

# DATASMART CITIES

## Empowering Cities Through Data







# Executive Summary

Cities in India have become engines of growth of the country and occupy the centre stage of socio-political deliberations. In the past few decades, cities have also become the hub of India's knowledge economy, propelling an innovation ecosystem. The challenges of managing the growth of cities in an increasingly resource-constrained scenario and with a complex and changing social fabric are not new. What has changed is the way solutions to these challenges are sought in a world transformed by digital technologies.

With the launch of the Smart Cities Mission in 2015, India started paving a new pathway towards transforming urban management with the power of digital technologies. While the Mission has opened a floodgate of opportunities for cities in applying ICT (Information & Communication Technology) solutions, there is also a greater awareness of the need for building on the 'city-as-a-platform' concept. The concept recognizes the value of enhancing engagement among all four stakeholders of the quadruple-helix model—Government, citizens, academia, and industry, along with improvements in the internal workflow and decision-making processes of city Governments. In this context, the need for city Governments to take 'digital leadership' has become more pronounced.

This essentially calls for building an enabling ecosystem supported by a robust system of data acting as a backbone. Therefore, making cities 'DataSmart' is key in realizing the full potential of technology interventions and innovation ecosystems in cities. This strategy document aims to lay down the basic premise, foundational pillars and a suggested roadmap for cities to improve their readiness for intelligent use of data in addressing complex urban challenges.

With the deployment of IoT (internet of things) devices, sensors and other methods to 'sense' the city, the sources and size of the data generated in a city are increasing every day. DataSmart Cities are those that have successfully imbibed a culture of data awareness and data usage in its functioning. The envisaged outcome of becoming DataSmart is to bring greater efficiency, accountability, and transparency in city governance decisions while fostering civic engagement, co-creation, and innovation in problem-solving.

The foundational pillars for becoming DataSmart include a) well-capacitated institutional structures across all tiers of governance along with the formation of networks and alliances; b) process enablers-such as policies and standards; and c) technology platforms to support implementation of policy intents. These three pillars, (referred to as People, Process, Platform in this document) are envisioned to support the creation of an open data culture, leading to greater data exchange for open innovation and co-creation. Eventually, this will lead to the creation of a thriving data marketplace as a sustainable model for smart city solutions for businesses. The institutional structures and the way forward suggested in this strategy document are derived from the building blocks mentioned above. While the primary beneficiary would be the cities and their citizens, appropriate structures have been suggested at both national and State levels to ensure a complete ecosystem transformation.

The first foundational pillar includes identification of responsibilities and actors for implementing the principles of data governance in both letter and spirit. These structures will essentially anchor implementation of the other two pillars while being cognizant of the present realities in cities. The idea is to encourage cities to think through the 'what' and 'who' of an institutional mechanism in order to create a contextual manifestation of the same. The suggested structures at all three levels, i.e., national, State and city are meant to complement each other while upholding the spirit of cooperation in a federal system. The objective is to drive the larger ecosystem to create space and capacity for data-driven decision-making.

The second foundational pillar refers to a robust and forward-looking data governance paradigm. While data is being considered as the lifeline of next-generation smart cities, it also brings about challenges of privacy, security, rightful use, and potential bias. This strategy document attempts to address some of these critical issues by recommending the creation of an appropriate policy along with regulatory and institutional instruments at the city level. However, many of these issues are evolving in their nature and complexity, and hence it would be premature to suggest full-proof solutions. It is envisaged that an enabling ecosystem with a more capable city-Government, an aware and engaged citizenry, and collectives of non-state actors would continue to build mutual trust and collaborate to seek solutions to tricky issues associated with data.

The implementation of the third foundational pillar is built on the guiding principles and architectural blueprint of the National Urban Innovation Stack proposed by Ministry of Housing and Urban Affairs (MoHUA) and National Institute of Urban Affairs (NIUA). The objective is to guide cities in the adoption of open data platforms, along with a roadmap for evolution to a mature data marketplace.

The DataSmart Cities also lay down the tenets of a Data Maturity Assessment Framework to be implemented through a self-assessment. The detailed guidelines for the Data Maturity Assessment has been finalised by MoHUA. The objective is to encourage cities assess their readiness against the three foundational pillars mentioned above, while combining the dual objective of robust processes and intended outcomes.

The Smart Cities Mission Directorate intends to initially implement the DataSmart Cities strategy for the existing 100 Smart Cities through their Urban Local Bodies (ULB). These cities will become the lighthouses for all other cities and towns across the country that aspire to emulate a paradigm of data-driven governance.



# Definitions

| Terms                    | Definition   |
|--------------------------|--|
| <b>CDO</b>               | City Data Officer  |
| <b>Data</b>              | Facts and statistics collected together for reference or analysis.   |
| <b>Data Agencies</b>     | Agencies which are consumers and suppliers of public data.   |
| <b>Data Set</b>          | A collection of related sets of information that is composed of separate elements but can be manipulated as a unit by a computer   |
| <b>DAM Unit</b>          | Data Analytics and Management Unit   |
| <b>MDO</b>               | Mission Data Officer   |
| <b>Meta Data</b>         | Data about data  |
| <b>NDSAP</b>             | National Data Sharing and Accessibility Policy   |
| <b>Negative List</b>     | List of Prohibitive datasets/feeds   |
| <b>OGD</b>               | Open Government Data   |
| <b>Open Data License</b> | The Open Database License (ODbL) is a copyleft ("share alike") license agreement intended to allow users to freely share, modify, and use a database while maintaining this same freedom for others. |
| <b>Open Government</b>   | Open Government is the governing doctrine which holds that citizens have the right to access the documents and proceedings of the Government to allow for effective public oversight.                |
| <b>Open Standards</b>    | An open standard is a standard that is publicly available and has various rights to use associated with it and may also have various properties of how it was designed (e.g., open process).         |
| <b>SCDA</b>              | Smart City Data Alliance   |
| <b>SCDN</b>              | Smart Cities Data Network  |
| <b>SPV</b>               | Special Purpose Vehicle  |

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# MESSAGE

## Durga Shanker Mishra

Secretary, MoHUA

The future of Governance is data driven and Indian cities are beginning to adopt this change in their functioning. Bringing data in 'focus' ensures a move towards outcome-based planning in governance. This helps us realistically assess the gaps between the outcomes and desired goals. Smart cities are looking to leverage data generated by systems and processes deployed in cities for generating business intelligence and improving their operational efficiency.

I am delighted to share with you this DataSmart Cities Strategy, through which our Smart Cities will embark on a journey to create a culture of data through various initiatives and engaging with various stakeholders in solving their urban challenges. The Strategy will give direction to the various stakeholders who may be working in vertically integrated structures, holding data produced by them in silos. Cities will be able to solve the myriad complex issues by unlocking this data and sharing them amongst key stakeholders.

'DataSmart Cities' Strategy would focus on evolution of culture of data driven governance in these cities and encourage cities to setup the building blocks of Data Culture at the City level through various efforts such as setting up Smart City Data Alliance, Smart Cities Data Network, Open Data initiative and City Data Policy etc. It also intends to enable peer to peer learning across cities over the data driven governance and outline reusable use cases in different domains.

I strongly believe that through this strategy, cities will be able to create multi layered partnerships amongst Government, citizens, academia and industry – the 'quadruple helix' ecosystem. These technology platforms for open data, data exchange coupled with data analysis and management tools will not only promote innovation and use of emerging technologies for economic growth in cities, but also empower communities through the practice of 'Open Government'.

I congratulate the team of officers in the Smart Cities Mission of the Ministry and their working group partners for successfully finalising this Strategy document and taking this initiative forward with high level of engagement with the cities and stakeholders.



# PREFACE

## Kunal Kumar

Mission Director, Smart Cities Mission, MoHUA

Over the past decades, cities in India have become the centre of economic growth for the country, and a place of hope and opportunity for people. The unprecedented growth of Indian cities has brought city governments at the centre stage of deliberations on charting a sustainable urban future. With expectations from city governments continually on the rise, Urban Local Bodies (ULB) across the country are relentlessly trying to deliver services for a better quality of life in an environmentally, socially and economically efficient manner. This is no simple task. At the same time, it brings forth the importance of imbibing data-intelligence in decision-making as a way forward in addressing urban challenges of present and future.

The Smart Cities Mission has triggered the creation of a favourable ecosystem in cities for harnessing the power of data through digital technologies. The Ministry of Housing and Urban Affairs (MoHUA) is committed to walking the path towards data-driven governance alongside Cities. MoHUA has released relevant strategic guidance and framework documents such as the National Urban Innovation Stack (NUIS) strategy and approach to help key urban stakeholders, i.e. governments, citizens, academia and industry create necessary culture and infrastructure for data-centric innovation and collaboration. The DataSmart Cities strategy document endeavours to continue this journey by laying a tangible roadmap for Indian cities to embrace a data-driven governance paradigm.

The DataSmart Cities strategy is built on three foundational pillars, namely people, processes and platforms, all of which require a thoughtful approach that enables seamless data-driven interaction while maintaining the privacy and security of citizens. As these interactions occur with increasing frequency and with emerging technologies, the realm of possibilities will expand. Thus the DataSmart Cities strategy is intended to be an evolving document that keeps pace with the needs of the urban ecosystem.

The Smart Cities Mission Directorate intends to initially implement the DataSmart Cities strategy for the existing 100 Smart Cities through their urban local bodies (ULBs). These cities will become the lighthouses for all other cities and towns across the country that aspire to emulate a paradigm of data-driven governance. I urge the Cities and all stakeholders to treat this strategy document as a call for participation in our joint effort towards creating a robust urban governance and innovation ecosystem for a more liveable urban future.

# Introduction

Why do we need  
DataSmart Cities





## India's Rapid Urbanization

1.1

India's urban population was 37.7 crore (31% of the overall population) in the 2011 census. This is projected to increase to 60 crore (40% of the projected total) by 2030 and over 80 crores (50%) by 2050. Moreover, as per the 2011 census, urban India contributed 63% to the country's GDP. This is projected to grow to over 75% by 2030 and more than 80% by 2050. The growing urban population places a significant burden on civic infrastructure and services like sanitation, water, sewage, housing, electricity and public transport.

The Government of India (GoI) is strongly committed to the 2030 Agenda, including the Sustainable Development Goals (SDGs), as reinforced by the Prime Minister and other senior ministers at

national and international meetings. India's national development goals and its "Sab ka Saath, Sab ka Vikas" (development with all, and for all) policy initiatives for inclusive development converge well with the SDGs. To quote Prime Minister Modi - "These goals reflect our evolving understanding of the social, economic and environmental linkages that define our lives." India will play a leading role in determining the global success of the SDGs.

GoI and its flagship initiatives of Smart Cities Mission (100 cities), AMRUT (500 cities), PMAY(U), SBM(U) and DAY-NULM (all cities/towns) are well-positioned in taking the lead to develop the Indian cities by leveraging the 'city-as-a-platform concept' for digital transformation of the economy and the society.

## The rise of Digital Governance and Urban Data

1.2

Cities are crucial units of local governance within a nation. The development and growth of a nation are influenced to a large extent by its cities. The Smart Cities concept relies on fostering a balanced confluence of two megatrends: Rapid Global Urbanization and Digital Transformation through the Industry 4.0 revolution. These trends have consequences on our efforts to improve liveability for citizens, enhance human capital and transform the relationship between Government, Civil Society, and Market Players in an environmentally, sustainable and inclusive manner.





The Smart City concept has highlighted many other opportunities. The power of data science and geographical information systems can be harnessed for enabling an exchange of ideas, solutions and manpower across the country that can be at the right place at the right time to help Indian cities across the country to fix local challenges. A vast geography of research institutions, individuals and organizations can be brought to work on the challenges of Indian cities. Such an ambition requires appropriate strategy to maximize benefits of such cooperation.

While Indian cities are the location of its financial institutions and economic drivers, they are also centres of learning and creativity, offering a rich matrix of life to their citizens. While rural India has had a long history of innovation, enterprise has been uniquely associated with urban India. It is predicted that the next generation of urban enterprises will be most likely dependent on digital technologies, data sciences, human ecologies mediated by advanced knowledge systems, new material sciences and new ways of managing resources and doing business. Enterprises require appropriate and vibrant ecosystems to flourish, and ecosystems require a variety of human actors, supportive environments and enabling technologies and catalyzing knowledge resources. Increasing the number of new enterprises and encouraging such 'startups' to flourish in Indian cities is an economic as well as social imperative, given the demographic dividend that India wishes to reap from having the largest working age population pool in the world.

Information is the biggest power of the modern times. It is imperative for the empowerment of communities that cities put out information regarding their functioning, their public services, their governance systems, achievements and failures in the public domain, thereby, empowering their citizens through the access to information. Citizens can collaborate with government easily and with increased frequency; both within their community and beyond, forming stronger groups and exchanging ideas and building new collaborations. A stronger 'voice' will be created for each citizen, both virtually and physically.

The future of Governance is data-driven and Indian cities are beginning to adopt this change in their functioning. Bringing data in 'focus' ensures a move towards outcome-based planning in governance. This considers not just the inputs that are reaching our citizens, but also the outcomes that these investments have over a period of time. This helps us realistically assess the gaps between the outcomes and the desired goals.

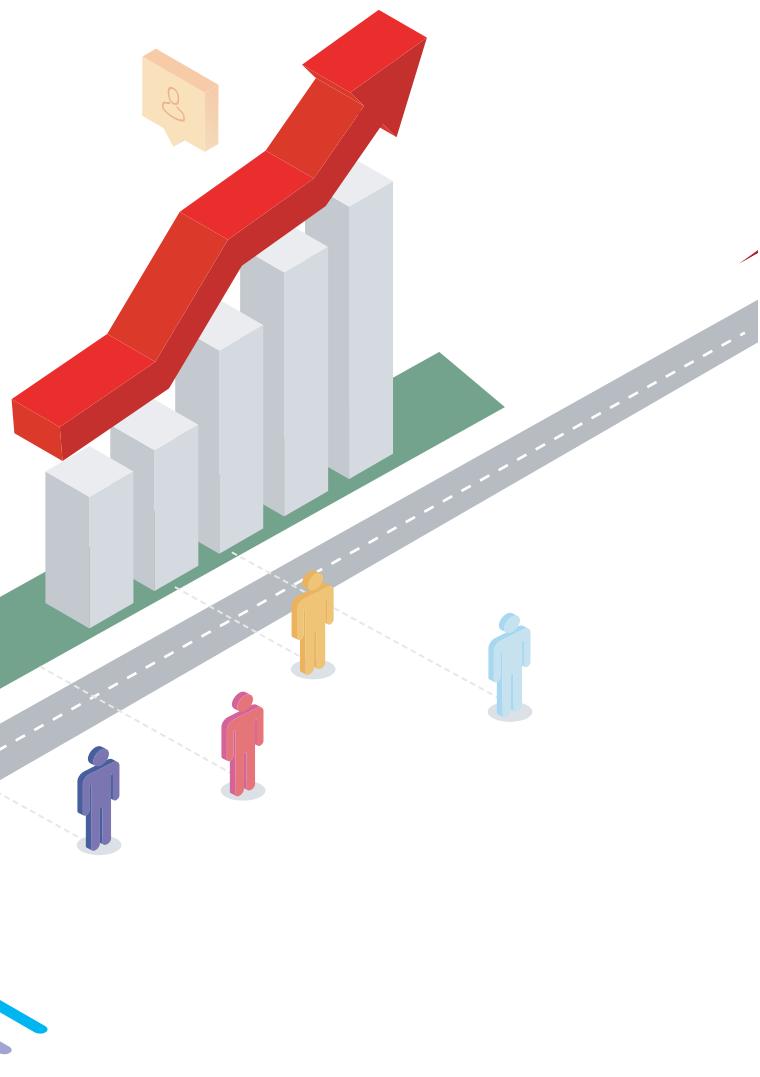
To support complex and elaborate city planning, we need a robust indicator framework, and the accuracy of this framework depends heavily on reliable data input. Such an approach would help Governments improve the liveability of cities for its citizens. The indicators required for measuring and assessing a city's liveability over time would require a strong foundation of data in the urban ecosystem. Achieving the right outcomes through data-led governance also brings into focus, the need for managing data as a process. This requires a robust data governance mechanism along with the supporting institutional structures.

# DataSmart Cities

Harnessing  
Data for Urban  
Transformation



To create, nurture and further the spirit of data-driven empowerment, collaboration and governance in cities, 'DataSmart Cities' strategy needs to be an evolving policy framework on data, which can catalyse the adoption of data-centric governance and foster a data culture in the urban ecosystem.

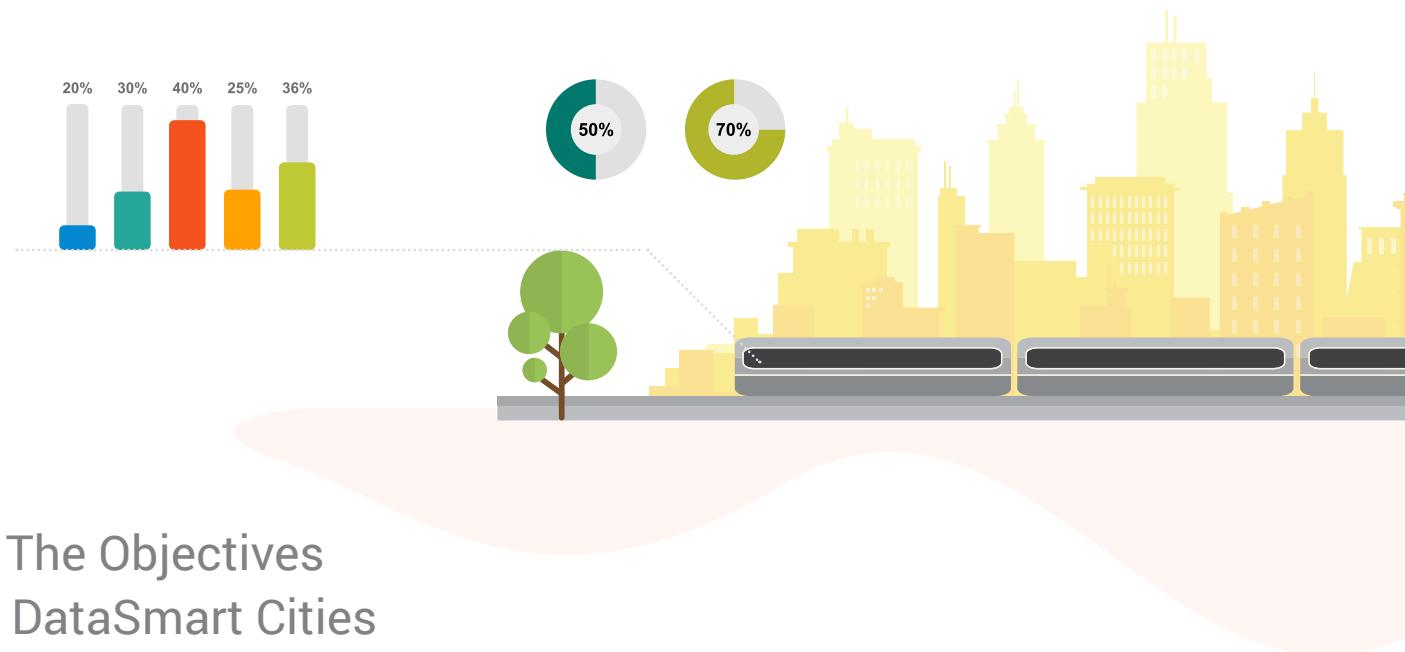


## Unlocking the Benefits of Urban Data

2.1

The functions integral to the working of a city are performed by different Government line departments, private sector, community organizations, and academic institutions through provision of infrastructure, services, research, co-creation and valuable feedback. However, there is an absence of incentives and systems among data producers/

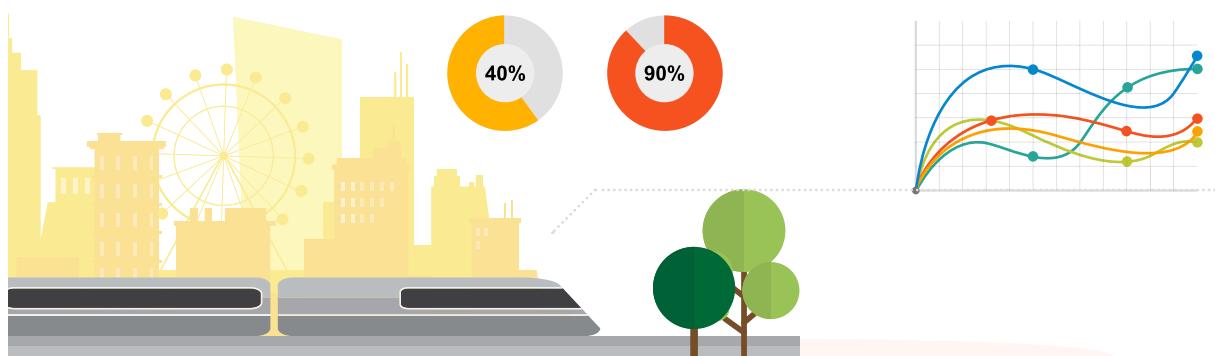
agencies/institutions to generate and share reliable data and protocols. Data available with these entities remains in silos, which needs to be unlocked and shared amongst them. Thus, to unleash the power of urban data for transformation it is crucial to unlock it and make it the common language of collaboration in the urban ecosystem



## 2.1.1. The Objectives of the DataSmart Cities

The objectives of the DataSmart Cities are to:

- **Institutionalize a “Culture of data”:** The trend to draw insights and create actionable intelligence for city governance is already on the rise. However, formal mechanisms for data collection, management and use needs to be put in place. Also, there is a need to create awareness, dialogue and collaboration among different stakeholders to harness the power of data as a potential economic resource.
- **Drive Data Governance:** To propose a data governance framework that facilitates the implementation of key processes within the data life cycle and builds capacity in all stakeholders on data-informed decision-making. The data strategy should foster public accountability and transparency.
- **Enable the framing of a City Data Policy:** To unlock the power of data in the context of privacy, security and ownership in the context of the city, it is critical that cities create data policies that balance privacy, legal and public benefit considerations. At the same time it must define the contours of collaboration between various Governmental/non-Governmental entities on data sharing and access.
- **Facilitate City Data Alliance:** It is important to assess the data available in all Government and non-Government entities that generate and store data crucial to better planning and functioning of the city and to engage them in the understanding, creation, and promotion of data-driven solutions for the city. The ‘quadruple helix’ comprising of communities, industry, academia and the Government will be constituents of the City Data Alliance.
- **Adopt appropriate Data platforms:** With a clear strategy, cities can adopt and deploy robust, secure and intuitive data exchange platforms, which will lead to the effective sharing and management of city data. Such platforms allow common programming interfaces, data representation formats and data models that are interoperable.



## 2.1.2. Perceived Benefits of the DataSmart Cities Strategy

The implementation of this initiative in Smart Cities will lead to the following benefits:

- **Empowerment of citizens:** When cities are open about how they function, connect with their communities through various platforms during the development lifecycle of myriad projects, put out information about their tax collections, their financial and environmental health and are open to informed debates, they become true proponents of 'Open Government'. Such cities constantly try to build trust with their citizens and engender a collective conscience amongst their communities around important issues facing their present and future. Citizens can collaborate with government easily and with increased frequency; both within their community and beyond, forming stronger groups and exchanging ideas and building new collaborations.
- **Data-driven governance and policy formulation:** Data will help City administrators in making better policies and decisions for the city. Data empowers city officials, citizens, and communities and helps promote evidence-based decision making. This will lead to greater efficiency in service delivery and resource allocation.
- **Promotion of Data Sharing and Exchange:** Efficient governance requires ready availability of relevant data. Unfortunately, data is locked up in various systems with different data owners. Open Data initiatives, data sharing, and exchange platforms will assist in facilitating G2G, G2C and G2B data sharing and exchange of data for effective decision making in real time.
- **Promotion of Multi-disciplinary research on Civic Issues:** Local data could unlock research on civic issues like transport, traffic and solid waste. Multidisciplinary researchers may provide different perspectives or solutions on civic issues to the city administration.
- **Co-Creation and Open Innovation and Civic Engagement:** City Governments will be able to work with entrepreneurs, industry, and academia to promote participation in governance, co-creation and open innovation. This will enable greater civic engagement through directed partnerships and

collaborations with external and parastatal government agencies, institutions, communities, academic, research, policy and civil society organizations.

- **The emergence of Innovative Technologies:** Data is fuel for the development of solutions based on emerging technologies like IoT, Artificial Intelligence (AI), Machine Learning (ML), Blockchain, etc. Data platforms will help cities become data ready to kick-start innovation in emerging technologies.
- **Enhancement of Transparency and accountability:** Smart cities intend to deliver reliable services to their citizens through various Smart Solutions. Implementation of the DataSmart Cities Strategy will lead to enhanced transparency and accountability among its citizens and communities by making reliable data available through data platforms. It will help build trust between the city Government and citizens.

## Key Strategic Partners

2.2

This overarching aim of this strategy is to benefit citizens. In the process, Governments at all levels will be benefitted:

Table 1: DataSmart Cities and its benefits at various levels

| Government                     | Benefits of DataSmart Cities  |
|--------------------------------|---|
| <b>City Administration</b>     | Municipal bodies can strategize, prioritize and manage service delivery to citizens. Data enables the identification of visual and analytical insight to manage cities more efficiently.  |
| <b>State Government</b>        | resources effectively to where they are most needed. Appropriate State-level policies can be rolled out.<br>States may choose to expand this framework to other major cities in addition to smart cities.   |
| <b>Central Government</b>      | For the Central Government, a DataSmart city platform helps to facilitate critical issues of national importance (e.g., pollution or drinking water availability) across multiple schemes.<br>National policies can be formulated keeping in mind the needs of the population which will be captured precisely through the use of DataSmart capabilities.<br>Incentive plans are being considered for the Smart Cities based on need and performance. |
| <b>Non-Government Agencies</b> | Entrepreneurs, Industry, and Academia are empowered with the availability of the required civic data.<br>They can become partners in co-creation and open innovation to design cost-effective and contextual solutions to address civic issues.   |

## Foundational Pillars of the DataSmart Cities

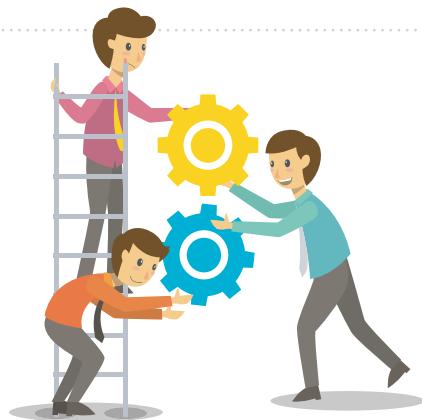
2.3

Achieving the benefits envisaged by this Strategy and facilitating beneficiaries in playing their perceived roles calls for a multipronged approach. The foundational pillars of the DataSmart Cities Strategy as mentioned below reflect this approach:



**People:** People are at the core of the successful implementation of any strategy. Resources will need to be allocated and a robust Institutional Governance need to be set up for multi-layered management of the DataSmart Cities Strategy and capacity building.

**Process:** Data Governance processes need to be institutionalized. A robust data strategy requires compliance and considerations to policies such as National Data Sharing and Accessibility Policy (NDSAP), Personal Data Protection Bill (2018) and City Data Policies. Policies go hand in hand with processes for identification, publishing, sharing and procuring of data sets and data feeds.



**Platforms:** A DataSmart Cities Strategy platform can be defined as a set of Digital Infrastructure components needed for the management, analysis and use of data for a data-led governance. These would include support of external platforms like Open Government Data (OGD) platform needs to evolve over the lifecycle of DataSmart Cities' roadmap. Platforms also need to support Standards for programming interfaces, models, ontology and file formats.

Each of the pillars mentioned above, need to be addressed through a City Data Policy and by institutionalizing the culture of data-driven-governance across all levels. These foundational pillars are covered in the subsequent sections.

# Process

Reimagining Data  
Governance in cities



# The need for a New Paradigm of Data Governance

3.1

It is not adequate to only have the data in place. Data should be reliable, trusted and be in a form so that sense can be made from it. This leads to the need of Data Governance. A simple and effective definition of Data Governance is as follows:

Data Governance is the exercise of decision making and authority for data-related matters.

It's a system of decision rights and accountabilities for information related processes, executed according

to agreed-upon models which describe who can take what actions with what information, and when, under what circumstances, using what methods

Governed data is data that is trusted and understood and for which someone is accountable for both the data itself and for addressing issues about the data. While there are many frameworks for data governance a simple, functional architecture of Data Governance, is depicted below which is relevant for a Smart City:

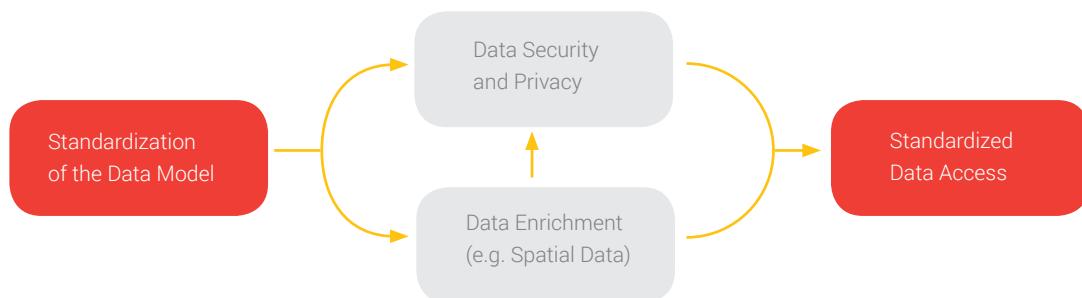


Figure 1: Data Governance Functions

## Bringing Coherence to Data Through Standards

3.2

For effective use of any data, it is important that the relevant metadata is established. This ensures among other things a consistent interpretation of the data elements. The City Data Officer (CDO) has to ensure this through the help of sectoral heads. Key elements of meta data include:

- ***The standardized name of the data element:*** This is the standard functional name by which the data element is called (ideally) everywhere in the ecosystem. Where a functional unit needs to call it something else, that alias is documented.
- ***The standardized definition of the data element:*** Just as there should be one standard name, there should also be only one standard definition for the data element. Where there is disagreement on the definition, the data owner must either change the definition or the errant data element must be defined and given a new name.
- ***The data quality rules:*** This includes the rules that specify good quality (e.g., format, range, valid values, pattern, and so on), as well as the level of quality needed for each intended use of the data.

<sup>1</sup> Gwen Thomas of the Data Governance Institute

## **Building Spatial Intelligence into our Cities**

**3.3**

Location intelligence is a key component of DataSmart Cities, as it provides the base framework for cities to collaborate and share information in the city space. Geo-spatial data provides local authorities with the insight to efficiently manage resources and meet the economic, social, and environmental needs of citizens. Fundamental elements of Geo-spatial data include the City base map having settlement and household information, complete transport network, water bodies, green spaces and utility networks, apart from other point of interests. The flow of real-time geo-spatial data from multiple sources such as mobile devices and sensors, will empower a city's data-driven strategy. Real-time processing of geo-spatial data will allow predictive analysis and provide proactive solutions to Cities' pressing problems.

An efficient and integrated resource management requires the elements of the city to be integrated in

a seamless standardised geographical database. All the application solution providers for a city must integrate their solutions with it. It must be considered as a foundational information system and should be established before any other system is developed. For city planning purposes, the following scales of geographic databases are needed (a) Regional Planning: Scale 1:25000, b) Master Plan: Scale 1:10000, and c) Zonal Plans/ Town Planning Schemes: Scale 1:1000.

Issues about intellectual property rights (IPR) should also be addressed and incorporated into City Data Policies. This is particularly relevant when application developers embed a map and other city data into their solution.

More details about the approach to building geo-spatial platforms for cities are provided in annexure-1.

## **Maintaining Trust by Ensuring Data Security and Privacy**

**3.4**

Managing security and privacy of data is crucial to building and maintaining trust between ecosystem participants and thus will be a critical element of the city data policy. Data collection, sharing and analysis must be ring-fenced by a privacy first approach to guarantee protections for residents and users. Smart Cities should develop ethical frameworks for data ownership and privacy which overcome any gaps in current legislation.

The usage rules for data elements must specify for what purposes the data can or cannot be used. For example, the patient's name in a hospital record may be fine to use by a doctor for a treatment plan, but not

for any analysis or marketing without the consent of the data owner (the patient).

For management of Privacy and Security of Data, it is recommended that all data access must be through Application Programming Interface (API) calls to ensure appropriate security controls. Cities should establish or comply with existing standards and certifications for data privacy and security. Except for open data, it is recommended that direct access to data be prohibited and use of APIs mandated. Data dissemination should be only to authenticated and authorized stakeholders (both internal and external) through data fiduciaries.

### 3.4.1. Data Categorization and Classification

Data will be categorized into two broad categories:

Personal Data:

Personal data means data consisting of information which is related to an individual who can be identified from that information (or from that and other information in the possession of the data users), including any expression of opinion about the individual but not any indication of the intention of the data user in respect to that individual. 'Data' is defined as information recorded in a form in which it can be processed by equipment operating economically in response to instructions given for that purposes.



Note: Personal Identifiable Information cannot be published by the City on Data Platforms under any data sets. Datasets must be anonymized before publishing.

Non-Personal Data:

Non-personal data also refers to anonymous information/data, namely information which does not relate to an identified or identifiable natural person, or personal data rendered anonymous in such a manner that the data subject is not or no longer identifiable. Anonymization means excluding any personal identifiers from data sets.



### 3.4.2. Classification of Data

Personal and Non-Personal Data will be classified into the following categories:

Table 2: Classification of Data Elements

Classification Class Definition

| Level 1 | Public       | Data available for public consumption and use.   |
|---------|--------------|--|
| Level 2 | Internal Use | Information which can only be disclosed to municipal corporation employees for managing operations or delivery of public services on a day to day basis. |
| Level 3 | Sensitive    | Data regulated by any city/ State/Central law or regulation like privacy law etc.  |

|                |            |   |
|----------------|------------|---|
| <b>Level 4</b> | Protected  | Data which needs to be protected e.g. Identity of citizens and disclosure /notification needs to be issued by the municipal corporation in case of any breach or loss of data.  |
| <b>Level 5</b> | Restricted | Data which could lead to a threat to life or loss of public assets or critical infrastructure and are accessible only through a prescribed process of registration and authorization by respective departments / organizations. |

## Eliminating Data Silos through Standardized Access

**3.5**

### 3.5.1. National Data Sharing and Accessibility Policy

National Data Sharing and Access Policy defines standards for publishing data sets and feeds. SCDOs must ensure adherence towards defined standards and classification

- **Open by Default:** Datasets are considered to be open by default unless classified as internal, sensitive, protected or restricted.
- **Meta Data:** Datasets and feeds must be published with proper metadata. Information about the datasets being published using common data taxonomy/structure is needed as it helps in providing easy access through Data Platform.
- **Data Catalogue:** As per NDSAP metadata elements for data sets or feeds are defined as follows:
  - a. Title (Required): A unique name for the catalog (a group of resources) viz. Current Population Survey, Consumer Price Index, Variety-wise Daily Market Prices Data, State-wise Construction of Deep Tube wells over the years, etc.
  - b. Description (Required): Provide a detailed description of the catalog e.g., an abstract determining the nature and purpose of the catalogue.
  - c. Keywords (Required): It is a list of terms, separated by commas, describing and indicating at the content of the catalog. Example: rainfall, weather, monthly statistics.
  - d. Group Name (Optional): This is an optional field to provide a Group Name to multiple catalogs to show that they may be presented as a group or a set.
  - e. Sector & Sub-Sector (Required): Choose the sectors(s)/sub-sector(s) those most closely apply(ies) to your catalogue.
  - f. Asset Jurisdiction (Required): This is a required field to identify the exact location or area to which the catalogue and resources (dataset/applications) caters to viz. entire country, State/province, district, city, etc.
- **Open data:** Data Sets and feeds should be published in formats specified under NDSAP, i.e. Open format. Data should be provided in freely available formats which can be accessed without the need for a software license.

- **Machine Readable:** Data Sets and Feeds should be machine-readable.
- **Formats:** As per NDSAP following data formats should be published:
  - a. CSV (Comma separated values)
  - b. XLS (Spreadsheet - Excel)
  - c. ODS (Open Document Formats for Spreadsheets)
  - d. XML (Extensive Mark-up Language)
  - e. RDF (Resources Description Framework)
  - f. KML (Keyhole Mark-up Language used for Maps)
  - g. GML (Geography Mark-up Language)
  - h. RSS/ATOM (Fast changing data, e.g. hourly/daily)

### 3.5.2. Maintenance and Support

- **Maintenance of Data Sets/ Feeds:** CDO will ensure that published data sets and feeds are up to date and relevant.
- **Support:** CDO will provide required technical and non-technical support over the queries/inputs/ suggestion received from users through email, portal or social media platforms like Facebook, Twitter.
- **Archiving:** CDO will define and set up the process for archiving process. Every data set/feeds catalogue must contain archiving information. Data Sets published over open data portal will be retained as per r etention policy. For specific file type (geospatial files), a recent copy must be made available to users through Data Platform.
- **Ownership:** All datasets/ feeds remain the property of publisher, i.e. CDO. The CDO will endorse Government Open Data License to ensure that published data is not misused or misinterpreted by its users. For more details on Open Data License, please refer: <https://data.gov.in/>
- **Terms of Use:** Smart City will publish Terms of Use to restrict the misuse of data and indemnify the city administration in case of any misuse by the end user.

# People

Institutional  
Governance  
Structure for  
DataSmart Cities



# Key Principles for Evolving an Institutional Structure

4.1

The primary goal of any institutional governance mechanism is to deliver on the set rules of the game. For the DataSmart Cities, these are derived from the principles of data governance, i.e., integrity, transparency, auditability, accountability, stewardship, checks and balances, standardization, and change management (The Data Governance Institute). These principles guide the 'what' part of an institutional governance structure.

It is also important to know who is responsible for delivering and enforcing these rules. While there could be one actor responsible for more than one rule, or vice-versa, there are two broad categories of

actors. These are: a) actors who have authority for decision rights, and b) actors who have accountability for execution (refer figure-2). The latter could be both individuals and group of actors operating as a hub or network. On the other hand, the aspiration to build a 'city-as-a-platform' model would mean the rise of a collaborative governance structure with multiple nodes, amongst which one node would assume centrality in decision-making (could be an individual or a hub).

The institutional structures to be created in DataSmart Cities should be a contextual translation of the above responsibilities and roles.

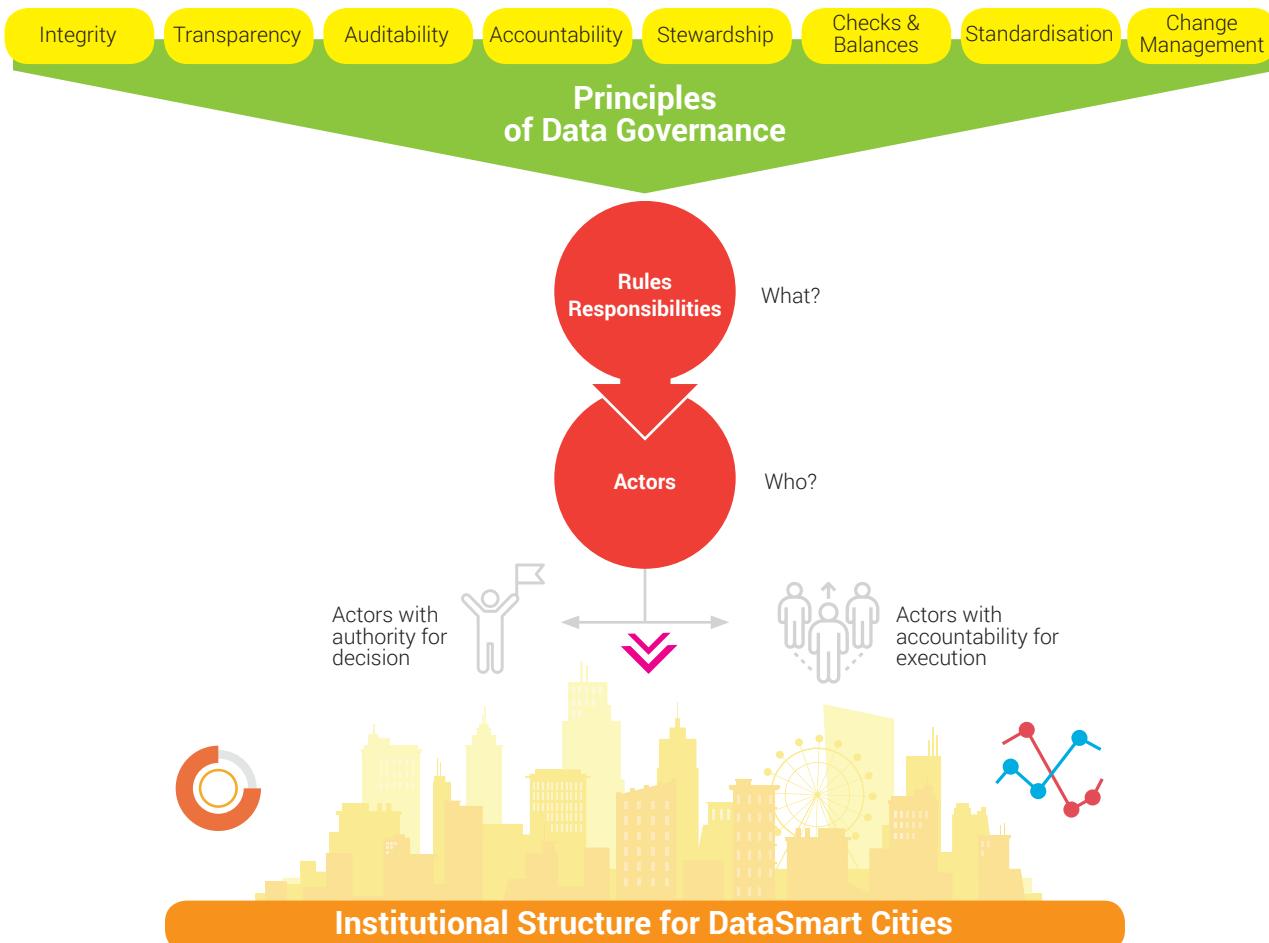


Figure 2: Guiding principles for creating institutional structures for Data-Smart Cities Strategy

Additionally, these structures should uphold the following guiding principles for seamless institutional governance:

- New roles to be integrated/aligned with existing institutional structures
- Rules of interaction to ensure that competing centers of power are avoided
- Operational protocols to ensure cross-functionality across horizontal (i.e., departmental) and seamless information flow through vertical structures (i.e., hierarchies)
- Complementarity of structures at multiple levels of governance, i.e., City, State and Center.

## DataSmart Cities: Recommended institutional structures at city level

4.2

The following table provides a quick view of the actors and their core responsibilities at the city level. More details about these suggested structures are provided in annexure-2.

| What<br>(Responsibilities)   | Who<br>(Actors)  |
|--|--|
| A city level Analytics and Management Unit (City Data Cell) integrated with existing Integrated Command and Control Centers (ICCC) and/or any other existing data platforms  | A pool of staff with skills in data science, ICT and domain knowledge (Data Champions and Data Coordinators)   |
| Implementation of data strategy at the city level which includes: <ul style="list-style-type: none"> <li>• Creation of City Data Cell</li> <li>• Identification of key data sets and publish high-value data sets on the OGD Portal</li> <li>• Convening stakeholders and create networks/ alliances</li> <li>• Ensuring compliance with NDSAP, privacy compliance and required disclosures.</li> <li>• Prioritize data security by ensuring the Confidentiality, Integrity and Availability of data through risk management processes and best practices</li> <li>• Creating systems of resilience and recovery with respect to data</li> </ul> | City Data officer (CDO) - a senior official of the rank of a Chief Technology Officer/Chief Information Officer/Department Head IT or above. CDOs will be supported by a pool of Data Coordinators. The CDO will work with all the departments including those which are outside the jurisdiction of the municipal corporation. For example, power utilities, telecom networks, gas distribution, etc. |
| Commitment and enhanced participation from non-State stakeholders (i.e., citizens, industry, academia) on data-sharing, co-learning and co-creation, creating an open Data Culture, bridging capacity-building needs, creating awareness about importance of Data Culture.   | A City Data Alliance comprising of various key stakeholders including city Governments, other key actors in policy making, various Government department and agencies, representatives of leading academic and research institutions in the city, community organizations, entrepreneurs and advocacy groups   |

Table 3: Roles and Responsibilities at the City Level

## Driving Data Collaboration within States

4.3

It is envisaged that DataSmart cities will continue to empower themselves with better data culture across the vertically and horizontally integrated structures at the city level. Relevant departments and agencies in the respective States will play an important role in helping cities achieve this integration. Two aspects of integration where the State agencies can play a direct role are mentioned below:

**Sectoral data integration in verticals** - Respective State-level departments and agencies related to one particular sector can share data in a common platform. These will gradually need to follow standard data protocols suggested by the national policies and offer cities an integrated platform for accessing sectoral datasets managed by specific departments (such as department of commerce, water resources etc.).

**Horizontal integration of data through State data agencies** - This will largely happen through State level agencies responsible for the collation of data from multiple sectors and thus offer a centralized data repository. The departments for municipal administration under the Urban Development Department (UDD) and the department of statistics in respective States can play a pivotal role in this regard through their MIS platforms. Some States have also formed State Data Centers (SDC) responsible for hosting various applications and servers for different Government departments functioning within the State. Many States also have a State Informatics Officer (or Chief Data Officer for the State) as a State-level conduit of the National Informatics Centre (NIC). It is imperative that Cities, work in coordination with these State-level data entities to realize the full potential of the data hubs and make the desired shift towards a complete data lifecycle, i.e., from data collection to data intelligence. Development of a State level Urban Observatory would add value in this context.

Following are few suggestions for institutional structures for the States to consider in order to become a key functionary in implementing the DataSmart Cities strategy:

- States can nominate/ appoint an officer in charge of urban data who will work in coordination with State Data Centre (SDC) and Directorate of Municipal Administration (DMA) and any other municipal data platforms.
- A State level data hub can be created, or an existing municipal data hub can be upgraded to facilitate implementation of the DataSmart Cities Strategy. This can be a joint cell participated by SDC, DMA and Smart City Mission (SCM) State nodal agency.
- A network of smart cities, Government departments, NGOs, academia, industry can be facilitated at a regional or State level. This alliance can facilitate peer learning and can also act as a knowledge partner for training and capacity building on data.

## Supporting Institutional Structures proposed at National level

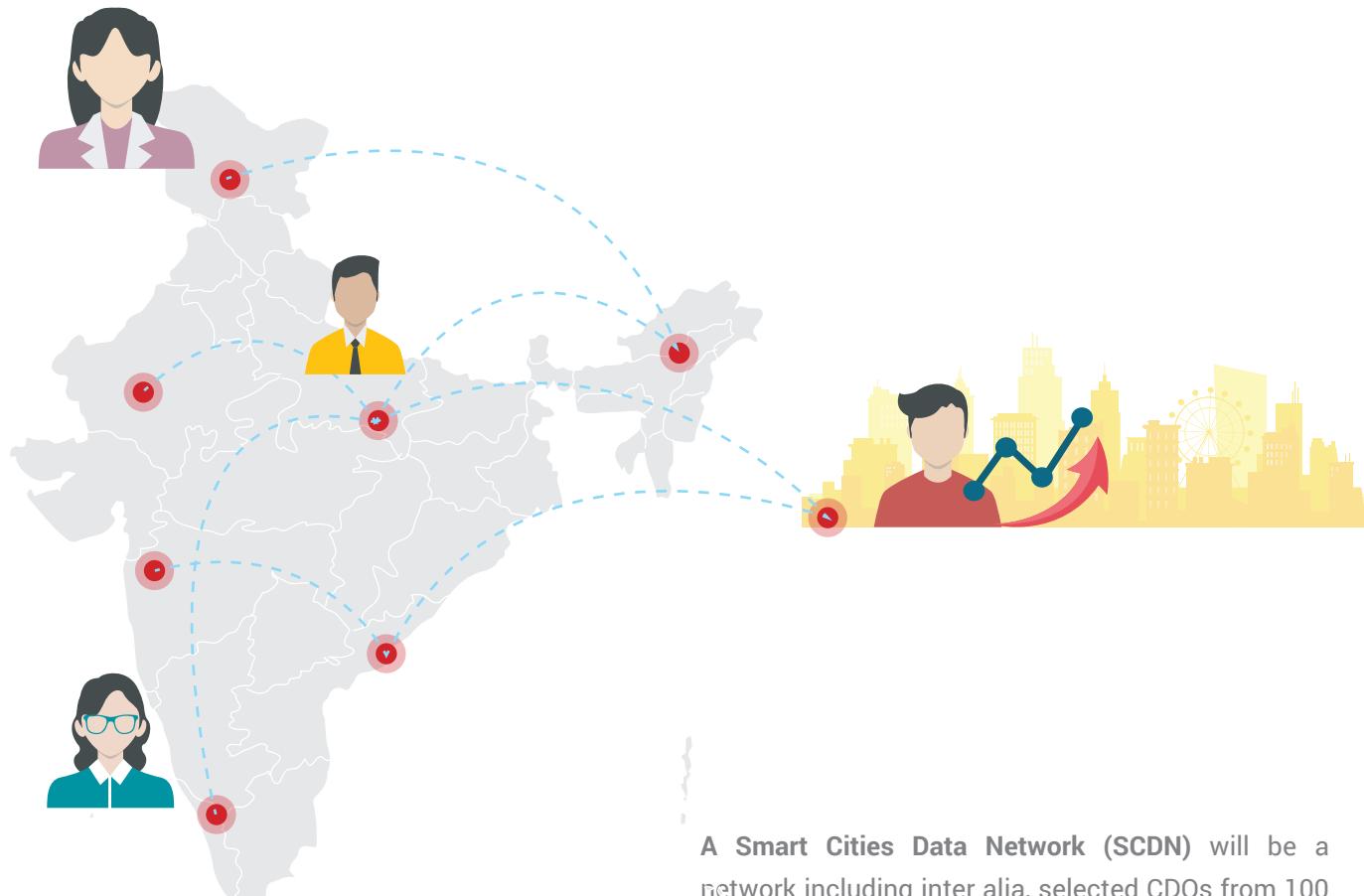
4.4

A **Mission Data Officer (MDO)** will be nominated for SCM by the Mission Director, SCM. The MDO will be an officer of the rank of Director or above in MoHUA. The MDO will be the officer responsible for implementation of the Strategy at national level. The MDO will engage with all 100 smart cities, NDSAP Nodal Ministry (MEITY), NIC and other relevant agencies and organizations to achieve outcomes outlined under the strategy. The MDO will continuously identify key data sets, and high-value data feeds to be published on the OGD Portal. The MDO will prepare and continuously review a negative list in line with NDSAP and other Government policies in consultation with SCDOs.

A **Data Analytics and Management Unit (DAM Unit)** will be constituted within the Smart Cities Mission office to function as a support to MDO in implementing DataSmart Cities strategy. The cell would be constituted of relevant experts in legal framework,

data science, data analytics, communications, and other relevant fields. The cell would act as a key support structure to the MDO to evolve the strategy over time, create capacity building within the smart cities ecosystem, coordinate with different stakeholders, advise on legal frameworks, and create data analytics capabilities within the mission. The DAM Unit will provide coordination, implementation, and hand-holding support to Smart Cities. The DAM Unit will review progress with smart cities every month based on defined Key Performance Indicators (KPIs), chalk out plans, share ideas, brainstorm new use cases, enable peer-to-peer learning and build and share solutions around data sharing, privacy, exchange, data-driven governance amongst various stakeholders of the smart cities and release a status report on the implementation of the strategy every quarter. In short, the DAM Unit cell would be the backbone for implementation of the strategy at national level.





A Smart Cities Data Network (SCDN) will be a network including inter alia, selected CDOs from 100 smart cities, along with representatives from other Ministries of Government (both State and center), industry associations, research organizations, academic institutions and legal firms. MDO will be the convener of SCDN. The SCDN will meet at least once every quarter, physically or virtually. SCDN will act as an advisory body for implementing the DataSmart Cities Strategy of SCM. SCDN will help define policy contours, bring in expertise in understanding the data landscape in other parts of the world, identify best practices in Indian cities, and help in interpreting the legal framework around data. SCDN thus will help the Mission in its effort to use data as a tool for empowerment of the society.

## Building Cooperation in a Federal Structure

4.5

The structures at the three levels of governance are best conceptualized as non-hierarchical. They should complement each other while functioning with desired level of autonomy to achieve their own purpose.

The figure below represents a conceptual framework for integration and compliance between three different levels of data-platforms. It does not show a hierarchical structure, but each one of these represents autonomy of a particular level of urban governance and decision-making.

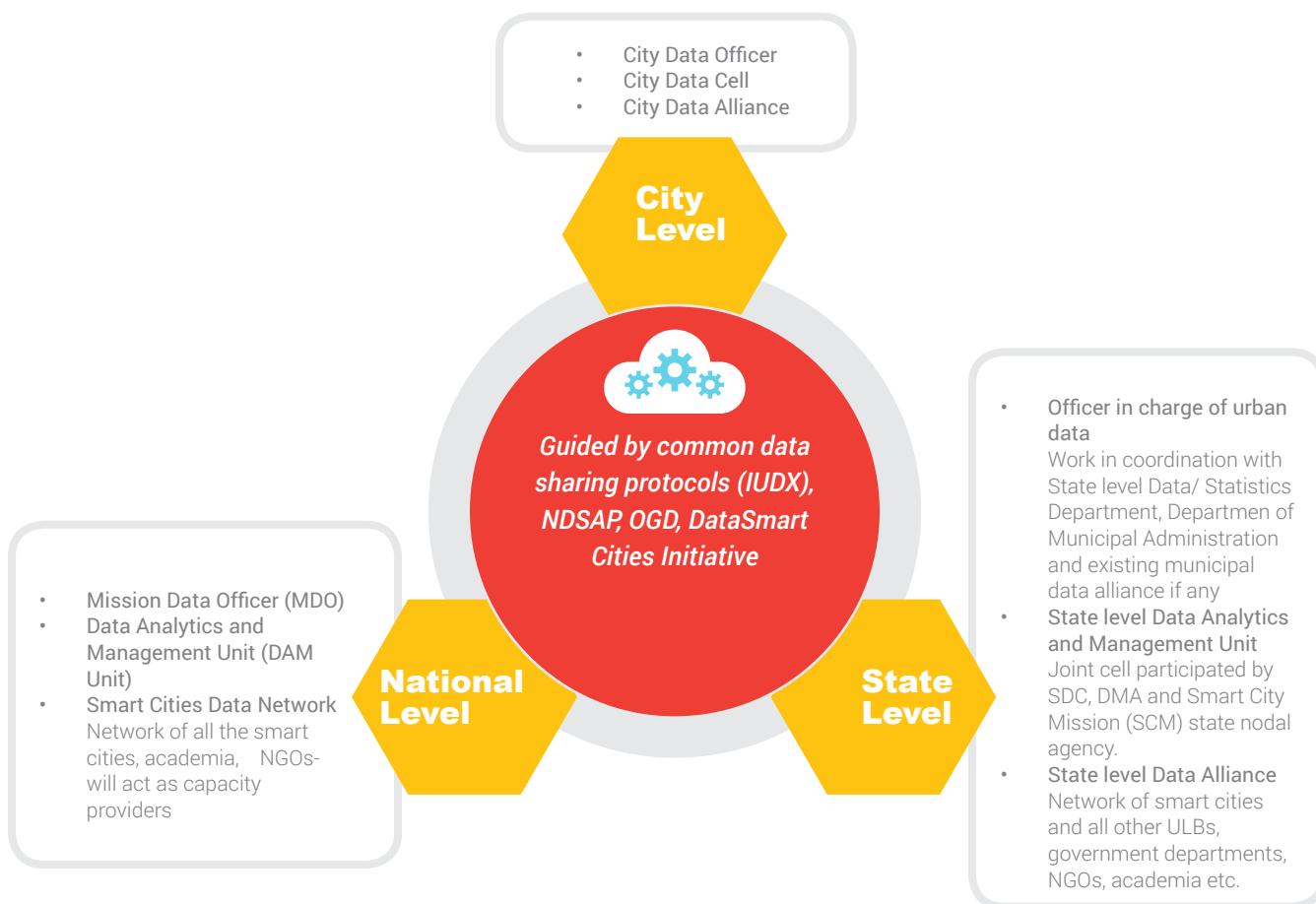


Figure 3: A conceptual framework for the alignment of data platforms at different levels

The proposed data analytics cells (or observatories) will work at different scales (i.e., City, State, National) in a coordinated and integrated manner while being

capable of generating contextually relevant analysis for achieving their respective objectives (refer the following table).

Table 4: Advantages of becoming DataSmart Cities at different levels of governance

| Tier                    | Key Functions   | How the Data Hubs/ Observatories can contribute   |
|-------------------------|---|---|
| <b>ULB/Smart City</b>   | Assess performance  | <ul style="list-style-type: none"> <li>• Track status of achieving service delivery goals in cities</li> <li>• Track compliance with city master plan and aid in iterations</li> <li>• Measure outcomes of schemes, projects, plans, and policies</li> <li>• Track performance through Ease of Living Index, Municipal Performance Index and Sustainable Development Goals</li> </ul> |
|                         | Aid in day-to-day decision making                           | <ul style="list-style-type: none"> <li>• Response to emergencies, disasters, grievances</li> <li>• Service delivery, traffic management</li> <li>• Identifying strategic priorities, fix problems, reduce inefficiencies</li> </ul>   |
|                         | Aid in preparation of plans (land use, infrastructure etc.) | <ul style="list-style-type: none"> <li>• Inform city managers to spot trends in city growth, better forecast impacts and, in turn, inform city plans</li> <li>• Inform regulatory instruments</li> <li>• The National UO can facilitate big data analysis for better decision making</li> </ul>   |
| <b>State and Centre</b> | Status check  | <ul style="list-style-type: none"> <li>• Comparative regional analysis through Ease of Living Index and Municipal Performance Index (of all smart cities in the State)</li> <li>• Assess impacts of programs like SCM, AMRUT, PMAY(U), HRIDAY, SBM (U), DAY-NULM in the State</li> <li>• Track progress towards Sustainable Development Goals</li> </ul>                              |
|                         | Formulate Policies  | <ul style="list-style-type: none"> <li>• Formulation of State/ national policies/reforms for improvement in Ease of Living and Municipal Performance of all cities in the State</li> <li>• Formulate contextually relevant policies based on successful case studies (smart solutions/ reforms) in different cities in the State</li> </ul>   |
|                         | Long term planning  | <ul style="list-style-type: none"> <li>• Identification of data collection requirement in all urban centers based on insights from smart cities in the State, calculation of city GDP</li> <li>• Phase-wise planning for raising the performance of all cities' and bring it at par with smart cities, insights for investment decisions</li> </ul>                                   |

Table 4: Advantages of becoming DataSmart Cities at different levels of governance

## Alignment of the Data Actors with the Urban Local Body

4.6

It is of immense importance that institutional governance aligns with the city governance and not establish a parallel structure. The municipal commissioners of Smart cities will designate a senior official of the rank of a Chief Technology Officer/Chief Information Officer/Department Head IT or above as the CDO. The CDO will act as custodian and driver of City Data Policy (CDP) and a flag bearer of open Government initiative in the respective city.

At the same time, city leadership needs to provide full administrative and logistical support to CDO. Only this can make a city-wide change in Data Culture possible. Leadership, commitment and communication will be



crucial aspects in achieving goals highlighted under the strategy. Thus, it is advised that City Leadership takes active interest in appointing suitable CDOs and providing full support to him/her to successfully implement the City Data Strategy. CDO will report directly to City Leadership and act as a single point of contact for all internal and external stakeholders in the city.

## Capacity Building of Data Officers

4.7

SCM intends to implement DataSmart Cities for all 100 Smart Cities through their ULBs to leverage the potential of data for solving complex urban problems impacting their citizens. This would require regular capacity building of data officers at all levels, vis., City Data Officers, Data Champions and Coordinators and members of City Data Alliance for them to effectively discharge their duties to make these cities DataSmart Cities.

Capacity building of these officers needs to be done in a peer-to-peer manner where various stakeholders of the data ecosystem can collaborate, exchange data and learn. A 360-degree capacity building mechanism needs to be put in place to ensure a learning system

where a variety of stakeholders can benefit from the content and strategies created in one place.

This can be made possible through the National Urban Learning Portal (NULP) which can create a resource-rich ecosystem of learning and knowledge sharing for city managers and primary stakeholders in the data ecosystem of India. It should induce information exchange and collaboration between city administration, professionals, industry, academia, researchers, and startups who strive to solve data challenges with state-of-the-art technologies. This will promote co-creation and innovation and empower Governments and citizens to meaningfully and instantly interact with each other to catalyse urban development for the greater good.

Some of the features of this entity that will enable the capacity building of data officers can be:



### Open Online Learning Platform

Open and free content on a platform for capacity building on the various domain.



### Local Customized Content Delivery

Platform will support content delivery in local languages.



### Collaboration and Engagement

Collaboration and engagement feature to facilitate user discussions over content through the platform. The platform will also generate user insights to gauge the effectiveness of the content.



### Learning Management

Learning management to track user statistics and generate user insights.



### Certification

Users will receive a certificate at the end of their training which can get attached to their record.

The NULP will enable city administrators and officers to create batches and assign trainings to their employees and monitor the progress on a real-time basis thus creating a virtual training environment. They will also receive a certification at the end of their training which will get integrated into their records. This platform can also be hosted on a cloud, creating a seamless learning experience that can be leveraged on the move. The cities will also be able to create a knowledge pool of resources which are tagged for powerful text search capabilities. They will be empowered to provide feedback and inputs and to hold meaningful discussions with each other to create a robust data system for the country.

Stakeholders such as sector experts, industry members, and data officers will be able to connect and share training content or material instantly through this platform. This will encourage them to work together and contribute to the capacity building

The DAM Unit will also be largely responsible for providing capacity building support to the data officers for implementing the DataSmart Cities strategy. The cell would be constituted of relevant experts in legal frameworks, data science, data analytics, communications, and other relevant fields. The cell would act as a key support structure to the MDO to evolve the strategy over time, provide capacity building within the smart cities ecosystem and help in coordination with different stakeholders.

# Platform

Digital  
Infrastructure of  
a DataSmart City



## SmartData Platform and where does it fit in

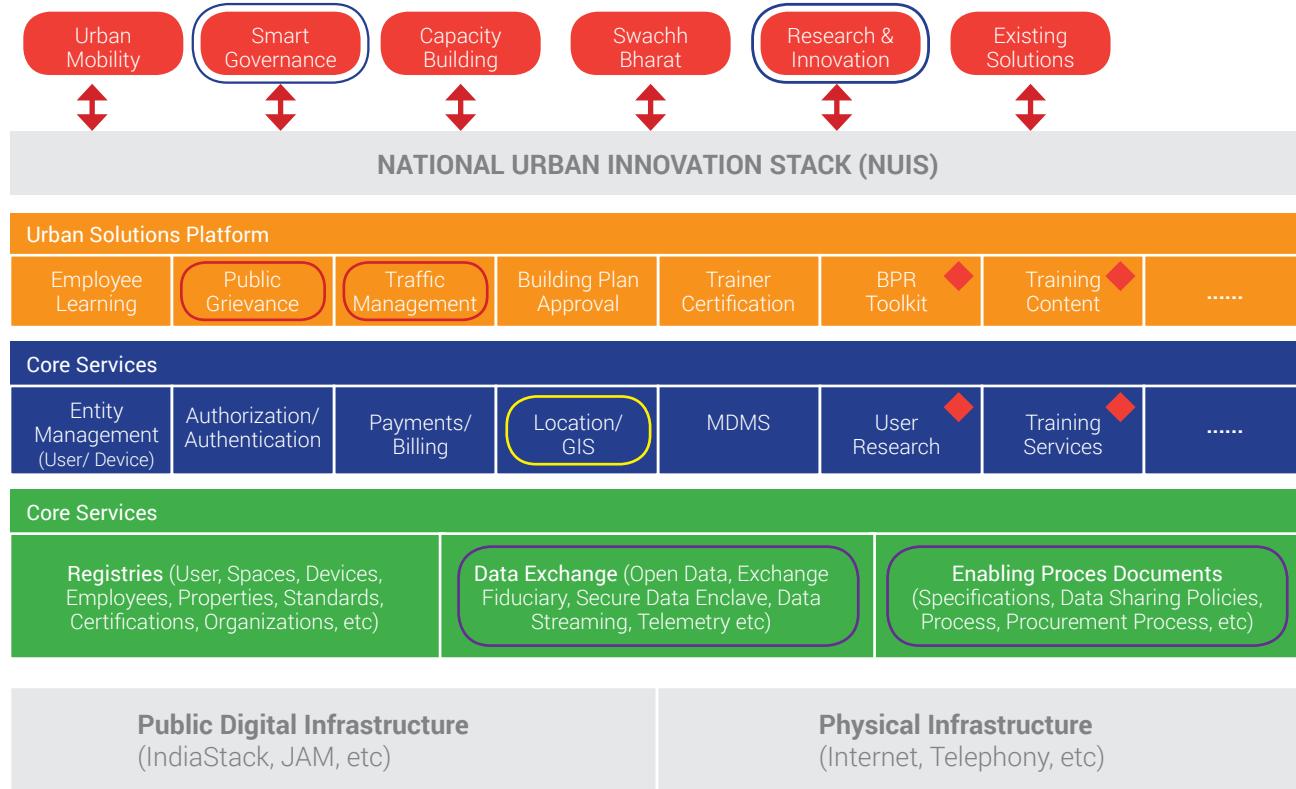
5.1

A DataSmart Cities Strategy Platform can be defined as a set of Digital Infrastructure components needed for the management, analysis and use of data for a data-led governance as laid out in this strategy document.

Smart Cities Mission, MoHUA and National Institute of Urban Affairs (NIUA) have jointly released a strategy paper on National Urban Innovation Stack (NUIS). This document lays down the architectural blueprint for the entire stack as shown in the figure below. NUIS stack provides a good framework of

where a DataSmart platform fits in the entire ecosystem.

As shown in the figure below, the NUIS stack has three layers comprising Core Data Infrastructure, Core Service and the Urban Solution Platform. The DataSmart Cities Strategy will have an influence on all these layers. The red boxes around the examples in the NUIS stack demonstrate the overlap between the DataSmart Cities Strategy with the innovation stack. This is only representational but provides a good idea of where the intersection of data platform lies.



◆ Non Software Elements Process, Documents, Policies

Figure 4: NUIS Architecture

The data platform is of prime importance to this Strategy. It defines the data access principles, the potential sourcing model and the publishing model for the city data.

# Guiding Design Principles

5.2

Much of the design philosophy laid down by the NUIS stack is applicable to the DataSmart Cities Strategy Platform as well.

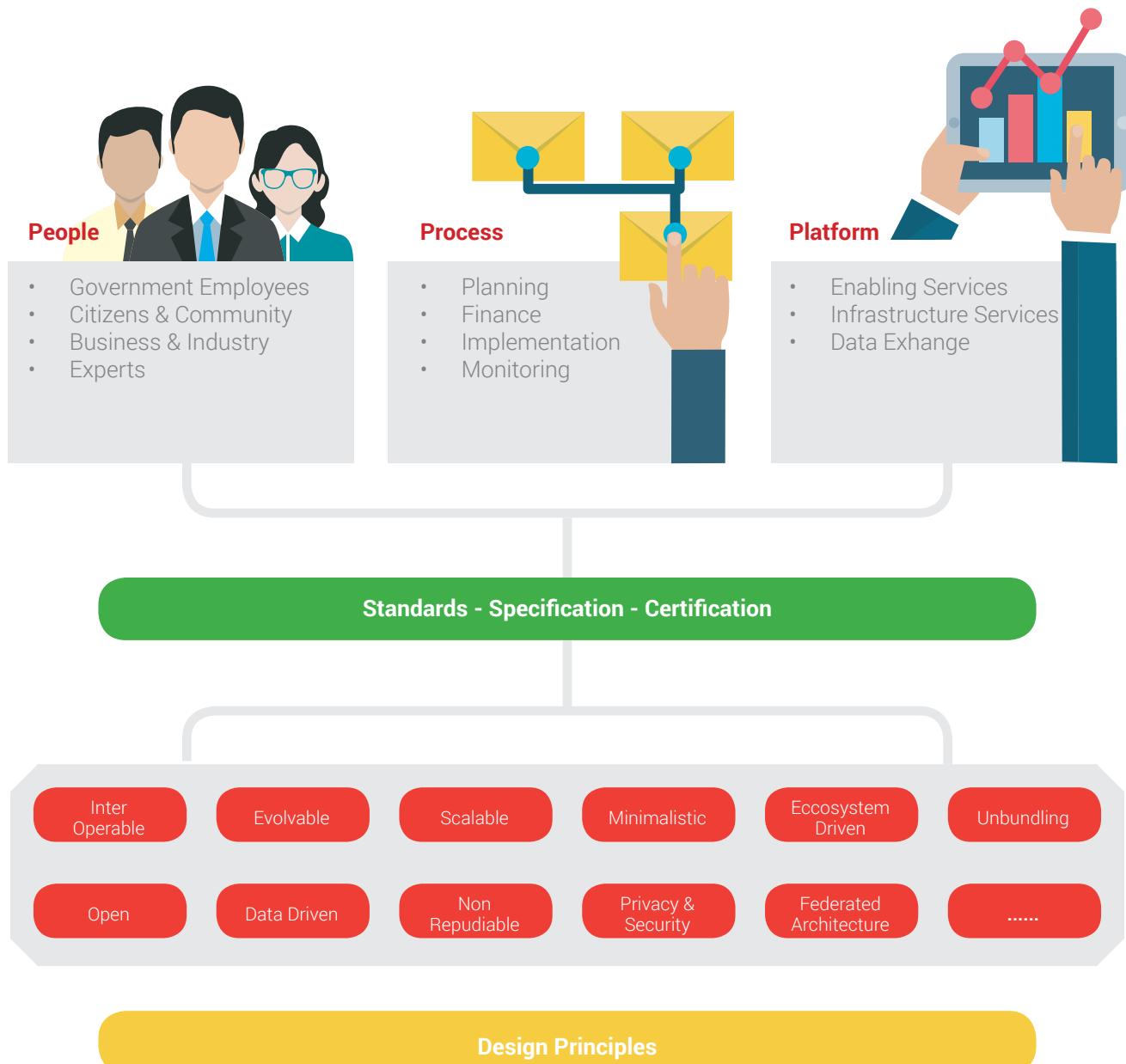


Figure 5: NUIS Stack design Principles

Just as has been indicated in the NUIS stack design principles, inter-operability, scalability, open yet secure are the key tenets of a Data Platform.

Non-repudiability and quality are two implicit requirements without which the data loses much of its relevance.

## Evolution Roadmap of the platform

5.3

It is envisaged that the technology platform will start through a readily available open-data platform and evolve eventually to a mature data market place. The

figure below depicts the evolution of data platforms, as the data maturity increases in cities:

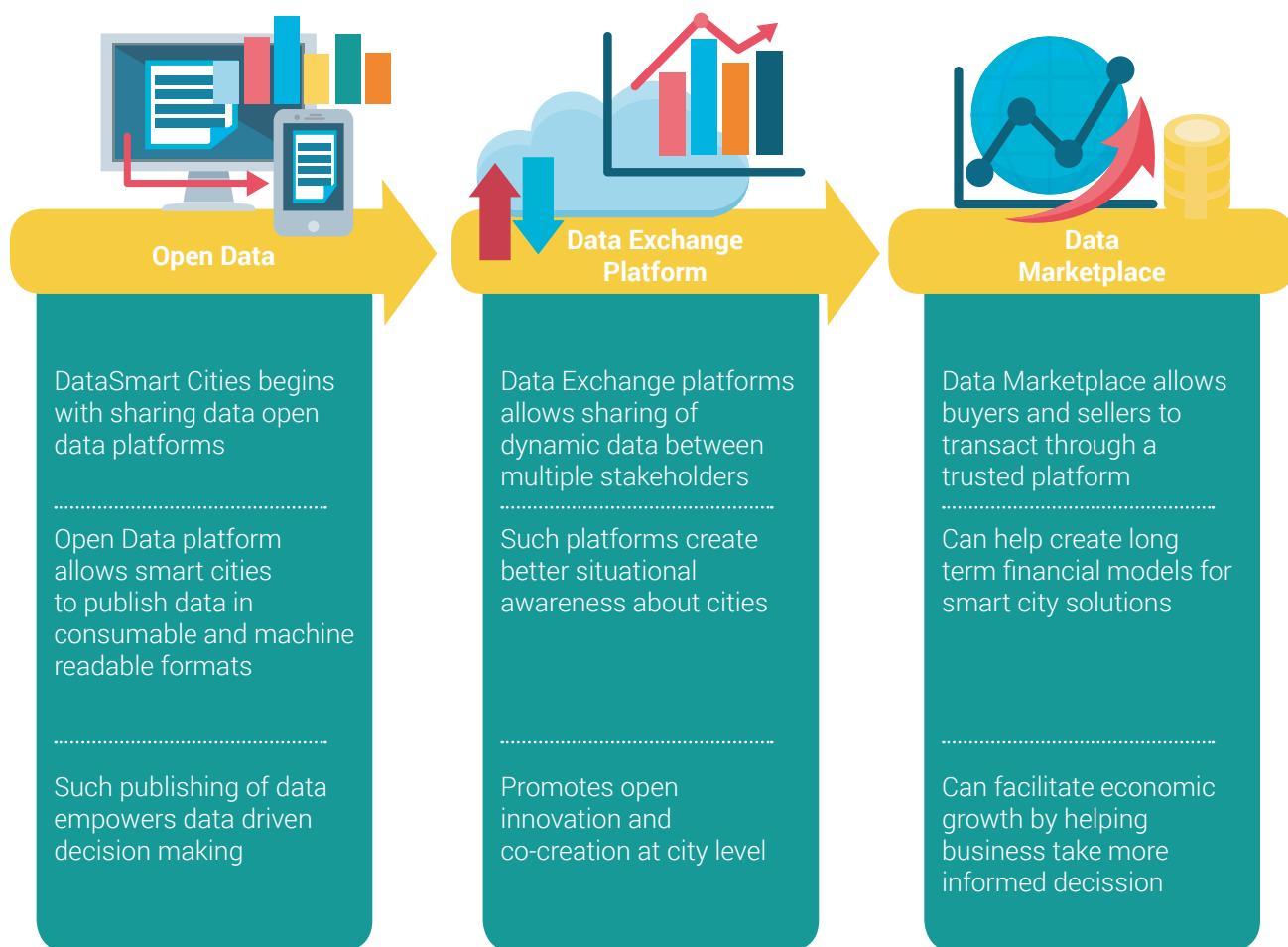


Figure 6: Roadmap of the Data Platforms

The following table provides the purpose and the outcome of the platforms at the various stages of the roadmap:

| Model                         | Purpose   | Outcome   |
|-------------------------------|---|---|
| <b>Open Data Platform</b>     | <ul style="list-style-type: none"> <li>• To create a better understanding of cities</li> <li>• To empower communities through data</li> <li>• To provide insights for data-driven decision making</li> <li>• To strengthen research around cities</li> <li>• To provide free and open static and dynamic datasets covering historical data in a consumable format</li> </ul>  | <ul style="list-style-type: none"> <li>• Increased transparency and accountability</li> <li>• Greater trust on Government</li> <li>• Enhanced G2G, G2B and G2A (Academia) collaboration</li> <li>• Leads to social audit and open Government</li> <li>• Increased public participation</li> <li>• Improved resource or asset visibility</li> <li>• Better decision making thereby leading to more efficient and cost-effective solutions.</li> <li>• Deepen open innovation and co-creation.</li> </ul> |
| <b>Data Exchange Platform</b> | <ul style="list-style-type: none"> <li>• To allow stakeholders to publish and consume the data via a secure platform</li> <li>• Many to many relationships among stakeholders can be established</li> <li>• Platform act as Data Broker to create partnerships between data producers and consumers</li> <li>• Free and open exchange</li> <li>• Controlled exchange via a platform through API metering</li> </ul> | <ul style="list-style-type: none"> <li>• Better decision making thereby leading to more efficient and cost-effective solutions.</li> <li>• Enhanced G2G, G2B, and G2A collaboration</li> <li>• Helps foster data-driven decisions by diverse players in the urban economic ecosystem</li> <li>• Development of vibrant app ecosystem</li> <li>• Leads to advanced research in academic and research institution</li> <li>• Deepen open innovation and co-creation.</li> </ul>                           |
| <b>Data Marketplace</b>       | <ul style="list-style-type: none"> <li>• Marketplace to sell and buy data via a secure platform</li> <li>• One to one relationship among publisher and consumer</li> <li>• Compliance of legal framework around data</li> <li>• Data exchange and payment through the data portal</li> <li>• Central and decentralized architecture.</li> </ul>   | <ul style="list-style-type: none"> <li>• Evolution of the marketplace would help strengthen the urban economic ecosystem</li> <li>• Enhanced G2G, G2B, G2A, and B2B collaboration</li> <li>• Helps cities develop new business models</li> <li>• Empowers communities through the sharing of data</li> <li>• Promotes the development of emerging technologies like Artificial Intelligence (AI), Machine Learning (ML), and Blockchain</li> </ul>  |

Table 5: Data Platforms roadmap

## Open Data Platform ([data.gov.in](https://data.gov.in))

5.4

The Open Data Platform can provide an early foundation for implementing the DataSmart Cities Strategy.

The Central Government through the Ministry of Science and Technology has formulated the NDSAP, while Ministry of Electronics & Information Technology (MEITY) is the nodal Ministry to implement the policy. The policy was notified by DST (Government of India Gazette dated 17th March 2012). For more details on NDSAP, please visit the following link: <https://data.gov.in/>



In pursuance of the NDSAP- Policy notified by GoI in March 2012, MEITY through NIC has set up the Open Government Data (OGD) Platform India to provide open access by the proactive release of data available with various ministries/ departments/ organizations of GoI.

The OGD Platform is now available as Software as a Service (SaaS) model. It is envisaged that Ministries/ Departments will release datasets on proactive/auto consumption basis through Application Programming Interfaces (APIs)/Web Services, i.e. in line with the principles of Open by Default from all e-Government

Service Applications particularly from Digital India initiative of the Government.

The main features of OGD platform include single point access to open datasets, responsive web layout design, enhanced visualization platform, better user experience and efficient discoverability of resources, cataloguing of similar resources, APIs, embedding catalogues, widgets to share filtered set of data catalogues, catalogues subscription, community participation through forums, blogs, infographics, visualizations, etc.

### 5.4.1. Government Open Data License-India:

Government Open Data License has been recently approved to ensure that the data sets released are not misused or misinterpreted (for example, by insisting on proper attribution), and that all users have the same and permanent right to use the data.

Smart Cities endorse Government Open Data License to ensure that published data is not misused or misinterpreted by its users. (For more details visit: [link: https://data.gov.in/](https://data.gov.in/))

Cities like Pune and Surat have already started publishing datasets through City Data Portals. Smart Cities Mission intends to unlock civic data for all 100 cities as per NDSAP. Smart Cities Mission will drive and support the implementation of this strategy in consonance with NDSAP. Smart Cities Mission Open-Data portal will be hosted at <https://smartcities.data.gov.in/>.

# India Urban Data Exchange

5.5

India Urban Data Exchange (IUDX) will be an open source software platform that will facilitate secure, authenticated and managed exchange of data amongst various data platforms, 3rd party authenticated & authorized applications and other data sources, data producers and consumers, both within a city to begin with and scaled up across cities eventually at a national level, in a uniform & seamless way.

The platform will provide full control to the data owners as to what data to expose and to whom. Built-in accounting mechanisms will enable it to connect with payment gateways which will form the foundations for a data marketplace. The whole platform will be developer friendly, via definitions of open APIs and data schema templates (formats for interpreting data), so that a whole new application ecosystem gets created.

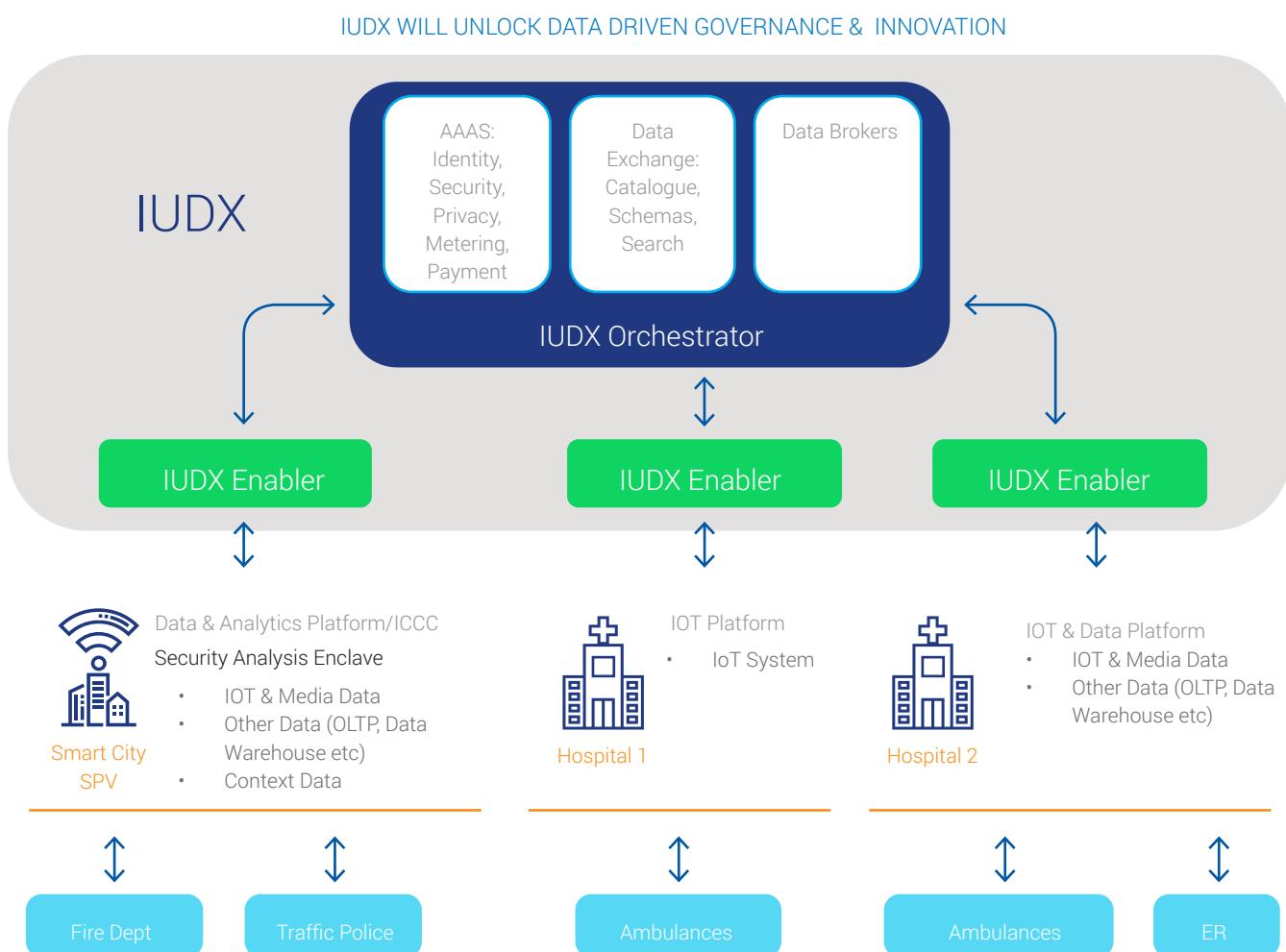


Figure 7: IUDX Platform Functional Architecture

The initial focus will be to enable data exchange between various city departments, between Governments & citizens and Governments & private sector within a city. Going forward, the initiative will scale up to data sharing between various cities & their stakeholders on a national level data sharing platform. It will directly address the issues that inhibit sharing & extraction of maximum value from the city's data.

More details on IUDX are provided in annexure-3.

## Data Marketplaces

As cities start to mature in their generation, usage and governance of data, and develop city data policies with appropriate institutional supports and processes to foster innovation and collaboration, maintain privacy and security and eliminate silos, it will become possible to explore the monetization potential of urban data. When this stage is reached by some of the leading DataSmart Cities, the DAM Unit will collaborate with them and SCDN to develop guidelines for the establishment of data marketplaces in order to help cities unlock the potential financial benefits of urban data. A note on the emerging technologies and their impact on city level data is provided in annexure-4.



# The way ahead



While the most fundamental building blocks have been covered, two more initiatives are required to complete the picture. The formulation of the City Data Policy (CDP) and institutionalizing of a Data Culture.

## City Data Policy

6.1

City Data Policy is the first significant step in the direction to provide conceptual clarity over accessing and sharing protocols over city data. Data Policy must address concerns like data classification, categorization, archival, security, privacy, ownership,

etc. The absence of a City Data Policy also acts as a barrier towards setting up a data economy at the city level. City Data Policy provides clarity around ownership of data, legal framework, terms of use, etc.

CDO will formulate the CDP with milestones in consultation with Smart Cities Data Alliance (SCDA) and MDO. The policy so created will be taken up for approval by the Municipal Commissioner. The policy should among other things, include the following:

- a) **Stakeholders:** Identify relevant stakeholders and respective data needs. For e.g. Employees will require real-time data which could enhance their situational awareness on the ground.
- b) **Identify and create a plan to provision Data Sets and Feed** for development of Use-Cases that are beneficial to the city.
- c) **Current IT Systems:** Assess City IT Infrastructure and identify key IT systems (Project management System, Water, and Sewerage Management System) which could provide public data sets/feeds.
- d) **Proposed Smart Solutions/Projects:** Assess smart solutions or projects under implementation as per Smart City Proposal and identify data sets/feeds which could be published through Data Platform. Work with SI or implementation partner to provision to integrate the solutions with Data Platform.
- e) **Identify Data Sets** from reports or plan published by City Government and agencies through public funds. Also, identify different data sets/feeds which would be published by the city from time to time at regular intervals.
- f) **Road Map with Milestones:** Identify short-term, medium-term and long-term goals along with a timeline for publishing datasets and frequency to update it.

City Administration needs to set up enterprise processes to leverage the existing available data with City administration. City Leaders and officials must establish processes to allow data to flow between departments and users seamlessly internally without any user interventions. The idea is to unlock the data available in-silos with different stakeholders and make it available seamlessly.



## Institutionalizing of Data Culture

6.2

The prime objective in fostering a Data Culture in smart cities is to enable them to make better decisions. The DataSmart Cities Strategy would encourage cities to setup building blocks of Data Culture at the city level such as setting up Smart City Data Alliance, Smart Cities Data Network, and City Data Policy, etc. It also intends to enable peer to peer learning across cities over the data-driven governance and outline use cases for Smart Cities in various domains.

Following are key initiatives required to institutionalize the decision-making culture in Smart City:

- a) **Assess Data Requirements:** City Data Officer along with a team of data champions/ coordinators must assess the data requirements of various stakeholders in the smart city ecosystem. External stakeholders need to be engaged to understand the data requirements of the city.
- b) **Define Use Cases:** Department-specific use cases need to be outlined for decision making or policy formulation keeping in mind the need of stakeholders to enable data-driven governance. Governance includes decision making as well as policy formulation.
- c) **Stimulate Data Demand:** Data demand needs to be stimulated by city leadership in different stages of Project/policy conceptualization, design, implementation, and monitoring. City Leadership may outline the KPIs and scorecard for each line of service to assess the performance of its resources, i.e. manpower, capital, assets to stimulate the data demand across the enterprise.
- d) **Publishing Cross-Cutting Data Sets:** City Data Officer must identify cross-cutting data sets and publish it on a platform based on data needs of various stakeholders in a routine manner. Cross-cutting data sets at the city levels could be leveraged by any department for its purpose. For example location of schools, rates of property in different areas on the map, etc.
- e) **Hackathon / Data Challenges etc. for Urban Innovation:** Government alone cannot solve all its problems. It needs to bring academia and industry together to solve its urban complex problem through co-creation and open innovation. City Data Officer must design a program to solve its problems through a structured challenge process.

## Mission: Data Roadmap

6.3

To facilitate the journey towards a robust Data-Driven Decision-making culture, MoHUA has undertaken a series of initiatives as summarized below:

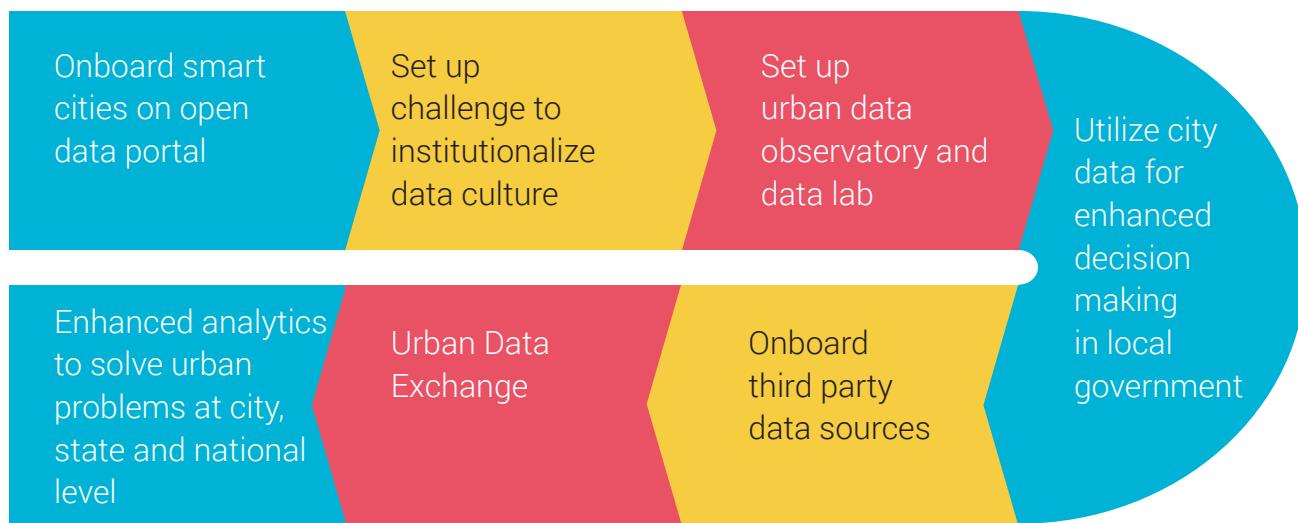


Figure 8: Mission Data Roadmap

- **Onboarding Smart Cities on Open Data Portal** - An Open Data Portal has been created ([smartcities.data.gov.in](http://smartcities.data.gov.in)) for all of the cities' data to be shared on a common platform. This platform consists of all data of a city which are not sensitive (as per NDSAP as mentioned in section 3.4.2 of this document) and can be made available to the public to gain insights or for research purposes.
- **Periodically assess data maturity to Institutionalize Data Culture** – A Data Maturity Assessment Framework has been formulated in alignment with the DataSmart Cities strategy to accelerate the establishment of Data Culture in Smart Cities. In the path towards the success of Open Data initiative by MoHUA, the assessment aims to build a healthy spirit between cities by conducting periodic assessments. It will enable the cities to assess themselves in their journey to become DataSmart Cities. Activities for the cities could range from the building of governance structures, policy enablement, ensuring datasets compliance and quality with suggested guidelines, fostering of data alliances, creating a city data strategy and events such as hackathons, etc.
- **Setup Urban Data Observatory and Data Lab** – These will be in the form of labs, cells or visualization centres as described in an earlier part of the document. The Ministry is currently in its initial stages of setting up the India Urban Observatory at its Delhi HQ and will aim to streamline urban monitoring, supporting data collection for urban indicators through regular data analysis and regular dissemination of urban data. Similar such effort is needed at the level of States and the cities.
- **Utilize City Data for Enhanced Decision Making in Local Government** – The advanced analytics and monitoring streaming from urban data observatories and data labs in combination with the institutionalization of data culture will lead to greater focus on enhancing decision making in local Government using city data. The DAM Unit will facilitate the creation of appropriate toolkits, trainings and resources to support city administrators in incorporating city data into their

decision-making processes.

- **Onboarding of 3rd Party Data Source** – Onboarding of 3rd parties or formation of alliances will be extremely relevant as data lies not only in silos within the municipal departments, but agencies conducting surveys for gaining insights on their respective cities have a plethora of data which can be leveraged if used in the right manner. Conducting hackathons or data-related events at an academic level can help a city gain different angles/perspectives that might have been missing in previous data analysis exercises. Hence, the formation of alliances with these agencies can be of great benefit towards this initiative.
- **Urban Data Exchange** – MoHUA aims for this exchange platform to be an open source software platform that will facilitate, authenticate and manage secure exchange of data.
- **Enhanced Analytics to Solve Urban Problems at City, State and National Level** – As cities bring holistic urban data into the Urban Data Exchange, the DAM Unit will coordinate the application of emerging analytics, methods and technologies to identify and address urban challenges in a systemic manner at the City, State and National Levels.

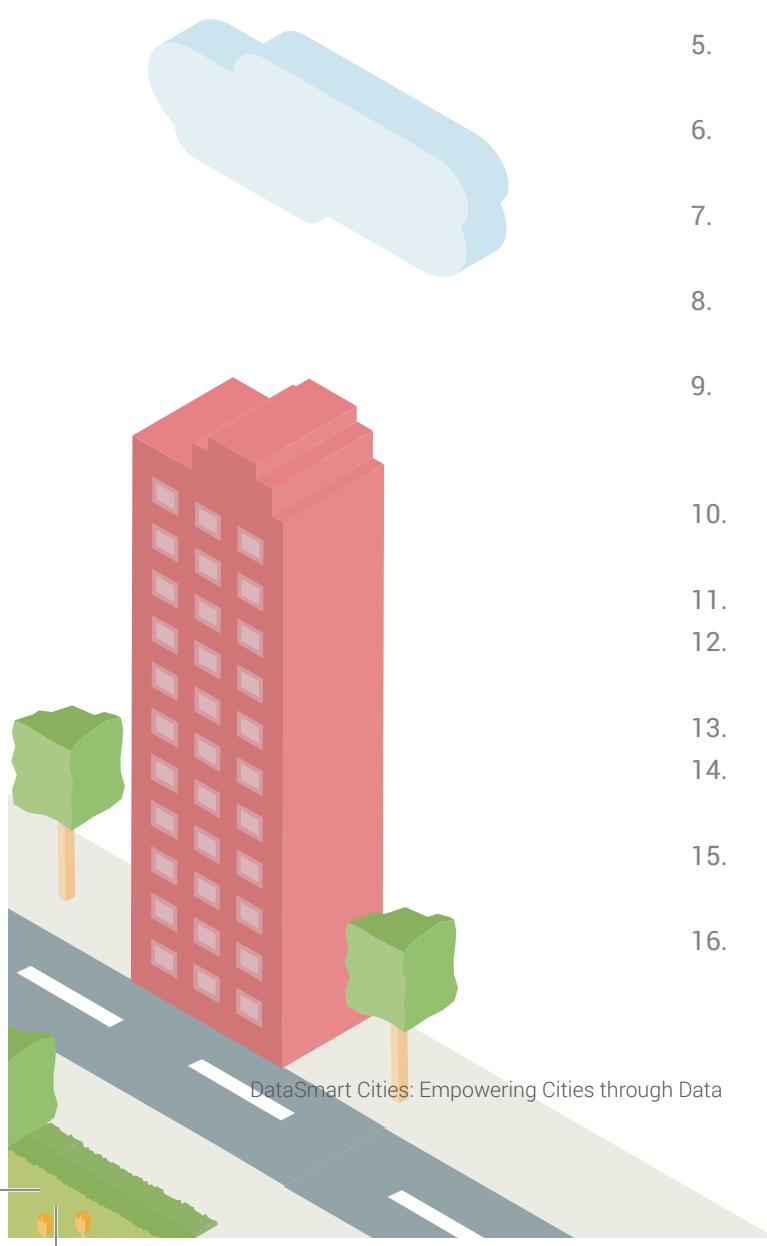
## 6.4. Conclusion

Smart Cities Mission intends to implement DataSmart Cities Strategy for all 100 Smart Cities through their ULBs to leverage the potential of data for solving complex urban problems impacting their citizens by encouraging the sharing of non-sensitive data on a common portal (Open Data initiative).

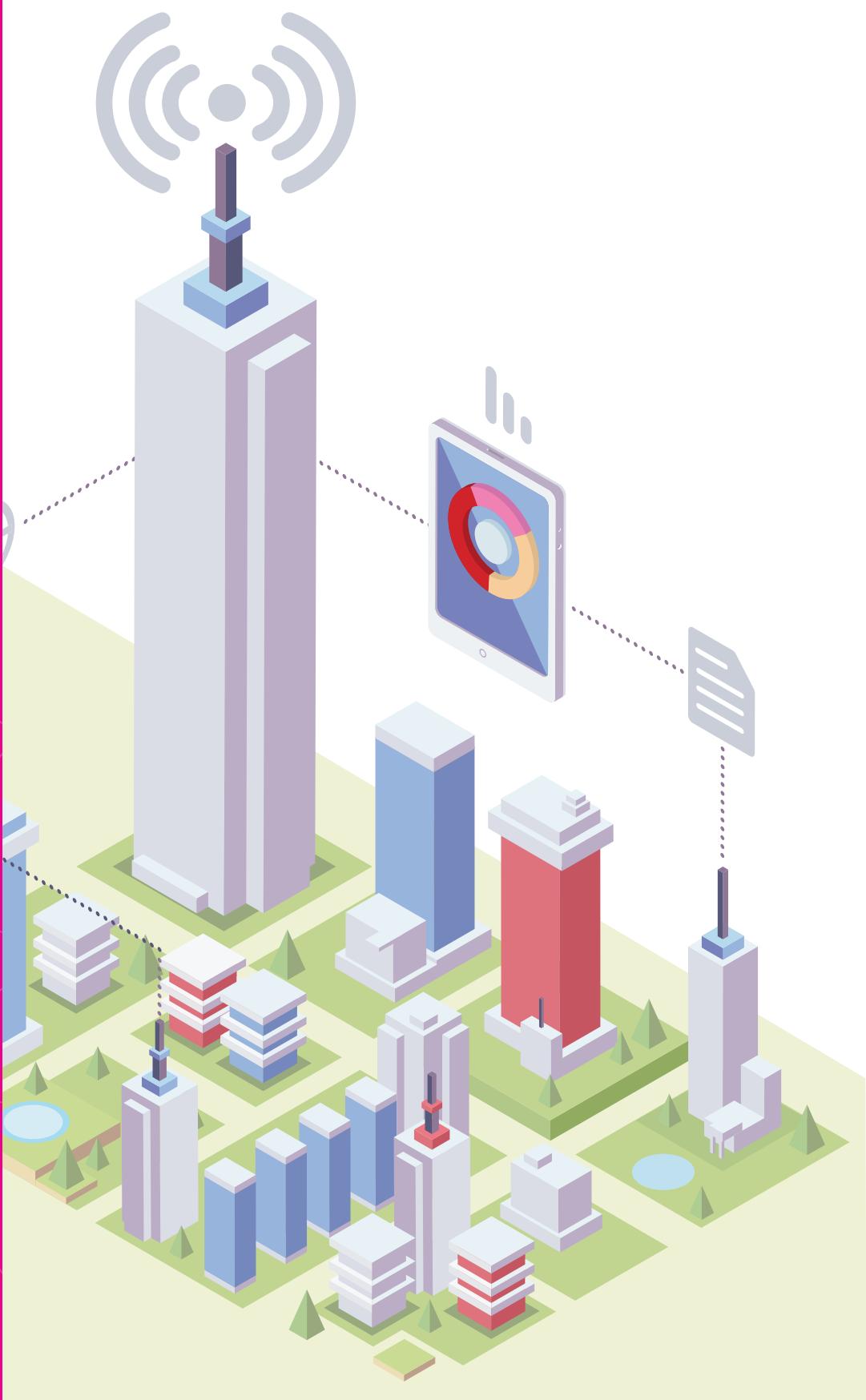
Relevant departments and agencies in the respective States will play an important role in helping cities achieve this integration. Two aspects of integration where the State agencies can play a direct role are sectoral data integration in verticals and horizontal integration of data through State data agencies.

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# Annexure



## Annexure 1: Role of GIS platforms in DataSmart Cities

8.1

Geographic Information System (GIS) is critical aspect in urban analytics as it facilitates spatial analysis which is key for cities which by definition is a geographic entity. GIS as one of the key "system of records" for a city would help various city agencies to work in tandem and collaboratively at all stages such as planning, design, engineering, construction, asset management, operations and development, managing outage situations during emergencies, overall monitoring and for community participation.

Apart from, urban planning, utility services, transportation, public works and citizen engagement, GIS is also being increasingly used in the construction of Smart, Green Buildings as GIS easily interfaces with BIM solutions. Latest developments in 3D GIS and Indoor GIS allow creation of intelligent and interactive digital city models that makes it easy for the city planners to create "what-if" scenarios. This

helps them in understanding short and long term impact of various planning decision they take.

To fully realize the power of technology and yield the benefits to users, there is a need for integrated and collaborative GIS based Information and Communication Technology Platform where we can seamlessly integrate GIS & MIS with Sensor Networks, IoT, Space Technologies, Navigation Systems, Real-time location Intelligence etc. to Innovate, Optimize and Manage Resources, thereby ensuring an improved quality of life for citizens. GIS Platform plays a key role in end-to-end requirements of implementing Smart Solutions for different Departments in an integrated way. Starting from Planning, it supports Designing, Building, Operations, Analytics for Decision Support, Monitoring and Reporting etc. for Smart City Solutions.



Key benefits of an integrated GIS platform include:

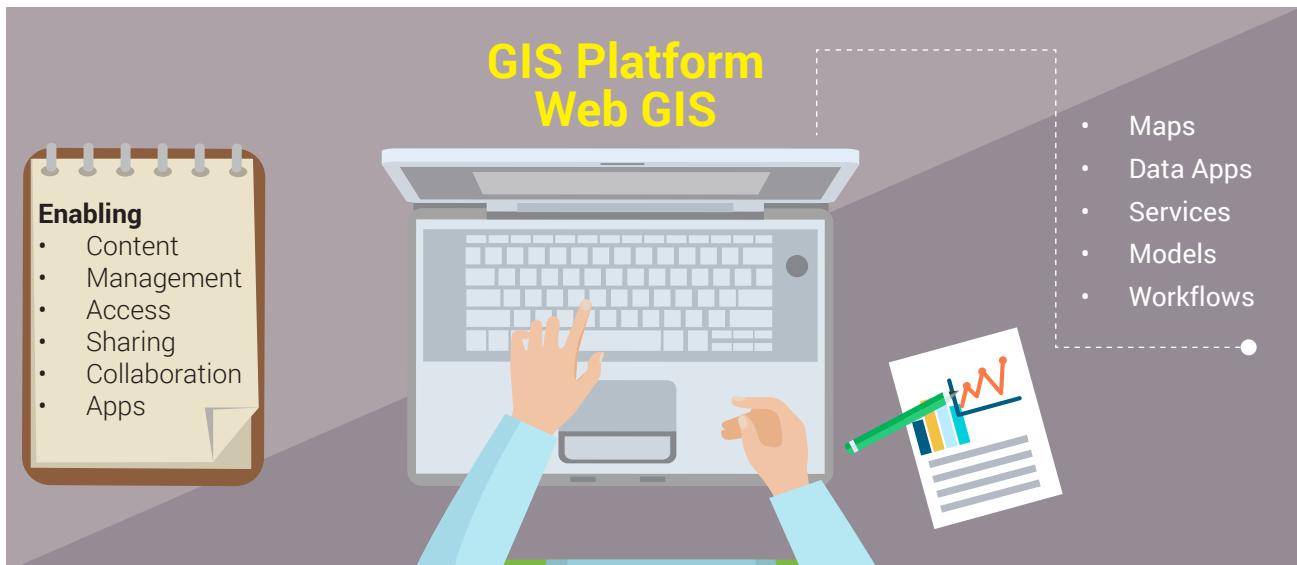
- A Geospatial Platform with a gallery of standardized datasets to allow city-wide use, published via standard web services so that government and private sector entities and citizens at large have the same city level view of GIS data
- Standardized City-wise geospatial datasets, web services ensuring quality and availability
- Collaborative Platform for Accessing & Publishing Contents in a Secured way. Utilize Tools and Solution Templates for building Segment Specific Solutions & Dashboards.
- Seamless Integration of Standardized Data Warehouse covering Spatial / Non-Spatial information required by various levels of City & Departments. All Department & stakeholders will benefit as it will save time, money, and eliminate duplication of efforts.
- Standardized Modular GIS Applications for Planning, Management, Analyzing Data Repository for GIS based Decision Support System
- Promote “virtual geographic information” and transactional workflows that allow department users to remotely update and add content to designated layers.
- Inclusive access to City-wise GIS and its GIS-DSS by private enterprise and citizens – bringing the City onto a single GIS frame and oriented to an all-inclusive support to development activities;
- A designated City-wise entity to drive the effort, a g-data based governance model, an oversight board, providing accountability and transparency to the process, and institutionalized relationship with other government departments, private enterprise and citizens.

The high-level solution architecture recommended by the National Informatics Centre (NIC) is to be **Hybrid In-Premises Cloud and SoA** based distributed Server architecture which supports Creation, Access, Sharing & Dissemination of Geo-Spatial Information, i.e. Web Maps, Apps, Tools & Services through a Simple to use Common Platform. This GIS platform—combined not only with the government’s

authoritative data but also its high-quality maps, visualizations, spatial analysis, models, and other rich applications made available as geo services—would lead to the creation of government-to-citizen, government-to-business, government-to-education, and government to-government applications that would integrate all levels of government and support open access, collaboration, and transparency.



Utilities      Infrastructure      Public Safety      Governance      Communication      Transportation      Healthcare



Sensor Network



Utility Database



Thematic Layer Repository



Topographic Database



Imagery Database



Property Database



Amenities Health Centres School



3D Visualization

Current systems for smart cities largely focus on Infrastructure in terms of ICT, Use of IOT/Sensors and Command Control Centers. The foundation view of Smart Cities has to also include "Planners View" associated topographic, utility, and other location specific survey process and systems for smart city.

Any data coming from devices (IOT, Sensors) and various heterogeneous survey platforms (Drone, LIDAR, DGPS, mobile etc.) has to sit atop of foundation data (representing ground reality as base map) at

particular level of accuracy as per the application requirements. In fact, real time monitoring, tracking and surveillance data include data generated as part of MIS & e-governance workflows to be integrated at top of same foundation data.

The important policies to be referred in this regard are: National Geospatial Policy, 2016; Remote Sensing Data Policy, 2011; National Map Policy, 2005; Drone Regulation 1.0 etc.

## Annexure 2: City level roles and responsibilities



### City Data Officer (CDO)

#### Role

The CDO will act as custodian and driver of City Data Policy (CDP) and a flag bearer of open government initiative in respective city. CDO's major responsibility is to put data to its right use i.e. for generating insights, using data for effective service delivery or infrastructure delivery, improving civic operations by making real time decision making etc. City data officer will work with city leadership to assess and tap the potential of data and set up data culture across the organization and outside the organization.

City Data officer will report directly to City Leadership

and act as single point of contact to all internal and external stakeholders in the city. Leadership need to also deploy dedicated skilled resources to drive the data initiative through CDO. Core objective of setting up City Data Office is to focus on setting up data driven governance culture across organization. It is implied that city leaders will be providing the required leadership support to drive the data driven decision making through seamless data collection, processing and analysis across all departments/government agencies.

#### Responsibilities

- a. The CDOs will create a City Data Policy (CDP) for their respective smart cities which will be reviewed every month to keep it contextual to the need of the times. The policy should be created post engagement with relevant stakeholders. The SCDA would act as advisory body for the review of CDP from time to time. It will be responsibility of Municipal Commissioner to ensure that the policy evolves as per the needs of various stakeholders of the city and relevant upgrades to policy are carried out time to time accordingly.
- b. Coordinate with MDO to align with mission data strategy and priorities with respect to Open government initiatives and policies.
- c. Organize regular meetings of Smart City Data Alliance (SCDA).
- d. Coordinate with officers of various other government departments/agencies within the city for the effective implementation of City Data Policy.



- e. Publish Data Catalogues and Data Sets/Feeds on OGD portal: CDOs will publish data Catalogues and Data Sets/Feeds on OGD Portal and will ensure that such data sets are updated at regular time intervals as needed and create mechanisms for continuous feedback from citizens and stakeholders on type of data sets to be published. The CDO will be responsible for publishing of such data sets/ feeds as mandated as part of Mission Data Strategy.



## Data Champions

### Role

Data champions (DCs) will be senior functionaries, not below the rank of a Head of Department or equivalent, who would champion the implementation of the City Data Policy in their respective departments/ organizations. DCs needs to act as trainers and lead

the team of data coordinators at the department level. DC will be first touch point of CDO in different city organizations and must undertake continuous capacity building programs for their CDOs and other staff.

### Responsibilities

- a. Shall identify the data sets/feeds, derived information, intelligence or data challenge with respect to day to day operations of the department.
- b. Actively publish/ enable to publish data sets/feeds identified as relevant to the resolution of critical use cases for the city. They will work closely with the CDO for active implementation of the City Data Policy.
- c. DCs will be assisted by the Data Coordinators within the department to streamline processes of data reporting, collection and analysis etc. DCs will be responsible for data quality.
- d. DCs will undertake activities to engage with their stakeholders and evolve their department's strategy on data in line with the deliberations.





## Data Coordinators

### Role

Data Coordinators will assist DCs at the department/government agency level as reporting staff.

### Responsibilities

- a. Aggregate the data demand from various channels.
- b. Sensitizing the department employees over the importance of data quality etc



## Smart City Data Alliance (SCDA)

### Role

The SCDA will provide a collaborative framework to create and define use cases to solve critical city problems through the use of data, catalyse the right set of collaborations and networks to make available such data and undertake continuous dialogue between various stakeholders in the city around the City Data Policy so as to inform and evolve the CDP effectively. The alliance will undertake education and

awareness about data in the community, understand and address concerns on data privacy and security, build use cases for city problems, create data collaborations between various government and private agencies for solving relevant use cases and continuously evolve the culture of data in the city's context.



## Responsibilities



- a. To act as an advisory group to the city leadership on the City Data Policy.
- b. To assess the data needs of various Smart City stakeholders.
- c. To promote data driven governance and policy formulation.
- d. To design and implement solutions and analysis using city data.
- e. To support industry to design solutions using emerging technologies like AI, ML and Blockchain.
- f. To assess and design use cases critical to the citizens of the respective cities.
- g. To generate awareness in various stakeholders towards open government initiatives.
- h. To bring Smart Cities stakeholders on common platform to influence the city data priorities.
- i. To facilitate data for co-creation and collaboration over civic issues
- j. To provide critical feedback to the city over the quality and relevance of data provided by Smart City.
- k. To deliver 4 Research paper annually using City Data on Civic Problems in Smart City
- l. To design and develop two prototype/ solutions annually on Civic Problems in Smart City
- m. To organize a data-challenge every half yearly on complex civic problems
- n. To organize a Hackathon annually and support shortlisted solutions at city level
- o. To set up scholarship for postgraduate and graduate interns to work with Office of CDO.
- p. To publish the progress report every month
- q. Prioritize the Data Sets/Feeds for publishing on Data Platform:
- r. To sensitize ecosystem partners to share the data for leveraging data for solving civic challenges
- s. To support, engage and encourage network/groups/members of data enthusiasts in Smart City
- t. To improve city capacity over data driven governance and policy formulation
- u. To support CDOs by extending resources (like interns, researchers, technology experts), funds (program sponsorship etc.) and technology (solutions etc.)
- v. To share data available with partners on Data Platform to promote city data.

## Annexure 3: Representative use cases of Data Exchange (IUDX)

8.3

Smart City projects have been conceptualized through a comprehensive process of citizen engagement and hence are very contextual, relevant to the city's needs and are being implemented by cities through their respective Smart City SPVs. The resulting output/outcomes are therefore quite different for each city, with each city investing in applications, infrastructure,

and services that meet the hopes and aspirations of their citizens and stakeholders. Each city chooses System Integrators (SIs), hardware and software vendors (OEMs), and application developers that best meet its needs through a transparent bidding process.

An illustration of various urban services and Integrated Command and Control Centre (ICCC) in a smart city is shown below:

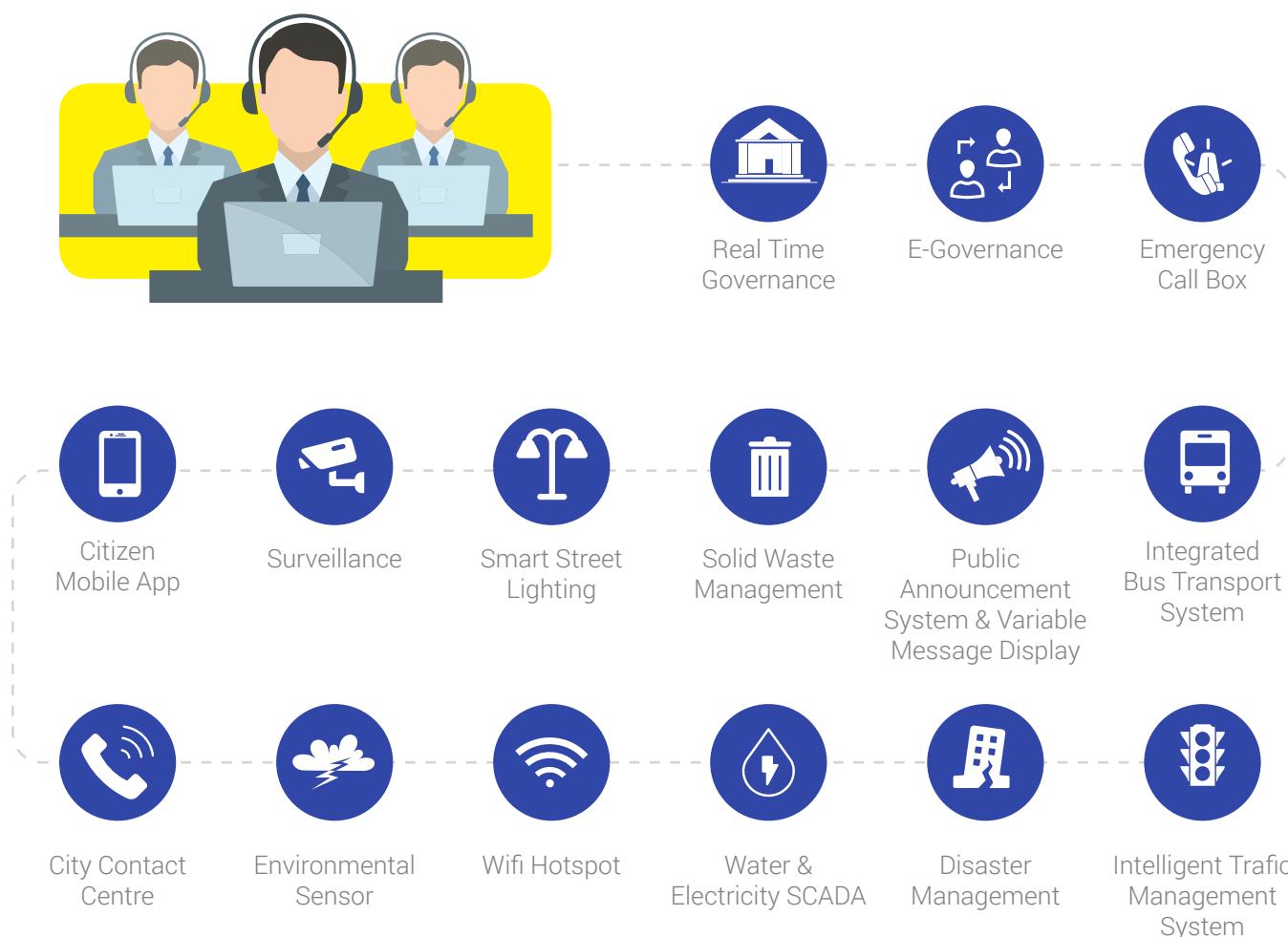


Figure 9: City Command and Control Center

### Stakeholder-specific IUDX Use Cases

A sample set of use cases benefiting various stakeholders in the smart cities eco-systems, by use of a standardized data exchange framework, are highlighted as follows:

Table 6: Sample Use Cases using IUDX

| Stakeholder  | Scenario   | Solution   |
|--|--|--|
| <br><b>Smart City SPV</b> | <p>Smart City SPV CEO would like to fully leverage the investment made under various ICT projects especially ICCC to solve urban challenges like Water Supply, Health, garbage, Emergency Response, Street Light, Environment, Traffic, etc. Data feeds like traffic camera, CCTV feeds, city bus transport data, etc. are under control of different layer of administration like traffic, police, and transport dept. etc. and remain in various silos. Consequently, the city ICCC is not fully operational and utilized.</p> <p>As a CEO he needs a solution to leverage the potential of ICT solutions and take it to the next level to engage the communities in the city to make his city truly smart which works for its citizens.</p> | <p>By integrating the IUDX platform with the existing ICCC platform, it is possible to share data from different applications using standardized APIs. Two systems can easily start sharing and consuming data thereby addressing the challenges posed by different SI/Vendors. SI successfully integrated IUDX and configured various use cases to leverage the potential of ICCC platform in solving civic issues that needed data from more than one source. The city SPV was able to build a standard operating environment among various line departments by cross-leveraging their respective strengths and authorities.</p> <p>The IUDX platform also allowed SPV to integrate a variety of sensors, devices from different suppliers without investing in a different application every time while buying a particular field device, sensor, etc. This helped avoid vendor lock-in as standard-based data sharing was enabled.</p> <p>IUDX also provides a various mechanism that ensures data control, access authorization and secure exchange with seamless sharing of data; the city was able to build monetizable data sets to help sustain their operations.</p> |

|  |  |   |
|--|--|---|
|  <p><b>System Integrators</b></p> | <p>XYZ Ltd (a System Integrator-SI) is working with City Public transport company to set up smart devices on buses to monitor and track the real-time location of buses. The client has asked SI to provide an analytic application to identify un-viable routes.</p> <p>SI estimates license cost to onboard the licensed analytics solution, but cost estimate is on the higher side. Client instructed SI to work on an open source solution to reduce the cost. SI is worried about the efforts and it's cost implication.</p> | <p>Open Smart Cities Consortium India (OSCI) platform has set up a Marketplace to allow startups to distribute innovative new applications. Many creative analytics applications are operational and are available on the OSCI marketplace.</p> <p>SI identifies a suitable application and start-up partner on the OSCI Marketplace that can address the client need, SI works with the start-up to integrate the start-up application with its solution to meet the client requirements.</p> <p>SI saved a lot of effort by leveraging a working application available on OSCI marketplace.</p>   |
|  <p><b>OEMs</b></p>             | <p>OEM has launched environment sensors to check the Air Quality Levels, which could only work with its proprietary application code. OEM is finding it challenging to provide affordable solutions to Smart Cities.</p>   | <p>OEM enables its product integration using IUDX framework allowing the developer community to design innovative solutions using its product for Smart Cities.</p> <p>A local start-up designed an innovative algorithm on the IUDX platform to predict the air quality in the city using environment sensors. OEM integrates the algorithm with its product line and offers a high-quality and affordable solution to Smart Cities.</p> <p>OEM also started conducting workshops with Smart Cities and the start-up community under the OSCI ecosystem to educate them on its product's features. As a result, the OEM was able to align with many other start-ups to provide customized solutions.</p> |

|  |  |   |
|--|--|---|
|  <p><b>Start-ups</b></p>              | <p>ABC Inc., a start-up, has deep expertise in Artificial Intelligence (AI). ABC Inc. has designed a predictive algorithm using AI to predict the next swine-flu outbreak in the city. ABC Inc. needs a lot of city data and lab data to perfect its algorithm.</p> <p>The challenge is the availability of quality data e.g. lab test data of patients visiting private labs.</p> | <p>On the IUDX platform, ABC Inc. got access to masked public and private labs historical data of Swine flu cases, which preserved the privacy of individuals. ABC Inc. also got access to spatial and demographic data of the city. ABC Inc. used these disparate data sets and perfected its algorithm for predicting the swine flu outbreak in the city.</p> <p>ABC Inc. deployed the prototype and showcased it to city healthcare officials showing a risk heat map. City officials were amazed that the algorithm was able to predict the outbreak with 95% accuracy.</p>                               |
|  <p><b>Citizens</b></p>               |  | <p>Citizens have experienced improved quality of life as Smart City SPV can leverage the data generated through various technology projects deployed across the city. Smart City is working with various start-ups to deploy innovative open source solutions to address urban challenges.</p>  |
|  <p><b>Academic Researchers</b></p> |  | <p>Sumit (name changed) is doing his Ph.D. in Mathematics from a reputed university. He conceptualized the mathematical model which could potentially reduce traffic congestion. But he needs real-time traffic data to design a working prototype before he could showcase the product to the industry. He shared his limitation with his Professor guide who suggested him to check the availability of data on IUDX platform of the city. Sumit was able to access the daily traffic data at no cost as he registered himself as a university researcher. He was able to design his working prototype.</p> |



## Universities

The university has set up the Data Science Center under the Department of Statistics. They have also designed the certificate course for teaching data science using various statistical techniques. University Data Science cell is approached by Smart City -City Data Officer to design solutions around City Urban Challenges. Data Science cell deployed three students to work over select areas with City Data Officer. University students using the data from IUDX platform designed an algorithm which could work to predict the outbreak of communicable diseases in the city. City Data Officer using developer deployed the open source code on the OSCI platform which is now being used by ten other cities.



## Developer Community

City Data Officer has set up a developer community group to invite like-minded developers to work on the open source code for city operations. Developer community contributed to the development of solutions, and in turn, developers got hands-on experience in designing and working over Smart City solutions.

Also, developers who have experience on different components like devices, interface, security, etc. contributed to add best features to make the product rich in features.

CDO received an overwhelming response from the developer community.

## Annexure 4: Emerging Technologies and the impact on City Data

8.4

Emerging technology needs to be a core part of every city's strategy. While each city's strategy for how to best exploit them will vary, these technologies will have the most significant global

impact across industries. The evolution of these technologies and the benefits derived from them depend, to a large extent, on the availability of relevant data and their usage.

Table 7: New Technologies for data acquisition

| Technology   | Description   | Sample Use Cases  |
|--|---|---|
| <br><b>Blockchain</b> | Distributed electronic ledger that uses software algorithms to record and confirm transactions with reliability and anonymity. The record of events is shared between many parties, and information once entered cannot be altered, as the downstream chain reinforces upstream transactions. | <ul style="list-style-type: none"><li>Identity management</li><li>Voting</li><li>Peer to peer transactions</li><li>Supply chain management</li><li>Smart contracting</li><li>Provenance / traceability</li><li>Asset registration/ownership</li><li>Trade finance</li><li>Record management</li></ul>             |
| <br><b>Drones</b>   | Air- or water-based devices and vehicles, for example, Unmanned Aerial Vehicles (UAV), that fly or move without an onboard human pilot. Drones can operate autonomously (via onboard computers) on a predefined flight plan or be controlled remotely.  | <ul style="list-style-type: none"><li>Insurance claim validation</li><li>Precision farming</li><li>Infrastructure inspections</li><li>Railway safety</li><li>Cargo delivery</li><li>Construction site management</li><li>Forestry management</li><li>Facility inspection (wind, turbine, oil rig, etc.)</li></ul> |

|   |  |  |
|---|--|--|
| <br><b>Internet of Things</b>                            | <p>A network of objects – devices, vehicles, etc. – embedded with sensors, software, network connectivity and compute capability that can collect and exchange data over the internet. IoT enables devices to be connected and remotely monitored or controlled. The term IoT has come to represent any device that is now “connected” and accessible via a network connection. The industrial IoT is a subset of IoT and refers to its use in manufacturing and industrial sectors.</p> | <ul style="list-style-type: none"> <li>• Inventory and material tracking</li> <li>• Real-time asset monitoring</li> <li>• Connected operational intelligence</li> <li>• Customer self-service</li> <li>• Usage and performance benchmarking</li> <li>• Data integration and analytics</li> <li>• Connected service parts management</li> <li>• Remote service</li> <li>• Real-time market insights</li> <li>• Flexible billing and pricing models</li> </ul> |
| <br><b>Robots</b>  | <p>Electro-mechanical machines or virtual agents that automate, augment or assist human activities, autonomously or according to a set of instructions – often a computer program.</p>   | <ul style="list-style-type: none"> <li>• Manufacturing</li> <li>• Hazardous industries</li> <li>• Hotels and tourism</li> <li>• Service industry</li> <li>• Automation of predictable tasks</li> <li>• Data management</li> </ul>  |
| <br><b>Virtual and Augmented Reality (VR &amp; AR)</b> | <p>A computer-generated simulation of a three-dimensional image or a complete environment, within a defined and contained space that viewers can interact with in realistic ways. VR is intended to be an immersive experience, sometimes with the addition of information or visuals to the physical world, via graphics and audio overlay, to improve the user experience for a task or a product.</p>   | <ul style="list-style-type: none"> <li>• Immersive journalism</li> <li>• Virtual Workplaces</li> <li>• Virtual Showrooms</li> <li>• Manufacturing/product design</li> <li>• Architecture &amp; construction</li> <li>• Education &amp; training</li> <li>• Big data management</li> <li>• Entertainment</li> <li>• Healthcare</li> <li>• Merchandising</li> </ul>  |



## Artificial Intelligence

Software algorithms that can perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and language translation. AI is an “umbrella” concept that is made up of numerous subfields, such as machine learning, which focuses on the development of programs that can teach themselves to learn, understand, reason, plan, and act (i.e., become more intelligent) when exposed to new data in the right quantities.

- Managing personal finances
- Trading systems
- Real-time fraud and risk management
- Automated virtual assistants
- Underwriting loans and insurance
- Customer support, transactions, and helpdesks
- Data analysis and advanced analytics

Data will form a basis for the development of these technologies in years to come. While some of these technologies like AI and robots will require the availability of relevant and structured data, other technologies such as blockchain and drones

will create data that will loop back into the data ecosystem thereby enhancing the Data Culture of cities. This system of data creation and usage which will form an integral part of DataSmart Cities.







**Ministry of Housing and Urban Affairs**  
Government of India