Harnessing the Potential of
Artificial Intelligence

AI Playbook
for Cities

CONTENTS

"It gives me immense pleasure to release the AI Playbook for Cities – a comprehensive document on the role of Artificial Intelligence and its extensive potential in the context of Indian cities. It introduces urban practitioners and policy makers to AI, while providing a step-by-step guide for its adoption in cities, along with an indicative framework for outcomes.

The adoption of new technologies is begetting improvements in quality of life, increased connectedness, and delivering benefits to citizens. Cities are already improving their productivity by adopting and adapting to emerging technologies including autonomous systems, robotics, artificial intelligence, and IoT sensors for their current operations. AI's role in facilitating the improved scale of services, inclusive access to government services, and effectiveness in service delivery implies a whole new pathway for government interventions. AI-enabled smart urban solutions have the potential to bring numerous benefits, including inter alia more efficient energy, water and waste management, reduced pollution and traffic congestions, and increased reliability of public services.

One of the key tenets of our Hon'ble Prime Minister's Digital India Campaign is to ensure that the government services are made available to citizens more efficiently by leveraging data and digital technologies. The Smart Cities Mission has triggered the creation of an ecosystem in cities for harnessing the power of data and digital technologies. Through the DataSmart Cities initiative - an ambitious data-driven development program launched by the Smart Cities Mission in 2019, 100 cities have undertaken a journey to transform the way they utilize data for providing core services, clean environment, and healthier quality of life to their citizens. The AI Playbook has been created at an opportune time, when cities are looking to transform themselves in consonance with opportunities arising from the rapid pace of urbanization.

I am glad that MoHUA, MeitY, NITI Aayog, World Economic Forum and several other stakeholders were able to come together and jointly create this playbook. I believe this playbook will act as a foundational document for city administrators, policy makers and practitioners.

Shri Hardeep Singh Puri
Hon'ble Minister, HUA

"Digital technologies are changing the way we live and work in an unprecedented manner. The ever-expanding use of Artificial Intelligence in various urban sectors has sparked interest in governments across the world about its abundant prospects, owing to its vast potential in unlocking economic value and mitigating social challenges.

There are many examples of how by deploying AI, the conventional ways of working can be changed extensively to bring more efficiency and effectiveness in service delivery and improve lives of citizens. As AI becomes better and more pervasive, it is an appropriate moment for us to comprehend its ability and commence the building of AI footprints in our cities. If leveraged to its full potential, it can aid in transforming cities for making them smarter, faster, and predicting opportunities for advancement.

Smart Cities Mission, through its wide gamut of inventive initiatives and regular citizen engagement, has helped build greater appetite for more transformative interventions. In line with the vison of transforming cities through technology and innovation, I am delighted to note the release of AI Playbook for Cities, a document to facilitate AI adoption in cities for better urban governance.

I congratulate the teams from MoHUA, MeitY, NITI Aayog, World Economic Forum and all others who have contributed to this landmark publication. This playbook will act as a ready reference for guidance to city practitioners throughout their AI journey.

Shri Kaushal Kishore
Hon'ble MoS, HUA

"Artificial Intelligence (AI) is primed to disrupt our world. The economic potential of AI has been widely highlighted by policy makers, technologists, academics, and civil society across the globe. With machines becoming intelligent and enabling high-level cognitive processes like thinking, learning, and decision making, coupled with advances in data collection and aggregation, analytics and computer processing power, AI presents tremendous opportunities to complement human intelligence and enhance the way people live and work.

In India, NITI Aayog released the National Strategy on Artificial Intelligence in 2018. It highlights the potential of AI to solve critical challenges being faced by citizens in areas such as health, agriculture, and education, in addition to the economic returns that it can bring. An integral part of this strategy involves tackling complex challenges by introducing technological interventions. India's enormous scale and opportunity landscape provides the ideal testbed for developing such solutions and ensuring their long-term sustenance.

AI continues to advance rapidly and the discourse on AI ethics and governance is evolving likewise. Globally, a number of different sets of 'AI ethics principles' have been put forward by various organizations. To showcase how India can leverage AI responsibly, NITI Aayog has also released papers that showcase how AI needs to be used responsibly – 'Part 1, Principles for Responsible AI' and 'Part 2- Operationalizing Principles for Responsible AI' that will help balance innovation and governance of potential risks.

I am pleased that NITI Aayog could support MoHUA in developing this AI Playbook for Cities and propel the AI agenda for urban India. This Playbook is meant to serve as an essential roadmap for the AI ecosystem in urban India, encouraging adoption of AI in a responsible manner in cities and building public trust in the use of this technology.

Shri Amitabh Kant
CEO, NITI Aayog

"The world is witnessing two megatrends at present. First, it is the rapid and large-scale urbanization, wherein more than 50% of world population now lives in urban areas and second the advent of emerging technologies which has spurred a new era of technological advancements. We stand at a confluence from where on the superposition of these two trends could unleash innumerable benefits for our urban populace including enhanced quality of life, improved state of urban environments, mitigating impacts of climate change, and combating sudden public health crises and economic shocks.

MoHUA, through its flagship Smart Cities Mission, has successfully laid the foundation of technology deployment in cities via various initiatives like Integrated Command and Control Centers, National Urban Digital Mission and DataSmart Cities Strategy. Since the inception of the Mission in 2015, all 100 cities have reinvented themselves to challenge the status quo and have come up with innovative means of leveraging technology to increase their operational efficiencies, revamp service delivery to citizens, and augment their capacities.

AI is poised to become the catalyst for the next wave of smart urbanization and will create a transformative impact on economic productivity and quality of life. The AI Playbook for Cities is an attempt to chart out a roadmap for AI implementation across cities and empower them with the foundational understanding of its deployment. It also contains a set of illustrative use cases for cities and other invested stakeholders. The exponential pace of technological advancements can pose a new array of challenges for cities and may derail their efforts of becoming smart. This playbook also aims to augment the preparedness of cities and provides them with processes and frameworks on the adoption and deployment of AI solutions.

I would like to congratulate the Mission Director, Smart Cities Mission and appreciate the work done by his team in the Ministry, who along with partners have created this wonderful playbook for cities. I consider this playbook to be a critical step towards ensuring that the transformative potential of AI is used for the benefit of citizens and humanity overall.

Shri Manoj Joshi
Secretary, MoHUA

"As one of the frontier technologies shaping businesses and service delivery, Artificial Intelligence has graduated from being just a technology to becoming a capability of national importance.

Speaking at India's first global AI summit - "Responsible Use of AI for Social Empowerment (RAISE)" that was organized by the MeitY, the Honorable Prime Minister of India stated India's vision to become a global hub for AI. To fulfil his vision, MeitY is working on the National Programme on AI (NPAI), which is in the advanced stages of finalization. It will take a holistic effort on the part of the government, our lawmakers, industry, academia, and the common citizen, to ensure that we unlock this potential. Through its "AI for All" approach, MeitY already has several initiatives underway to prioritize the use of Responsible Deployment of Artificial Intelligence for Social Good.

For instance, MeitY launched the 'Responsible AI for Youth' program to provide India's youth with an innovative mindset and a range of skills to prepare them for employment in the digital economy. In May of 2020, The Ministry of Electronics and IT and NASSCOM jointly launched the National AI Portal of India (INDIAai.gov.in) and subsequently the National Language Translation Mission (for making use of NLP for Indian regional language translation), PARAM SIDDHI AI (for supercomputing), Visvesvaraya PhD Scheme, Centre of Excellence in Artificial Intelligence, FutureSkills PRIME, etc. MeitY has also recently released 75 case studies of successful and impactful AI use cases implemented across India by various government agencies, corporates, start-ups, and academia to promote awareness on the potential of AI at work.

It is a pleasure to see MoHUA striving to create enabling measures to achieve the AI aspirations of the urban sector. Given our commitment to Responsible AI for All, I am pleased that MeitY could contribute to developing this AI Playbook for Cities. Given MoHUA's demonstrated steadfastness to secure the data and tech ecosystem in the urban sector, I am certain that stakeholders across the smart cities and innovation ecosystem will find immense value in this toolkit as well. MeitY is keen to support the burgeoning governance and scaling needs of the innovation that it to follow through the NPAI.

Shri K Rajaraman
Secretary, MeitY

" India's urbanization will be one of the defining features of the 21st century. Its city governments have the potential to propel economic development, create better livable environment for citizens, and ensure environmentally sustainable growth. At the current growth rate, India's urban population is estimated to reach 600 million by 2030 and by 2050 this will become more than 80 million (WUP, 2018). The quality of India's urbanization will be instrumental in the overall quality of life and economic outcomes of the country.

It is essential to note that urbanization brings with it both opportunities and challenges. The ability of cities to maximize agglomeration benefits while minimizing the negative effects of accompanying challenges, would decide how successfully India's urbanization drives the achievement of national outcomes. It is imperative for India to manage urbanization well to enable its citizens to achieve their full potential. This will require tremendous leadership and vision along with the ability to engage, understand, and act based on evidence, test solutions in an agile manner, and adopt latest ideas and solutions. Traditional solutions will have to give way to an ever-evolving paradigm of innovation.

Digital technologies bring immense power of visualization, analysis, integration, and decision-making for city leaders. They can help drive the process of solution discovery by enabling creation and curation of networks, set up mechanisms for testing solutions, and measure their success post deployment.

Disruptive technologies are realigning everything human. The availability of vast amounts of data, exponential computing power, and technologies like Artificial Intelligence (AI) and Machine Learning (ML) are creating countless opportunities (and challenges) in every aspect of our lives. The advent of such technologies, along with the Internet of Things (IoT), and innovations in computing, collectively termed as Industrial Revolution 4.0, have immense significance in the future of urban governance.

AI offers the possibility to augment human workers with cognitive support from data, devices, and algorithms, allowing them to focus on relatively important tasks, thereby leading to improvements in service delivery. AI is expected to dramatically improve efficiencies, effectiveness, and inclusiveness of existing operations. It is in this context that city governments world over are trying to harness the power of AI for addressing a variety of issues.

The Smart Cities Mission at the Ministry of Housing and Urban Affairs, in collaboration with MeitY NITI Aayog, and World Economic Forum has developed an 'AI Playbook for Cities' to enable cities to utilize the power of AI for urban governance, making them more productive, livable and sustainable. It emphasizes on how cities may operationalize this technology to improve the overall city functioning and service delivery to citizens. The Playbook aims to guide local governments and help the teams responsible for implementing AI solutions to ask right questions, follow best practices, identify, and engage the right stakeholders, and create the right set of outcome indicators.

The playbook incorporates feedbacks and experiences consolidated through inter-ministerial consultations, multi-stakeholder consultations and a series of one-to-one consultations with AI experts in India and globally, as well as wider public consultations, conducted over the last 18 months. This Playbook can be considered as a starting point for city leaders as they plan for creating technology teams and investing in digital & technology intensive solutions. It is not supposed to act a template and its use must be continuously adapted with mindfulness of the context at hand.

While working with the team, my experience as a city commissioner and the shared experiences of the Smart City Commissioners, CEOs and CDOs have helped in enriching this playbook. The team has endeavored to create a framework attuned to the ground realities of Indian cities. I thank the teams at MoHUA, MeitY, NITI Aayog, WEF, Smart City CEOs and CDOs for their outstanding efforts to cocreate this playbook.

Shri Kunal Kumar
Mission Director, Smart Cities Mission, MoHUA

EXECUTIVE
SUMMARY

Cities attract people as they offer prospects for better quality of life, economic opportunities, access to leisure, recreation, and entertainment. No wonder, more than 50% of the world's population is now urban. While large scale urbanization across the world has brought immense benefits in the form of prosperity, health, and wellbeing, it has also presented concomitant challenges in the form of bad air quality, congestion, crime, poor services et al.

India's growing urbanization is a key trend in its contemporary development trajectory. Today, the country has close to 400 million (35%) people living in its urban areas. This urban population is projected to reach 600 million by 2030 and >800 million by 2050 (WUP, 2018). It is estimated that two-thirds of India's GDP comes from its cities, with potential to increase in the future. In this background, it becomes imperative for India to manage its urbanization well, as its quality will be instrumental in achieving its nationally cherished goals. Its city administrations, urban local bodies, are placed right at the center of this debate. The future poses both opportunities and challenges for them, as they go about the task of creating livable and sustainable environments for their residents.

In their efforts for providing solutions for their city's day-to-day issues in areas like water management, waste management, mobility, housing etc., urban local bodies have, so far, largely deployed traditional 'brick and mortar' technologies. This has started to change with programs like the Smart Cities Mission providing impetus to harnessing of digital technologies through deployment of integrated cyber-physical solutions. With fast changing external environments, population densities, employment and mobility patterns, city administrations do not have the luxury of business-as-usual planning and implementation techniques. Traditional channels of city planning have reached a crucial inflection point, accentuated by events like the COVID-19 pandemic. The complexity of such challenges is set to deepen in the future with significant strain on sustainable and equitable management of resources thereby necessitating the move to a new normal of urban practice.

This new urban practice would require optimized city planning, built upon agile and adaptive processes of ideation, implementation, and evaluation. It would need to be responsive to emerging trends, be able to solve problems through cost-effective and sustainable ways. City administrators play an instrumental role in matters related to land use planning, labor market mobility, and delivery of civic services. They provision transportation systems that impact the ability of people to live, work, and play together. Affordable housing markets are coordinated by them.

The ability of cities to perform these complex socio-economic functions successfully is crucial for quality of life, economic growth, and job creation.

Emerging technologies can help combat limitations of traditional solutions in the face of ever-increasing and ever-changing challenges. Artificial Intelligence (AI), for example, can be seen as a General-Purpose Technology (GPT) like electricity, which will have a significant, transformative impact on almost all spheres of human activity. The availability of vast amounts of data has enhanced the potential of technologies like Artificial Intelligence (AI) and Machine Learning (ML) to unlock incredible potential when deployed responsibly. The advent of allied technologies like robotics, Internet of Things (IoT), and innovations in computing together have led to the fourth industrial revolution which is of immense significance in the future of urban governance. City administrators, therefore, must be able to use such technologies effectively in their day-to-day endeavors.

India's growing number of smartphone users, deepening internet penetration and multiplying e-transactions indicate its growing digital footprint. This, along with a gamut of digital government solutions has been instrumental in ensuring the benefits of technology reaches the masses. Mature public digital platforms like UPI, Aadhar, GST, NUIS etc., have bolstered digital adoption at scale and speed. More recently, the National Urban Digital Mission (NUDM) is spearheading a paradigm shift towards shared digital infrastructure across India's towns and cities. A crucial underlying factor contributing to the success of these initiatives has been the parallel, consistent effort to strengthen data governance, standardize data systems and streamline data access.

Ministry of Housing and Urban Affairs (MoHUA) has spearheaded the establishment of significant building blocks for data governance, like easy-to-use toolkits, frameworks, platforms to enable India's urban ecosystem to integrate the use of data in its functioning. Based on the 3P approach (People, Process, Platform), its DataSmart Cities Strategy has helped evolve a 'culture' of data-driven governance in Smart Cities. The adoption of the strategy is now being undertaken in all towns and cities over 100,000 in population (around 500 in number). MoHUA is therefore well-placed to build upon these interventions to catapult to adoption of emerging tech solutions to address the ever-expanding needs of urban India.

The success of technology initiatives is contingent upon its synergy with other interventions in the ecosystem, namely policies, regulations, human capacity, and operational integrity to build sustainable models. City administrators are central to contextualizing these interventions as per realities of their local circumstances in consultation with community stakeholders. This Playbook aims to be an instrument to aid such administrators and guide them through possible processes and frameworks regarding adoption and deployment of AI solutions. It remains agnostic to potential use-cases, which may differ across diverse geography and sectors, and hence is focused more on the 'how' than the 'what'. This Playbook can offer valuable insights to users as they think of creating technology teams and investing in digital technology-based solutions. The Playbook is not supposed to act as a template and its use would need to be continuously contextualized.

The key objectives of the Playbook are to:

Expose its users to potential opportunities created by AI in the urban sector

Provide reasonable guidance for setting up technology teams and governance structures thereof.

Propose possible frameworks for identification and prioritization of problems and solutions.

Inform users on broad aspects of procurement, deployment, and monitoring of AI solutions.

CHAPTER I:
INTRODUCTION

AI offers the possibility to augment city administrators with cognitive support from data, devices, and algorithms, allowing them to focus on the important tasks leading to improvement in service delivery.

AI is expected to dramatically improve efficiencies, effectiveness, and inclusiveness of existing operations thus contributing to improvement in service delivery to citizens.

What is AI? AI is a collection of technologies that enable a machine to perform cognitive functions normally associated with human minds like perceiving, reasoning, interacting, problem solving and creativity. The computer must learn how to respond to certain actions. Thereby, it uses algorithms and historical data to create models. AI as a science has been around for a long time. However, with the vast amount of digital data being generated in cities, it is an opportune time for inclusion of AI as part of city governments' functioning.

While this toolkit helps provide a roadmap for AI implementation across cities, the urban ecosystem has already made impressive strides on this front. This list below looks at potential use cases that might be of interest to cities.

AI Use Cases

AI systems continuously learn to generate improved output across a variety of sectors. Few ways in which AI algorithms can be implemented are as follows:

AI Implementation Cases	Description	Applications
Detection & Classification	Identify & categorize objects in images	'Classification' is identifying whether an image contains a specific type of object, such as a helmet, face mask, etc. for better law enforcement.
Forecasting & Prediction	Estimate the next value/response in a sequence	Forecasting the demand of road repair inventory, based on a set of input data such as previous time series consumption data, weather, traffic volume, etc. for better resource planning.
Clustering	Find patterns among disparate data points & categorize them based on similar attributes	Health record synchronization where multiple near-duplicate records of one person can be unified into a unique health profile.
Optimization	Generate a set of outputs that optimize outcomes for a specific objective function	Generating an optimum route for a vehicle using a combination of time of day, traffic data, fuel use and other variables.
Anomaly detection/ prediction	Determine whether specific inputs are out of the ordinary	Predictive maintenance: AI systems trained on time series data from IoT sensors, such as those monitoring temperature or vibration can detect or predict anomaly, such as leakages in a water distribution system.
Decision- making	Help with informed decision making	AI systems can help in detecting incidents in real-time and can dispatch the help or escalate the issue to appropriate authority in time for taking necessary actions

Urban Management Use-Cases

Use Case 1: Parking Management

Current State

Camera-based dynamic on-street parking charges (based on time)

Manual management of off-street parking (e.g., multi-level parking)

Future State

AI-based system for dynamic pricing engine (based on peak/non-peak times, occupancy, availability, etc.)

Prediction of available parking and future demand (based on prevailing traffic, weather, and mobility patterns)

Pattern matching on live video feeds to detect unauthorized parking or over occupancy.

Outcomes /Impact

Optimised revenue models due to customised pricing mechanism.

Reduced congestion due to effective parking management.

Use Case 2: Smart Water Metering

Current State

Manual Processes for measuring:

- Water consumption
- Demand mapping to water supply distribution system.
- Water Quality monitoring
- Ad-hoc scheduling of overhead water tank cleaning.
- Lack of instruments for leakage detection

Future State

Predictive maintenance based on pipeline integrity monitoring through probe imaging of water pipelines.

Automated Water Quality monitoring and water tank maintenance scheduling.

Prioritisation of repair works to dispatch field maintenance teams to decrease the percentage of non-revenue water (NRW) and to prevent supply disruption.

AI-based smart water network to analyse consumption trends and automate leak detection process.

Outcomes /Impact

Improved financial management from better monitoring of power yield in water pumping stations and subsequent reduction in non-revenue water.

Optimised resource allocation owing to automation of leak detection, effective distribution via mapping of supply and demand.

Improved coordination between departments through automated data management, collation and sharing.

Use Case 3: Integrated Storm Water Monitoring

Current State

Siloed storm water drainage infrastructure.

Ad-hoc and manual management of portable pumping units.

Manual weather data interpretation.

Delay in storm prone area evacuation arising from manual monitoring of critical infrastructure.

Future State

Integrated storm water monitoring using AI, through weather data based predictive analysis on water flow, and intensity of rain flow.

Simulation models for evacuation and city-wide, real-time monitoring of water levels.

Automated GIS terrain analysis and dewatering modelling for effective deployment of water pumping needs.

Outcomes /Impact

Improved city planning by appropriate allocation of budgets based on trend and predictive analysis.

Better disaster management via dynamic planning in disaster-prone areas instead of long-term static plans.

Improved climate outcomes through self-configuring weather forecast tools that help cities build more adaptive systems.

Use Case 4: Solid Waste Management

Current State

Linkage between waste collected and collection route of vehicles is weak.

Lack of geo-fencing on route collection across assigned areas.

Challenge in mapping waste segregation (dry, wet, recyclable/non-recyclable) at the point of collection.

Future State

AI-based analysis of waste collected by weight and frequency – daily, weekly, monthly for trends / waste collection profile across city.

Automated route planning through modelling of past GPS tagged routes and geo fencing.

AI-based monitoring of waste collected in correlation to city property datasets for residential vs commercial waste analysis.

Outcomes /Impact

Improved city financial management by revenue collection from commercial waste disposal.

Improved environmental impact by efficient waste segregation monitoring.

Use Case 5: Automatic Traffic Counting & Classification

Current State

Traffic flow and type of vehicles plying in the city is not known.

Lack of traffic volume creates problem in manging city traffic during peak hours.

Challenge in improving road conditions due to lack of traffic data.

Future State

AI-based analysis of traffic volume, vehicle classes.

Automated data analysis which will help traffic police and city authorities in traffic planning.

Creating green corridors during emergency and VIP movement.

Outcomes /Impact

Improved city traffic management by automated traffic data analysis .

Regulated traffic flow and reduction in travel time by proper traffic management and creation of green corridors as per traffic volume.

These use cases illustrate the wide-ranging applications of AI and allied technologies in the urban sector. All facets of city planning, and governance can find potential benefits from the adoption of such solutions. Further, it is heartening to note that concerted efforts are already being undertaken in many Indian cities to leverage their data systems to develop AI solutions for local needs.

Data, the fundamental precursor to AI

Data is at the core of every AI solution and availability of and access to high quality data is an important indicator for predicting the success of any city in developing effective and efficient AI solutions. With greater deployment of IoT devices and smart solutions in cities, the quantum of real-time data is increasing every day. Cities have various sources of data, both real-time and archival, including a multitude of sensors, citizen services applications, e-payment services, public transport systems, energy and utilities metering systems, geographic information systems, property management systems, and databases of various kinds. These sources can be leveraged to extract data in a robust, fair, and secure manner to fuel AI and advance towards the desired outcomes in urban management. Such wide-scale adoption of AI can augment the work portfolios of government officials, allowing public employees to focus on creative and robust avenues to improve service delivery.

However, some of the common challenges in leveraging this data are:

The metrics and standards used for ensuring the quality of data may not be standardised resulting in datasets with different data dictionaries that hamper data consistency. Problems with data quality always surface with data that may have been collected from multiple sources. Cities should ensure there are systems in place to develop metadata & data standards, SOPs to clean, and transform this data to make it AI-ready.

Issues with Data Privacy

Uncertainty of Data Quality

Data privacy and the use of personally identifiable information are critical issues to address before using AI. Due to the huge volume of data being collected and analysed, it is easy to have instances where sensitive information may be hidden among the anonymized data. Cities need to follow clear guidelines with more stringent consent requirements for data collection and strengthen supervision of organisations / agencies that manage the data across the value chain, with measures for failures to comply.

Cities will need to continuously strive towards making right data available to the right people at the right time to help build solutions to complex urban challenges. Recognizing data as the most important precursor to developing effective AI solutions, Government of India and various State Governments have institutionalized multiple initiatives to streamline data generation, collection, processing, storing, sharing and use.

It is important for city leaders, administrators, officials and all stakeholders within the urban development and AI space to be well-versed with this existing body of work.

Some data initiatives particularly relevant within the urban development space that have been institutionalized through the Ministry of Housing and Urban Affairs (MoHUA) and the Ministry and Electronics and Information Technology (MeitY) include the **DataSmart Cities Strategy,** Smart Cities ICT Standards with the Bureau of Indian Standards (BIS), **Open Government Data Portal, Smart Cities Open Data Portal, Meta Data & Data Standards, Policy on Open Application Programming Interfaces,** and **API Setu,** among others.

For successful development and adoption of AI solutions within cities, it is imperative for city leaders, administrators, and officials to align their work with these initiatives.

This involves:

- Contextualizing and implementing the DataSmart Cities Strategy at a city level.

- Undertaking continuous steps to improve quality of data generated through various city systems.

- Defining and adopting necessary Metadata & Data Standards, Open APIs, and Data Dictionaries.

- Ensuring regular use of relevant platforms for sharing of data.

For further reading:

- DataSmart Cities Strategy | MoHUA

- INDIAai.gov.in | MeitY, NeGD, NASSCOM

- National Strategy on Artificial Intelligence | NITI Aayog

- RESPONSIBLE AI Part 1 | NITI Aayog

- RESPONSIBLE AI Part 2 | NITI Aayog

- AI For All Program | CBSE, Ministry of Education & Intel

- AI For Everyone | Coursera

- AI Explained | Simplilearn

- What Is AI? | Edureka
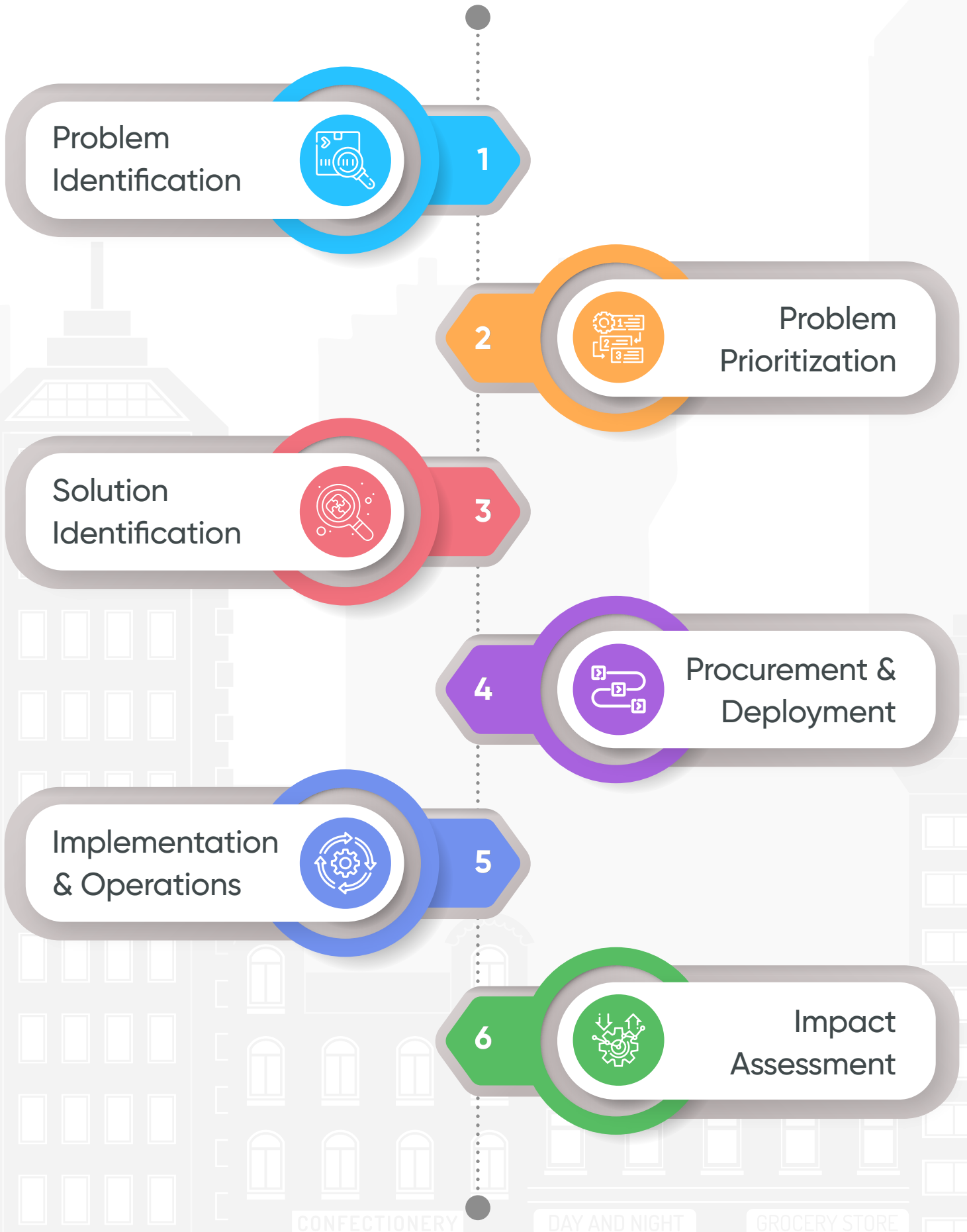
CHAPTER II:
AI TOOLKIT-
A STEP-BY-STEP GUIDE TO AI IMPLEMENTATION IN CITIES

A 'whole-of-ecosystem' approach where city administrators work in close coordination with relevant stakeholders – public agencies, industry, start-ups, and academic institutions – is necessary to be perceptive to the patterns and proactive support of city functions. Such an approach will enable early detection of problems, subsequent root cause analysis, prioritization of actions and deployment of interventions in identified areas. This synergetic model will be further complemented by innovation and technology teams that can help design appropriate solutions for chosen priorities and work with the city teams to deploy them effectively. It is therefore important to visualize innovation and process efficiency of cities as a systemic long-term exercise, instead of a short-term, person-driven, one-time activity. This chapter attempts to provide a step-by-step guide of how city leaders can navigate the process from problem identification up to impact assessment.

KEY STEPS FOR AI IMPLEMENTATION

1 Problem Identification

2 Problem Prioritization

3 Solution Identification

4 Procurement & Deployment

5 Implementation & Operations

6 Impact Assessment

1. Problem Identification:
What are the key issues your city is grappling with?

Needs of cities change rapidly. Rapid pace of change is compounded with complexity of emergent problems necessitating out-of-box methods for sensing the dynamic environment around. A critical first step, therefore, is to determine the city's needs, its most pressing problems, the issues citizens feel should be prioritized for resolution. This is easier said than done, as it needs active engagement with all relevant stakeholders across social, economic, and political spectrums along with consultation with experts and analysis of available data, both real-time and/or archival.

ACTIVITY 1

This phase involves identifying problems that need resolution. Few pointers below can help:

1. What are major issues the city is facing?
2. Are these spread across the city or restricted to specific areas?
3. What are root causes of these problems?
4. What share of the city's population do the issues impact?
5. How does it impact citizens' lives?
6. How long has this issue(s) persisted?
7. Have there been previous attempts to solve the issue(s)?
8. What groups will benefit from the solving of this issue and how?
9. Will tackling this issue negatively impact any specific section of society?
10. What are the consequences five years from now if the issue is resolved? And if it isn't?

Additional Resource: **'Making a City Smart: Lessons from Smart Cities Mission'**.

Problem identification is a comprehensive process and is unfortunately much neglected. Innovation is more about identification of the right problems to solve, rather than solutions themselves. Problem identification is an important skill and its availability in city teams cannot be exaggerated.

A. Citizen Engagement & Participatory AI

Open and participatory approaches of engaging with key stakeholders can help uncover practical challenges faced by citizens. Stakeholders may include – citizens, communities, industry bodies, domain experts, civil society, and academia. Potential avenues to gather feedback and suggestions include open public consultations, door-to-door surveys, online surveys/ polls, platforms etc. The relevant mechanisms for participatory AI highlighted in Chapter IV may be leveraged here such as Public Surveys, City AI Townhalls, etc.

Example: Stakeholder Engagement through Surveys

Public Surveys focusing on services delivered to the citizens may help identify key citizen issues. A lot of on ground information may be obtained using such surveys. For instance, in case of questions related to service delivery quality, we may get insights around:

- Service timeliness, accessibility, and quality
- Facility condition and convenience – hours of operation, location, safety measures
- Overall satisfaction with services
- If the service can be recommended to others

....

A sample question to obtain reasons for less utilization of a public service may look like:
"Question: Please select the 2 most important reasons for not availing public bus service?"**

Response options:
- Service is usually delayed
- Bus stop is too far
- Buses do not run as per schedule
- Ticket price is high
- Poor safety, especially during night-time
- Cannot find out which buses will come at what time

## B. Making sense of Existing Data

Existing services being delivered in the city have generated historical datasets, be it on physical files or online systems. Analyzing such data can help uncover major problems in the city. Some sources of data for this maybe:

a.   Analyzing the existing master plans/related documents.
b.   Public grievance redressal systems.
c.   National/State/City assessment frameworks.
d.   City budget records.
e.   Townhall meeting records.
f.   Problems highlighted on various digital platforms.
g.   Research studies of various kinds on public needs and data on existing services.

Example: Making sense of existing data

Grievances obtained through the city app may highlight specific areas of the city that are most prone to a particular issue. It can also help cities analyze the frequency and depth of the problem and identify priority problems to focus on.

....

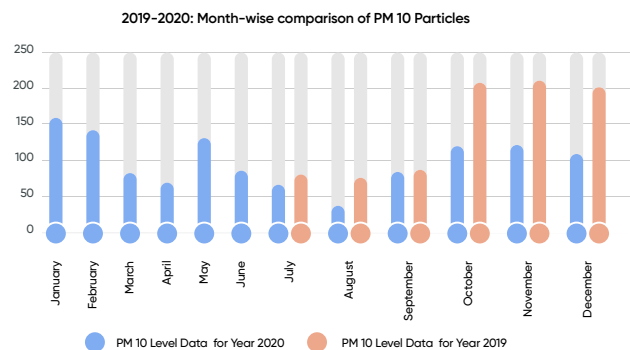### Question: What is the major issue for the citizens of a given ward?
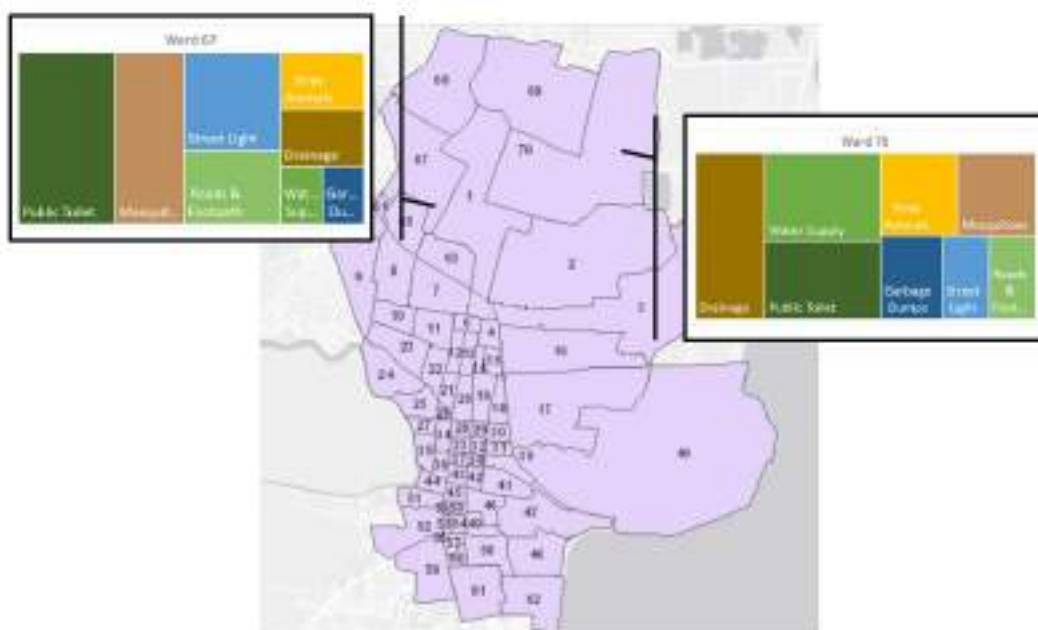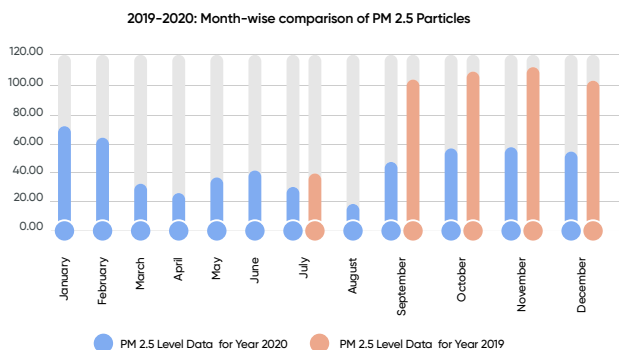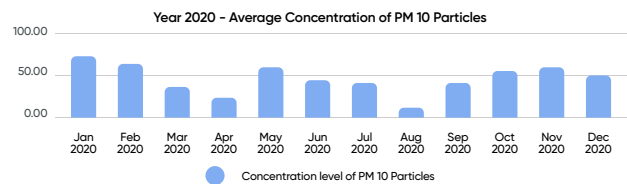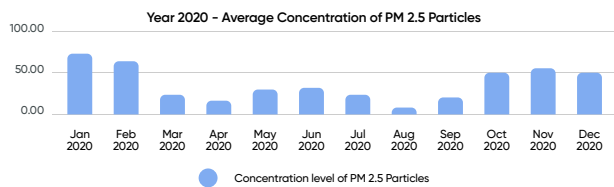
C. Sensing through IoT

Various IoT devices and sensors are being deployed in cities that generate an enormous amount of raw data. This data can be processed and analyzed to understand patterns and trends and thus, diagnose existing problems.

- Data from sensors in garbage bins
- User generated feedback from smartphones
- Data from environmental sensors
- Data from GPS, traffic intensity monitors
- Water supply data through sensors
- Video data from surveillance cameras

Example: Sensing through IoT

Using data from environmental sensors, issues such as areas with high pollutants levels, time of the year with high pollution levels, area impacted etc. can be uncovered.

Year 2020 - Average Concentration of PM 2.5 Particles

Year 2020 - Average Concentration of PM 10 Particles

2019-2020: Month-wise comparison of PM 2.5 Particles

2019-2020: Month-wise comparison of PM 10 Particles

2. Problem Prioritization:
Which issues to choose for development of AI-based solutions?

Once problems are identified, the city will need to undertake an exercise of prioritization among them. City teams need to identify areas where AI can have the greatest impact when leveraged while simultaneously mapping existing capabilities (including data and workforce) that will be required for the realization of such an exercise. For every problem amenable for AI-intervention, the city will have to consider issues such as data availability, data quality, technology readiness, financial readiness, availability of resources, etc.

Problem prioritization may be done by analyzing identified problems across the two pillars of **Ease of Implementation** and **Impact on City.**

An **indicative framework** along with sample questions is highlighted below. Each of these areas can be scored based on a binary response of Yes/No. For every yes, the weights are highlighted in bold. Further, these may be plotted on a 2x2 matrix as depicted below in Activity 2 with a maximum weight of 40 for each of the pillars.

Pillars	Components

Ease of Implementation	I. Data & Information:
	    Availability and access to relevant data from various sources
	II. Technology & Infrastructure:
	    Readiness of the existing tech infrastructure
	III. Organization & Governance:
	    Availability of technical expertise, operations support, governance mechanisms and processes, etc.
	IV. Analytics:
	    Availability and quality of analytics systems

Impact on the City	I. Coverage:
	    Proportion of the population being impacted by the problem
	II. Severity:
	    Severity of the problem as perceived by all stakeholders
	III. Duration:
	    Estimated period of adverse impact if problem persists
	IV. Financial implication:
	    Cost associated with design and deployment, as well as potential revenue implications

A. Ease of Implementation –

I. Data & Information (10)

Indicators	Weights
Is data being acquired from external stakeholders?	1
Is data integration being done already at the city level (for e.g., at the ICCC)?	1
Is the available data in a machine-readable format?	2
Is the data updated timely?	2
Is the data credible? Has it originated from a reliable source?	1
Is API-based data sharing available?	1
Is the data available in a geo-referenced manner?	1
Are processes around data ownership and sharing well defined?	1

II. Technology & Infrastructure (10)

Indicators	Weights
Have sensors and IoT devices been deployed?	2
Are there systems in place (such as MIS, city apps etc.) that capture and generate data – internal and external?	3
Does the city have the systems in place for data consolidation, storage, ETL, discovery, pre-processing and quality management?	3
Is the city using platforms such as IUDX for data exchange between public/private entities?	2

III. Organization & Governance (10)

Indicators	Weights
Does the city have a technology team that is familiar with AI?	2
Does the city have a policy on data standards - common metadata, data categorization, & classification?	2
Does the city enforce consistent data governance policies?	2
Are there mechanisms for financing the development of AI solutions?	2
Are there SOPs to ensure transparent data and analytics sharing across the city administration?	2

IV. Analytics (10)

Indicators	Weights
Are there established frequencies for data sharing across city departments? (no, yes, mostly adhered to, complete compliance)	3
How mature is the data analytics capability of the city (none, low, medium, or high)?	3
Does the city have predictive analytics capabilities?	2
Does the city have access to requisite tools for undertaking data analytics exercise?	2

B. Impact on City –

I. Coverage (10)

Indicators	Weights
Is the problem impacting a large section of the city population?	4
Is the problem benefitting marginalized communities (women, migrants, elderly, disabled people)?	3
Is the solution to the problem scalable to all parts of the city?	3

II. Technology & Infrastructure (10)

Indicators	Weights
Has the problem been identified as one of the most important problems by city stakeholders?	2
Does the problem pertain to important activities related to day-to-day lives of citizens?	3
Does the problem pertain to critical/emergency services that need immediate attention?	3
Has the problem been emphasized by city stakeholders repeatedly through various channels?	2

III. Duration (10)

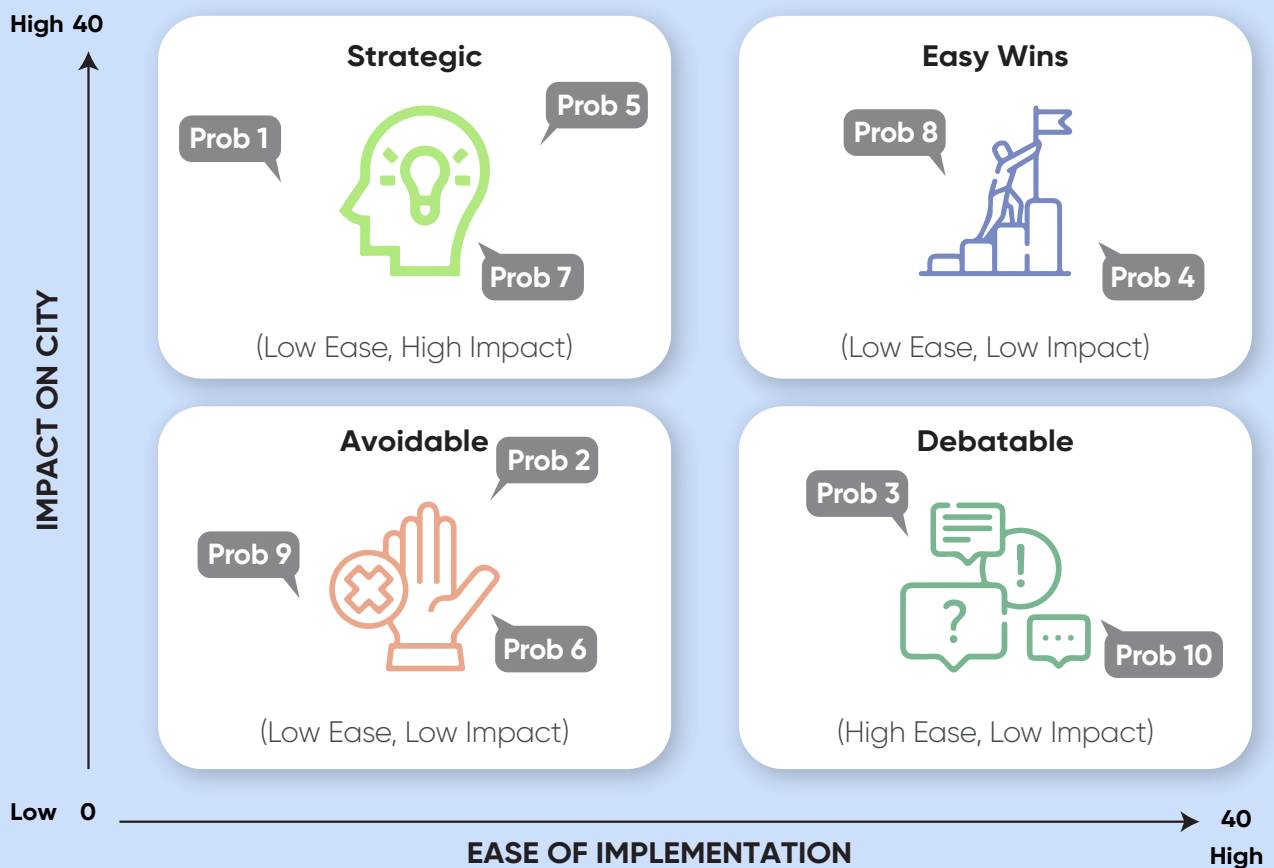| Indicators	Weights
Has the problem been in existence since long?	5
Can the solution help in increasing the life of assets/services?	5

IV. Financial implications (10)

Indicators	Weights
Are city stakeholders incurring financial loss due to this problem?	3
Does solving this problem generate any additional/new revenue for the city?	3
Does the city have the financial resources to solve the problem?	2
Does fixing the problem decrease costs?	2

The framework identified above is indicative in nature and cities will need to add/modify it based on their identified problem areas and priorities. The problems can then be mapped to one of the 4 quadrants – High Impact-High Ease (Quick Wins), High Impact-Low Ease (Strategic), Low Impact-High Ease (Debatable), Low Impact-Low Ease (Avoidable). While the problems under quick wins may be shortlisted for the solutioning phase, the city may look to commence work in parallel towards strengthening their ecosystems for tackling problems in strategic areas.

ACTIVITY 2

Plot all the solutions on this 2x2 matrix to help prioritize problems.

High 40

IMPACT ON CITY

Strategic

Prob 1

Prob 5

Prob 7

(Low Ease, High Impact)

Easy Wins

Prob 8

Prob 4

(Low Ease, Low Impact)

Avoidable

Prob 2

Prob 9

Prob 6

(Low Ease, Low Impact)

Debatable

Prob 3

Prob 10

(High Ease, Low Impact)

Low   0

EASE OF IMPLEMENTATION

40

High

3. Solution Identification:
How can cities source and test AI solutions to solve problems?

Upon prioritization of problems, city administrators can evaluate the potential ways to action the solution phase. While the earlier phases were focused on extensive engagement with citizens and relevant stakeholders, this phase would require extensive discussions at multiple levels with solution providers such as start-ups/industry partners through Proof of Concepts (PoCs)/pilots/sandboxes or through forums like hackathons/ datathons. This, however, would not be necessary in case of solutions which have been already tested and deployed at scale in the past.

A. Hackathons

A hackathon is any event conducted in a typically accelerated time frame where innovators come together to solve problems. The city may utilize such a program to create a functioning AI solution for the selected urban problem. For instance, Justice Hub, which has made legal and justice data open, accessible, and actionable, was born out of **the Agami Data for Justice Challenge** in June 2019. The challenge sought to curate a collaborative entrepreneurial effort that increases and evolves the use of data. The challenge invited applicants to create a data hub and create new datasets, and after a rigorous selection process, CivicDataLab was crowned as the winner and the platform continues to provide crucial datasets to this date.

MoHUA has published a guidance document on **Conducting Hackathons: A City Guide** which can be leveraged for this step. This guidance document highlights the importance of Hackathons as a process for crowdsourcing ideas/solutions to help overcome the ever-growing urban challenges. The document details the various types of hackathons that can be conducted and some case studies that will help understand their usage. It also lays down the various steps involved in organizing a hackathon from planning to execution.

B. Sandboxing

Given the evolving nature of AI applications, multiple reports of biases and inaccuracies in AI applications owing to underlying skewed datasets have come to the fore. Given this, there is a warranted suspicion of these technologies among the public. Therefore, it becomes even more imperative to conduct PoCs on ground to test AI-based solutions in controlled environments that can help build confidence required to scale these applications. These PoCs help solve identified problems in a test environment and require collaboration between city governments and solution providers. The IndEA architecture framework also recommends that it is desirable for all large

digital ecosystems to set up their own 'ecosystem sandbox' to validate compliance of a solution not only with regulatory requirements, but also test technological requirements like interoperability, security and privacy besides commercial viability and scalability.

For each AI pilot to be tested on the sandbox, a set of performance metrics and Key Performance Indicators should be framed on the problems identified and prioritized. While a testbed or sandbox in the urban environment can help in testing the AI solution, a reference architecture for such a sandbox can accelerate testing timelines. The urban sandbox or U-Box (as proposed under the National Urban Digital Mission, will not only provide feedback for iterations and necessary customization but will also promote innovation in the space of testing, deployment, and scaling projects. For further details, cities may refer to the details on **Sandbox (U-Box)** on the NUDM website.

A sandbox creates an enabling environment for:

- Assessing digital solutions for functionality, performance, security, usability, and user experience
- Testing emerging technologies including AI for algorithms, IoT devices and sensors to ensure
- Adherence to governance ethics, safety and security of data being sourced from the public
- Establishing Proof-of-Value quantitatively and qualitatively through user experience and feedback

A standard sandbox project may comprise of the following steps:
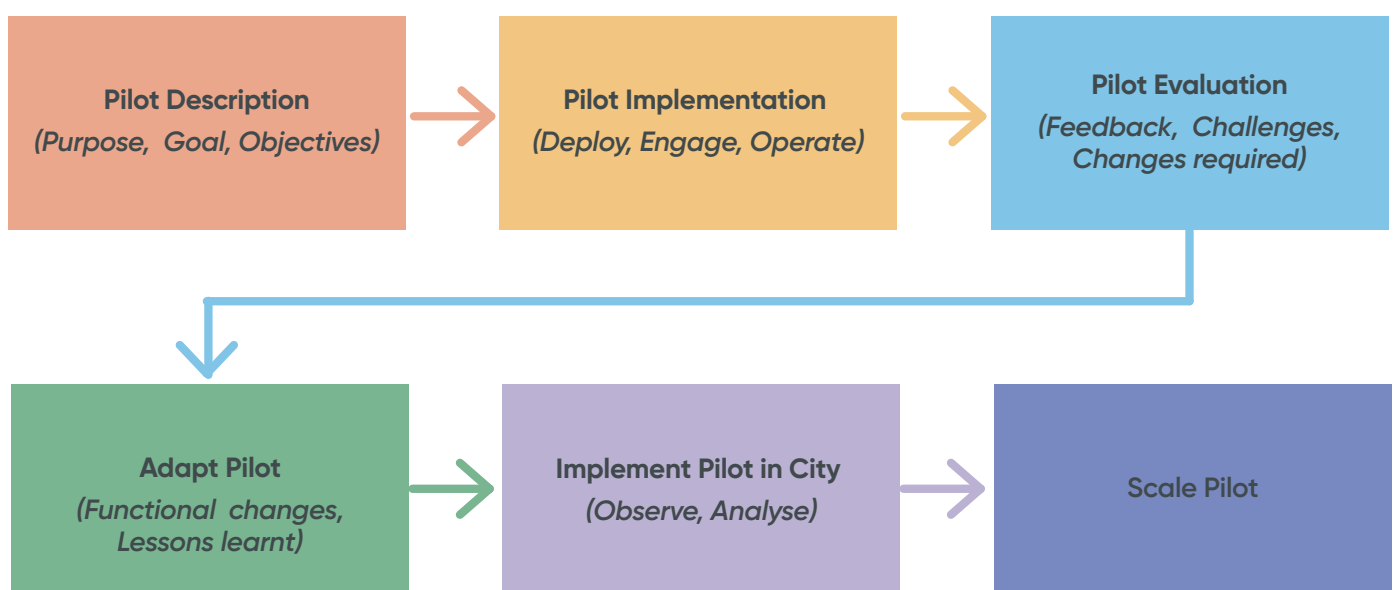
4. Procurement & Deployment:
How can you scale up AI projects?

Scalability Assessment

Post solution identification, following criteria should be considered while assessing the feasibility of scale up –

1 Potential for economies of scale

Investments needed to facilitate the collection of data to train AI models and the upgradation of existing infrastructure (hardware and software) can be substantial. Thus, the financial viability of a scaled implementation and operation should be assessed through projected cost reductions or incremental revenues.

2 Cross-Administration Alignment

Implementation will require strategic alignment across all stakeholders involved in the value chain. Each administration/team involved should institutionalize processes and build capacity towards adopting and operating the solution. Necessary cost-sharing/incentivization mechanisms can be adopted to enable this process.

3 Existing Legal, Regulatory and Policy Landscape

Both central and state laws, regulations and policies must be considered when assessing scalability. Any upcoming/evolving matters which can have an impact on the long-term viability of the solution must be considered.

4 Data Standards and Interoperability

Existing data pipelines must be assessed for quality parameters such as completeness and accuracy along with accessibility and interoperability with other systems. Any gaps identified will require a roadmap to prepare a solution-ready data pipeline.

5 Outcome Projections and Feasibility Assessment

Processes to assess progress of the scaled implementation must be set-up. Assessments of critical KPIs can be conducted quarterly, half-yearly and yearly to understand progress and strategize for course correction mechanisms.

On ascertaining feasibility, the project can be scaled in the following ways (Wilden, Busse, 2017)

Scaling Types

	Description	Mainly applies to	Examples
Roll-out	Introducing a solution to the market, or applying it in the entire area	Product and service innovations	AI-based water leakage detection solution, upon a successful pilot can then be scaled for further roll-out
Expansion	Adding partners or users to a solution, enlarging the geographic area, or adding features	Projects, platforms, process, and system innovations Projects, platforms, process, and system innovations	AI-based city chatbot service could begin with few use cases like Covid19 protocols and rules and when there is wide scale adoption it can be expanded to address other subjects
Replication	Replicating (exactly or by proxy) the solution in another context (city, geographic area), by retaining the original pilot partnership or forging new ones	Projects, platforms, process, and system innovations	AI-based traffic light solution that gives green light to emergency services once deployed in one metro can be contextualized and replicated in another metro

It is important to choose an implementation approach for procuring and deploying the solution in the city. Some possible methods are:

A. Tendering

A Request for Proposal (RFP) should be released for sourcing AI solutions from prospective vendors with expertise in designing and implementing AI solutions. This step can either commence right after the problem has been shortlisted or in the event of a successful PoC to scale the solution across the city. The RFP must include the following details-

- Project Scope
- Detailed problem definition
- Existing Operations
- Functional Requirements
- Technical Requirements
- Selection Criteria
- Desired Project Outcomes

Part Two of NITI Aayog's Responsible AI Approach Document for India, "Operationalizing Principles for Responsible AI" discusses the need for Model AI Procurement guidelines within governments to ease and optimize the process of AI procurement in governments. The Government e-Marketplace has also recently begun cataloguing AI and analytics tools to help better program management as well as data annotation.

While guidelines for AI procurement aren't readily available in the ecosystem yet, cities may refer to the guidance document published by the Smart Cities Mission on **Model RFP 2.0 for ICCC/ICT,** containing guidelines/ advisories, standards, and best practices. Many clauses from this document can be contextualized to AI procurement as per city requirements.

B. City Innovation Exchange (CiX) Platform

The **City Innovation Exchange** (CiX) platform, launched by the Smart Cities Mission, MoHUA facilitates procurement of innovative solutions. It connects city administrators with innovators and other stakeholders, acting both as a discovery platform and an innovation marketplace. The platform enables city teams to create innovation challenges, collaborate on testing and validating solutions while simultaneously reducing barriers for innovators to work with urban bodies. City administrations can choose to procure end-to-end solutions after a successful pilot, through the SmartProcure mechanism. **SmartProcure guidelines** provide further details on how best to source innovation.

5. Implementation & Operations:
How do you manage on-ground implementation?

The power of emerging technologies, like AI, is magnified when used in conjunction with other technologies, across functions, and departments. It is important to build integrated solutions, appropriate oversight mechanisms, and robust maintenance procedures while deploying such technologies. This will ensure that they are protected from value decay, hidden costs, and other unforeseen changes in the environment (e.g., cascading investment, falling adoption due to lack of transparency, unwarranted biases, etc.). Further, such systems should be financially sustainable in the long run. Therefore, cities may consider appropriate financing models viz. public-public and public-private partnerships to promote innovation.

Additionally, having the right teams is at the core of the successful implementation of any program or initiative. Cities will need to build in-house teams and enhance internal capacity to be able to understand and deploy AI projects.

Team Structuring- Competencies & Roles

The following **competencies** are required to operate AI related products and solutions-

1. **Data Capabilities-** Metadata Management, Data Collection, Data Modelling, Data Engineering, Data Transformation, Data Sharing & Privacy, Data Quality Assurance

2. **Analytics Capabilities-** Creation and utilization of diagnostic, forecasting and optimization solutions

3. **Urban Management Capabilities-** Understanding of urban management operations, scenarios, and desired outcomes

To fulfil these competencies, professionals and senior executives can be separately recruited. Administrations with existing data teams can assign additional duties if professionals are found AI-competent.

The following roles can comprise an ideal AI team for Cities-

Chief Innovation Officer

The Chief Innovation Officer manages the overall innovation process by identifying opportunities for AI-enablement and developing strategies for AI innovation and implementation. The role will include the identification of suitable architectures for AI operations and building partnerships to contribute to different parts of the AI value chain in terms of data contribution, technology implementation, etc.

Chief Technology Officer

The Chief Technology Officer is responsible for spearheading the AI efforts in the city from an operational perspective. This person will oversee the technical preparedness and implementation and can help in deciding the various solutions and technologies available in the market which are apt for the city conditions This role can be assumed by the existing Chief Technology Officer if he/she has existing competencies in AI.

Data Engineers

Data Engineers create data pipelines by designing and building the data infrastructure. They may also be called Data Architects and should possess system creation skills. They must be able to work with existing urban data pipelines and engineer/transform it so as to produce data which is robust for AI solutions
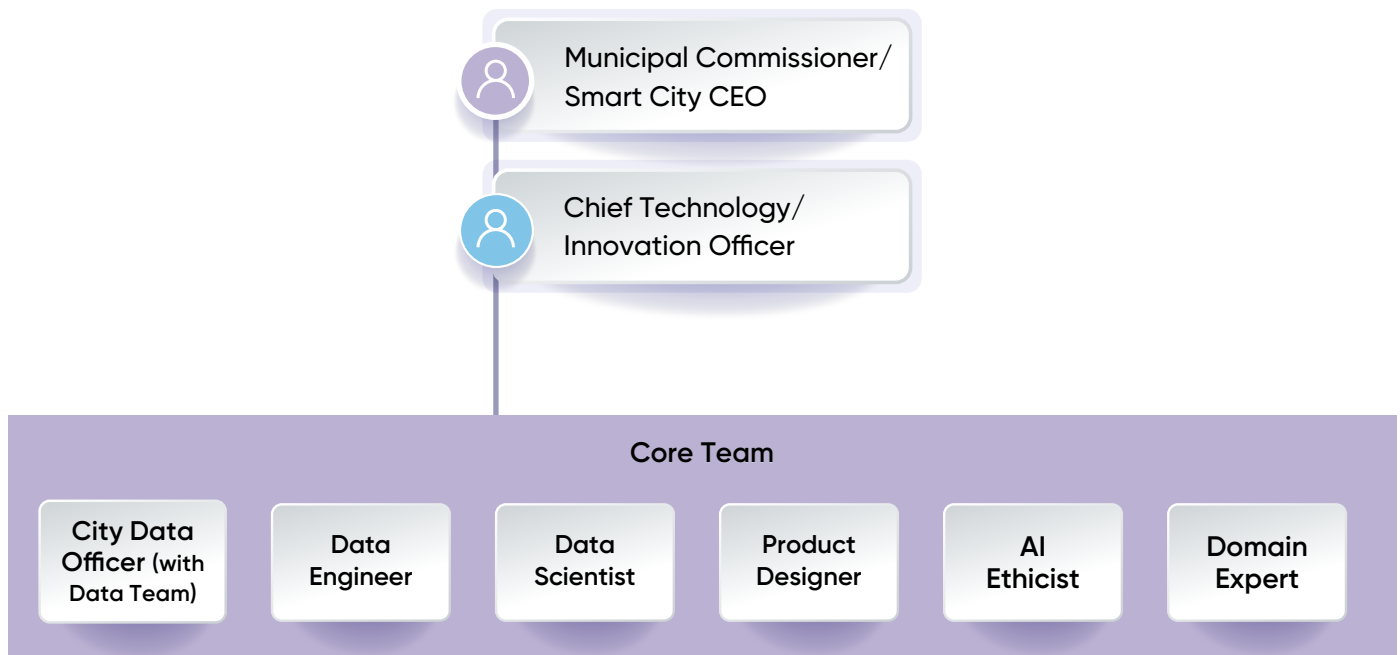
Data Scientists

The role will include data identification, pre-processing, data analysis, building models and algorithms, and presentation of data insights through visualisation techniques.

Product Designers

The Product Designer's role will be to build, integrate and operate in-house AI/ML solutions within the existing architecture. Application developers, infrastructure engineers/developers with experience in building, integrating, and operating large-scale machine learning systems are ideal candidates

Domain Experts/ Subject Matter Experts (SMEs)

This role can be fulfilled by a professional with prior experience of urban technology. Alternatively, a professional with experience in urban management can undergo comprehensive AI training to develop the ability to translate urban problem statements for the professionals with core Data & AI expertise.

AI Ethicists

AI Ethicists are responsible for understanding how AI systems impact people, and whether under-represented groups are treated fairly, and other ethical concerns are managed adequately

The following is an indicative organization structure of an AI Team and the relevant stakeholders:

Municipal Commissioner/ Smart City CEO

Chief Technology/ Innovation Officer

Core Team

| City Data Officer (with Data Team) | Data Engineer | Data Scientist | Product Designer | AI Ethicist | Domain Expert |

Operational Considerations

City administrations must not underestimate the need to build strong technology teams as they undertake their journey towards harnessing the power of emergent technologies for solving city problems. Apart from hiring best-in-class professionals, the AI value chain must be codified into well-defined Standard Operation Procedures when new products, solutions and systems are updated. Additionally, institutionalization of knowledge will enable building capacities.

Capacity building programs should be conducted recurrently to train new AI professionals on both technology and the knowledge of the urban domain. For tenured employees, such programs must be conducted to help them keep abreast of emerging knowledge in the field, and to help them operate newly adopted systems.

The proposed organization structure above delineates the expertise needed for effective deployment of AI based solutions on ground. Some of these expert roles can be assumed full-time by individuals with special skill sets. Others can be initially assumed on a part-time basis, provided the individual taking up the role meets the technical or functional requirements for the same. As the team grows and develops specialization in each of these and other roles, they can be translated into full-time positions.

Review and Monitoring

Regular monitoring is an essential component for successful implementation. Project implementations regularly face barriers and challenges, requiring an agile and iterative approach. The project team must set milestones, schedule regular progress reviews, and set up other communication mechanisms to ensure that emerging issues are addressed timely. The monitoring of actual project progress (against time, cost and quality and achievement of deliverables and benefits) in comparison to the plan or baseline and the collection of key progress metrics such as risks, issues, changes, and dependencies is vital for the city. The reporting of project status/performance at a summary level to the leadership, sponsor and other stakeholders through periodic meetings should also be done. A RACI matrix may also be used to ensure all stakeholders – city leadership, project team, solution provider etc. – are adequately apprised.

- Responsible – person(s) who undertake the work
- Accountable – person(s) ultimately accountable for the completion of the task
- Consulted – person(s) whose opinions are sought and support those responsible for completing the task
- Informed – person(s) who are kept up to date

Long-term sustainability of solution should be included as a key element of its implementation plan, with the ability to integrate with existing systems & future solutions, appropriate oversight mechanisms and robust maintenance procedures.

ACTIVITY 3

Some of these aspects along with questions that cities may ask, include:

Social
Does the solution alleviate social issues such as road safety, traffic management, predictive repairs?

Ethical
Does the solution pose any ethical risks due to conditions such as lack of transparency, lack of accountability etc.?

Legal
Are there any legal implications in the short/long term?

Transparency
Is the deployed solution transparent to all users? Are the users aware of how their personal data is being

Accessibility & Fairness
Is the solution only intended for specific city areas or can it be eventually scaled to the whole population?

Sustainable
Will the solution be relevant after 3-5 years? Can there be improvement in the algorithm that will lead to a more efficient experience?

Reliability
Is the solution designed to withstand downtime? Can the solution operate independently and correctly if the other city systems go offline for a period?

Risks/Harm
Is there any unintended harm to the public/private users from using the solution?

6. Impact Assessment:

How to measure outcomes, benefits & impact?

While AI solutions imagine a set of future scenarios in designing and developing the system, it is essential to make periodic, iterative assessments and evaluation of the solution outcomes for the target groups. This may involve a detailed mapping of envisaged outcomes to actual outcomes post AI deployment. Impact assessment may also include setting up pipelines and processes to incorporate feedback from the assessment back to the AI models that are to be deployed, to improve upon the accuracy of the AI solution. Cities may analyze impact across economic, social, and environmental aspects for the citizens. Benefits, for instance, can be cost reduction, process efficiency, realization of policy objectives, inclusiveness, increased well-being of citizens, better environment, etc.

ACTIVITY 4:

Measuring impact

For every AI solution deployment, cities would have identified specific goals and objectives. Post or even during implementation, it is necessary to map these indicators to understand the overall impact of AI deployment.

Key questions to answer may be:

- **What:** what are the specific indicators to be measured?
- **How:** how are the selected indicators measured?
- **When:** at what point in the AI project lifecycle are indicators to be measured?
- **How Often:** how frequently the indicators need to be measured?

Below table may be utilized for capturing the same:

🎯 GOAL 1		🎯 GOAL 2	
INDICATOR 1 [describe the indicator]	**PARAMETERS** • **How?** • **Who?** • **When?** • **How Often?**	**INDICATOR 1** [describe the indicator]	**PARAMETERS** • **How?** • **Who?** • **When?** • **How Often?**

For Example:

GOAL 1	**INDICATOR 1** Number of water leakages reported in the system

🎯	**PARAMETERS** • • •
	• How? – To be measured through appropriate data systems
	  When? – During and Post deployment
	  How Often? – Monthly
	
	Sample Outcome: Reduction in the number of leakages from X to Y

Other parameters for impact measurement:

System-based
- Increase in efficiency of system
- Reduction in processing time for critical responses
- Ability to accurately forecast/project future trends

Operations
- Overall ease of operation
- Facilitate early intervention
- Reduction in manual interventions

Access, Equity & Inclusiveness
- Improved ease of access
- Mitigation of bias

Environmental
- Prevention of environmental degradation
- Reduction in pollution of resources (air, water, land)

Stakeholders
- Direct impact on stakeholders
- Indirect impact on stakeholders

Example of KPIs for an "AI-based Chatbot"

- User Retention: The number of users returning to the bot in a given period
- Dashboard with real-time usage statistics
- Response Time: Bot's response time (average, min, max etc.)
- Fallback rate: This would capture Bot's failure in delivering service to users.
- User Satisfaction: A matrix defined through exit surveys of the users interacting with the bot. The users should be given the option to rate the Bot's service and an optional description of the issue if any.
- Bot Availability: Uptime / Downtime
- Word to Error Ratio: There should be a report that shows the 'word to error ratio' of the solution. (Error ratio means the ratio of number of correctly identified words by Bot to the words that were not correctly identified).

CHAPTER III:
RESPONSIBLE AI

On the heels of AI becoming increasingly entrenched in our daily lives, there are several cases where bias and discrimination of AI applications against individuals and social groups has come to the fore. It is imperative that such risks associated with the interaction of emerging technologies with societal solutions are not overlooked. AI-powered systems, especially those that automate decision-making, are particularly vulnerable to several implementation challenges, especially legal and ethical risks. Some of the challenges include:

Algorithmic Bias:

This bias can be manifested in several ways with varying degrees of consequences for the referred group. It can emanate from unrepresentative or incomplete training data or the reliance on flawed information that reflects historical inequalities. When left unchecked, different types of cognitive and societal biases can be amplified due to unfair representation of groups across religion, caste, gender etc. to have collective, disparate impact leading to lack of trust and disruption of the social order. For example, the model trained for facial recognition on a specific population may not work as seamlessly for all sections of the broader population due to unavailability of diverse gender/ethnicity/caste representation in the training data resulting in issues of using the solution at a population scale.

Inaccuracy resulting in the exclusion of services:

An unexpected correlation in the training data vs real-time data may lead to high accuracy in test cycles but produce significant errors at the time of deployment. This automation bias leads to systemic exclusion for accessing the services and benefits. For instance, traditional AI models often try to combine heterogeneous groups to derive one-size-fits-all insights when processing images to tune model parameters.

Principles of Responsible AI

It is pertinent to adopt a **principled approach** to establish ethical values that need to be upheld in the design and use of AI. India's ethical AI principles have been closely linked to the principle of non-malfeasance. In 2021, NITI Aayog released a two-part approach on Responsible AI. The first part of the strategy titled **"Towards Responsible AI for All"**, establishes broad ethics principles for the design, development, and deployment of AI in India. The second part of the strategy on **"Operationalizing Principles for Responsible AI"** explores means of adoption across the ecosystem through a cross-sector approach to manage risks and an agile approach to evolve with technological advances.

The broad responsible AI principles defined under the goal of "AI for ALL" are -

Principle of Privacy & Security:

Adequate safeguards must exist to maintain privacy and security of the data used and stored by an AI system.

Principle of Inclusivity & Non-discrimination

Benefits of AI systems should be made available to all, and no segment of individuals and communities should be denied benefits or overlooked due to any design constraints created in the system.

Principle of Equality

All stakeholders should be treated equally, and the benefits of AI enabled systems should be made available equally to all, unless there is a reasonable basis for differential treatment.

Principle of Safety and Reliability:

AI-enabled systems should operate as intended and no individuals, groups or communities should be harmed because of decisions the system makes either directly or indirectly (or risks are minimized to the extent possible).

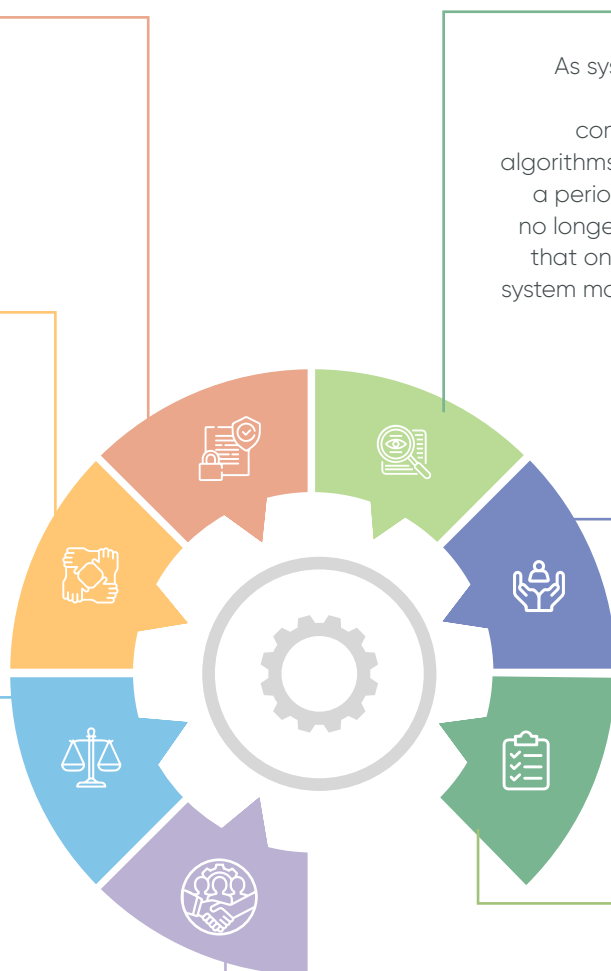**Principle of Transparency:**

As systems start relying on AI for decision making, recommendations and the complexities built into the self-learning algorithms almost make it a "black box". Over a period, it is possible that the system may no longer be "explainable" meaning thereby that one may not be able to explain why a system made a specific decision which needs to be proactively mitigated for.

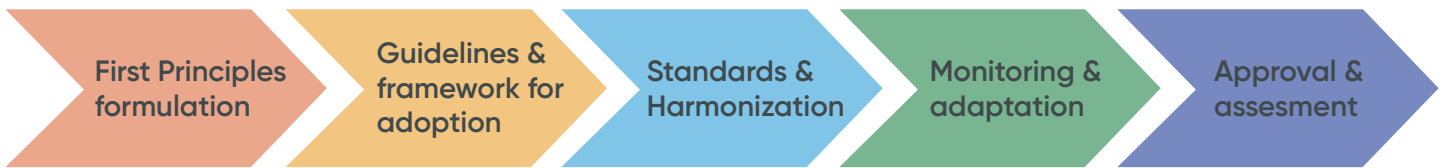**Principle of protection and reinforcement of positive human values:**

AI systems should promote positive human values and should not disrupt the social fabric of the community.

Principle of Accountability:

Mechanisms should be developed to hold different stakeholders liable to any concerns that emerge. Systems must also have robust grievance redressal frameworks that should be easily accessible by the users.

Milestones for capacity development towards ethical AI

First Principles formulation	Guidelines & framework for adoption	Standards & Harmonization	Monitoring & adaptation	Approval & assesment

While ethical principles provide a broad framework to assess and mitigate the risks of AI, their implementation needs to be conducted with nimbleness to not stifle innovation. The principles formulation should be followed up by appropriate enforcement mechanisms that are articulated for specific stakeholders viz. industry, research and academia, and citizens. A risk stratification approach that enforces pre-market guidelines and post-market surveillance based on the risk involved in the use of the specific AI-enabled technology provides a useful framework to implement ethical norms. Recently, the Government of Tamil Nadu has launched its Safe & Ethical Artificial Intelligence Policy recommending the use of a six-dimensional TAM-DEF framework along with a DEEP-MAX scorecard for the evaluation of AI systems before public rollout[1].

[1]Information Technology Department. **Government of Tamil Nadu. Safe & Ethical Artificial Intelligence Policy, 2020.**

Managing and Mitigating Risks

The use cases of AI may be classified into low, medium, high risk based on the impact they have on the people and the city. For example, a smart parking AI system that helps manage parking spots and guide vehicles to vacant spots is a low risk use case, as opposed to use of facial recognition technologies for surveillance of citizens and the data being used for law enforcement. The latter use case may result in irreversible harm if the technology is deployed without necessary checks and balances.

Determining the extent of human oversight in implementing an AI solution is a critical first step in ensuring adherence to the ethical principles. AI risks may be assessed for deciding the degree of human involvement or oversight. An **indicative decision matrix**, places risks across the parameters of **severity** of harm and **probability** of such harm. The definition of "harm" and the analysis of severity and probability will depend on the city context and will vary from sector to sector. Based on the risk management approach described above, there could be three broad approaches to classify the various degrees of human oversight in the decision-making process:

| **High Involvement:**	**Medium Involvement:**	**Low Involvement:**
This suggests that human oversight is active, with the human retaining full control of the system outcomes, while AI only provides recommendations or inputs.	This suggests that human is in a supervisory or monitoring role, with the ability to take over control, if the AI model leads to unexpected or undesirable events.	This suggests that the AI system has full control and there is almost no human oversight over the execution of decisions.

It is suggested that before proceeding with any AI solution, city administrators should study the AI use cases under consideration in consultation with relevant stakeholders and classify them as low, medium, and high risk as per the Severity and Probability of Harm which can be caused.

The Figure shows an **indicative decision matrix** to decide the right degree/model of human involvement, along with sample use cases mapped to it:
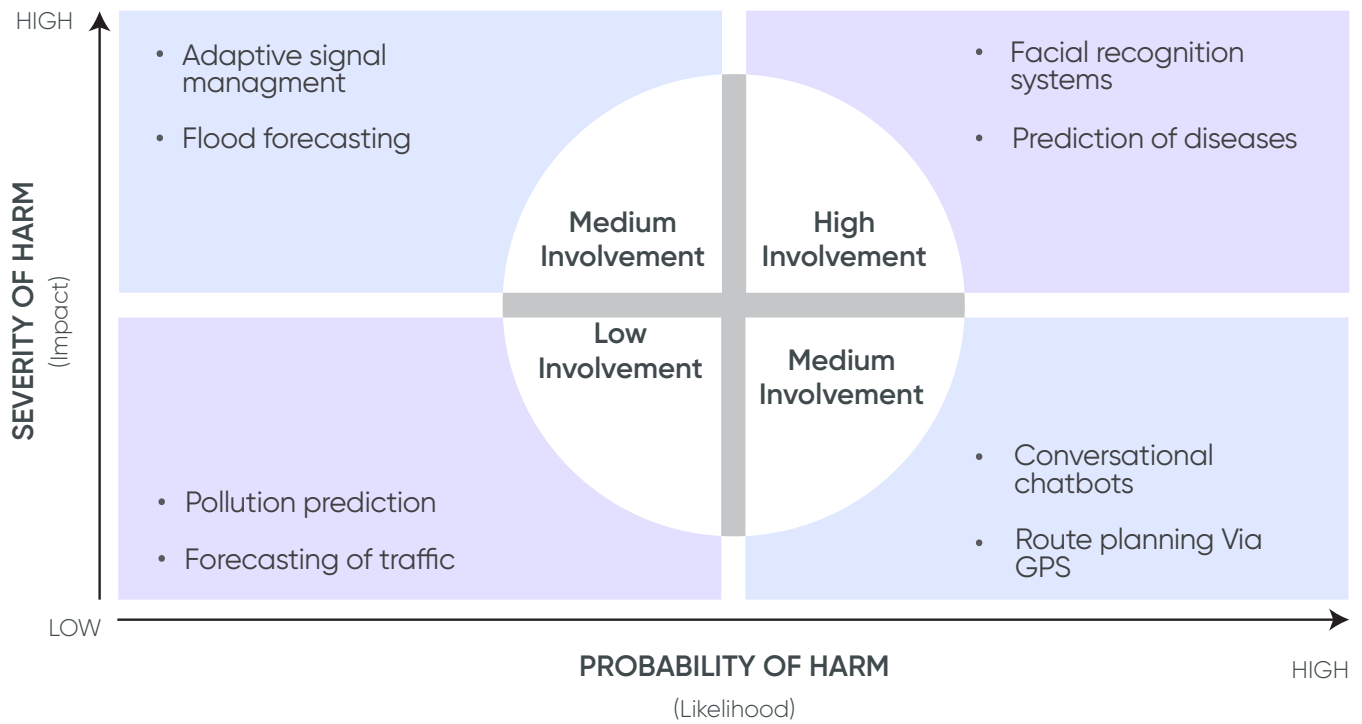
For high-risk use cases, cities may adopt some of the following mitigation measures while deploying AI-based solutions:

1. Oversight/Monitoring Mechanism:

The 'AI Ethicist' should work in conjunction with and liaison with representatives from city government, start-ups and industry and research bodies, civil society, and others, to monitor the use of AI solutions being deployed in the city. This would ensure bias-free decision-making algorithms and ethical usage of data to safeguard the privacy of citizens.

2. Regular Audits:

Depending upon the use case and risk assessment, an AI system may be mandatorily audited internally and by independent third parties at different stages to ensure compliance with the regulatory framework.

3. Impact Assessments:

City leaders may mandate as part of procurement policies or by themselves conduct periodic impact assessments based on impact on human rights, risk to users and compliance with principles of AI Ethics. An accreditation system can be used to test and validate the algorithm to ensure the system works reliably and is tamper proof.

4. Internal policies and procedures:

City leaders may develop policies and procedures to govern the deployment of AI systems. Procedures for risk management, risk disclosures, public consultation, continuity of

operations and grievance redressal mechanisms will help to build trust in the systems.

5. Point-based ratings system

May be used to rate an AI application against defined parameters. City leader should either direct the vendor or itself establish a localized detailed risk management plan to deal with identified risks and unintended consequences post deployment. Any identified risks should be assessed and mitigated against before deployment and in case of any harm, adequate and accessible grievance redressal mechanisms should be put in place. Users should have recourse to complain or address concerns through a simple, accessible, cost-effective system. If necessary, users/whistle-blowers may be allowed to make anonymous complaints as well.

6. Grievance redressal:

A robust and structured grievance redressal mechanism is essential to ensure transparency and accountability and enhance the engagement with the citizens on AI projects. In doing so, a multi-modal approach with a combination of online and offline methods is required depending upon the nature of services provided by that solution. It should additionally go through the feedback loop mechanisms from the citizens perspective which can be in the form of ratings, comments etc.

7. Delineating Accountability:

Digital solutions built using AI should have mechanisms for defining accountability at the institutional level as well as at the developer level. It would ideally help in keeping a check on the privacy and security aspects and ensuring regulatory outcomes of the proposed solution. A decentralized mechanism should be approached for building accountable institutions that help in allocating responsibilities at different levels.

CHAPTER IV:
PARTICIPATORY AI

Participative planning is an important pillar for sustainable transformation of city spaces. Since AI solutions have immense potential for causing large-scale impact for millions of residents, there is an increasing need to ensure that diverse citizens groups are involved in every stage of their design and deployment process.

Participative planning ensures key social and ethical implications of AI solutions are carefully considered before the solution reaches final stages of deployment and ultimately can help with its successful adoption. Participatory planning helps in the AI-based solution being seen as an ethical and trustworthy city asset rather than an adversary fraught with controversy and bias. Engaging the public will not only improve the community's trust of the AI, but also improve the degree of social responsibility of the AI's implications.

While top-down planning often fails to engage stakeholders from all the diverse and complex socio-economic backgrounds that are typically seen in Indian cities, bottom-up planning often fails to align with the larger strategic vision for the city. Hence there is a need to adopt a closely integrated, balanced and agile approach towards participatory AI planning that is deeply rooted in the unique context and socio-economic realities of the city.

Principles for Participatory AI:

1. Algorithmic Transparency

2. Trust among all stakeholders

3. Affirmative Consent

4. Citizen Data Stewardship

5. Contextualized to the socio-economic realities of the city

6. Commitment to Mitigate Bias

7. Continuous Oversight and Reflection

8. Inclusive & Collaborative by Design

Non-Participatory AI deployment runs the risk of stakeholders not accepting and adopting AI-based solutions. Specifically, a mechanism is needed for communities to be involved in the designing of AI solutions and to ultimately accepting to the AI's decisions or at least the logic used to arrive at the decisions. Some methods of ensuring participatory AI planning and stakeholder engagement are illustrated below:

1. Citizen AI Outreach Campaign

For citizens to meaningfully participate and contribute to AI discussions, it is important to demystify these technologies and their potential. Cities may run mass AI outreach campaigns for citizens to help them understand how AI solutions may be leveraged successfully to solve civic issues and improve service delivery. Focus may be on imparting basics of emerging technologies, their potential, and busting myths about their use and impact.

Interactive or self-explanatory videos can be made to explain how AI can be leveraged to make cities more safe, efficient, and sustainable. Videos can be made on how AI solutions have a mitigating effect on issues such as climate change and air pollution, mobility, water and sanitation, universal accessibility, child-safety, etc. The videos need to be simple enough to be grasped by everyone and could be uploaded on city websites or broadcasted in public places.

2. City AI Town Halls

Periodic AI Townhalls should be organized at a ward level to facilitate community brainstorming, identify hyper-local issues/problems, and prioritize problems that may be suitable for AI interventions. These forums may also be utilized to ideate on AI solutions, budgets, obtain community buy-in and discuss challenges/issues with implemented AI solutions.

These community AI townhalls may play a very important role in institutionalizing a bottom-up approach for identifying hyper-local use-cases for AI, involving citizens in city AI planning, and collecting valuable feedback on solutions implemented / in the pilot stage.

Opportunities for participation by citizens can be advertised on the website or app of every authority/organization involved in town-planning activities and through RWA networks. To make these sessions more effective, AI solution documents, proposals, plans and any other relevant documents should be uploaded on an open forum such as websites of respective city governments prior to the session and in a lucid language.

3. Urban Design Challenges

Urban design challenges provide cities the opportunity to collaborate with design organizations, non-profits, start-ups, and citizens and make urban development and planning more inclusive.

Cities can design specific AI challenges to address important civic problems and invite proposals from organizations on how they would solve these challenges through deep-tech interventions. Organizations that form collaborative partnerships to blend technical and design expertise with citizen participation should be given preference.

Such design challenges allow for crowdsourcing of solutions for the most complex problems and form collaborative teams to work on them with support from citizens, and civic implementation bodies.

The city acts as convenor, enabler and facilitator that keeps the selectedorganizations aligned and encourages all stakeholders to work

together and produce feasible strategies and concrete solutions for addressing the challenge. Thus, the project aims to bridge the gap between city-led and private-led development and find new ways to overcome the lack of a common vision and understanding.

4. Active Citizen Labs

Cities can run sectoral citizen labs in partnership with academic institutions, research organizations and citizen volunteers. Such labs can be set-up for different sectors such as mobility, housing, energy, water, and sanitation, etc. These labs give an opportunity to research organizations and academic institutions that specialize areas of urban development to partner with citizens to develop prototypes and tech interventions that address hyper-local urban issues.

Such labs promote urban planning that is seen more as a co-creation of concepts and solutions on urban challenges in cooperation with different actors in the society than an activity performed solely by the local authorities and that goes beyond the land-use planning. They also provide a platform for young citizens to develop expertise and experience in solving some of the most complex urban problems in partnership with esteemed institutions. These labs are designed to create a space where citizens innovate, co-create and test new designs, solutions, and services in real-life environments e.g., on mobility, services, housing, and energy.

Through the co-creative development process the city civic bodies, citizens, service providers, local businesses, cooperate in the planning and design of AI solutions from the very beginning and stay involved throughout the lifecycle of the project. The project also facilitates fast piloting of solutions by better integration of planning and implementation processes

5. Participatory AI Budgeting

An important part of participatory AI and planning at large is participatory budgeting. Participatory budgeting radically improves transparency in urban development and planning and allows citizens to weigh in on how city funds should be allocated to different problems and AI solutions.

Participatory AI budgeting is a structured process that facilitates participation of non-elected citizens in discussions around how city funds should be allocated towards different AI solutions. When citizens are bought-in on the idea of allocating funds towards a particular AI solution, they are more likely to adopt the solution and ensure its smooth implementation.

For successful implementation of such sessions, it is important for the city to have a structured procedure for deliberation in place beforehand. This includes shortlisting proposals for discussion, identifying the voting procedure, etc.

6. Innovation Sandboxes and Participatory Testing

Given the impact potential of AI applications within the urban development space, it is imperative that these solutions are comprehensively tested before their wide scale deployment. This is where innovation sandboxes become a valuable tool.

The concept of sandbox is highly essential in the development context of cities. An innovation sandbox provides a space for small-scale community testing of an AI solution in a controlled environment before its wider deployment.

Citizens can volunteer to be part of the sandbox testing phase of the solution and work closely with regulators and innovators in ensuring that any potential risks of the solution are flagged and resolved before the solution is approved and cleared for going live. AI solutions may be given a safety and responsibility certification for successfully completing the sandbox testing phase and only such solutions may be allowed for wider deployment within the city. Any biases with the input data or algorithm may be highlighted during this phase.

7. Focused Groups

Despite the fast-increasing digital penetration in urban setups in India, AI solutions and their value propositions still run the risk of excluding certain citizens or impacting them differently.

Community based focused groups are an effective tool for discussing AI solutions and issues with their accessibility, collecting feedback about their impact, etc. with different citizen groups.

Focused groups discussions on solutions can help bring out inputs that improve their user-friendliness, make them more accessible and help city officials collect valuable feedback about their impact on different communities.

8. Public Surveys

Public surveys are considered an effective and quick tool for collecting public inputs and suggestions. Public surveys may be used to gather inputs around which civic issues are of most importance to citizens, prioritize problem areas, gauge their level of understanding and awareness around particular AI solutions etc.

Public surveys can also be a vital tool for gauging the public perception about an AI solution and its usefulness, impact, accessibility etc. This can help in evaluation of AI solutions in the pilot phase as well as monitor AI solutions that have been implemented.
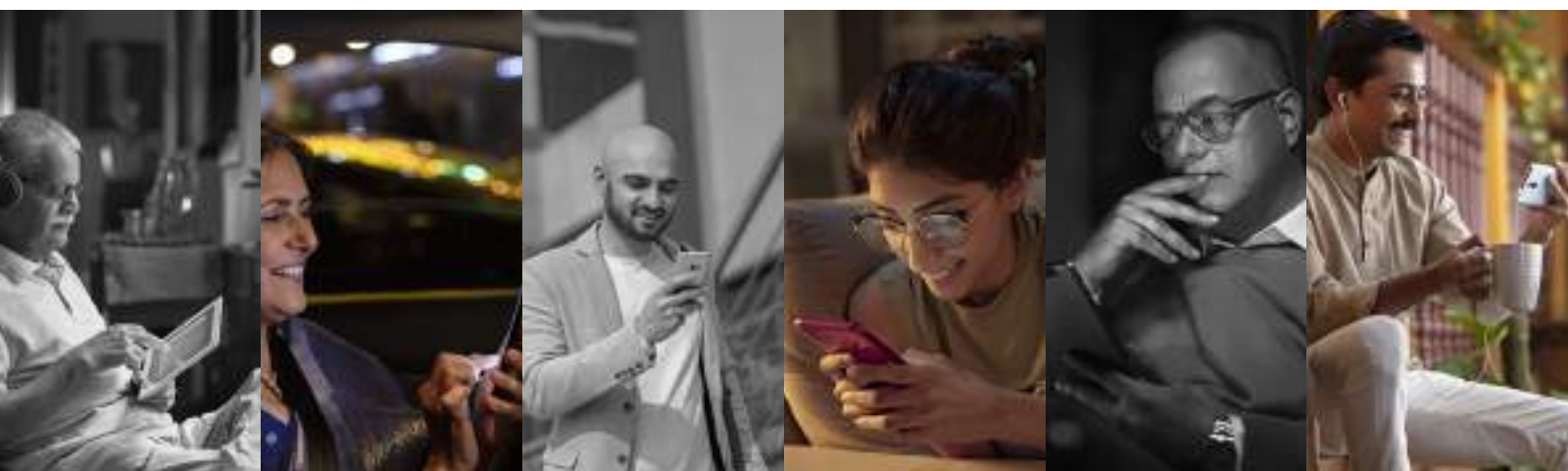
9. Community Data Stewardship & Data Rights

Data is the building block and most important input for any AI solution. The success of AI solutions often depends on the quality of training data available during the development and testing phase.

AI solutions within the urban development space often need vast amounts of data for development and operations. Moreover, such solutions also generate large amounts of high-quality data that have immense potential for economic and societal transformation. This data is a valuable public resource that can be utilized for innovation, research and development, policy making and evaluation and better service delivery to citizens.

Hence there is a need to ensure that citizens have a mechanism for exercising their rights over this data and making decisions over its use. Cities should institutionalize comprehensive data sharing policy, framework, and tools for ensuring accessibility and sharing of city data.

Further, every city may consider maintaining an instance of their data portal within the India Urban Data Exchange (IUDX) and the Open Government Data Portal. Such data portals should have data stewardship mechanisms that allow citizens to exercise control over the use of their data, request access to data sets and flag datasets based on privacy, security or use concerns.

Ministry of Housing and Urban Affairs
Government of India