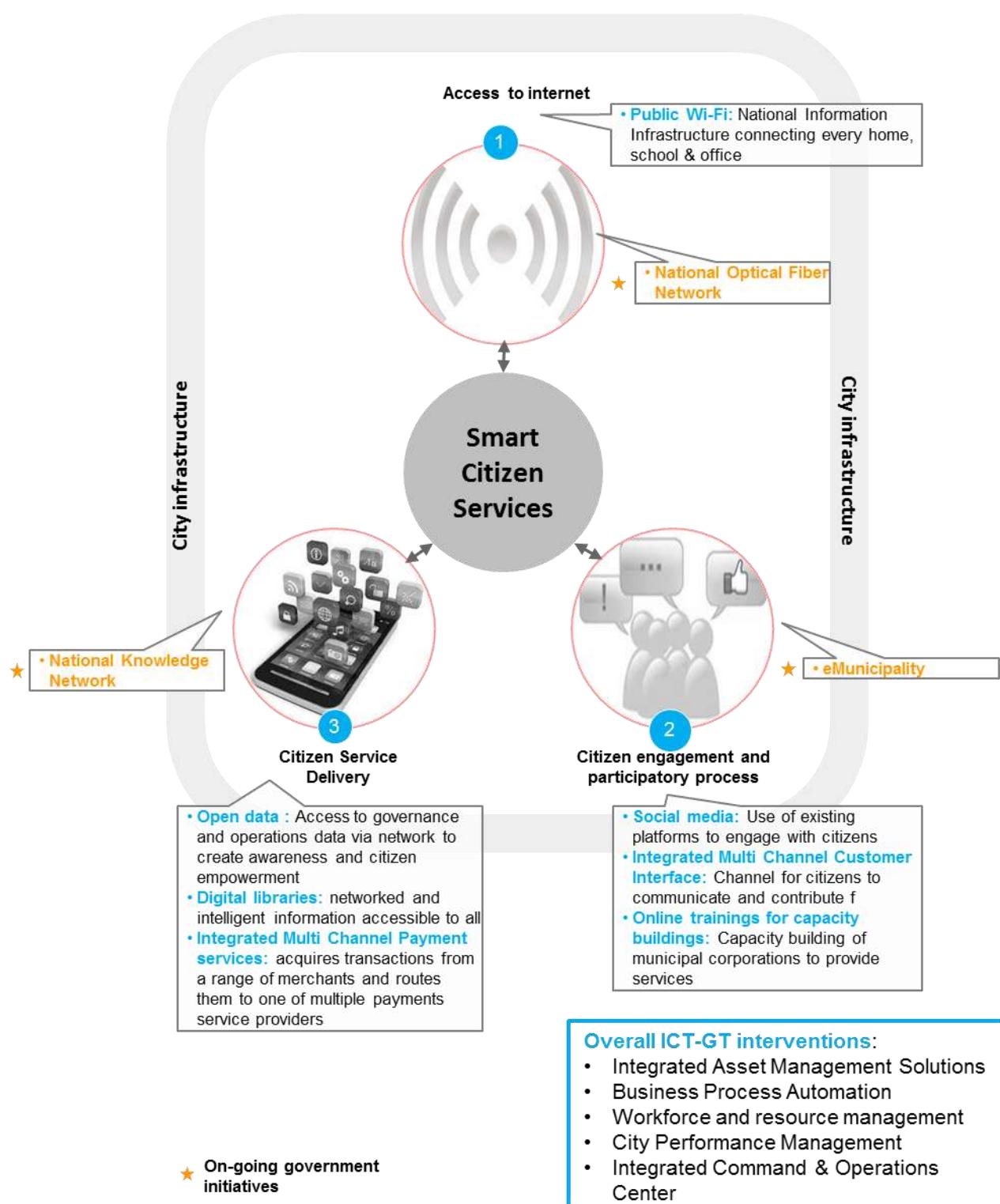


Figure 24: Smart citizen services

ICT-GT enablers to overcome key challenges in Smart Citizen services:

Table 22: Smart citizen services: Mapping ICT-GT enablers to challenges

Issue	Sub-issue	ICT-GT enablers
1. Access to internet and online services		
a) Lack of public Wi-Fi	High costs	Public Wi-Fi: City wide public Wi-Fi service will provide seamless high speed internet services to citizens. Providing city-wide Wi-Fi services would need huge investments in Wi-Fi equipment's, fiber connectivity, etc. Telecom technologies can play a major role in providing public Wi-Fi services leveraging existing telecom infrastructure.
	Feasibility	
2. Citizen engagement and participatory process		
a) Citizen awareness	Manual records and lack of access to data	Open data: Provides access to current and archived government data. Digital libraries: Citizens can get easy access to current and archived data, journals, newspapers, books and reports through online portals.
b) Limited citizen engagement – In person	Limited citizen response to initiatives	Social media: Use of social media and other channels to create citizen awareness on participatory governance.
	Limited involvement from government	<i>Requires policy interventions.</i>
c) Limited citizen engagement – Online	Limited platforms	Integrated Multi Channel Customer Interface: Integration of services can optimize the use of existing platforms.
	Limited involvement from government	<i>Requires policy interventions.</i>
	Lack of skills and capabilities	Online trainings for capacity buildings: Municipal capacity building can be carried out through online training sessions. Business process automation: Process automation can assist in leveraging current workforce for more productive and desired activities like engaging with citizens.
3. Citizen service delivery		
a) Low access to government data	Manual records	Open data: Provides access to current and archived government data. Digital libraries: Citizens can get easy access to current and archived data, journals, newspapers, books and reports through online portals.
b) Difficulty in integration with government services	Restrictions in information sharing	<i>Requires policy interventions.</i>
	Lack of skills and capabilities	Online trainings for capacity buildings: Municipal capacity building can be carried out through online training sessions. Business process automation: Process automation can assist in leveraging current workforce for more productive and desired activities like engaging with citizens.
c) Limited online services	Limited services	Integrated multi-channel customer interface: Providing integrated services across multi-channels can optimise the costs for each service provider. It also provides tremendous convenience to the citizens.
	Intermittent access to internet	Public Wi-Fi: City wide public Wi-Fi service will provide seamless high speed internet services to citizens.
	Low capacity and capabilities of local bodies	Online trainings for capacity buildings: Municipal capacity building can be carried out through online training sessions. Business process automation: Process automation can assist in

Issue	Sub-issue	ICT-GT enablers
		leveraging current workforce for more productive and desired activities like engaging with citizens.
	High costs	<i>Covered under section new business models.</i>
d) Lack of single point of service	Fragmented institutional roles	Integrated multi-channel customer interface: Different departments can plug into the same platform to provide their services to citizens through a single point of access.

Description of ICT-GT enablers/smart solutions:

- **Newer technologies:** India can leverage on advances in technologies such as 3G and 4G, networking, telecom infrastructure etc. to provide internet to all the citizens.
- **Integrated multi-channel customer interface:** Multi-channel customer interface such as service desk, contact centre or citizen services portal help in recording citizen's requests/issues via multiple channels like face-to-face, web, mobile, kiosk, etc.
- **Digital libraries:** Modern digital libraries with up-to-date content accessible to all, networked and intelligent information technology, interconnection, high efficiency and convenience
- **Online trainings and capacity building:** Use of ICT to conduct trainings for municipal authorities in providing smart citizen services
- **Public Wi-Fi:** City-wide public Wi-Fi service will provide seamless high speed internet services to citizens

Overall ICT-GT enablers:

- **Integrated asset management solutions:** Integrated asset management of all safety infrastructure assets including the associated data, processes, information systems and governance for manageable operations and higher sustainability
- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **City performance management:** Monitor the performance of city subsystems through the use of digital technologies and big data analytics to manage city governance, efficient performance and proactive crisis management
- **Integrated command and operations centre:** Leverage integrated command and operations centre to monitor city services on real time. Improve/synchronise maintenance activities to reduce downtime and improve maintenance effectiveness
- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting and scheduling, shift management, mobile applications to execute tasks and efficient performance management tools

Ongoing government initiatives

Initiatives	Brief Description
National Optical Fiber Network	The National Optical Fiber Network (NOFN) project aims to provide internet access using existing optical fiber and extending it to the Gram Panchayats. The project intends to enable the government of India to provide e-Services and e-Applications nationally.
National Knowledge Network	The objective of the National Knowledge Network (NKN) is to interconnect all institutions of higher learning and research with a high speed data communication network to facilitate knowledge sharing and collaborative research. It will bridge the existing knowledge gap in the country. It will help the country evolve as a knowledge society and spur economic activities in the knowledge domain. Under this network, it is proposed that the core and associated links to around 1,500 institutions shall be established.
State Wide Area Network	Under this scheme, technical and financial assistance are being provided to the states/UTs for establishing SWANs to connect all state/UT headquarters up to the block level via district/ sub-divisional headquarters, in a vertical hierarchical structure with a minimum bandwidth capacity of 2 Mbps per link (Expandable up to 34 Mbps). Steps have been initiated to integrate all SWANs using the National Knowledge Network (NKN). Four states namely Gujarat, Tamil Nadu, Karnataka and Andhra Pradesh have been integrated using NKN.
e-Municipality	Assist the municipal bodies across India to improve service delivery, transparency & information management by improving following processes: <ul style="list-style-type: none"> - Registration and issue of certificates such as birth/death - Payment of property tax, utilities bills and management of utilities - Grievance and suggestions - Building approvals - Procurement and monitoring of projects - Health programmes - Accounting system - Personnel information system
India Post	Transforming Department of Posts into a “Technology-Enabled, Self-Reliant Market Leader” by increased market share and revenues, new products and services, improved service delivery, motivated workforce and rural development. Core India Post services as part of the IT modernisation program include: <ul style="list-style-type: none"> - Mail products and services - Banking products and services - Insurance products and services

e-District	<p>Deliver identified high volume citizen services with clearly laid down service levels and outcomes to improve efficiency and effectiveness of citizen interaction with district administration.</p> <p>Electronically deliver citizen services along with Business Process Re-engineering (BPR) for improving the quality of services to citizens.</p> <p>Create a robust and scalable platform which leverages the State Data Centres (SDC), State Wide Area Networks (SWANs), State Service Delivery Gateways (SSDGs) and state portals for providing e-enabled services with both back-end and front-end linkages.</p>
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5.3 : Smart environmental management

Background:

Cities are the biggest emitters of greenhouse gases and have a large role to play in climate change mitigation and adaptation.

The main components of the ecosystem are:

1. **Monitoring:** City governance forms the foundation to the smooth functioning of the city. It includes the day-to-day activities of the local government and coordination with various other agencies to ensure that services are provided to all citizens across the various strata of the society.
2. **Analyze hazard and assess risk:** This includes quantification of the risk from the hazard and plan for action in case of emergency.
3. **Raise alerts/advisory:** Alerts are raised through various channels of communication including conventional media as well as social media.
4. **Respond to emergency:** Response to emergency includes medical, fire and police services along with disaster management services.
5. **Take long-term action:** The situation is investigated and the impact is analyzed in detail to draw a plan of action for long-term prevention or remediation.

Key issues:

India has witnessed a drastic change in temperatures and rainfall patterns. The floods in Uttarakhand, cyclone Phailin, etc. have brought about huge economic losses. Poor collaboration between agencies at national, state and local level leading to missed risk notifications has led to huge losses during natural calamities. There is lack of data and modelling frameworks at the city level. Adaptation needs city specific knowledge of vulnerability and impacts, which is resource intensive and requires an updated and comprehensive database. It also needs a downscaling of climate change impacts for specific urban locations in order to plan location-specific adaptation strategies. In addition, urban planning and design lack the basic concepts of climate appropriateness and passive design strategies in urban design⁷⁵.

⁷⁵Environment and Urbanisation, Vol 22 No 2 October 2010: Mainstreaming climate change adaptation in Indian cities, (Sharma, Oct 2010)

Climate Change and Environmental Management

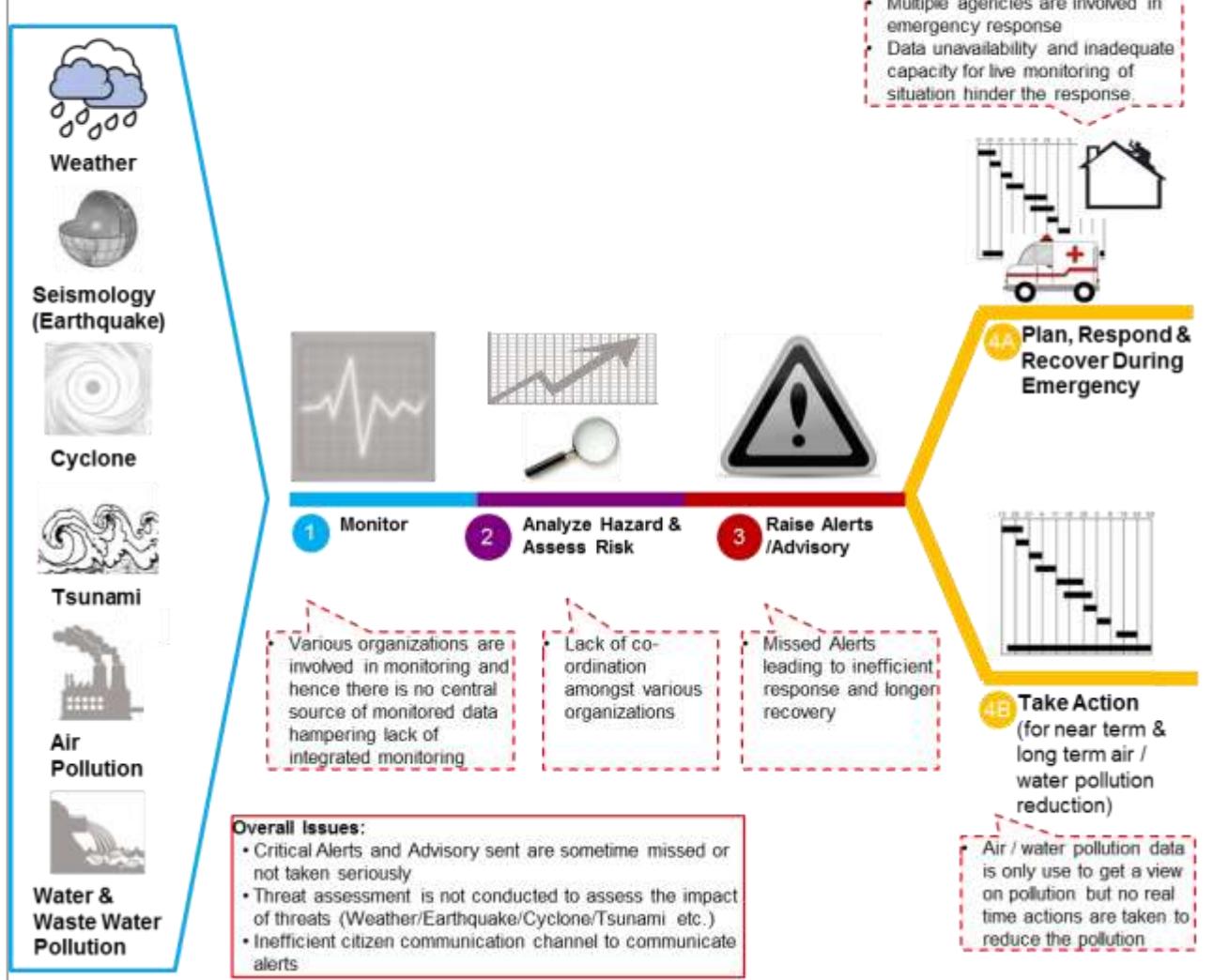


Figure 25: Current state of focus on climate change in cities

Detailed description of the key issues and sub issues across the key components:

Table 23: Issues and challenges in climate change and pollution mitigation

Issue	Sub-issue	Description
a) Monitoring		Various organisations are involved in monitoring and hence, there is no central source of monitored data hampering lack of integrated monitoring.
b) Lack of coordination amongst various organisations		Lack of coordination amongst various organisations.
c) Lack of coordination amongst various organisations		Missed alerts leading to inefficient response and longer recovery.
d) Emergency response		Multiple agencies are involved in emergency response. Data unavailability and inadequate capacity for live monitoring of situation hinder the response.
e) Long-term action		Air/water pollution data is only used to get a view on pollution but no real time actions are taken to reduce the pollution.

Issue	Sub-issue	Description
		real-time actions are taken to reduce the pollution.

ICT-GT enablers:

Smart Climate Change and Pollution Management

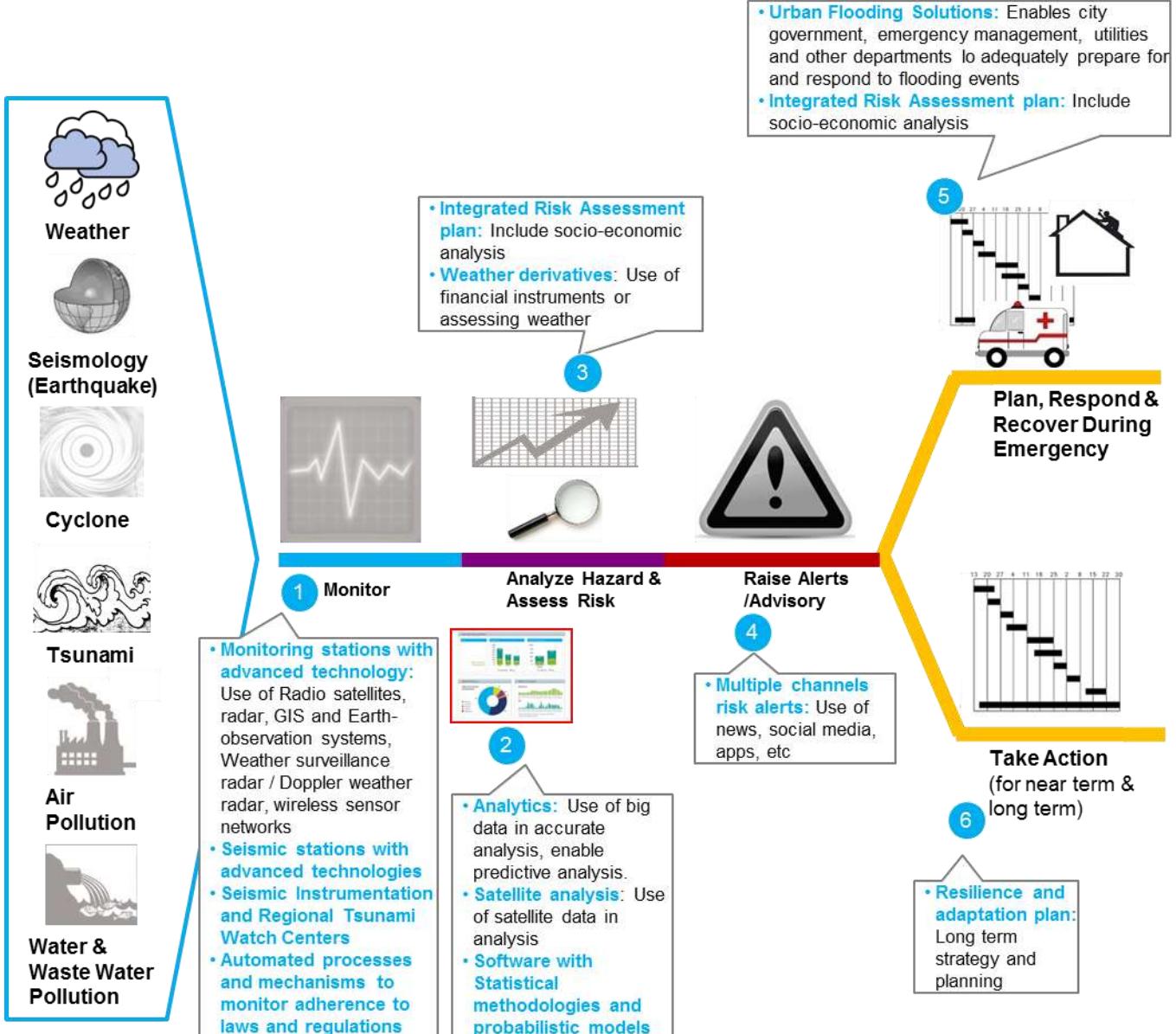


Figure 26: Smart climate change mitigation

Leveraging air/water pollution meters to identify air/water pollution at various key areas in city and using that data to decide interventions to reduce air/water pollution to ensure safe and clean environment to citizens. Weather monitoring stations can provide real-time visibility on weather conditions and predictive analytics can predict the risks like cyclone, floods, drought and earthquakes well in advance.

Detailed description:

- **Weather monitoring stations with advanced technology:** Radio satellites, radar, GIS and Earth-observation systems are among the ICT tools available to improve urban readiness. Aerial photography,

satellite imagery, grid technology and use of global positioning systems now make it possible to track gradual, long-term weather movements. Weather monitoring stations can provide real time visibility on weather conditions. Meteorological doppler weather radar system with the provision of advanced meteorological software uses cutting-edge technology to optimize the forecasting of extreme precipitation and severe thunderstorms at long ranges. It is based on a highly sophisticated klystron transmitter, which delivers excellent data quality. Wireless sensor networks are a cost-effective and scalable method for detecting early flood signs, forecasting floods, and monitoring flooding areas. Sensors can be spread along the course of a river to measure increased water levels and generate alerts wirelessly by SMS. The network can also be used to monitor weather conditions and rainfall, making easier and more accurate forecasting of floods, and determine the likeliness of flooding in areas close to the coast, river, etc.

- **Analytics:** Sensors in space and on-ground to monitor and measure weather, land use, vegetation, oceans, cloud cover, ice cover, precipitation, drought, water quality, sea surface temperature, and many more geophysical parameters. Modelling and simulations to predict climate behaviour over the next 100 years, and beyond. Huge climate simulations typically run daily. This helps to predict future weather with high resolution simulations, to improve farming operations, to develop agronomic models, to assist farmers in adapting to climate change, and to protect the agribusiness
- **Integrated risk management plan:** A risk analysis based on socio-economic calculations. The calculations are performed both for various parameters like change in rainfall, seawater level etc. The analysis gives the opportunity to evaluate risk and construct a detailed comprehensive plan. Risk assessments should not only be done at center but also at state/city level since it allows state/city governments to identify how the effects of climate change will manifest within their jurisdictions
- **Hedge climate risk:** Weather derivatives can be used by organisations or individuals as part of a risk management strategy to reduce risk associated with adverse or unexpected weather conditions. For instance, farmers can use weather derivatives to hedge against poor harvests caused by failing rains during the growing period, excessive rain during harvesting, high winds in case of plantations or temperature variability's in case of greenhouse crops, etc.
- **Multiple channel risk alerts:** Use of multiple channels like news, social media, mobile devices and applications to proactively alert citizens and municipal employees to potential risks can help cities to communicate specific instructions and take timely preventive actions
- **Resilience plan:** A robust, holistic and comprehensive climate resilience plan must combine built infrastructure, human capital, and information technology solutions that enables cities, organisations and stakeholders to analyse and respond to severe weather events as efficiently as possible
- **Adaptation plan:** Adaptation planning covers how the city will change to meet the new challenges posed by climate change. Planning might cover long-term infrastructure changes, like higher sea walls, more green space, or securing additional municipal water supply resources, as well as policy changes like restricting new development in flood zones, etc.
- **Emergency preparedness and recovery:** Making pre-disaster decisions to improve the effectiveness of response and recovery is especially important to reducing the loss of lives and decreasing the amount of time it takes to recover from hazard events, like flooding or hurricanes. Emergency response managers and teams should be prepared and trained to reduce vulnerability
- **Seismic stations with advanced technology:** Seismic system to provide remote monitoring of regional seismic activities around the country, particularly the quake prone areas. Using Kinematics and Quanterra data acquisition, storage and telemetry equipment, digitally recorded seismic measurements at remote sites are stored and then transmitted to the Central Processing Station (CPS) for further processing and dissemination
- **Satellite analysis:** Satellite analysis plays an important role in locating the centres of tropical cyclones. Satellite pictures can be received at hourly intervals and form a near real-time observational basis for tracking tropical cyclones. The appearance of a well-formed eye is a definite indicator of where the storm is. If an eye is absent, it is still possible to obtain a reasonable estimate of the centre location by tracing the spiral rain bands of the storm or by studying the relative motion of cloud features near its centre
- **Seismic instrumentation and regional tsunami watch centres:** Real-time data from seismic instrumentation networks allow Regional Tsunami Watch Centres (RTWC) to locate the epicenter of an earthquake and to measure its magnitude. As from a certain magnitude threshold, which varies with the

source zone, subsea earthquakes have a potential to generate a tsunami. So just based on these seismic data, the regional centre can issue a tsunami watch message to national authorities in the endangered region. Depending on the vicinity of the tsunami source zone to a certain coastline the national tsunami warning focal points might issue immediately a tsunami warning or wait for the first tide gauge readings if the tsunami generation can be confirmed or not. The real-time sea-level measurements also allow these centres to refine the information concerning the tsunami amplitude. Besides the monitoring capability a fully-fledged RTWC should also swiftly process and analyse these data around-the-clock, 24 hours a day, seven days a week

- **Wireless sensors:** Wireless sensors that measure a dozen of the most relevant water quality parameters (like ph., dissolved ions, dissolved oxygen, etc.) is connected to an online server for real-time water quality control. It helps in potable water monitoring, chemical leakage detection in rivers, remote measurement of swimming pools and spas, and levels of seawater pollution
- **Statistical methodologies and probabilistic models:** Statistical methodologies and probabilistic models help in assessing environmental water pollution risk, since risk is a “probabilistic measure for degree of harm associated with pollutant levels”. The probabilistic approach in the analysis is designed to test the significance of pollution measuring parameters in the probability distribution model
- **Rigorous laws and regulations, automated processes and mechanisms to monitor them:** Well-defined pollution control requirements are needed at a central level. Rigorous regime to administer laws and regulations for effective environmental protection at city level are needed. Proposed factory only be allowed to set up if it is sited in an appropriate industrial estate and can comply with pollution control requirements. Licenses for factories or usage of hazardous substances should be only issued when applicants show that they are adhering to legal requirements, such as having the necessary pollution control equipment. Factory inspectors from city management carry out regular checks on industrial premises to ensure there is compliance with regulations on the ground
- **Wireless sensor network:** A WSN-based vehicular pollution monitoring platform which is capable of measuring different types of pollutant concentrations contained in smoke produced by the vehicle and reports the status automatically whenever required to the concerned agencies
- **Urban flooding solutions:** Enables city government, emergency management services, utilities and other departments to adequately prepare for and respond to flooding events. It includes real-time infrastructure flow and capacity information with simulation tools and weather forecasting tools. It identifies the exact path of a storm; how much precipitation it will bring; how it will affect the saturation levels of the area; the resulting flooding potential; and the predicted effects on urban drainage systems, city streets and receiving water bodies

5.4 : Smart city governance and operations

Background:

City government depends on various public and private agencies to deliver a variety of services to its citizens. So governance, collaboration and integration of this network of multiple providers becomes very important to achieve city objectives.

The main components of the ecosystem are:

- **City governance:** City governance forms the foundation for the smooth functioning of the city. It includes the day-to-day activities of the local government and coordination with various other agencies to ensure that services are provided to all citizens across the various strata of the society
- **Operations and maintenance:** Operational maintenance is the care and minor maintenance of equipment using procedures that do not require detailed technical knowledge of the equipment's or system's function and design. This category of operational maintenance normally consists of inspecting, cleaning, servicing, preserving, lubricating, and adjusting, as required. Such maintenance may also include minor parts replacement that does not require the person performing the work to have highly technical skills or to perform internal alignment
- **Public infrastructure asset management:** Infrastructure asset management is the integrated multidisciplinary set of strategies in sustaining public infrastructure or municipal assets such as water treatment facilities, sewer lines, roads, utility grids, bridges, and railways. It includes maintaining an inventory of all the public assets at disposal and making efficient use of the same
- **Integrated operations and command centre:** Leverage integrated command and operations centre to monitor city services on real-time. Improve/synchronise maintenance activities to reduce downtime and improve maintenance effectiveness
- **Citizen services:** Public citizen services are the interface of the government with the public. These include but are not limited to bill payments, tax payments, registering complaints, etc.

Key issues:

Currently most of the cities depend on manual processes to govern, collaborate and integrate these agencies which lead to lots of inefficiencies and untapped potential. These issues are discussed in detail in the next section.

City Governance and operations

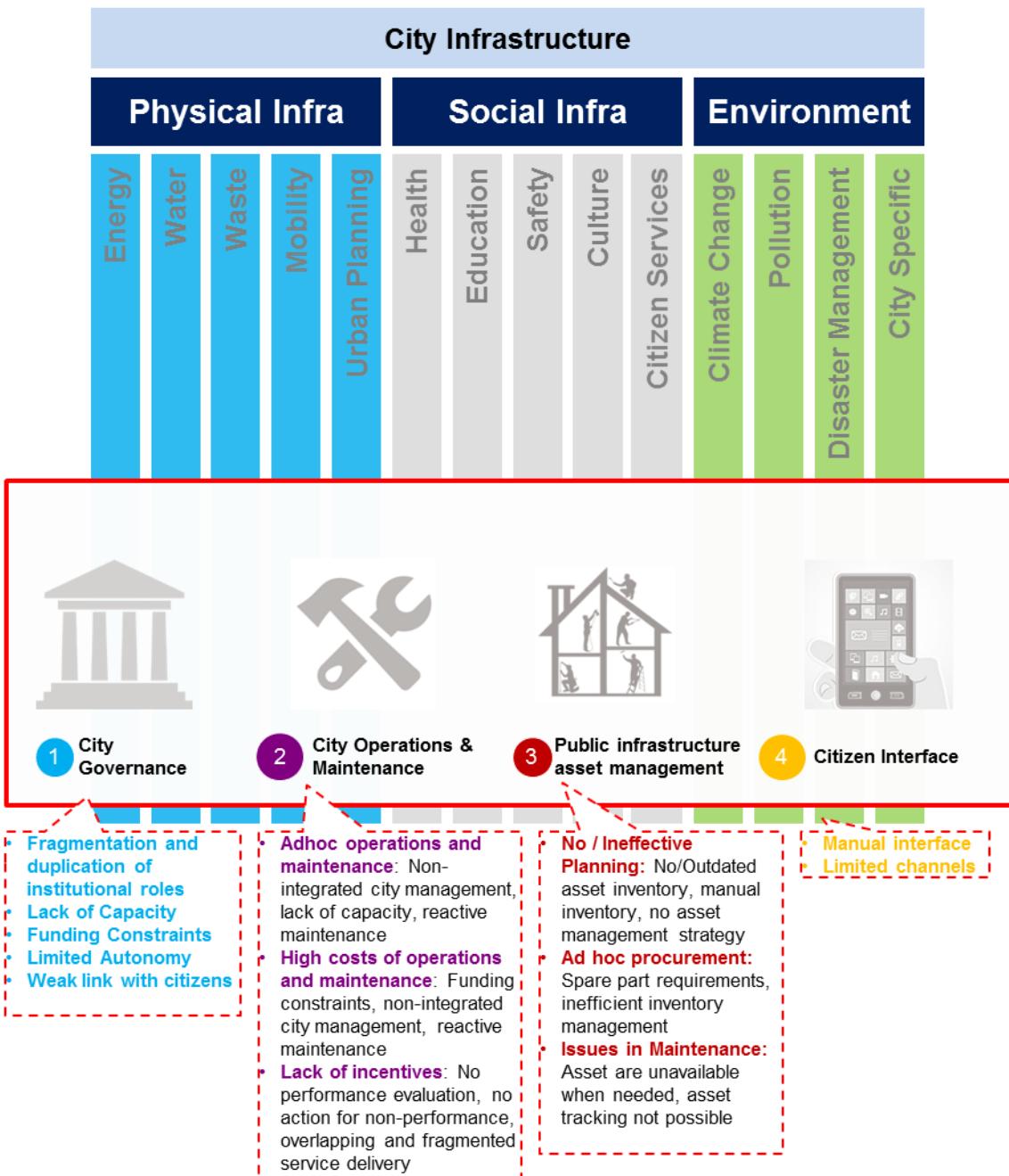


Figure 27: Current state of governance and operations in cities

Detailed description of the key issues and challenges across the value chain:

Table 24: Issues and challenges in governance of cities

Issue	Sub-issue	Description
1. City governance		
a) Fragmentation and duplication of institutional roles		Urban governance is distributed across the central government, the state government and the urban local body. The existing institutional framework for urban planning and governance doesn't specify clearly the roles and responsibilities of the state government, parastatals like water supply , sewerage boards and the ULB.
b) Lack of staff		Some departments are understaffed whereas others are staffed with people who do not have adequate skills. Performance incentives are geared towards input controls rather than service outputs so that it becomes difficult to match people having specific skills with their functional responsibility, which would enhance services.
c) Funding constraints		The statutory framework, which lays down the powers of municipal bodies, does not provide them with any major role in capital financing of infrastructure and services. Municipal entities need to be strengthened as local governments have 'limited' sources of revenue and predictable formula-based transfers from state governments.
d) Limited autonomy		Urban local bodies have limited influence over the key service providers in their jurisdictions. Instead, key service providers are often accountable to the state government, as they are parastatal institutions.
e) Weak link with citizens		Due to fragmentation of service delivery responsibility, urban governance is not adequately responsive to citizens. Inclusion of state parastatals in service delivery makes it even more remote from urban citizens.
2. Operations and maintenance		
a) Adhoc operations and maintenance	Unable to track service provider performance	Service providers are not held accountable for low service performance.
	Non-integrated city management	City services like water, energy, transportation etc is delivered by different entities. There is minimal collaboration during planning and maintenance. This leads to duplication of efforts and complexity.
	Lack of staff	Lack of capacity at ULBs is one of the major issues for adhoc quality of operational and maintenance.
	Reactive maintenance	Operations and maintenance are most often reactive, when something has already gone wrong, and not preventive.
b) High costs of operations and maintenance	Non-integrated city management	Each department maintains different set of staff and there is no/little synergy in term of operations and maintenance leading to increased cost.
	Reactive maintenance	Operations and maintenance are most often reactive, when something has already gone wrong, and not preventive. This adds to the operations and maintenance costs.
c) Lack of incentives	No performance evaluation	The prevailing approach in most cases does not require ULB service provider's performance to be evaluated against outcome standards.
	No action for non-performance	There is no provision by which a service provider may be threatened with revocation of license in case of non-performance and the reissuing of the same to another service

Issue	Sub-issue	Description
		provider.
	Overlapping and fragmented service delivery	Overlapping and fragmentation also weaken the incentives for performance because service agencies, councils and others are not held responsible for specific aspects of governance, management and service delivery.
3. Public infrastructure asset management		
a) No / ineffective planning	No/outdated asset inventory	A majority of the municipalities in India do not have a comprehensive asset inventory. Where available, the inventories are not up-to-date.
	Manual inventory	Inventories are maintained in manual records and hence difficult to access while developing the asset planning strategy.
	No asset management strategy	There is no comprehensive asset management strategy developed by the municipalities in India.
b) Adhoc procurement	Spare part requirements	Due to absence of asset inventories, spare parts are procured as and when required or on ad hoc basis resulting in higher rates and sometimes wastages.
	Inefficient inventory management	Inventories where available are not well managed. This does not assist authorities in decision-making.
c) Issues in maintenance	Asset are unavailable when needed	Asset such as spare parts are unavailable when needed leading to major issues in maintenance.
	Asset tracking not possible	Asset tracking is not possible and when unavailable in the market, maintenance work needs to be halted until required parts are procured.
4. Citizen interface		
a) Manual interface for citizen services	While major metros and Tier II cities now have online services, small cities in India still rely on manual interfaces, such as booths for citizen services.	
b) Limited channels for citizen services	There are limited channels used by ULBs to communicate key information to citizens. Social media is not leveraged by many ULBs.	
c) Various and disintegrated interfaces	Given the fragmentation in institutional arrangement, there is lack of single interface for citizen services or registering complaints.	

ICT-GT enablers:

Technology can play an important role by aiding in improving governance, collaboration and integration of these agencies to significantly improve the city services. City command and operations centre can become the central hub for governance, collaboration and integration. Technology can also help in involving citizens by leveraging mobile and web channels for city management.

Smart City Governance and Operations

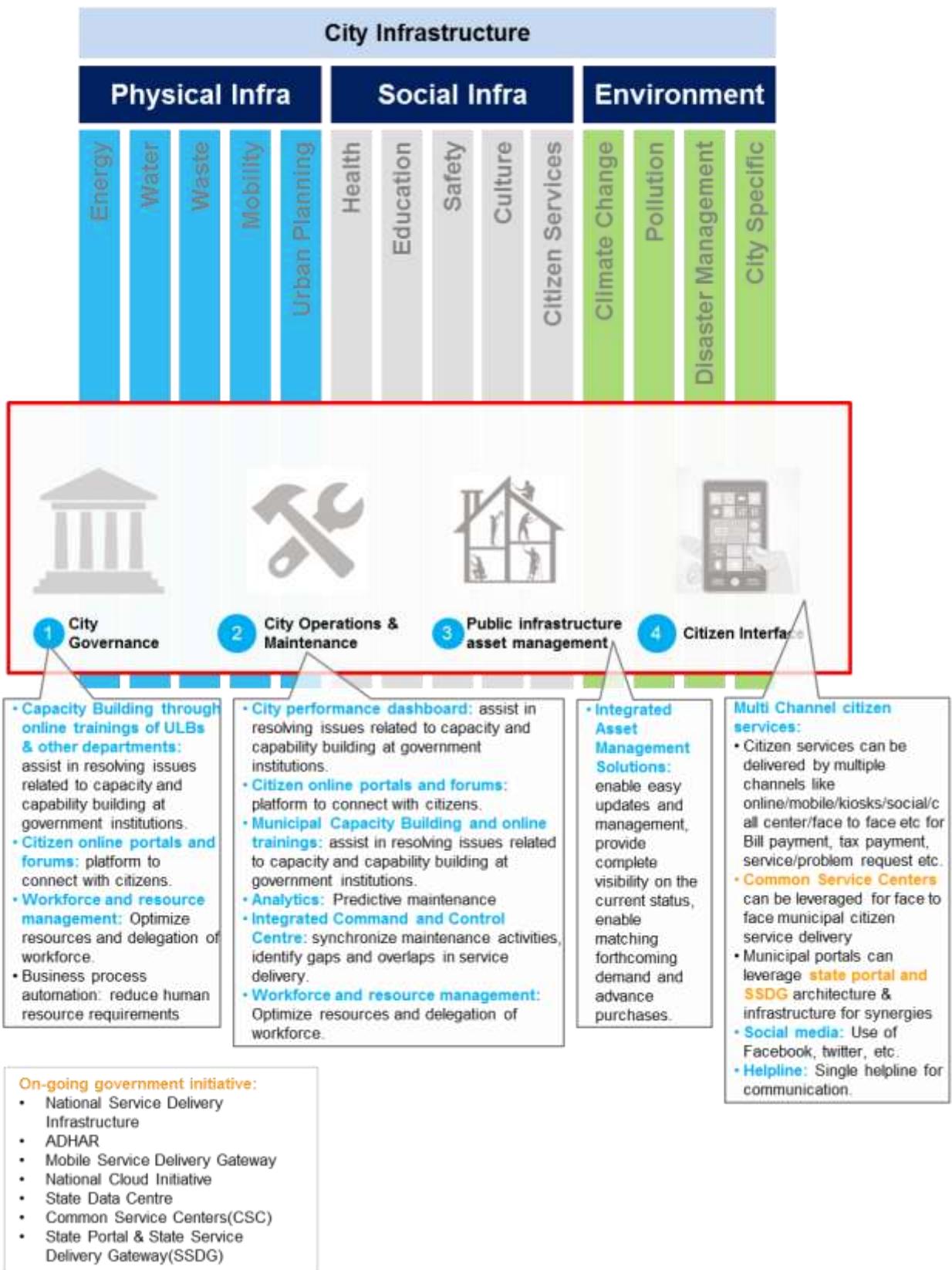


Figure 28: Smart city governance and operations

ICT-GT enablers to overcome key challenges in city governance and operations:

Table 25: Smart city governance and operations: Mapping of ICT-GT enablers

Issue	Sub-issue	ICT -GT enablers
1. City governance		
a) Fragmentation and duplication of institutional roles		<i>Requires non-ICT interventions.</i>
b) Lack of staff		Capacity building through online trainings of ULBs and other departments: Use of online systems for training programmes. Workforce and resource management: Optimise resources and delegation of responsibility within the workforce. Business process automation: Business process automation minimises workforce requirements.
c) Funding constraints		<i>Covered under new business models.</i>
d) Limited autonomy		<i>Requires non-ICT interventions.</i>
e) Weak link with citizens		Citizen online portals and forums: Citizen online portals and forums can help the government connect with citizens and seek their ideas and feedback on government programmes.
2. Operations and maintenance		
a) Adhoc quality of operations and maintenance	Unable to track service provider performance	City performance dashboard: Provides an ability to track performance and empowers citizens to question non-performance.
	Non-integrated city management	Integrated command and operations centre: Enables integration and management of services across various departments and sectors.
	Lack of staff	Capacity building through online trainings of ULBs and other departments: Use of online systems for training programmes. Workforce and resource management: Optimise resources and delegation of responsibilities within the workforce. Business process automation: Business process re-engineering followed by automation improves process efficiency and reduces turnaround time.
	Reactive maintenance	Analytics: Use of predictive analytics to understand equipment performance and maintenance requirements.
b) High costs of operations and maintenance	Non-integrated city management	Integrated command and operations centre: Enablement of integration of operations/management across various departments and services to optimise on costs and efficiency.
	Reactive maintenance	Analytics: Use of predictive analytics can empower the controller to initiate proactive maintenance.
c) Lack of incentives	No performance evaluation	City performance dashboard: City performance dashboard provides complete visibility on the performance of the service providers.
	No action for non-performance	
	Overlapping and	Integrated command and operations centre: Helps in

Issue	Sub-issue	ICT -GT enablers	
	fragmented service delivery	identification of gaps and overlaps in service delivery. <i>Requires additional policy interventions.</i>	
3. Public infrastructure asset management			
a) No / ineffective planning	No/outdated asset inventory	Integrated asset management solutions: Lowers operation cost by improving asset maintenance practices. Provide visibility on asset, asset usage, maintenance schedules, parts, etc.	
	Manual inventory		
	No asset management strategy		
b) Adhoc procurement	Spare part requirements		
	Inefficient inventory management		
c) Issues in maintenance	Asset are unavailable when needed		
	Asset tracking not possible		
4. Citizen interface			
a) Manual interface for citizen services	Multi-channel citizen services: Multi-channel citizen interface(mobile/web/online/phone/face-to-face/kiosk/social media) for citizen services such as bill payment, tax payment, issuance of online certificates, grievances registration, etc.		
b) Limited channels for citizen services	Multi-channel citizen communication- Social media: Use of social media can provide multiple channels for two way communication with citizens.		
c) Various and disintegrated interfaces	Helpline: Single helpline number provides a single point of contact for citizens to reach the authorities.		

Detailed description of ICT-GT enablers /smart solutions:

- **Business process automation:** Re-engineer, optimise and automate business processes using business process management solution to have a fully integrated and policy-driven set of automated business processes that increases efficiency and reduces service delivery costs
- **Multi-channel citizen services:** Multi-channel citizen interface (mobile/web/online/phone/face-to-face/kiosk/social media) for citizen services such as bill payment, tax payment, issuance of online certificates, grievances registration, etc.
- **City performance dashboard:** Monitor the performance of city subsystems through the use of digital technologies and big data analytics to manage city governance, efficient performance and proactive crisis management
- **Integrated asset management solutions:** Integrated asset management of all governance infrastructure assets including the associated data, processes, information systems and governance for manageable operations and higher sustainability
- **Integrated command and operations centre:** Leverage integrated command and operations centre to monitor city services on real-time basis. Improve/synchronise maintenance activities to reduce downtime and improve maintenance effectiveness
- **Multi-channel citizen communication:** Multi-channel customer interfaces (service desk/contact centre/citizen services portal) help in recording citizens' requests/issues through multiple touch points depending on the convenience of the citizens.

- **Workforce and resource management:** Leverage the workforce and resource management solutions to improve workforce engagement and task management. Optimise the workforce with the help of workforce management solutions like planning, forecasting & scheduling, shift management, and mobile based applications.

On-going government initiatives

Initiatives	Brief Description
National Service Delivery Infrastructure	<p>Project:</p> <p>To act as a core infrastructure for achieving standards-based interoperability (IIP/IIS).</p> <p>To evolve gateway messaging standards and build a government owned central gateway.</p> <p>Secure messaging and interoperability between various e-Governance applications.</p> <p>De-link the back-end departments/Service Providers (SP) from the front-end service access providers.</p> <p>Shared services hub for departmental application – Payment gateway services, mobile gateway services, authentication services (via UID), etc.</p>
AADHAR	<p>The UIDAI/AADHAR will offer a strong form of online authentication, where agencies can compare demographic and biometric information of the resident with the records stored in the central database.</p> <p>The purpose of the UIDAI/AADHAR is to issue a unique identification number (UID) to all Indian residents that is (a) robust enough to eliminate duplicate and fake identities, and (b) can be verified and authenticated in an easy, cost-effective way. The UIDAI/AADHAR will design and create the institutional microstructure to effectively implement the policy. This will include a Central ID Data Repository (CIDR), which will manage the central system, and a network of registrars who will establish resident touch points through enrolling agencies.</p>
Mobile Service Delivery Gateway	<p>Mobile governance (m-Governance) aims to leverage wireless and new media technology platforms, mobile devices and applications for delivery of public information and services to all citizens and businesses. It aims at widening the reach of, and access to, public services to all citizens in the country, especially in the rural areas by exploiting the much greater penetration of mobile phones in the country. It also leverages the innovative potential of mobile applications in providing public services. The overall strategy aims at making India a world leader in harnessing the potential of mobile governance for inclusive development.</p>

National Cloud Initiative	<p>DeitY has initiated a project named as ‘MeghRaj’ for creating a Government of India cloud (GI Cloud) computing environment at the national level. This will act as a common repository of cloud-based infrastructure resources and applications available on demand. The GI Cloud is envisaged to provide the following outcomes:</p> <ul style="list-style-type: none"> - Optimal utilisation of ICT infrastructure - Speedy development and deployment of e-Gov applications - Quick replication of successful applications - e-Gov app store hosting -certified applications
State Data Centre	<p>State data centres have been provisioned for the states to consolidate services, applications and infrastructure to provide efficient electronic delivery of G2G, G2C and G2B services. These services can be rendered by the states through common delivery platform seamlessly supported by core connectivity infrastructure such as State-Wide Area Network (SWAN) and Common Service Centre (CSC) connectivity extended up to village level. SDCs also provide better operation and management control and minimise overall cost of data management, IT resource management, deployment and other costs.</p> <p>National Data Centres, managed by NIC, have been identified as DR sites for the SDCs.</p>
Common Service Centres (CSCs)	<p>The CSCs provide high quality and cost-effective video, voice and data content services, in the areas of e-Governance, education, health, tele-medicine, entertainment as well as other private services. A highlight of the CSCs is that it offers web-enabled e-Governance services in rural areas, including application forms, certificates, and utility payments such as electricity, telephone and water bills.</p> <p>CSC's can be leveraged to provide the face-to-face channel for citizen service delivery.</p>
State Portal and State Service Delivery Gateway (SSDG)	<p>The National e-Governance Plan (NeGP) of the Government of India aims to make all government services accessible to the common man in his/her locality, through common service delivery outlets and ensure efficiency, transparency and reliability of such services at affordable costs to realise the basic needs of the common man.</p> <p>The Government desires to create an integrated information infrastructure that will expand, integrate and enhance the utility and reach of the services provided by the Government by utilising the network of the Common Service Centres.</p> <p>This project aims to enhance the services provided to the citizens through Common Service Centres (CSCs). It is envisaged that State Portal (SP) along with State Service Delivery Gateway (SSDG) will be developed and implemented so that citizens are provided with outlets where they can access the services under a single interface mechanism in the form of the portal.</p> <p>Municipal service delivery portals can leverage similar architecture & infrastructure. Municipal portals can be linked to state portal and SSDG to ensure standardisation across states.</p>

Financing Mechanisms

6. Financing mechanisms

Developing smart cities requires a considerable amount of investment and hence requires a mix of different financing models and mechanism involving both public and private stakeholders. Following are some of the mechanisms which could be considered:



Figure 29: Financing mechanisms

1. **Tax incentives:** Favourable tax treatment for firms has the potential to be an extremely effective policy tool for encouraging urban development beneficial to all citizens. For e.g., policy support for clean energy in the US has revolved primarily around tax incentives, including the Production Tax Credit (PTC), Investment Tax Credit (ITC), and accelerated depreciation. In situations where project developers do not have sufficient taxable income, tax equity investors provide capital in return for passive ownership to capture the value of the tax and accelerated depreciation benefits. Any tax concessions for smart city development (i.e. on infrastructure status, exemption on import, and materials) will improve the internal rate of return of the project. Profits from development, operations, and ownership of a smart city should enjoy some income tax exemption to increase attractiveness of the investment. In India, many of the individual components of a smart city would fall under the definition of infrastructure, however some of these activities would currently warrant tax concessions under various sections of the Indian Income Tax Act while others would not. Harmonisation here could prove beneficial. Moreover, Tax Increment Financing (TIF) is a funding instrument that may be used to develop smart cities. Funds raised from TIF are used to develop infrastructure, clean energy projects, and revive properties back to productive use. This occurs mostly in conjunction with private development projects. Funds are generated by growth in the Equalised Assessed Valuation (EAV) of properties within a designated territory over a period of several decades. When an area is declared as eligible for TIF, the amount of property tax the area generates is set as a base EAV amount. As property values increase, all property tax growth above that amount can be used to fund redevelopment projects within the designated area. The increase, or increment, may be used to pay back bonds issued to pay upfront costs, or may be used on a “pay-as-you-go” basis for individual projects. At the conclusion of the designated period, the increase in revenue over the base amount is distributed annually among the taxing bodies in the city that are based on property values.
2. **Debt market:** Fixed income (debt) capital offers investors a consistent and predictable return and provides borrowers liquidity from a broad pool of funders. India's debt capital market has grown in size over recent years, and some technical aspects governing its function have been upgraded. However, stringent rules on corporate bond holdings continue to restrict asset allocation and dampen liquidity of this important vehicle for smart city financing. In order to attract global capital to urban development projects, a vibrant

corporate bond market should remain a key priority for policymakers. There is much more to be done from a policy perspective, including a reduction of high stamp duties for issuers, which currently vary by state, as well as increasing the cumulative cap on foreign participation. Furthermore, India's debt markets would benefit deeply from a liquid market for hedging instruments (i.e. credit swaps or interest rate futures) as well as further improvement of liquidity across the government security (g-sec) yield curve.

3. Equity investments

- **Real estate:** Smart city development requires significant real estate investment, which globally is structured and regulated differently than infrastructure. Commercial, industrial, and residential property development with integrated technology and planning presents vast opportunity for foreign investment
- **Venture capital:** The decreasing cost of both technology and internet bandwidth presents tremendous opportunities for technology to enhance the life of citizens. Rapid adoption of digital infrastructure (estimated to be five times faster than electricity or telephony adoption globally) presents a high-risk, high-reward opportunity for global venture capital into innovative firms. Several US firms have begun to leverage their balance sheet to invest in early to mid stage start-ups that are closely aligned with their strategic direction. Multinational corporations along with traditional venture capital firms are aggressively increasing their investments to drive the Smart City industry. Venture capital may also help to seed dramatic change in other key areas of cities, such as education

4. Leverage existing funding: Government of India has allocated funds for urban development under AMRUT and many other national/state schemes. This funding can be leveraged for some of the smart cities initiatives.

5. Support from states and central government: State and central government to provide viability gap funding (VGF) for the smart cities initiatives under 100 smart cities programme.

6. Public private partnership: Smart city initiatives often engage in various types of Public Private Partnerships (PPPs) as infrastructure particularly benefits from a formal alignment of government and industry capacities, technology, assets, and capital. The key to a successful PPP is the ability for both parties to thrive within the agreement, which is often seen with partnerships that have strong governance, realistic objectives, dedicated income streams, and manageable level of risk equitably shared between the parties. The option to choose the source of funding whether it is PPP or others, should be left to the states.

7. Innovative business models: Some new business models are changing traditional funding discussions by procuring Smart City solutions such as Software-as-a-Service (SaaS). The systems that help cities manage electricity, water, waste, traffic flows, municipal operations, and city services are becoming increasingly complex and can be expensive. Although the return on investment may be attractive, complexities often make it challenging for cities to kick-start their smart city projects. With a cloud approach, cities experience operational efficiencies with electric, gas and water meters, sewer and waste management systems, as well as other city services.

It is suggested that for various initiatives, the procurement strategy should be determined based on level of control and investment required. It is also felt that a one-size-fits-all approach may not work for the entire gamut of ICT interventions which are envisaged.

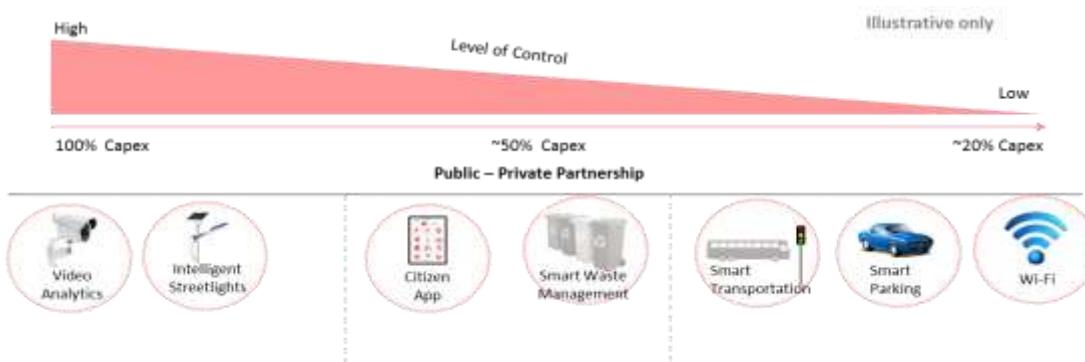


Figure 30: Level of control and PPP models



Governance Structure & Organizational Requirements

7. Governance structure and organisational requirements

7.1 Governance and programme management structure

Developing smart cities would call for prioritisation of various smart cities initiatives which a city can undertake. It would also call for significant investments for implementation of key smart cities applications and ICT infrastructure. Given the high stakes involved it is felt that a clearly defined governance structure needs to be in place. Governance structure needs to be in place to drive a balance between agility of decision-making and engagement amongst the various government departments. Along with a clearly articulated and a very thoughtfully structured governance structure, Programme Management Unit(PMU) is needed across national, state and city levels to ensure timely execution of various milestones as well as ensure alignment with goals of various stakeholders. Following is the governance and PMU structure across national, state and city levels:

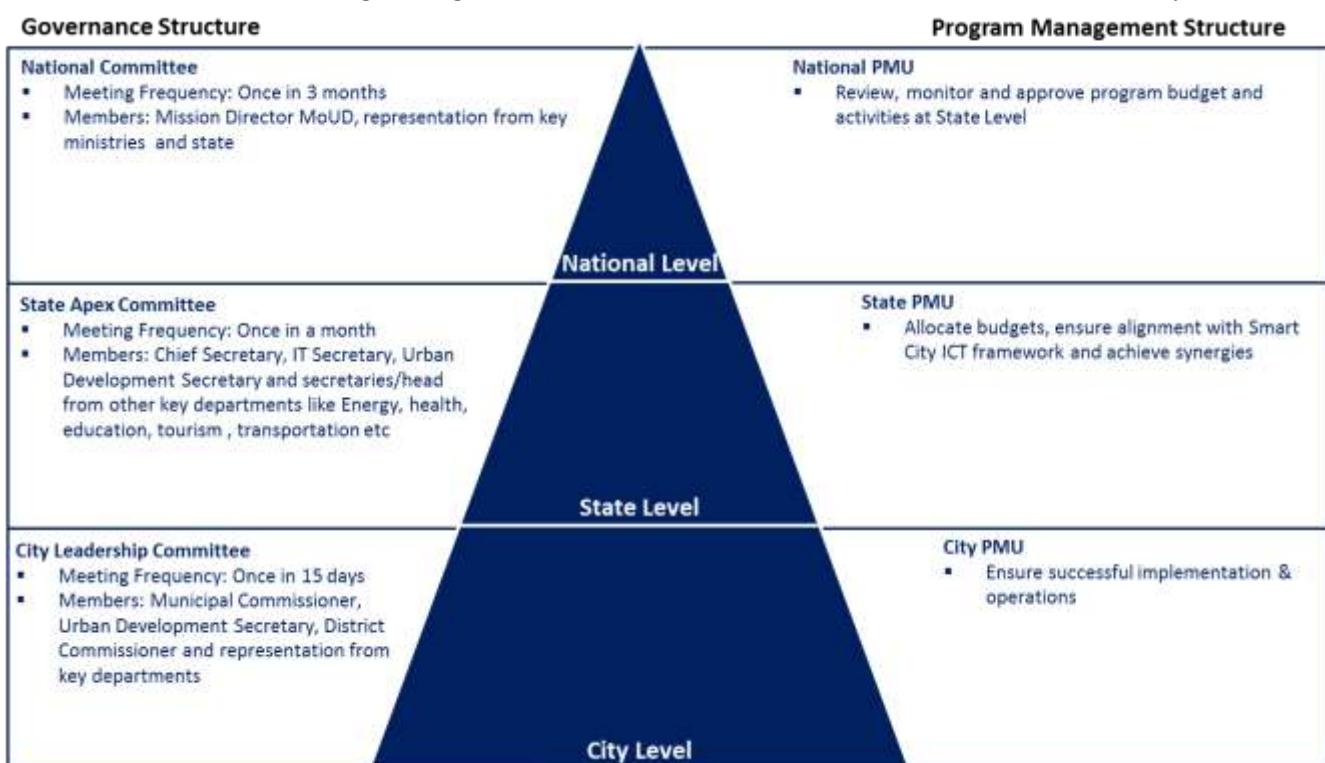


Figure 31: Governance and programme management structure

Overview of the proposed governance structure

- National committee:** National committee led by Mission Director MoUD will have representations from key ministries and states. Committee governance meeting will be scheduled once in three months. Key governance decisions includes
 - Oversees the smart cities programme
 - Provide policy and strategic direction
- State apex committee:** State apex committee will be led by Chief Secretary and include Urban Development Secretary, IT Secretary and representatives from key state departments
 - Ensure national policy and strategy implementation
 - Take key policy and strategic decision at state level
 - Ensure coordination and timely decision form various departments at state levels
- City leadership committee:** Provide leadership and decision-making at city level. Led by Secretary/PS-UD and will have representation from the Divisional commissioner, Municipal Commissioner, Deputy commissioner/collector, CIO of the ULB and representatives from various departments like urban development, water, energy, tourism, traffic, etc.

- Ensure development of Integrated smart city development plan and project reports
- Ensure coordination at city level
- Provide key decisions for issues related smart city implementation at city level

Overview of the proposed programme management structure

1. **National PMU:** PMU at the centre with following key responsibilities:
 - Allocate budgets at state level
 - Monitor budget spends at state level
 - Monitor programme process at state level
2. **State PMU:** PMU at the state level with following key responsibilities:
 - Allocate budgets based on city integrated smart city development plan and national guidelines
 - Alignment with national smart city frameworks
 - Ensure national and state investments/initiatives are leveraged like usage of state data centres, state service delivery gateways, common service centres, etc.
 - Monitor projects progress of each city
 - Monitor budget allocation and spend
3. **City PMU:** PMU at the city or municipal level with following key responsibilities:
 - Prepare integrated smart city development plan including city infrastructure plan, city digital plan and validate with key stakeholders
 - Coordinate with key stakeholders at city and state levels for various inputs/issues/decisions
 - Prepare smart city proposal/detailed project reports for approved initiatives
 - RFP/RFI roll out, supplier/vendor evaluation and management
 - Lead development of project plans, change management plan, capability development plans, etc.
 - Manage system integrators and other vendors
 - Constitute city leadership committee
 - Manage project financials

7.2 : Organisational requirements

Proposed structure for three city segments

Developing smart cities would require new roles at city level to guide and manage implementations of various ICT applications and infrastructure. Following are the high level view on organisational requirements based on the types of cities:

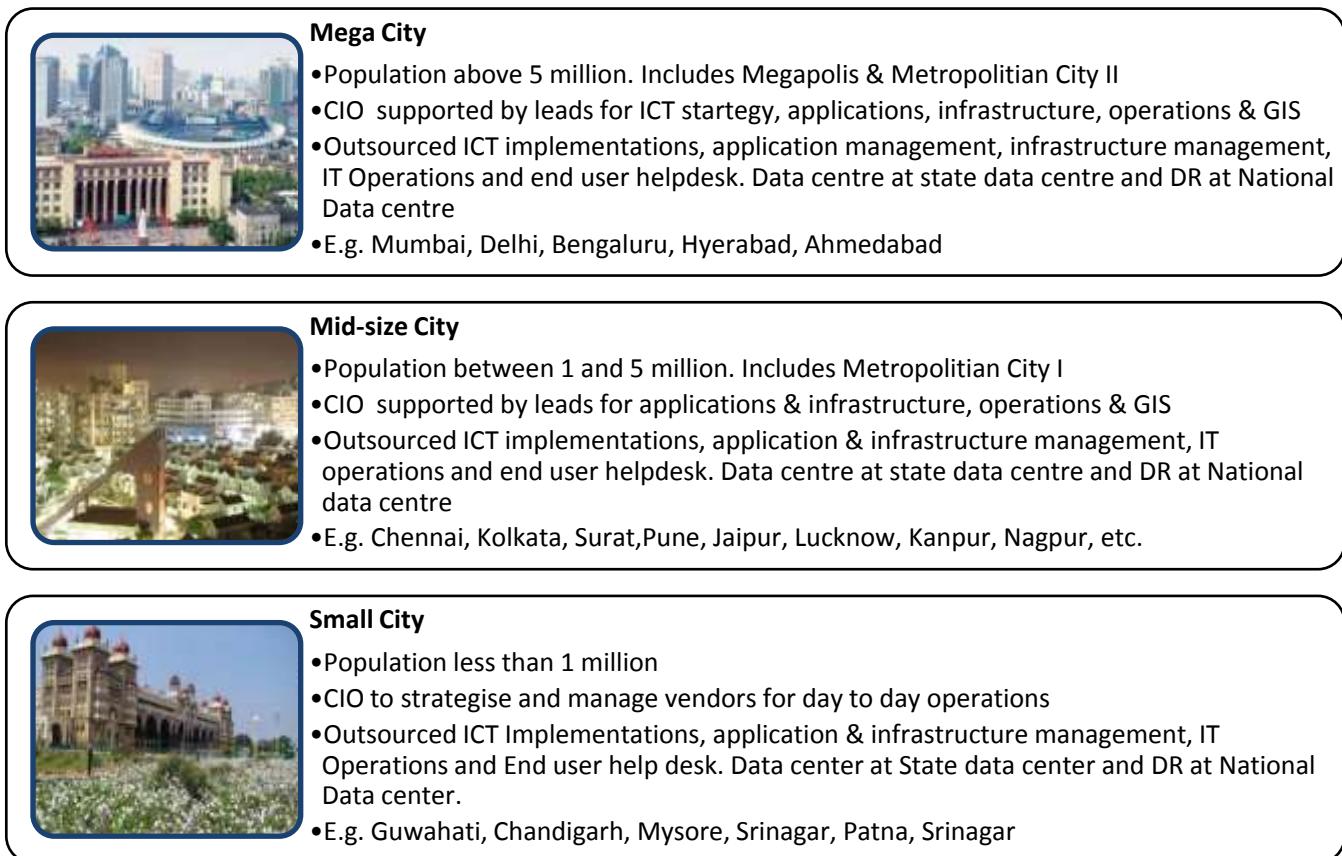


Figure 32: Organisational structures for three categories of cities

Mega city organisational structure

The following structure is proposed for mega cities:

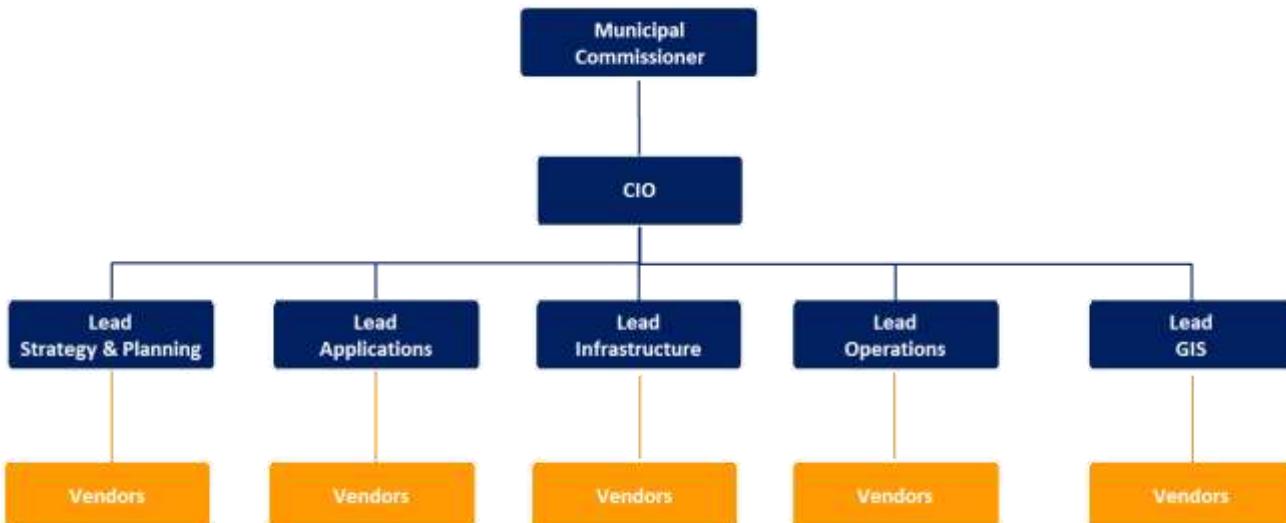


Figure 33: Mega city governance structure

Overview of the roles:

1. CIO: CIO at municipal level will be responsible for:

- Integrated smart city development plan including smart city infrastructure plan, smart city ICT master plan and validate with key stakeholders

- RFP/FRI roll out and supplier/vendor evaluation
- Development of solutions and architectures
- Successful implementation and integration of solutions, applications and infrastructure
- Management of project timelines and financials
- Services roll out and operations management

2. Lead strategy and planning: Strategy and planning lead will be responsible for:

- Participate in vendor evaluation for system integrators and change management vendors
- Development of overall IT strategy, EA roadmap and operations roadmap in alignment with the outcomes of smart city programme
- Develop overall technology architectural direction for IT's technology portfolio, define target state blueprints for business, application and technology architecture
- Allocate resource capacity to right activities
- Strategise and achieve synergies between infrastructure, services and various sectors

3. Lead applications: Key responsibilities of the applications lead include:

- Participate in vendor evaluation for system integrators
- Oversee, review and approve the development and roll out of solutions/applications
- Ensures introduction of new services happens in a planned and controlled manner
- Ensure appropriate operational service documentation is created and accepted by stakeholders prior to the introduction of a new service
- Develop service readiness and risk plan and ensure that transition risks are identified and mitigated
- Conduct service delivery training and plan knowledge transition
- Implement operational changes and conduct service rehearsals
- Authorise and conduct service handover

4. Lead infrastructure: Key responsibilities of the infrastructure lead include:

- Participate in vendor evaluation for DC/DR vendors
- Monitor, measure, report and review current performance of services and components in the enterprise IT environment and ensure IT capacity meets business needs
- Ensure disaster recovery and business continuity provision, BC/DR plans and scenarios

5. Lead operations: Key responsibilities of the operations lead include:

- Participate in vendor evaluation for IT operations vendors
- Manage day-to-day service operations, source and deliver components of standard services from a defined service list
- Verify service operations against stated service level agreements and operational level agreements

6. Lead GIS: Key responsibility include

- Formulate geospatial strategy for city
- Managing vendors
- Day-to-day operations of GIS applications
- Management of Geospatial data, applications and projects

Mid-size city organisational structure

For a medium city, the infrastructure and applications lead role can be played by one person who can also oversee and monitor the performance of vendors in the area. Also, CIO can manage the strategy and planning for a mid-size city. Following is the proposed structure for governance.

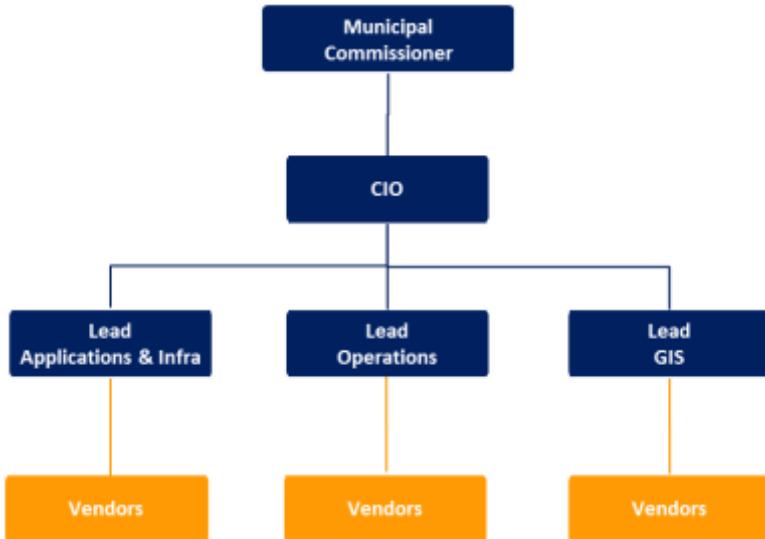


Figure 34: Mid-size city governance structure

Small city organisational structure

For a small city, CIO can manage the roles of strategy and planning, applications, infrastructure as well as operations lead. Following is the proposed governance structure for a small city.

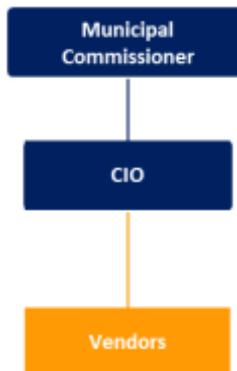


Figure 35: Small city governance structure

7.3 : Change management and capability development

Introduction

The smart city programme will bring change to the operating model, roles, technology landscape, citizen services and processes. This would require the right mix of policy and implementation support in the areas of organisational development, human resource development, strategic planning, technology improvements, and resource mobilisation capacities. Therefore a holistic approach which focuses on change management and capability development will be needed. This in turn will ensure equity, inclusiveness and responsiveness of Urban Local Bodies (ULB) officials and stakeholders. The specific objectives of the overall change management plan would include:

1. Efficient functioning of the institutions of local governance.
2. Develop capabilities in the areas of project development and management, operation and maintenance, procurement, financial management, budgeting and accounting.
3. Promote sustainable urban planning and habitats and use of information and communication technologies and e-Governance.
4. Support training and capacity building institutions, to meet the human resource needs of ULBs.

Approach

To ensure effective and integrated change management, the approach below is proposed with the following activities.

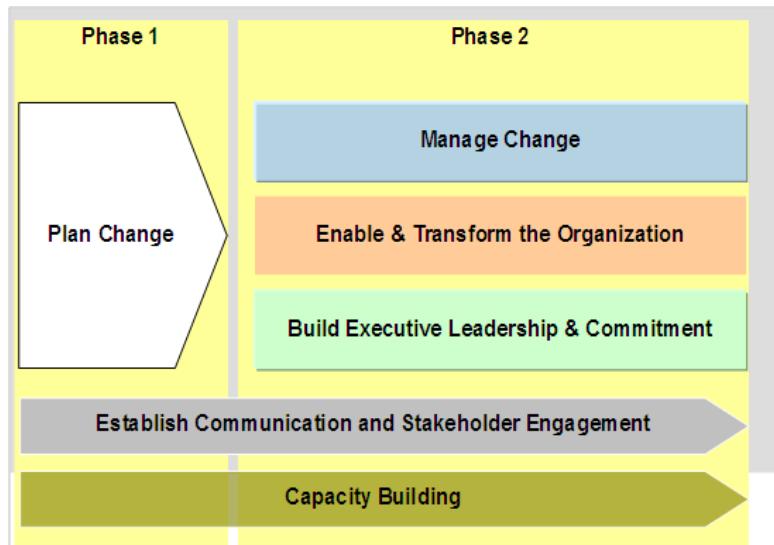


Figure 36: Change management approach

- **Plan change:** Identification of various change management and capacity building requirements for the programme:
 - **City stakeholder engagement plan:** Stakeholder identification and activities
 - **Communication and awareness plan:** Audience and communications channel analysis
 - **City level change leadership plan:** Consisting of change task force across municipalities
 - **Training needs analysis:** Studying the impact on offices and roles and subsequently define the training needs
 - **Capacity building plan:** Need for governance and institutional structures, change capability, workforce enhancement, performance support
 - **Change management work plan :** Comprises of activities, proposed team structure to manage change, enable and transform the organisation and build executive leadership and commitment
- **Manage change:** A team of change management specialists along with senior government officials will work towards effectively managing business change to ensure that individuals receive the support and guidance they need throughout the change effort. This will involve equipping the workforce to respond positively to the change as well as to fulfill their roles and responsibilities. The following activities will be performed:
 - **Stakeholder engagement:** Conduct meetings with Individual stakeholders and in focused group sessions on a periodic basis to assess the current concerns of stakeholders
 - **Communications and awareness programme:** Implementation of the communication plan which involves communication content development, coordination and execution of communication activities
 - **Change measurement:**
 - Conducting change readiness surveys which will help ascertain the readiness for change at the field and office level and provide actionable insights
 - Business readiness to assess if all aspects (especially people readiness, structure readiness, change readiness, support and training) for successful deployment are in place before Go Live decision is taken
 - Management of change dashboards to report metrics from the change programme such as number of stakeholders interviewed, training completion ratio, change readiness scores,etc.

- **Enable and transform the organisation:** Transforming the way people work ensuring that individuals adopt and own the new processes, technology, and ways of working associated with the change
 - **Training delivery:** Developing training content, train the trainer, delivery of training in the field
 - **Performance support material:** Developing job aids, standard operating procedures, support infrastructure
 - **Capacity building:** Taking action on various capacity building requirements identified in the plan stage
 - New contractual arrangements, structures, re-deployment options
- **Build executive leadership and commitment:** Ensuring that the vision and end-point of the change are clearly articulated and understood by all. Ensuring that leaders are actively engaged and are leading their people through the change

Methodology

Capacity building for the smart city programme will focus on managing and sustaining changes which are introduced in process, technology, citizen services, ways of working and operating by focusing on governance and institutional structures, change capability, training & performance support, and workforce enhancement. The implementation of multiple solutions and new process will significantly impact the way employees work across various departments. To manage a large scale implementation which impacts a large number of users directly or indirectly, the Capacity Building (CB) programme would operate at three different levels:

Capability Building Operation Levels

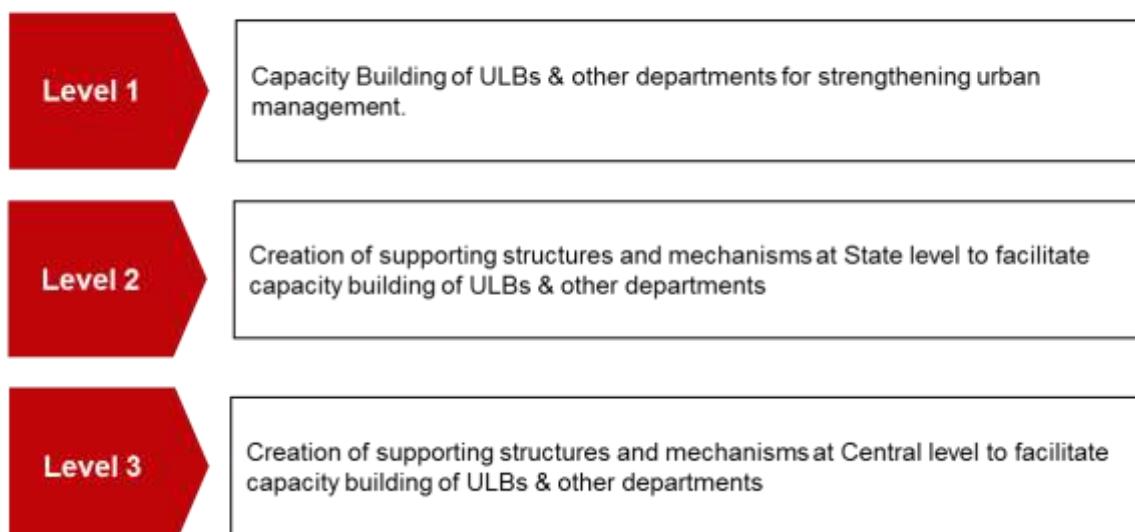


Figure 37: Capability building operations levels

The high-level approach for capacity building at these levels is highlighted below.

Level 1: Capacity building of ULBs for strengthened urban management

- Establishment of a city management cell
- CB support for preparation of integrated city plans
- Preparation of business and financial plan for projects
- Training programmes for city staff and the identified stakeholders
- Exposure of key stakeholders to live developmental projects
- Adoption of best practices and documentation of impact assessment

Level 2: Creation of supporting structures and mechanisms at state level to facilitate capacity building of ULBs

- Establishment of state level management cell
- Preparation of state level capacity building strategy and capacity building plan
- Strengthening of available training institutions to support the training needs of states and ULBs
- Preparation of training modules
- Conduction of workshops/seminars/conferences
- Exposure of key stakeholders and decision makers to live developmental projects studies

Level 3: Creation of supporting structures and mechanisms at central level to facilitate capacity building of ULBs

- Establishment of central level management cell
- Training programmes/seminars/workshops
- Conduct case studies, training modules, and documentation of best practices
- Knowledge dissemination among state and Urban Local Bodies
- Exposure of key stakeholders and decision makers to live developmental projects studies

Further, for all the levels mentioned above, training needs are to be assessed covering the key domain areas related to the smart cities. An illustrative, domain areas and typical training need requirements are depicted below.



Figure 38: Training needs requirements

TRAINING NEEDS FOR VARIOUS LEVELS of STAKEHOLDERS :				
SI.No	Areas For Training	ULBs	State	Central
1	Stratagy & Management	Low	High	Medium
2	Procurement & Logistics	High	High	Low
3	Production & Operations	High	High	Medium
4	Information Technology & Communications	Medium	High	Medium
5	Live Developmental Projects & Best Practices	Low	High	High
6	Public Affairs	High	Medium	Low
7	Human Resources	Low	High	Low
8	City Planning	High	High	Low
9	Sustainability & Risk Management	High	High	High

NB:

High : In-Depth Level of Training
 Medium : Medium Level of Training
 Low : Basic level of Training

ILLUSTRATIVE

Figure 39: Training needs assessment

Smart City Conceptual Architecture



8. Smart city integrated conceptual architecture

8.1 : Architecture principles

Smart city development will need composite planning and solution blueprint. The smart city solutions architecture needs to follow the following architecture principles:

Table 26: Architecture principles

#	Principle	Description
1	Human Centred Inclusive Design	User interface and application to be designed in such a way that it is accessible, easier to use and understood by all.
2	Multi-channel Platform	Applications should be accessible to stakeholders over multiple channels like mobile, web, phone, kiosk, social media, face-to-face, etc.
3	Open Standard Based Design	To ensure standardisation, inter-operability and flexibility amongst multiple solutions. Reduces the Integration complexity and total cost of ownership.
4	Technology & Vendor Agnostic	An architecture which is technology and vendor agnostic and helps in achieving cost-effectiveness.
5	Service Oriented Design	To ensure technology independence, reusability and interoperability in the long-term.
6	Preparedness for failure	Architecture should be designed to tolerate failure and have recovery tools and/or processes defined.
7	Fit for purpose, unique and reusable	Each capability should be implemented only once without duplication. Web Services/Interfaces should be exposed to ensure reusability/integration.
8	Integrated Approach	Integrate planning, execution & monitoring of applications & systems to ensure the wheel is not reinvented, solutions are not over-engineered and ownership is clear.

8.2 : Conceptual architecture and blueprint

India is seeking a paradigm shift to develop smart cities. In order to deliver its vision, IT transformation is needed to enable India to enhance its service delivery, while providing a platform to launch new initiatives and provide new smart city services.

The objective of this section is to provide a comprehensive view of the technical architecture that incorporates the vision of connecting the channels, processes, applications, and technical infrastructure.

The following is the suggested conceptual integrated architecture for the proposed 100 smart cities mission:

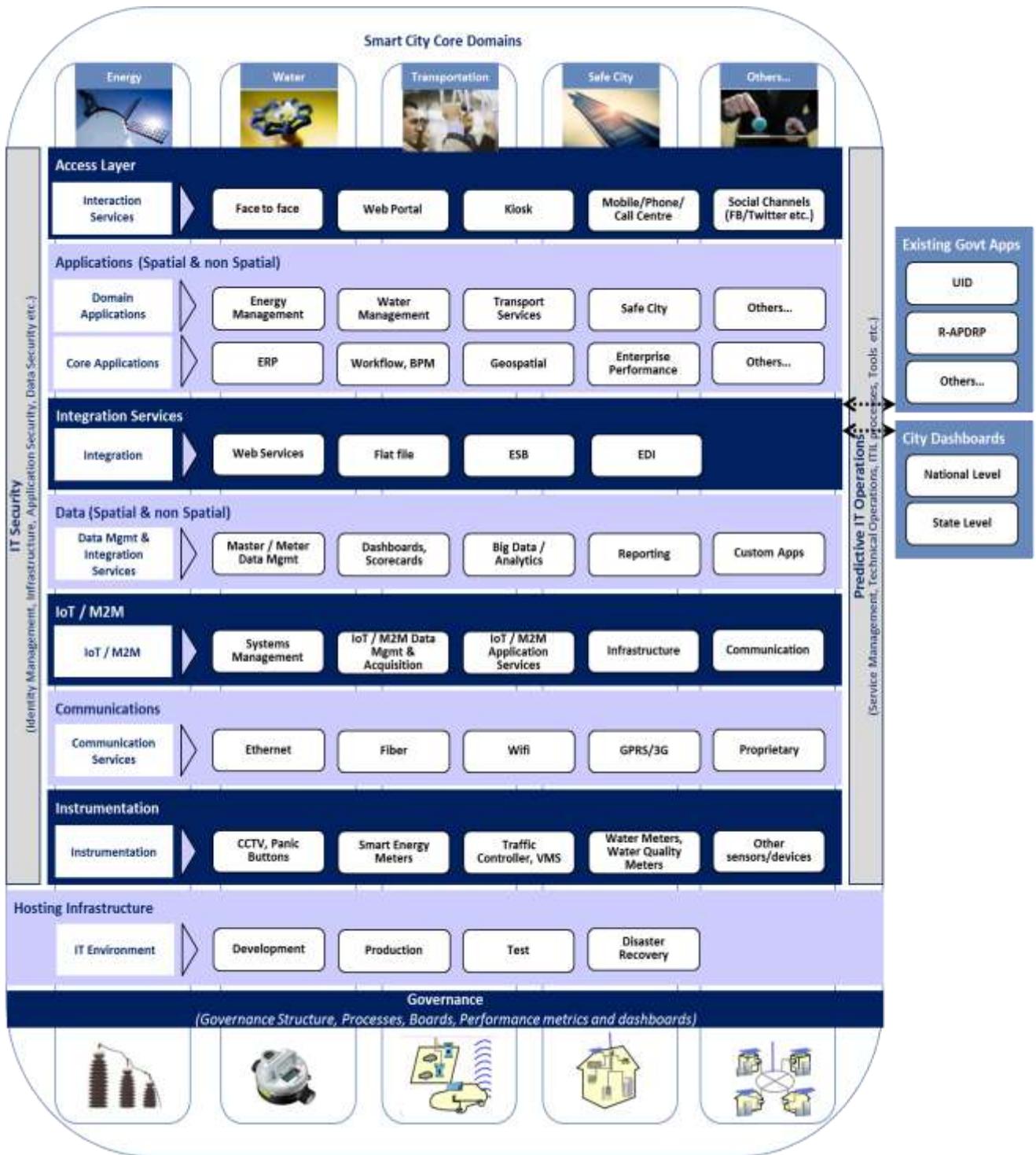


Figure 40: Smart city conceptual architecture

Overview

The various components of the suggested integrated ICT-GT architecture for 100 Smart Cities Mission are as follows:

- **Access layer**



Access layer provides multi-channel (web/mobile/phone/kiosk/face-to-face/social) access to all stakeholders (including citizens, businesses and city management) in a consistent fashion. This will enable the citizens to access the smart city services over numerous channels, city management to reach out to third-party vendors or citizens for provision and monitoring of services. This layer enables the citizens to obtain consistent information irrespective of the channels. It also enables business partners, other countries and government agencies to transact business. Social channels like Facebook, Twitter also help in increasing citizen engagement by taking feedback from citizens on specific services, encouraging them to actively participate in some and taking their suggestions on others.

- **Applications**



Comprises of applications to enable smart city domains like water, energy, transportation, etc. and also core enterprise applications like ERP, BPM and performance management. These services will be designed to be consumed across delivery channels (i.e., web, mobile, call centre, kiosk, point-of-sale and IVR), increasing both cost savings and speed of service delivery. Fully integrated service based architecture will support the solution's adaptability, enabling future capabilities to be added to the overall system in a principled manner. Once developed, new services can quickly be leveraged to create composite services and enhanced business processes

- **Integration services**



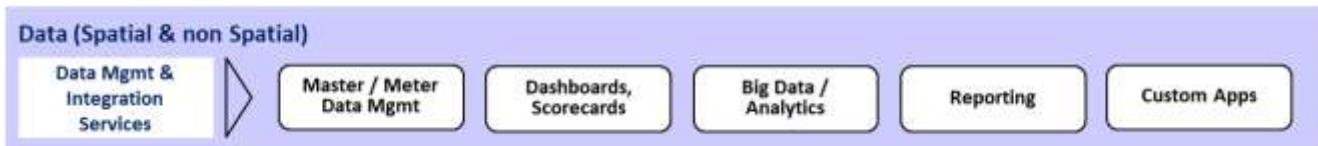
Collection of middleware services to integrate all existing and new applications, solutions from external partners (service providers, consumers, retailers, logistics providers, suppliers, regulators, etc.) and with the enterprise data warehouse:

- **Web services:** Standardised way of integrating web based applications over an internet protocol backbone. Web services allow different applications from different sources to communicate with each other without time-consuming custom coding since all communication is in XML. Web services are not

tied to any one operating system or programming language. For e.g., Java can talk with Perl; Windows applications can talk with UNIX applications, etc.

- **Flat file:** Flat files store data as one continuous string of information and can be used to import or export data from applications that have no other means of interaction
- **Enterprise Service Bus (ESB):** Software architecture model which allows communication via a common communication bus that consists of a variety of point-to-point connections between providers and users of services in a service-oriented architecture. The multi-language and multi-platform design of an ESB allows processing of data between applications from various sources. Data files are passed to and from their destinations based on established guidelines that are common to all parties sharing the information to ensure that the data maintains its integrity as it is routed
- **Electronic Data Interchange (EDI):** An electronic communication method that provides standards for exchanging data via any electronic means. The exchange of EDI documents is typically between two different companies, referred to as business partners or trading partners. By adhering to the same standard, two different companies, even in two different countries, can electronically exchange documents (such as purchase orders, invoices, shipping notices, and many others). EDI replaces postal mail and fax since EDI documents can flow straight through to the appropriate application on receivers' computer and processing can begin immediately. For instance a purchase order from buyer's system to Supplier's system and a return invoice from Supplier to Buyer's system

- ***Data***



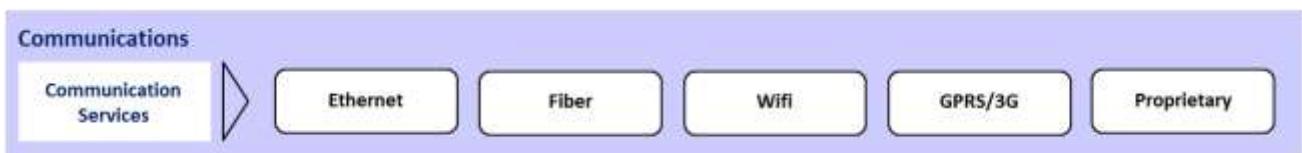
Cleansed and harmonised data (energy, water, transportation, etc.), is made accessible across the entire enterprise to enable actionable insights and cross-functional leverage. This integrated data layer provides operational data into the metrics and analytical tools upstream as well as enables the MIS/Data Warehousing capabilities for city management. Master data management will enable city-wide consolidation of data across sectors and owners including citizens, products, services, suppliers, and key performance indicators. Big data and analytics will enable analysis of large structured and unstructured data to generate insights which can be leveraged for public safety, transportation planning, etc.

- ***IoT/M2M***



The Internet of Things (IoT) is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure. IoT offers advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects) is expected to usher in automation in nearly all fields, while also enabling advanced applications like a smart grid. IoT typically comprises of sensors which collect data, applications which analyses this data for further consolidation and transmission of data to Analytics engine and decision-making server.

- ***Communications***



A network layer, which provides a framework and technology foundation for designing, building and managing a communication network. The layer provides Wired/Wireless connectivity via various services like GSM, GRPS, 3G, Wi-Fi, Proprietary, etc. The network of interconnected objects not only harvests information from the environment (sensing) and interacts with the physical world (actuation/command/control), but also uses existing Internet standards to provide services for information transfer, analytics, applications and communications.

- ***Instrumentation***



This layer includes smart devices like sensors, meters, devices, controllers, cameras, etc.

- ***IT security***

IT Security (Identity Management, Infrastructure, Application Security etc.)
--

Security layer comprises the comprehensive security framework, standards, policies and tools/solutions for enterprise wide security. Some of the core components of IT security are:

- Application security
- Infrastructure security
- Data security
- Information protection
- Identity and access management
- Risk management

With growing digitalisation and increasing number of devices in Internet of Things, IT Security should have the capacity to preempt risk through actionable intelligence, advanced analytics and accelerated response. It also needs to ensure efficient resilience so as to recover from deliberate attacks, accidents, threats or incidents.

- ***Predictive IT operations***

Predictive IT Operations (Service Management, Technical Operations, ITIL processes, Tools etc.)

The operations architecture comprises processes, organisation, and technology that support the IT operations environment. The operations architecture can be considered a combination of two disciplines; the operations management of processes, standards and controls and the technical architecture of those toolsets used to support those processes. The key components typically include incident management, problem management, service request management, service catalogue management, service reporting, asset & configuration management, capacity & availability management, business continuity management and enterprise reporting. Predictive operations which is the need of the hour is based on big data and a self-learning predictive analysis engine, to monitor and correlate a multitude of data to improve service delivery and operational processes.

- **Hosting infrastructure**



This layer adopts Service Oriented Infrastructure (SOI) approach instead of traditional technology based approach. Service Oriented Infrastructure (SOI) is a paradigm for provisioning and automation of virtualized and integrated infrastructure components that can be described as a service, and provided to any consuming application requirement. The aim is to create a shared pool of virtualised resources including servers, storage, network switch, load balancer, etc. which can be allocated or de-allocated to a service independent of the underlying infrastructure. Hosting platforms can be a combination of physical servers, virtual machines or private cloud so as to ensure the following:

- Pooled and virtualised infrastructure
- Improve efficiency through automated infrastructure
- Reduced failure to hit SLAs
- Reduced turnaround time for virtual infrastructure improving time-to-market for new applications
- Highly scalable, robust and modular architecture
- Logical and physical separations of key devices
- Fully redundant, totally secured, predictable and service-ready

- **Governance**



The governance layer organises governance activities to drive alignment, accountability, structure, and processes to ensure operational efficiency. The key elements include **Governance Structures** which facilitate clear and efficient organisational alignment to achieve end objectives, **Governance processes** which enable effective decision making across planning delivering & operating IT and **Goals & Metrics** which provide insight and guidance for both city and IT leadership to drive decisions.

8.3 : Leveraging existing government investments for smart cities

Cities should leverage the ICT infrastructure created by Government of India which includes State Data Centers for hosting smart cities applications. Similarly, State Wide Area Network (SWAN) should be leveraged for providing connectivity. Common Services Centres should be leveraged to provide face-to-face service delivery channel for municipal services. Refer the city subsystems sections on water, energy, transportation, etc. to find out more about other important Government of India initiatives which can be leveraged for smart cities.

About state data centres and other important common infrastructure⁷⁶

Government of India has envisioned state data centres for the states to consolidate services, applications and infrastructure to provide efficient electronic delivery of G2G, G2C and G2B services. These services can be rendered by the States through common delivery platform seamlessly supported by core connectivity Infrastructure such as State Wide Area Network (SWAN) and Common Service Centre (CSC). SDCs also provide better operation & management control and minimise overall cost of data management, IT resource management, deployment and other costs.

⁷⁶ Refer DeitY website - <http://deity.gov.in/content/data-centre>

National data centres, managed by NIC, have been identified as DR Sites for the SDCs. So the same can be leveraged for smart cities DR.

8.4 : Smart city standards

Smart cities would leverage various ICT solutions to improve efficiency and capacity of various city subsystems like water, energy, transportation, public safety, etc. In order to ensure interoperability in this complex ICT environment, it is important that ICT solutions conform to smart cities standards. We have provided a list of applicable global standards relevant for smart cities in addition to DeitY standards which are available in DeitY website. New standards would also need to be developed.

The following are some of the global standards which could be applicable for Indian cities:

Table 27: Smart cities standards

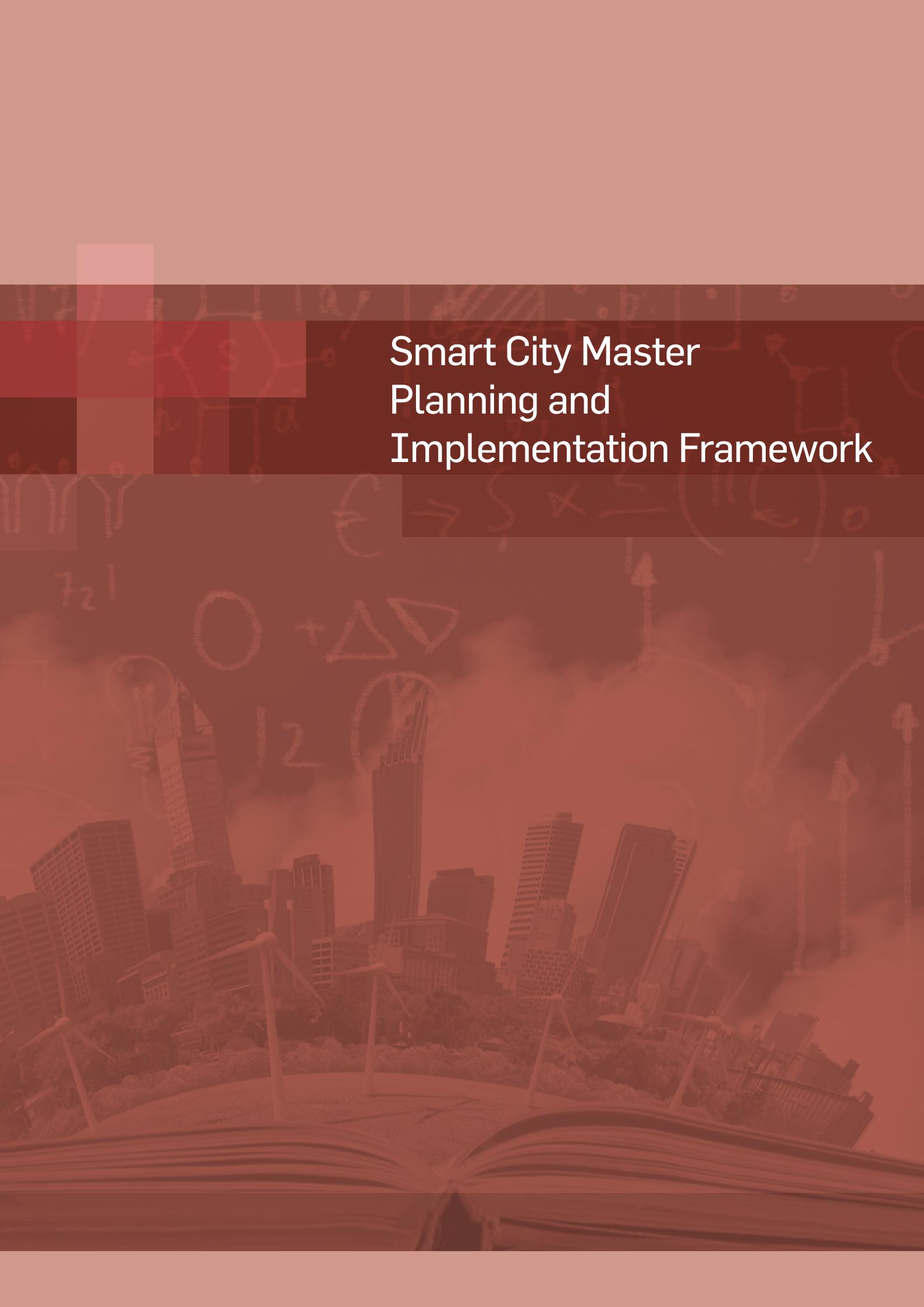
#	City Sub System	Organization	Document ID	Title
1	Climate & Pollution Management	ANSI	ANSI/ASQ E 4	Specifications and guidelines for quality systems for environmental data collection and environmental technology programmes.
2	Climate & Pollution Management	VDI/DIN	VDI 4201 Blatt 1	Performance criteria on automated measuring and electronic data evaluation systems for monitoring emissions – Digital interface – General requirements.
3	Climate & Pollution Management	CSA	Z762-95 (R2011)	Design for the Environment (DFE).
4	Climate & Pollution Management	ITU	L.1410 (12/2014)	Methodology for environmental Life Cycle Assessment (LCA) of Information and Communication (ICT) goods, networks and services.
5	Energy	BSI	BS EN 14908-5:2009	Open data communication in building automation, controls and building management implementation guideline – Control network protocol – Implementation.
6	Energy	CENELEC	EN 60730-1	Automatic electrical controls for household and similar use – Part 1: General requirements (IEC 60730-1:2010, modified).
7	Energy	DIN	DIN SPEC 33440	Ergonomic design of user-interfaces and products for smart grid and electro mobility.
8	Energy	ETSI	ETSI GS OSG 001 V 1.1.1	Open Smart Grid Protocol (OSGP).
9	Energy	ETSI	ETSI TR 102935 V 2.1.1	Machine-to-Machine communications (M2M) – Applicability of M2M architecture to smart grid networks – Impact

#	City Sub System	Organization	Document ID	Title
				of smart grids on M2M platform.
10	Energy	GOST R	GOST R 55060-2012	Automatised control systems of buildings and structures. Terms and definitions.
11	Energy	IEEE	IEEE 1851-2012	IEEE standard for design criteria of integrated sensor-based test applications for household appliances.
12	Energy	ISO	ISO 16484-5: 2014	Building automation and control systems – Part 5: Data communication protocol.
13	Energy	ISO/IEC	ISO/IEC 15067-3:2012	Information technology – Home Electronic System (HES) application model – Part 3: Model of an energy management system for HES.
14	Energy	NEMA	NEMA SG-AMI 1	Requirements for smart meter upgradeability.
15	Energy	NEN	CR 205-006:1996 en	Home and Building Electronics System (HBES) – Technical report 6: Protocol and data integrity and interfaces.
16	Energy	UTE	UTE C15-900U*UTE C15-900	Coexistence between communication and power networks – Implementation of communication networks.
17	Energy	VDI	VDI 3807 Blatt 2:2014-11	Characteristic values of energy consumption in buildings – Characteristic heating-energy, electrical-energy and water consumption values.
18	Energy	ISO	ISO 13153:2012	Specifies a framework of the design process for energy-saving single-family residential and small commercial buildings, with the energy consumption ratio as the key criterion. It is intended to assist in the development of design guidelines for practitioners who design energy-related parts of buildings.
19	Energy	ISO	ISO 50001:2011	Specifies requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organisation to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and

#	City Sub System	Organization	Document ID	Title
				consumption.
20	Energy	RAL Güte	RAL-UZ 170	Basic criteria for award of the environmental label – Energy services provided under guaranteed energy savings contracts.
21	Energy	VDI	VDI 3805 Blatt 1:2011-10	Product data exchange in the building services – Fundamentals.
22	Energy	VDI	VDI 3814 Blatt 7:2012-05	Building Automation and Control Systems (BACS) – Design of user interfaces.
23	Energy	EN	BS EN 15331:2011	Criteria for design, management and control of maintenance services for buildings.
24	Energy	BSI	BIP 2207	Building information management – A standard framework and guide to BS 1192.
25	Energy	ISO	ISO 16484-1:2010	Building Automation and Control Systems (BACS) – Part 1: Project specification and implementation.
26	Energy	ISO	NEN-ISO 29481-2:2012 en	Building information models – Information delivery manual – Part 2: Interaction framework.
27	Energy	ISO/IEC	ISO/IEC 18012-2:2012	Information technology – Home electronic system – Guidelines for product interoperability.
28	Energy	VDI	VDI 3814 Blatt 5	Building Automation and Control System (BACS) – Advices for system integration .
29	Energy	UNI	UNI 10951:2001	Systems of information for the maintenance management of buildings – Guidelines .
30	Energy	GEFMA	VDI/GEFMA 3814 Blatt 3.1:2012-09	Building Automation and Control Systems (BACS) – Guidance for technical building management – Planning, operation, and maintenance – Interface to facility management.
31	Governance & Operations	ISO	ISO/PAS 22720	Association for standardisation of automation and measuring systems open data services 5.0.
32	Governance & Operations	ITU	ITU-T X.207	Information technology – Open systems interconnection – Application layer structure.
33	Governance & Operations	AFNOR	X30-025*BP X30-025	Good practices for the transparency of the information about the social conditions of production and product

#	City Sub System	Organization	Document ID	Title
				distribution.
34	Governance & Operations	ISO	ISO 37120:2014	Provides city leaders and citizens, a set of clearly defined city performance indicators and a standard approach for measuring each. Though some indicators will be more helpful for cities than others, cities can now consistently apply these indicators and accurately benchmark their 12-city services and quality of life against other cities.
35	Governance & Operations	ISO	ISO 37120:2014	Sustainable development and resilience of communities – Indicators for city services and quality of life.
36	Governance & Operations	ISO	BS ISO/TR 37150	Smart community infrastructures – Review of existing activities relevant to metrics.
37	Governance & Operations	ASTM	ASTM E 1121	Standard practice for measuring payback for investments in buildings and building systems.
38	Governance & Operations	BSI	BS 8587:2012	Guide to facility information management.
39	Healthcare	NEN	NEN 7512:2015	Health informatics – Information security in the healthcare sector – Basis for trust for exchange of data.
40	Others	EIA	TIA TSB 4940:2013	Smart device communications – Security aspects.
41	Transport	CEN	CWA 16030:2009	Code of practice for implementing quality in mobility management in small and medium sized cities.
42	Transport	CEN	DD CEN/TS 13149-6:2005	Public transport – Road vehicle scheduling and control systems – CAN message content.
43	Transport	CEN	NEN-EN-ISO 24534-3:2013	Intelligent transport systems – Automatic vehicle and equipment identification – Electronic Registration Identification (ERI) for vehicles – Part 3: Vehicle data.
44	Transport	CEN	NPR-CEN/TR 16427:2013 en	Intelligent transport systems – Public transport – Traveller Information for Visually Impaired People (TI-VIP).
45	Transport	ISO	BS ISO 14813-1:2007	Intelligent transport systems – Reference model architecture(s) for the ITS sector – ITS service domains, service groups and services.

#	City Sub System	Organization	Document ID	Title
46	Transport	ISO	ISO 15118-1:2013	Road vehicles – Vehicle to grid communication interface – Part 1: General information and use-case definition.
47	Transport	ISO	ISO/TS 24533:2012	Intelligent transport systems – Electronic information exchange to facilitate the movement of freight and its intermodal transfer – Road transport information exchange methodology.
48	Transport	ISO	SS-ISO 15784-1:2008	Intelligent Transport Systems (ITS) – Data exchange involving roadside modules communication – Part 1: General principles and documentation framework of application profiles (ISO 15784-1:2008, IDT).
49	Transport	ABNT	ABNT NBR 14022	Accessibility in vehicles of urban characteristics for public transport of passengers.
50	Transport	ISO	ISO 39001:2012	Specifies requirements for a Road Traffic Safety (RTS) management system to enable an organisation that interacts with the road traffic system to reduce death and serious injuries related to road traffic crashes which it can influence.
51	Transport	ISO/TR	NPR-ISO/TR 12859:2009 en	Intelligent transport systems – System architecture – Privacy aspects in ITS standards and systems.
52	Transport	VDI	VDI 4466 Blatt 1	Automatic parking systems – Basic principles.
53	Urban Planning	BSI	BIP 2228:2013	Inclusive urban design – A guide to creating accessible public spaces.
54	Urban Planning	BSI	BS 8904:2011	Guidance for community sustainable development.
55	Urban Planning	BSI	PAS 181:2014	Smart city framework – Guide to establishing strategies for smart cities and communities.



Smart City Master Planning and Implementation Framework

9. Smart city master planning and implementation framework

9.1 : Smart city master planning

Developing smart cities in India needs a balanced focus on infrastructure development and ICT-GT initiatives. Traditionally, city master planning was only focusing on physical infrastructure, economic development and environmental planning. City development plans were developed considering physical, economic and environmental infrastructure, but considering the role ICT-GT plays in improving efficiency and capacity of city infrastructure, it is important to include ICT-GT planning as key element of city master planning and city development plans.

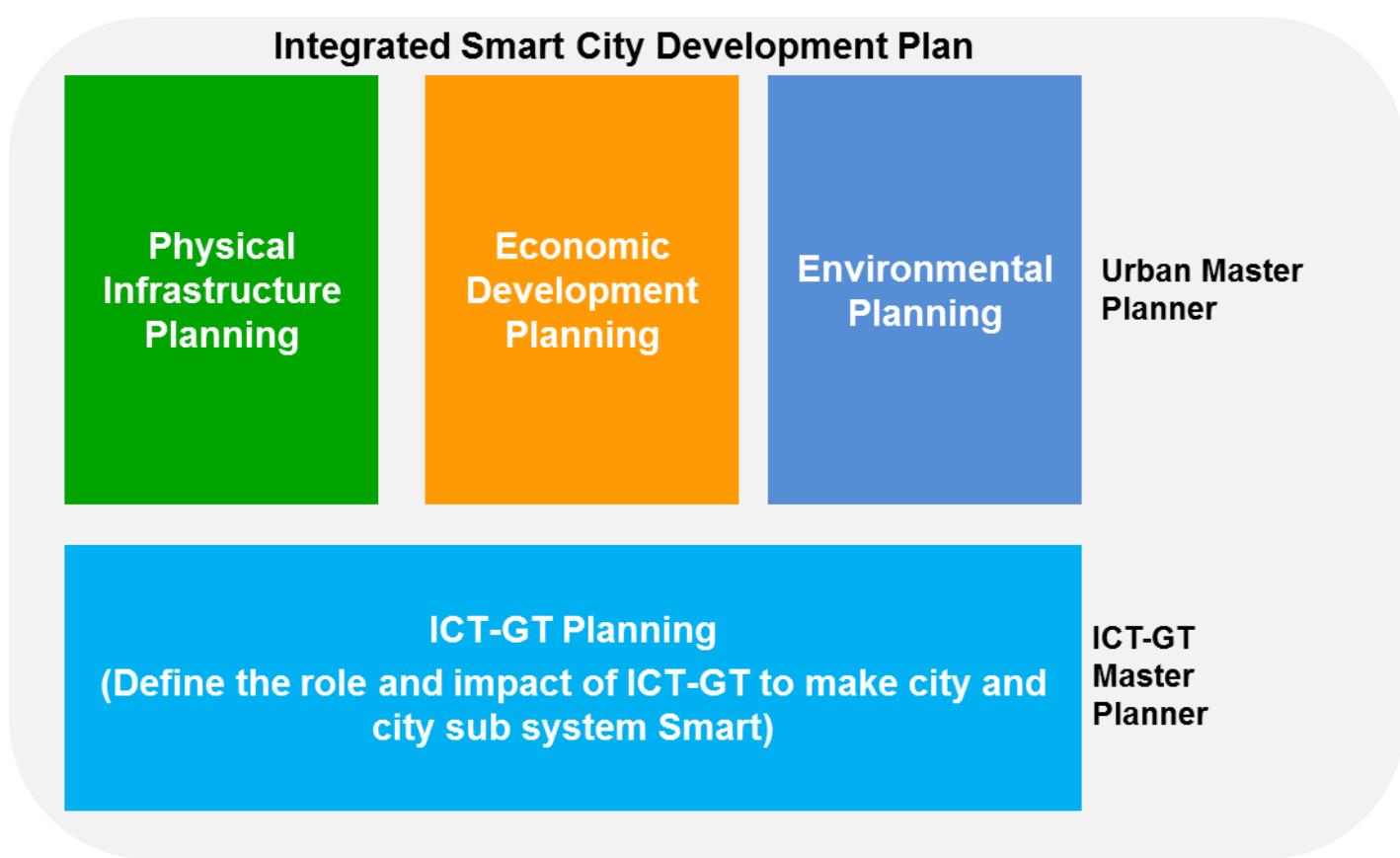


Figure 41: Smart city master planning

ICT-GT planning would cover the following:

- Issues/need analysis for all city areas
- Exhaustive list of initiatives
- Prioritisation based on economic, social and environmental assessments
- Technical & Functional requirements and specifications
- Investment plan
- Revenue/cost recovery model with IRR/breakeven analysis
- PPP model

In case of brown field cities where existing city development plans are available, retrofitting approach needs to be taken up for smart cities project. Integrated smart city development plans needs to be developed to include ICT-GT planning, leveraging existing city development plan.

If existing city development plans are not available then integrated smart city development plans need to be developed from scratch.

9.2 : Smart city implementation plan

Smart City Mission(SCM) is launched for development of smart cities in India. The cities to be shortlisted under Smart City Mission shall have to compete for funding in the City Challenge which has been announced recently by MoUD. For cities to participate in the City challenge, cities will require to prepare a proposal. .

Following are the sequence of activities which a city is expected to undertake beginning with developing a proposal to compete in the city challenge launched by MoUD, to rolling out various ICT initiatives.

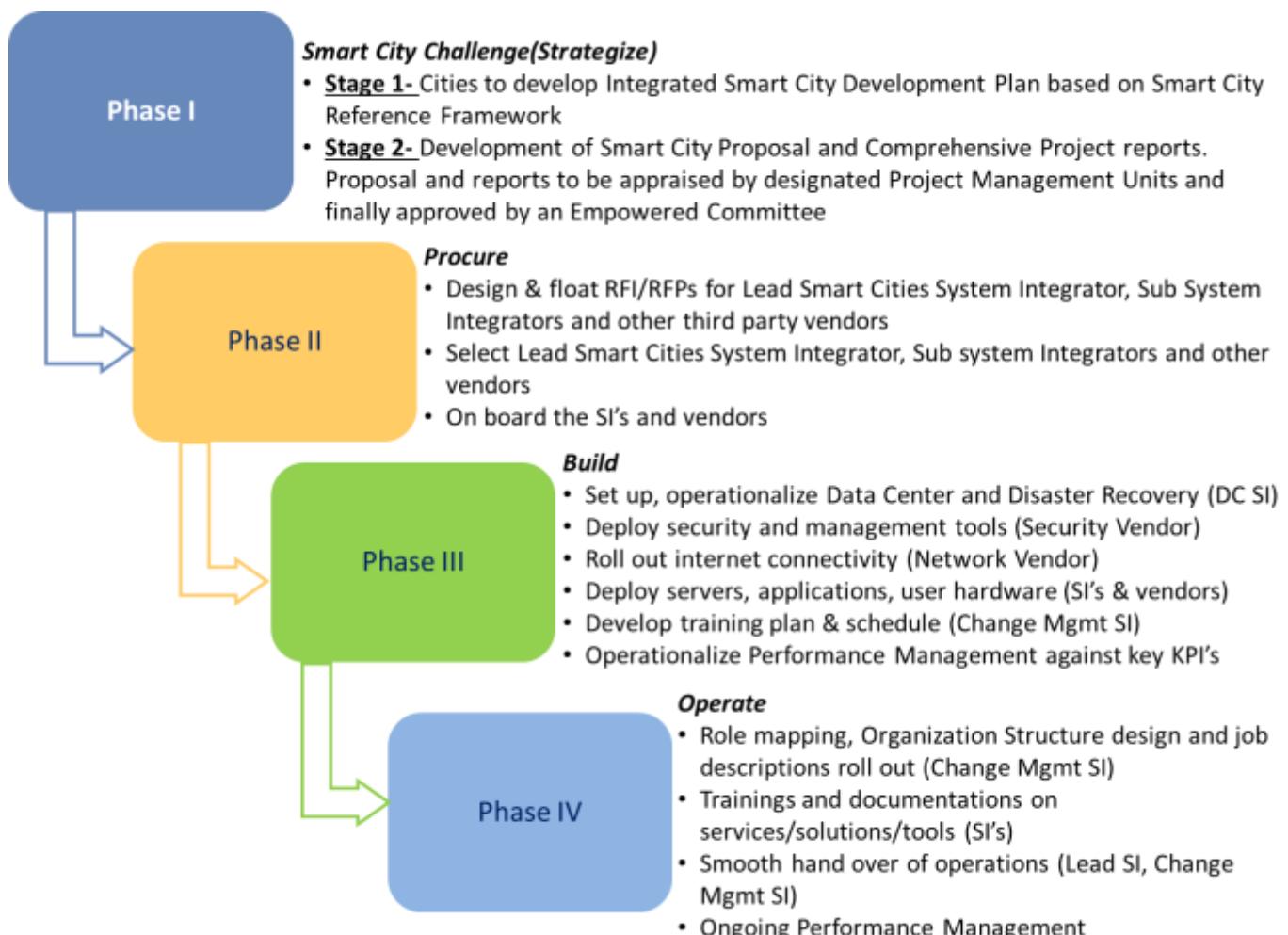


Figure 42: Implementation plan

1. Phase I- Smart city challenge (strategise): Strategy and planning for the smart city programme.⁷⁷

Following are some of the key activities of Phase I:

- a. **Stage 1- Integrated smart city development plan (city wide concept plan):** Cities to undertake development of integrated smart city development plan based on smart city reference framework. Integrated smart city development plan will include smart city vision, stakeholders (citizen/businesses/city management/others) challenges/needs, AS-IS analysis of city infrastructure(physical/social/environmental/economic/institutional), review of previous plans, financing plans and smart city roadmap. Based on integrated smart city development

⁷⁷MoUD- Draft Concept note on Smart City Scheme

- plan, cities would be sanctioned an initial amount for preparation of professional and comprehensive project reports. At national level, process to empanel consultant would be taken up for faster procurement. List of empanelled consultants will be communicated to state governments to aid in consultants' procurement.
- b. **Stage 2- Smart city proposal:** Smart city proposal (comprehensive project reports) will be prepared for selected initiative. This would include details on initiatives and financial plan.
2. **Phase II-Procure:** PMU to be formed at city level for project development and management. City PMU to develop RFI/RFPs for evaluation and selection of lead system integrator and subsystem integrators. Following are some of the key activities of Phase II:
- a. **RFI/RFP development:** City PMU to develop and float RFI/RFP for selection of SIs for various initiatives based on smart city ICT master plan and financing model
 - b. **Proposal evaluation and vendor selection:** City PMU in conjunction with state PMU to select the SIs based on technical and financial proposal
3. **Phase III- Build:** Programme implementation with periodic progress reviews and appropriate approvals. Following are the key activities of Phase III
- a. **Data centre and disaster recovery:** Leverage state data centre and NIC for DR. Set up and operationalise the data centre and disaster recovery center
 - b. **Network:** Design of network. Implement network architecture and roll out network connectivity
 - c. **Applications/solutions:** Subsystem vendors and SI to design, develop, deploy, test & roll out applications and solutions as per the requirements laid out
 - d. Development of ITIL-based IT operating and service delivery model for efficient operations and service delivery
 - e. Timely procurement of hardware and software with the procurement strategy depending on the level of control and investment required
 - f. ICT change management vendor to develop change management plans, organisation structure, role definitions, training plans and schedules
 - g. Municipal PMU consultant to programme manage and monitor the performance of the all SIs, conduct quality reviews, run governance boards and reporting to ensure the solutions meet the requirements and also meet the timelines
 - h. Municipal PMU to prepare a risk management and mitigation plan and ensure risks are managed proactively
4. **Phase IV- Operate:** Go live, training and transition of services, solutions, tools, processes and way of working with effective Change Management and performance monitoring to ensure smooth operations. Some of the key activities of Phase IV will be:
- a. **ICT operations partner:** Municipal PMU to develop RFI/RFPs for selection of ICT operations partner to manage the operations of smart city applications and infrastructure for five years
 - b. **Handover to operations partner:** SIs to handover the operations and management of smart city applications and infrastructure to operations partner
 - c. **Training:** Change management SI conducts trainings on organisation and role changes. Ensures all SIs conduct trainings as per requirements and training plan as well as publish documentation and training materials on tools/processes/applications and policies
 - d. **Support:** Core SI to operationalise integrated support for end user/functional/data centre/security on a multi-vendor environment
 - e. **Performance measurement:** Municipal PMU to monitor performance of all SI's, operations partner and solutions against SLAs and OLAs drafted as part of the proposals and design documents

Refer smart city concept notes and Smart City Mission documents from Ministry of Urban Development to know more details on way forward for smart cities project in India.



Smart City Performance Management Framework

Version 1.0 | March 2023

Prepared by:

Smart City Institute

www.smartcityinstitute.org

Smart City Institute

10. Smart city performance management framework

Performance management framework

Performance management, monitoring and evaluation are critical elements utilized by the city to improve organisational and individual performance and to enhance service delivery. The establishment and development of the performance management framework ensures integration between strategic planning and performance management by linking the solutions/services to indicators and targets that can be used to measure performance.

Following is the proposed performance management framework, which is developed based on global city performance framework like ISO : 37120 and others:



Figure 43: Smart city performance management framework

Overview of the performance management framework elements

1. **Service performance:** Measures the performance of citizen services across areas like energy, water, waste, mobility, etc. to ensure more effective governance and delivery of services. Following are some of the illustrative performance indicators to assess performance across the areas of service performance:

- Total electricity energy use per capita
- Response time for emergency response services from initial call
- Response time for fire department from initial call
- Number of fire fighters per 100,000 population
- Number of police officers per 100,000 population
- Percentage of city population living in slums

- Number of homeless per 100,000 population
 - Percentage of city population with regular solid waste collection
 - Percentage of city population with potable water supply service
 - Number of internet connections per 100,000 population
 - Kilometres of high capacity public transport
 - Number of personal automobiles per capita
 - Percentage of people using public transport to work
 - And many more
2. **Social performance:** Performance management solution to monitor and track the performance of social services like health, education, safety, etc. This will help the municipals to assess whether the current state of these services is optimum and/or what are the improvement opportunities. Following are some of the illustrative performance indicators to measure social performance:
- Percentage of students completing primary education
 - Primary education student/teacher ratio
 - Number of higher education degrees per 100,000 population
 - Number of physicians per 100,000 population
 - Percentage of convictions and case closure for criminal cases
 - Citizen score for city governance
 - Citizen score for citizen services
 - And many more
3. **Environmental performance:** Measurement of environmental health of the city to assess how good or bad is the state of environment and what are the areas the city needs to focus on for improvements. Following are some of the illustrative performance indicators to measure environmental performance:
- Particulate matter concentration
 - Greenhouse gas emissions measured in tones per capita
 - NO₂ concentration
 - SO₂ concentration
 - O₃ concentration
 - Noise pollution
 - Green area (in hectares) per 100,000 population
 - Annual number of trees planted per 100,000 population
 - And many more
4. **Economic Performance:** Measurement of the state of the city's financials to track and monitor aspects like city's revenue generation, budgets, expenditure, industrial expansion, businesses development, employment, poverty etc. with the aim of making a city self-sustaining and increasing its revenue generation. Following are some of the illustrative performance indicators to measure economic performance:
- City's unemployment rate
 - Assess value of commercial and industrial properties as a percentage of total assessed values of all properties
 - Percentage of city population living in poverty
 - Percentage of people in full time employment
 - Youth unemployment rate
 - Number of businesses per 100,000 population
 - Capital spending as a percentage of total expenditures

- Own-source revenue as a percentage of total revenues
- Tax collected as a percentage of tax billed
- And many more

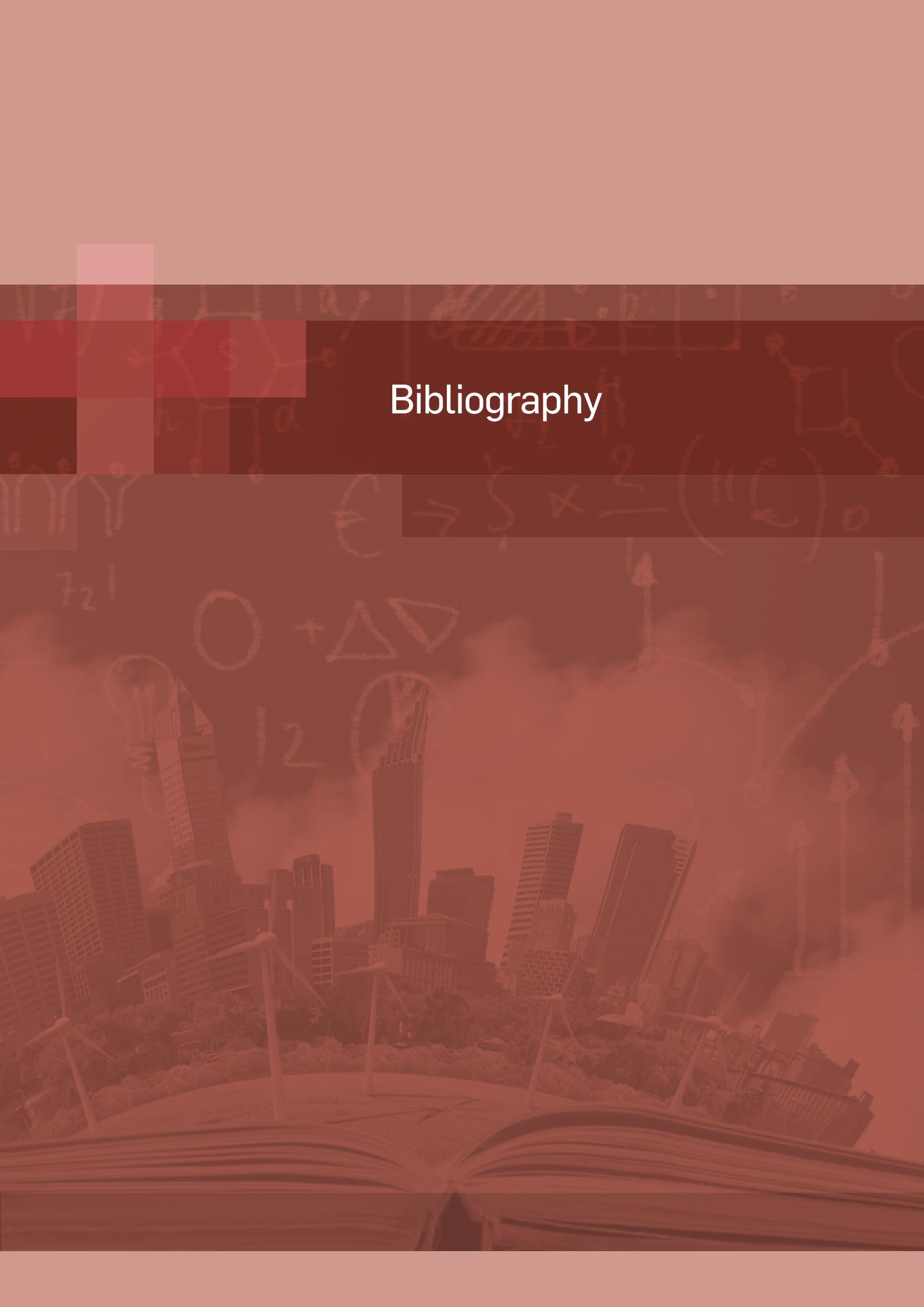
Performance management approach

Developing a smart city is a journey not a destination, so cities need to adopt continuous improvement philosophy to define, measure and improve city performance on a continuous basis. City performance targets needs to be define based on benchmarking with global and Indian cities. Following is the approach which is recommended:



Figure 44: Performance management approach

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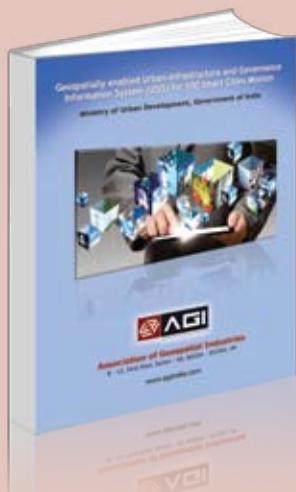


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AGI's Concept paper on "**Geospatially enabled Urban-infrastructure and Governance Information System (UGIS) for 100 Smart Cities Mission**," outlines the integration between the Smart City Life Cycle and the associated Geospatial Workflow. Spanning across all stages of the Lifecycle, right from Planning and Design to Build, Operate, Maintain, Manage and Sustain the Smart City operations. AGI's recommendation is of a holistic Geospatially enabled Urban-infrastructure and Governance Information System (UGIS) which provides current and up-to-date information to all agencies and users.

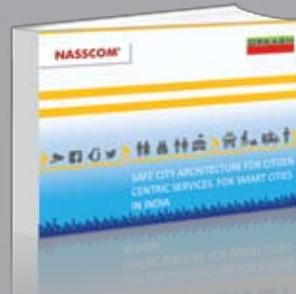
AGI's recommendation further considers the integration of both spatial and non-spatial data environments. This approach provides planners a unified view of the benefits that accrue through adoption of Geospatial technology based solutions across the development of a Smart City. It also integrates with NASSCOM's Report titled "**Integrated ICT and Geo-Spatial Technologies Framework for the 100 Smart Cities Mission**," expanding on the application and benefits of geospatial technologies for smart city applications where ever references for user applications are drawn.

An Architecture for Safe City Citizen Centric Services for Smart Cities in India

The challenge of urbanization, infrastructure bottlenecks and rising populations in cities, carries with it the problem of increased threat level. The demand for heightened public safety and security is, thus, a fundamental component of what a Smart City must deliver to its citizens. Ensuring that Smart Cities are in fact 'Safe Cities', requires the integration of security and safety infrastructure with ICT leading to a very responsive engagement with citizens.

This is the third in a series of reports by NASSCOM and ORKASH for developing a public safety and security architecture for cities in India. The first two titled 'Perspectives for Safe cities in India - a need and market assessment' and 'Perspectives for Safe cities in India - a government and capacity building policy assessment, examined in detail the architecture for making cities safe.

The focus of this report titled 'An Architecture for Safe City Citizen Centric Services for Smart cities in India' is on the Safe City Citizen Centric Services, as required by Smart Cities in India. This report is the culmination of insights from a wide variety of stakeholders, within the Smart City community in India: industry representatives, subject matter experts, civic society and government stakeholders.



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