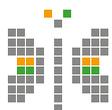


DATA-DRIVEN TRANSPORTATION SYSTEMS

BEST PRACTICES



Smart City
MISSION TRANSFORM-NATION



Ministry of Housing and Urban Affairs
Government of India





Ministry of Housing and Urban Affairs
Government of India

ABOUT MINISTRY OF HOUSING AND URBAN AFFAIRS (MoHUA)

The Ministry of Housing and Urban Affairs is the apex authority of Government of India to formulate policies, coordinate the activities of various central ministries, state governments and other nodal authorities and monitor programs related to issues of housing and urban affairs in the country. The Smart Cities Mission was launched by the Ministry in 2015 to promote sustainable and inclusive cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of 'Smart' Solutions.

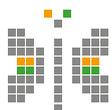


ABOUT ROCKY MOUNTAIN INSTITUTE (RMI)

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing. RMI has been supporting India's mobility and energy transformation since 2016.

DATA-DRIVEN TRANSPORTATION SYSTEMS

BEST PRACTICES



Smart City
MISSION TRANSFORM-NATION



Ministry of Housing and Urban Affairs
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Document outline

Learning from global and national examples can help Indian cities in implementing data-driven transportation systems. This document outlines examples of cities from around the world and India that have implemented/are implementing several data use cases effectively. The use cases mirror the city/government use cases outlined in the Policy Workbook and additionally include a case study for how cities can enable the multimodal use case for travelers.

1.0	Safety and security: Rio de Janeiro	06
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1.0 Safety and security: Rio de Janeiro

Rio de Janeiro's integrated control center, built in 2010, allows more than 30 city agencies to monitor what is happening across the city in real-time.¹ The control center receives data from over 900 cameras installed at strategic points all over the city, 100 rainfall gauges, GPS trackers in about 8,800 buses and municipal vehicles, and numerous other sensors designed to track and predict metrics to aid the city's operations. The control center is manned 24x7 by a rotating team of 400 operators and is looked at as a global example for Smart City operations, particularly for its high level of integration across agencies and functions.

» **Rio de Janeiro's integrated control center allows over thirty city agencies to monitor what is happening across the city in real-time to aid its operations.** «

Then Mayor of Rio de Janeiro, Eduardo Paes, commissioned IBM to set up the Operations Center in 2010, following a storm that killed sixty-eight people. At the time, city departments were spread all over the city. The goal

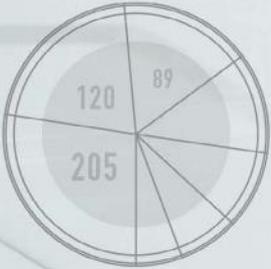
of the central command center was to integrate these agencies so that they can see real-time happenings around the city and find solutions to problems. The plan for the Operations Center came out of Mayor Paes's vision to make Rio safer and improve its infrastructure. The increased visibility and centralized format allows the city to respond more effectively to traffic incidents, natural hazards and other events in order to keep citizens safe. Between 2010 and 2014, the control center allowed the city to reduce emergency response time by 30%.²

The operations center is manned by more than thirty agencies directly involved with the municipality's operations and is designed to assist the city with its daily routine, plan major events and during emergency situations like traffic accidents, blackouts and mudslides. It also aims at preventing major emergencies by predicting upcoming weather events. The city has invested in the latest technology to forecast the weather and was a pioneer in acquiring a radar for the exclusive purpose of preventing flooding and mudslides. The press also has a room at the control center, providing an additional channel for citizens to stay informed.



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The project was designed and managed by the IBM Smarter Cities³ unit, which incorporated IBM's hardware, software, analytics and research. They, in turn, farmed out some of the work: local companies handled construction and telecommunications; the network infrastructure and video-conferencing system (linking the operations center to the mayor's house) was provided by Cisco; the digital screens were manufactured by Samsung.⁴

According to Mayor Paes, the project cost Rio nearly INR 104 CR. The success of the initiative

has been a result of the city's heavy investment in the team and technology.

» **The centralized format and increased visibility allows the city to respond more effectively to traffic incidents, natural hazards and other events in order to keep citizens safe.** «



2.0 Transportation, route and infrastructure planning: Digital Matatus Project (Nairobi)

The Digital Matatus Project illustrates how the ubiquitous nature of cellphone technology can be leveraged to collect data for essential infrastructure and make the data available to support innovation and improved services for citizens.⁵ Matatus are privately owned mini-buses in Nairobi, Kenya, which are very popular because they are affordable and convenient.

» **The Digital Matatus Project was designed to resolve inaccessibility, inconsistency and unreliability in transportation by using digitization.** «

Over 70% of Nairobi's population uses matatus as a form of transport.⁶ However, the matatus system has numerous challenges typical of an informal transit system: lack of access to timetables, routes and stops. The project aimed at

addressing the challenge that transit data for matatus. A core part of Nairobi's transportation system was inaccessible, inconsistent, and unreliable.

The Digital Matatus Project⁷ was designed to solve these problems using digitization, as well as by providing a resource to the city government for improved planning (for example, the map was used to help guide the development of a bus rapid transit system for Nairobi). The Digital Matatus Project is a collaboration between Kenyan and American universities, supported by a grant from the Rockefeller Foundation. It is focused on capturing matatus transit data for Nairobi, developing mobile routing applications and designing a new transit map for the city using cellphone technology.

The data, maps and applications are all free and available to the public. The project was launched in 2012, with the first wave of data

collected between 2012 and 2013 and the first paper map of the matatus system was published in January 2014.

To collect the data, students from the University of Nairobi traveled all of the matatu routes using an app to collect data points such as routes, stops and visual notations (signs and shelters). Once the data was collected, the team held workshops convening various stakeholders in Nairobi's transport sector to gain better insight into reading the GPS data collected through the app.

The data then needed to be cleaned and formatted to General Transit Feed Specification (GTFS), a common format for public transportation schedules, so that it could be used more easily with mapping tools. This proved challenging as several typically required data points for the standard did not exist for the matatu system (e.g., operating schedules, calendars).

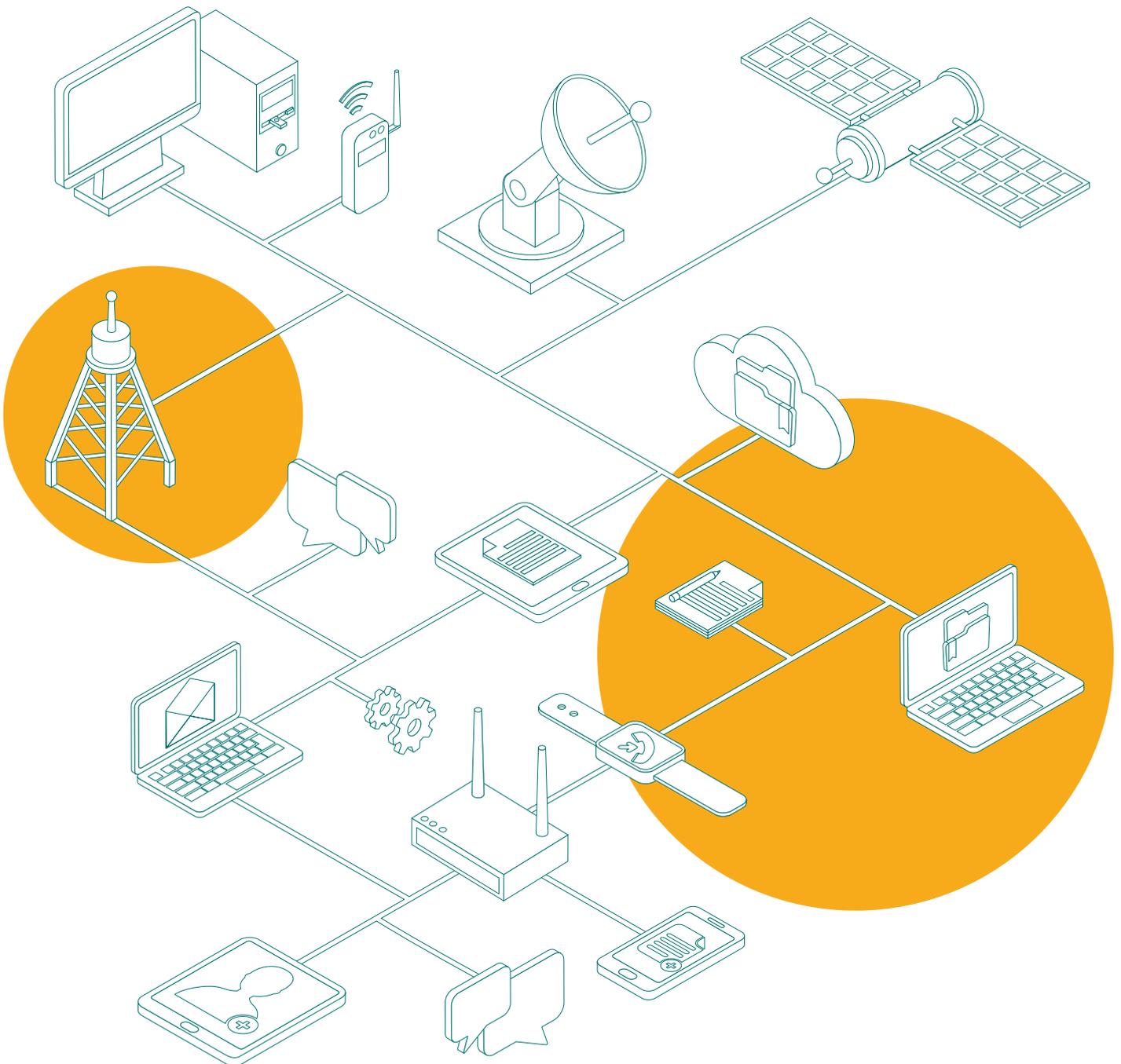
» The project focuses on developing mobile routing applications and designing a new transit map for the city using cellphone technology, which is freely available to the public. «

Additionally, fares, routes and stops were not consistent, and could be modified last minute based on factors such as weather, traffic or commuter demands. To overcome these chall-

enges, the team worked with a group of transit specialists and advocates to develop a modified and flexible GTFS standard that could work for transit systems with a large amount of informal transit like Nairobi.

The data was then processed according to the new GTFS standards and released in the form of a paper map and transit apps. Some of the transit apps include Ma3route, Flashcast,

sonar, digital matatu, and matatu map. The City of Nairobi has recognized the importance of the digitization and is using this data to create a new trip planning tool for the city. Learning from the success story of Nairobi, several other cities in Africa are also planning to map their informal transit sector. This case study may prove a relevant example for addressing similar challenges related to the lack of data for India's informal transit system.



3.0 Real-time system management: New York City

New York City has one of the largest traffic management centers in the world. The center receives feeds from over 600 closed circuit television cameras trained on major arteries, allowing operations staff to track traffic conditions at key locations throughout the city.

The center operates 24x7. Real-time video feeds allow staffers to adapt traffic lights to changing circumstances, such as increased traffic volume and accident or construction delays; operators are able to change signal timing with a single click.

In addition to real-time monitoring and signal adjusting, the center uses the data it collects to improve default signal timing. For example,

» The center operates 24x7 with real-time video feeds that allow staffers to adapt traffic lights to changing traffic circumstances and construction delays with a single click. «

signals have different default patterns for different times of day, developed based upon studies conducted by the agency of traffic patterns throughout the city during different times. The city has also staggered signals for crosswalks and traffic lights to give pedestrians a head start (called Leading Pedestrian Intervals or LPIs), after conducting a study across 100 intersections where LPIs were installed and finding a 37% decrease in the number of pedestrians killed or seriously injured.⁹

The updated congestion management system called Midtown in Motion was originally launched in 2011 to help city traffic engineers identify congested areas and adjust traffic signal patterns in real-time to reduce traffic jams. In its first year of implementation, travel times on the avenues in Midtown improved by 10%.¹⁰

The system has since upgraded its existing intelligent traffic signal infrastructure to a more advanced system that uses RFID readers and cameras to transmit real-time information to the city's traffic management center. The system has won awards such as the International Road Federation's Global Road Achievement Award.



4.0 Enforcement and regulation: Bangalore B-TRAC



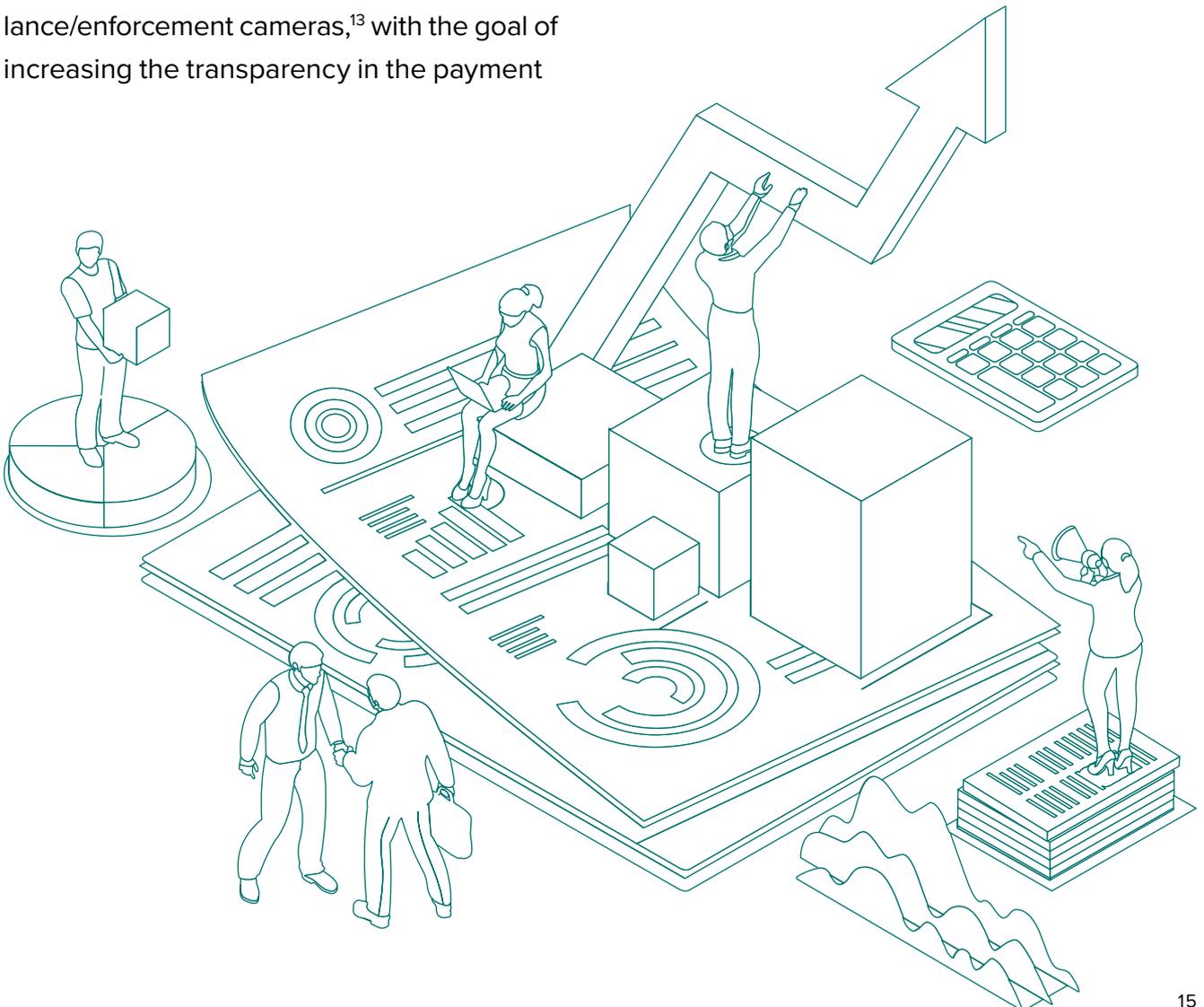
The Bangalore Traffic Improvement Project, or B-TRAC, is aimed primarily at improving the enforcement of traffic laws and reducing road accidents. The initiative was launched in 2006 and includes setting up of signals, installing cameras, developing a state-of-the-art Traffic Management Center and improving capacity building.¹¹

An impact study released in February 2013, found that the B-TRAC project helped reduce road accidents by almost 35% between 2007 and 2012, facilitated the remodeling of 46 traffic junctions, and helped in catching traffic violators and collecting fines.¹²

A key piece of the project was the installation of automated enforcement, including surveillance/enforcement cameras,¹³ with the goal of increasing the transparency in the payment

of fines. Additionally, as part of the project, new penalties were introduced to help discourage driving violations, including: suspension of drivers' licenses by repeat offenders, implementation of uniform speed limits, road safety training, and establishment of three new traffic police stations.¹⁴

A second phase of the project, B-TRAC 2.0, began in 2016. This phase includes the real-time monitoring and regulating of traffic flow at intersections. As of October 2018, 35 of the city's 363 traffic signals have been replaced with adaptive ones, through a contract with Bharat Electronics Ltd.¹⁵ There are also plans in place to install more than 400 high-definition CCTV cameras at major intersections throughout the city.¹⁶





5.0 Road and infrastructure maintenance: Ola potholes initiative and Waze Connected Citizens Program

» **Ola can provide cities with a map showing a live view of bumps and potholes, and a measure of their severity.** «

In their recently published report Ease of Moving Index, Ola offers to provide cities with pothole data in order to aid road maintenance. Based on the data collected through sensors installed in Ola Play cars, combined with GPS data from the mobile application, Ola can provide cities with a map showing a live view of bumps and potholes, as well as a measure of their severity. The sensors accelerometers and gyroscopes measure changes in acceleration and direction across three axes.

The magnitude of acceleration allows for Ola to differentiate between minor and major potholes. This new tool has the potential to address a serious challenge in India as potholes reportedly claimed six lives per day across the country in 2016.¹⁷ Potholes can also cause and exacerbate traffic congestion. This tool can help cities understand better where they need to focus efforts and resources to fix potholes



» The Connected Citizens Program allows city and state governments to expand their view of the transportation system, without having to invest in road sensors and traffic cameras. «

In addition to the location and severity indices provided, Ola can also supply the cities with average vehicles speeds at the location of each pothole, to further help the city with resource prioritization. Once a pothole has been fixed, the map will be updated within a few hours.

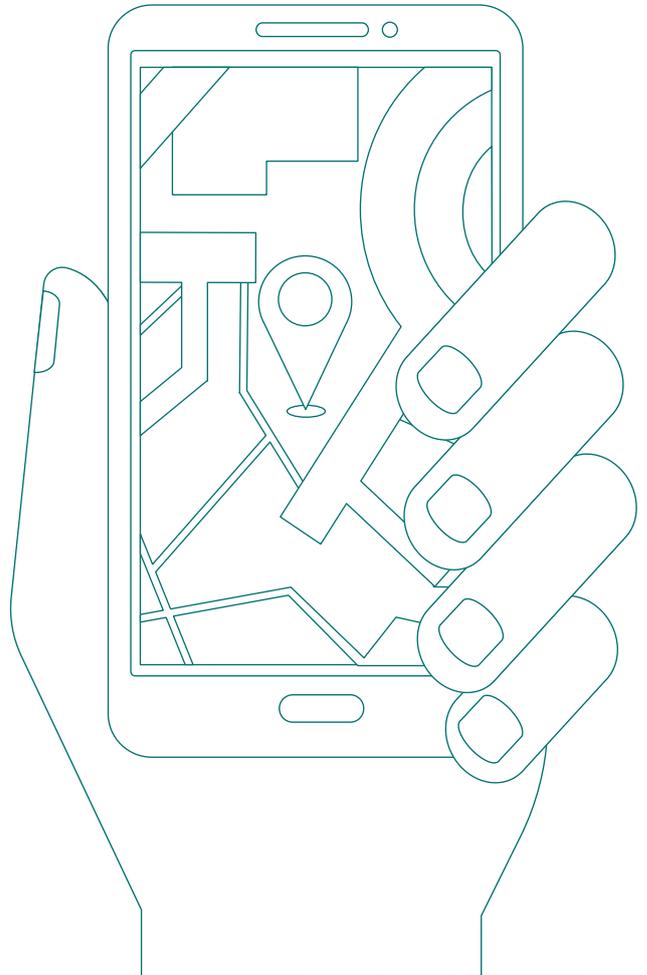
This offer is similar to the services offered by Waze, a Google-owned traffic and navigation app, through its Connected Citizens Program, an initiative launched in 2014 in which Waze provides cities with user driving information in return for real-time and advanced notice of con-

struction and road closures. The city of Washington DC has used this partnership to acquire data supplied by Waze to aid the city’s “war on potholes”.¹⁸ This case had the same goal but a different method of achieving it. Instead of using sensors, the Department of Transportation asked users to submit information about potholes via Waze. After less than a month, the city had received 10,000 pothole reports through Waze, compared with 11,000 potholes identified in three months via conventional reporting means. Leveraging the 650,000 users of Waze in the city through a crowdsourcing approach, allowed the city to find potholes in a more effective and efficient manner.

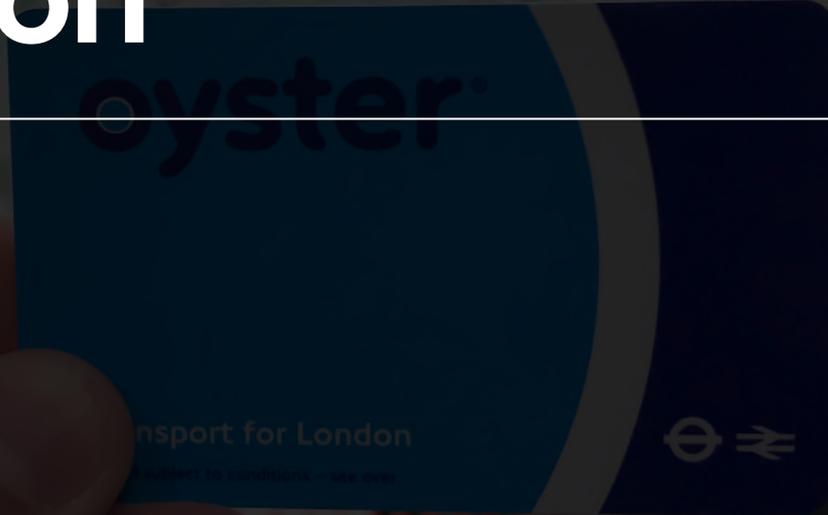
The Connected Citizens Program allows city and state governments to expand their view of the transportation system, without having to invest in more road sensors and traffic cameras while simultaneously supporting Waze by allowing the company to grow and improve its services in those cities. Waze has partnered with over 100 cities around the world through the Connected Citizens Program, providing them with data to help with city planning, transportation regulation and infrastructure maintenance. Some other notable examples include Rio de Janeiro, which has embedded the Waze API into the city control center to help with day-to-day monitoring of road conditions, as well as Boston, which uses Waze's real-time data to control the traffic signals in 550 of the city's intersections to reduce congestion.

These examples illustrate one of the many ways that data from mobility and mobility services can help improve cities' mobility systems, infrastructure and services. It also demonstrates

that private companies are willing to share data when the use case is very clear and the use of the data is transparent.



6.0 Enabling multimodal travel: London



The city of London has taken a number of steps to promote multimodal travel. One key initiative was the development of the Oyster Card, a smart payment card, which is accepted across modes of public transport, including bus, tube, tram, London Overground, Emirates Air Line, River Bus Services and most national rail services in London.¹⁹ The card allows travelers to store credit so that they can pay as they go, in order to make public transport easier and more appealing. Since the card was introduced in 2003, over 86 million cards have been issued; since 2010, more than 80% of all bus and London Underground trip payments were made using Oyster Cards.²⁰

The London public transport system is made up of a network of services operated by several different agencies. The goal of the Oyster Card is to allow passengers to easily move between services without having to buy separate tickets from each operator individually, in order to promote the attractiveness of public transit.

» The goal of the Oyster Card is to allow passengers to easily move between services without having to buy separate tickets from each transit operator individually. «

TfL started investigating the possibility of a single smartcard for the city in 1993. In 1998 it signed a contract with companies Transys and Cubic Corp to begin a four-year rollout. In 2002, 80,000 transport workers were given Oyster Cards as a trial. Eighteen months later, after ironing out initial challenges, the Oyster Card was rolled out to the general public, in the form of a plastic smartcard with a radio frequency identification tag (RFID) embedded to enable contactless ticketing. Implementing the Oyster Card system cost a reported £161 million²¹ or about INR 1104 CR, at the exchange rate in 1998.²²

The UK's Department for Transport recognizes the Oyster Card as an incredibly successful integrated scheme that delivers significant

benefits both to passengers and to TfL, such as greater convenience, better understanding of travel patterns, reduction in costs as a result of fewer paper tickets being sold, reduced boarding time for buses and reduced loss of revenue through fraud.

Common payment cards are being implemented in a number of additional cities around the world, including Singapore and Mumbai. India is planning to implement a nation-wide payment card through the One-Nation-One-Card policy, which is set to be released in the near future.

Several cities are also implementing multi-modal transport apps with integrated payments such as Helsinki's Whim app.



Case study summaries and key takeaways



City/government use case: Safety and security

Case study

» Rio de Janeiro, Brazil: integrated control center

Takeaways

» Rio's integrated control center receives data from hundreds of cameras, GPS trackers, rain-fall gauges and other sensors to allow a team of operators to monitor what is happening across the city in real-time. The center brings together over thirty agencies in the same facility. It has reduced emergency response time by 30%.

Links to more information

- » www.youtube.com/watch?v=Vol11eIZ5sg
- » www.cor.rio



City/government use case: Transportation, route and infrastructure planning

Case study

» Nairobi, Kenya: Digital Matatus

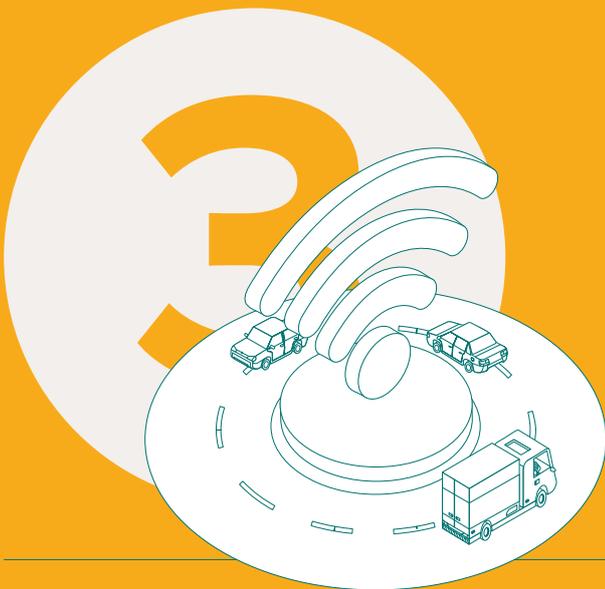
Takeaways

» Nairobi found an innovative way to map and track the city's informal transit, an integral part of the city's transportation system, to better plan and provide information on routes. The city leveraged cell phone technology for data collection to avoid investment in additional monitoring infrastructure.

Links to more information

» www.digitalmatatus.com





City/government use case: Real-time system manage- ment

Case study

» New York City, USA: traffic management center

Takeaways

» New York City's network of video feeds from around the city allows operators to change traffic signals in real-time, as well as track patterns and conduct studies to improve default signal timing.

Links to more information

» www.fox5ny.com/news/260647307-video



City/government use case: Enforcement and regulation

Case study

» Bangalore, India: B-TRAC

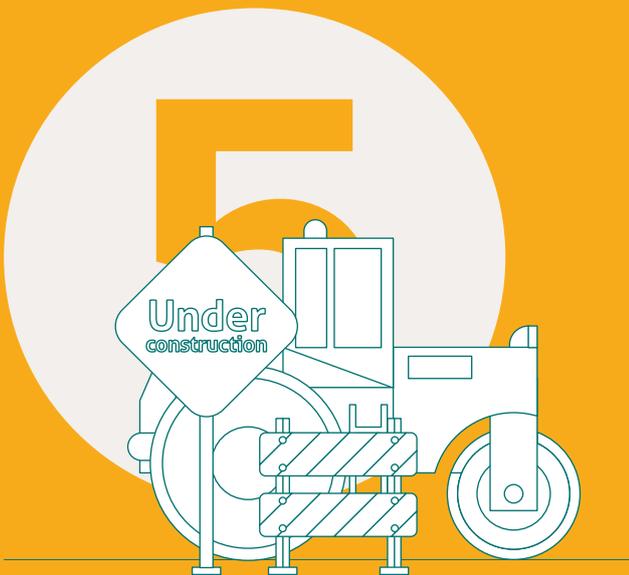
Takeaways

» Bangalore's B-TRAC project uses data solutions to improve monitoring and enforcement of traffic regulations.

Links to more information

» www.bangaloretrafficpolice.gov.in/Btrac.aspx





City/government use case: Road and infrastructure maintenance

Case study

» Multiple cities: Ola potholes initiative and Waze Connected Citizens Program

Takeaways

» Data collected by mobility service providers such as Ola and Waze can provide the city with critical information about the state of infrastructure, which can help it identify and prioritize maintenance needs.

Links to more information

» [www.ola.institute/\(report pages 94–95\)](http://www.ola.institute/(report%20pages%2094-95))

» www.waze.com/ccp



City/government use case: Enabling multimodal travel

Case study

» London, U.K.: Oyster Card

Takeaways

» Enabling multimodal travel, such as through the implementation of a common payment card, benefits both cities and travelers by allowing for improved convenience and efficiency, increased public transit ridership, better understanding of travel patterns and reduction in costs as a result of fewer paper tickets being sold.

Links to more information

» www.oyster.tfl.gov.uk/oyster/entry.do



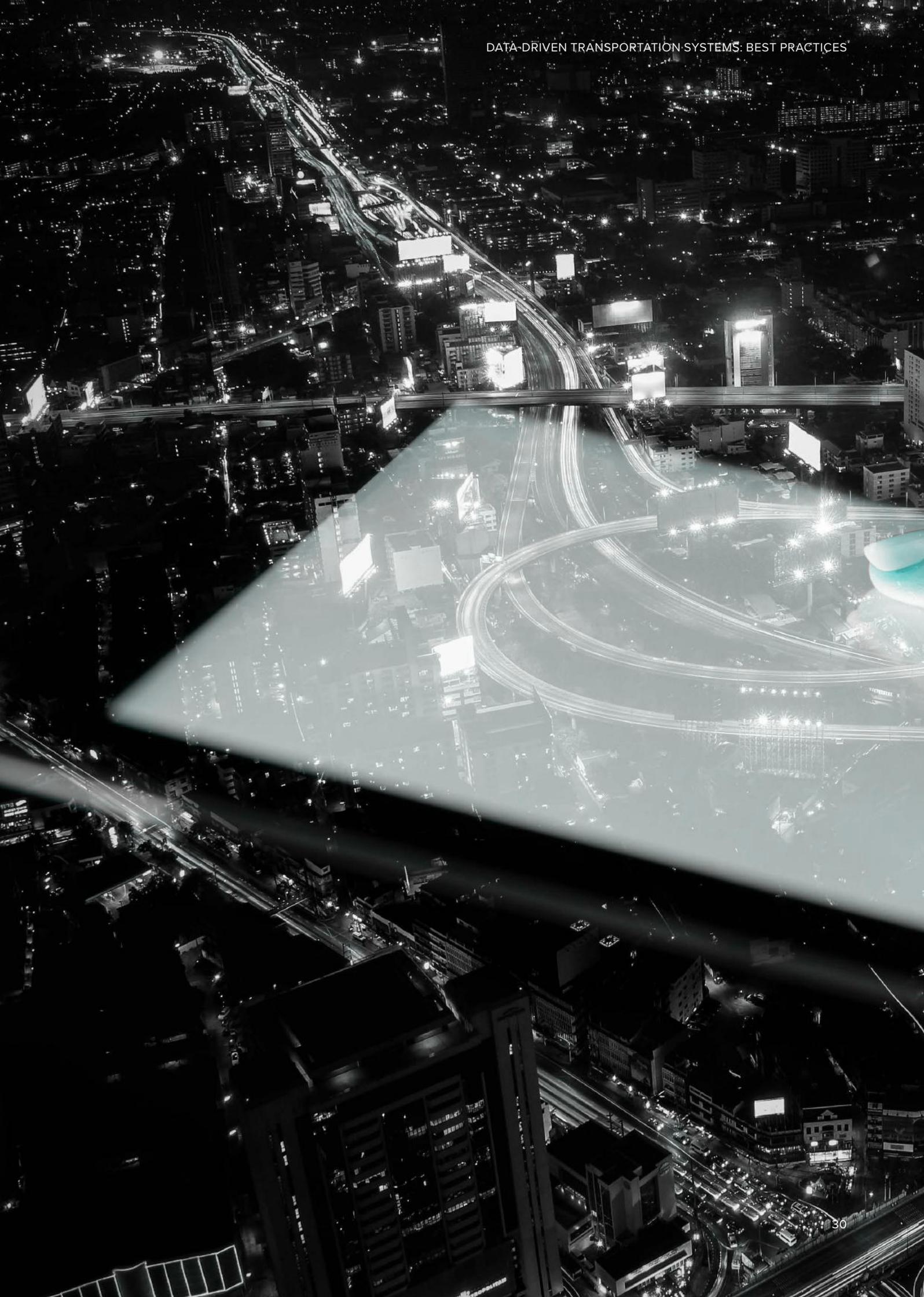
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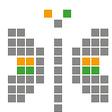
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DATA-DRIVEN TRANSPORTATION SYSTEMS

POLICY WORKBOOK



Smart City
MISSION TRANSFORM-NATION



Ministry of Housing and Urban Affairs
Government of India





Ministry of Housing and Urban Affairs
Government of India

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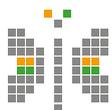


ABOUT ROCKY MOUNTAIN INSTITUTE (RMI)

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing. RMI has been supporting India's mobility and energy transformation since 2016.

DATA-DRIVEN TRANSPORTATION SYSTEMS

EVALUATION METRICS



Smart City
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Ministry of Housing and Urban Affairs
Government of India



Document outline

This document aims at helping the city manager assess and track progress in the use of data in the transportation sector. It builds on the recommendations outlined in the Policy Workbook to provide a checklist of key benchmarks that a city may aim to achieve in order to develop a robust data collection and sharing ecosystem and enable a strong data-driven transportation system. This checklist was first introduced in the Policy Framework. Achieving each of the checklist items at a basic level will ensure that the city develops a foundational data capability and capacity. However, many of these checklist items are ongoing. For example, a city may originally define and prioritize a set of data use cases but it should revisit these priorities and add additional use cases as the city's goals and data capacity evolve. These benchmarks are summarized in Table 1 and described in more details in Table 2 with suggestions on how to achieve them and monitor continued progress, with respect to each as the ecosystem continues to develop and strengthen.

SUMMARY OF CHECKLIST ITEMS FOR MONITORING PROGRESS

DOES THE CITY HAVE...

- 01** Institutional framework outlined in the DataSmart Cities strategy, including a City Data Policy
- 02** An appointed transport data champion
- 03** Clarity and communication around the purpose and value of data collection and sharing
- 04** Defined and prioritized transport data use cases
- 05** Sufficient data collection mechanisms
- 06** Appropriate safeguards for data privacy and security
- 07** A participatory framework for transport data stakeholders
- 08** A city-level data-sharing platform
- 09** Investment in mobility data initiatives



Benchmarks for monitoring progress



Benchmark: Institutional framework outlined in the DataSmart Cities strategy, including a City Data Policy

Achieving this benchmark

Refer to the DataSmart Cities strategy for complete implementation details. Steps include:

- » Appointing a City Data Officer
- » Appointing Data Champions and Data Coordinators within each relevant department/agency
- » Developing a City Data Alliance of key stakeholders
- » Formulating a City Data Policy

When formulating the City Data Policy, consider:

- » Outlining guidelines for collecting and sharing data across the mobility sector
- » Taking into account feed-back and recommendations from the City Data Alliance
- » Reviewing National Data Sharing and Accessibility Policy (NDSAP)
- » Including requirements for government agencies to share data
- » Taking into account both private and public data owners
- » Considering ways the policy can push more private data to become open, such as requiring private companies to share certain datasets in return for utilizing public infrastructure

Monitoring continued progress

- » Ensure that the City Data Policy stays up-to-date and relevant
- » Continue to engage frequently with the City Data Alliance
- » Engage with the Mission Data Officer,

Mission Data Hub, and Smart Cities Data Network at the central government level to ensure that policies and developments are in line with national developments and to learn from other cities



Benchmark: An appointed Transport Data Champion

Achieving this benchmark

- » Outline the roles and responsibilities, based largely on the data goals of the city (see Policy Workbook for list of potential responsibilities)
- » Choose a candidate who has knowledge of the transportation space and is familiar with the relevant stakeholders. The candidate must understand how to manage data and have experience in interacting with data users
- » Allocate appropriate resources for the Transport Data Champion to develop initiatives (e.g., staff, funding, etc.); the size of the team required to support the Transport Data Cham-

Champion will vary depending on the city's size, availability of resources and complexity of its transport system. The team may be integrated with other data initiatives outside the transport sector as well

Monitoring continued progress

- » The Transport Data Champion's success in developing initiatives and achieving buy-in from the relevant stakeholders in the ecosystem
- » Whether the Transport Data Champion has sufficient support from the city to successfully convene stakeholders and carry out initiatives

3

Benchmark: Clarity and communication around the purpose and value of data collection and sharing

Achieving this benchmark

» Internally align with the city's goals and most pressing challenges for the transportation system (see Policy Workbook section on evaluating current city status and priorities for guidance)

» Research, understand and communicate the value and purpose of data sharing in the transportation sector to each key stakeholder (the Policy Framework and Policy Workbook serve as a starting point)

Monitoring continued progress

» Maintain communication and alignment between city government departments and various data stakeholders

» Periodically reassess to ensure goals and values are up-to-date





4

Benchmark: Defined and prioritized data use cases

Achieving this benchmark

» Define and select key data use cases on which to focus, based on the city's goals and challenges

» For each use case, clearly define how the required data will be used

» Clearly communicate to all government agencies and external stakeholders the goals and intentions for the data use cases and clearly layout how the data will be used

Monitoring continued progress

» Retain focus on several primary use cases

» Periodically reassess whether data use cases are still meeting the city's needs, and a) how they can be further developed or expanded

b) what new data use cases could be explored and implemented



Benchmark: Sufficient data collection mechanisms

Achieving this benchmark

- » Based on the desired use case, identify the necessary data
- » Evaluate what data are available: data that are already owned by the city (e.g., produced by monitoring infrastructure), publicly available, or available through an existing partnership
- » Identify where gaps still exist and what sort of data could be acquired to fill them
- » Collect the remaining data either by acquiring it from another data owner (if it already exists and they are willing to share), or by collecting it from scratch

For acquiring data from another data owner:

- » Make a specific request to the data owner for only the data that are needed to support the use case
- » Be clear and transparent with exactly how the data will be used
- » Make a value proposition to the data owner of how they will benefit from sharing the data
- » Use the consortium or other multi-stakeholder mechanisms (outlined below) as a platform for building these value-driven partnerships

Monitoring continued progress

- » Quality of data collected: e.g., accuracy, frequency and completeness
- » Age, reliability, and maintenance intervals of monitoring infrastructure
- » Investment in monitoring infrastructure by the city government and transit agencies
- » Success rate of data sharing requests and the types of requests that are successful (e.g., what types of data the companies are more willing to share, what sort of value proposition they are receptive to)
- » Maintain relationships with data-owning organizations rather than just making one-off requests

6

Benchmark: Appropriate safeguards for data privacy and security

Achieving this benchmark

- » Understand and evaluate what policies and guidelines are currently in place at the central-, state- and city-levels
- » Supplement with additional policy as needed to be embedded in the City Data Policy

Monitoring continued progress

- » Monitor compliance with data protection policies and moderate the data-sharing platform to ensure that data shared is scrubbed off personally identifiable information (PII)
- » Track any leaks of PII or data security breaches and update policies and protections as needed





Benchmark: A participatory framework for transport data stakeholders

Achieving this benchmark

- » Map the transport stakeholder ecosystem to identify all relevant parties who need to be involved
- » Gauge the stakeholders' level of interest in engaging in a participatory framework (e.g., through initial conversations or surveys)
- » Develop a participatory framework of some kind through which data stakeholders can surface shared challenges and help develop solutions to them. This framework could take many forms, ranging from less involved (e.g., an online format) to more involved. The format may depend on the city's capacity to facilitate as well as the level of interest of stakeholders in the city:

a) One possible (more involved) way to do this is to create a multi-stakeholder consortium that brings together critical mass among consumers and producers of data; this can be organized by the city government but should be an independent body

b) If the city has a strong and developed City Data Alliance, then the transport data stakeholder network could be developed as a subgroup of the existing Alliance

- » Extend invitations to stakeholders to participate on the platform/consortium/framework, making clear the value of data sharing and collaboration

- » Use the framework to get input from stakeholders and work collaboratively to align with the value of data-sharing and develop best practices for collecting and sharing data

Monitoring continued progress

- » Promote the findings of the stakeholder engagement through relevant networks and events (e.g., host a workshop on data best practices)
- » Convene/solicit input from stakeholders at regular intervals or as needed to maintain progress and momentum in developing and updating best practices and initiatives
- » Communicate with similar organizations in other cities to maximize knowledge-sharing
- » The number of stakeholders involved relative to the total number of players in the space, as well as their buy-in and commitment to data initiatives



Benchmark: Appropriate safeguards for data privacy and security

Achieving this benchmark

Either:

» Create a city-specific portal on the central government platform (open data platform, data exchange platform, and data marketplace)

» Develop an independent city platform to facilitate data sharing/exchange between data producers and consumers, beginning with an open data portal and eventually expanding to include a layer to broker transactions of private data between data consumers and producers:

a) Review the NDSAP implementation guidelines for national guidelines on implementing open data

b) Solicit input from data stakeholder platform on policy and portal/exchange design

c) Include guidelines for publishing data on the portal

In either case:

a) Require government agencies to participate

b) Engage non-government data owners and encourage them to participate in sharing data on the portal

c) Promote the portal as a tool for companies and individuals to use to support current work and new innovation

Monitoring continued progress

» Ensure the portal is actively monitored and curated to ensure the quality of the content

Some factors to monitor:

a) The amount of data openly available (e.g., number of datasets, variety of datasets, number of data points)

b) The quality of data that are available (e.g., accuracy, frequency and completeness)

» The number of stakeholders involved in the portal relative to the total number of players in the space

» The frequency of downloads of data sets hosted on the portal



9

Benchmark: Investment in mobility data initiatives

Achieving this benchmark

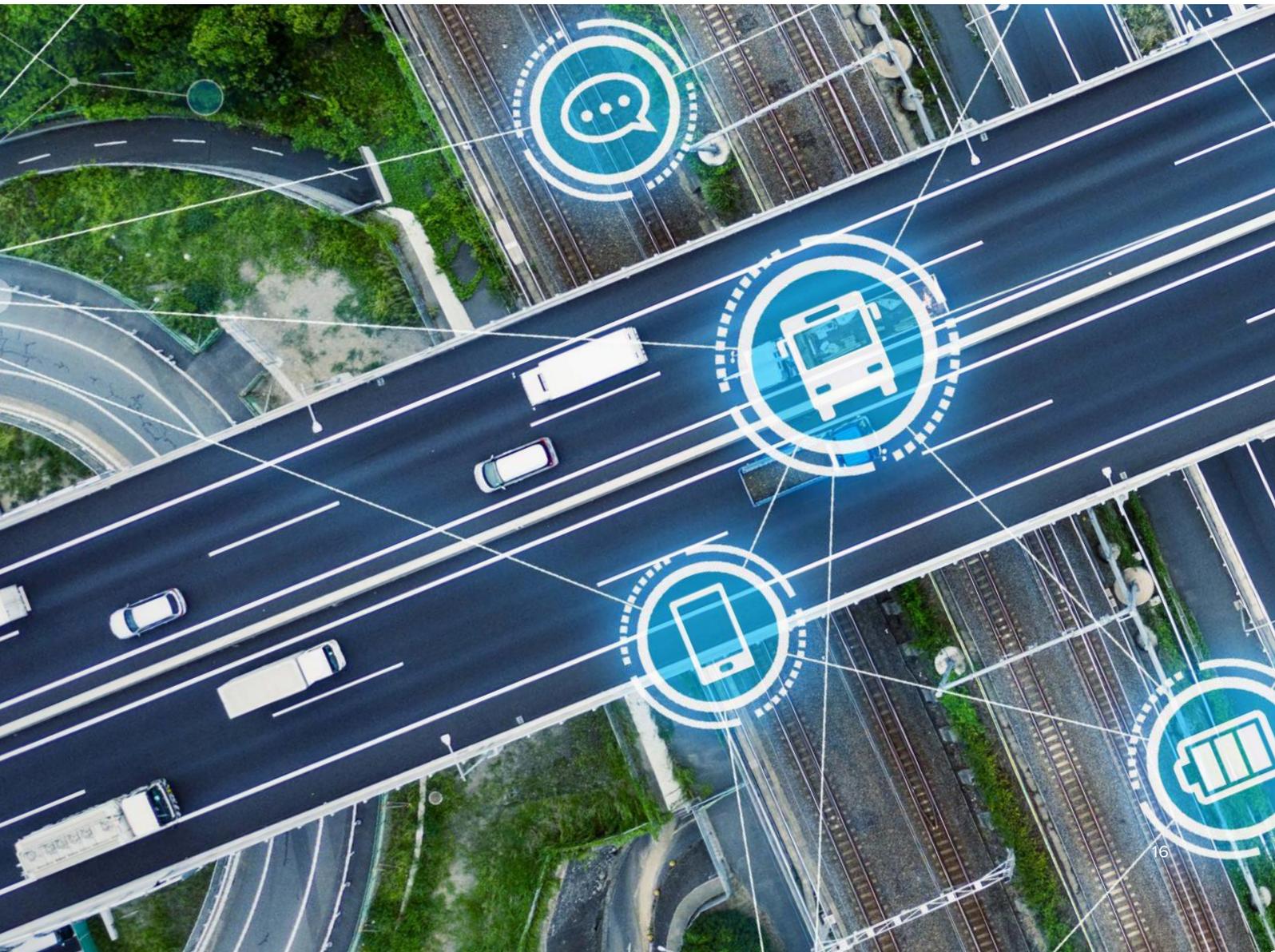
- » Identify highest priority initiatives that require funding
- » Assess the amount of funds available and potential additional sources of funding
- » Evaluate which investments will have the highest impact on improving data collection, sharing, and use ecosystem

Monitoring continued progress

- » Return on investment (e.g., relative to quality of data produced or improvement in KPIs of a particular project)

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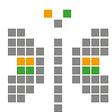
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DATA-DRIVEN TRANSPORTATION SYSTEMS

POLICY FRAMEWORK



Smart City
MISSION TRANSFORM-NATION



Ministry of Housing and Urban Affairs
Government of India





Ministry of Housing and Urban Affairs
Government of India

ABOUT MINISTRY OF HOUSING AND URBAN AFFAIRS (MoHUA)

The Ministry of Housing and Urban Affairs is the apex authority of Government of India to formulate policies, coordinate the activities of various central ministries, state governments and other nodal authorities and monitor programs related to issues of housing and urban affairs in the country. The Smart Cities Mission was launched by the Ministry in 2015 to promote sustainable and inclusive cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of ‘Smart’ Solutions.



ABOUT ROCKY MOUNTAIN INSTITUTE (RMI)

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing. RMI has been supporting India’s mobility and energy transformation since 2016.

DATA-DRIVEN TRANSPORTATION SYSTEMS

POLICY FRAMEWORK

Foreword



HARDEEP S. PURI

Honourable Minister of State
(Independent Charge),
Ministry of Housing and Urban Affairs

With a rapidly growing population and quickly evolving technologies and business models, there is a need to adopt new and fundamentally different pathways to develop a clean, cost-effective, and efficient transportation system to support the diverse needs of citizens. With initiatives like the Smart Cities Mission, Government of India has undertaken one of the most comprehensive planned urbanization programmes in the world. Smart Cities represent the exemplars of urban development in India, and as such are poised to lead the country in this transition. We envision Smart Cities to lead the adoption of smart solutions in provision of transportation infrastructure and services and are committed to support them in this endeavor. These Capacity Building Policy Framework Documents are expected to enable Smart Cities to develop strong data-driven transportation systems, and in turn lead the way for the rest of the country.

I congratulate the authors of “**Data-Driven Transportation**” for their outstanding work, as well as for their dedication in helping India build strong, sustainable transportation systems. Let this be the next step in building cleaner, more sustainable, more modern cities in India.



DURGA SHANKAR MISHRA

Secretary,

Ministry of Housing and Urban Affairs

The Capacity Building Policy Framework Documents are an exciting step in the Smart Cities Mission to make cities more citizen-friendly and sustainable. Since the launch of the Smart Cities Mission in June 2015, the program has made remarkable progress in driving the implementation of impactful projects to support citizen needs. The recommendations outlined in this document are a step on the path towards building the cities of the future, capable of supporting a growing and thriving urban population.

I commend Rocky Mountain Institute on their strong work and insightful recommendations in “**Data-Driven Transportation**”. I look forward to seeing the recommendations outlined in these documents put into practice to further improve the health, sustainability, and vibrancy of Indian cities.



KUNAL KUMAR

Joint Secretary (Mission Director Smart Cities),
Ministry of Housing and Urban Affairs

The Ministry of Housing and Urban Affairs is committed to supporting the development of sustainable, accessible, efficient, safe and clean urban transportation systems, and increasing the use of data is of critical importance to this effort. The Capacity Building Policy Framework Documents represent a step change in established practices and given the direct influence that the transportation system can have in our lives and environment, we believe it to be an essential change.

It gives me great pleasure to introduce **“Data-Driven Transportation”** as a new Capacity Building Policy Framework Document to support the development of India’s Smart Cities. It emphasizes the importance of developing efficient transportation systems to meet the needs of India’s growing urban population. It gives an overview of how data can be used in the transportation sector and provides suggestions for how cities can best develop and support their data collection, sharing, and use ecosystem.

Document outline

This document aims at providing a basic understanding of mobility data, to serve as a foundation for exploring ways to support its use in the passenger transportation sector.

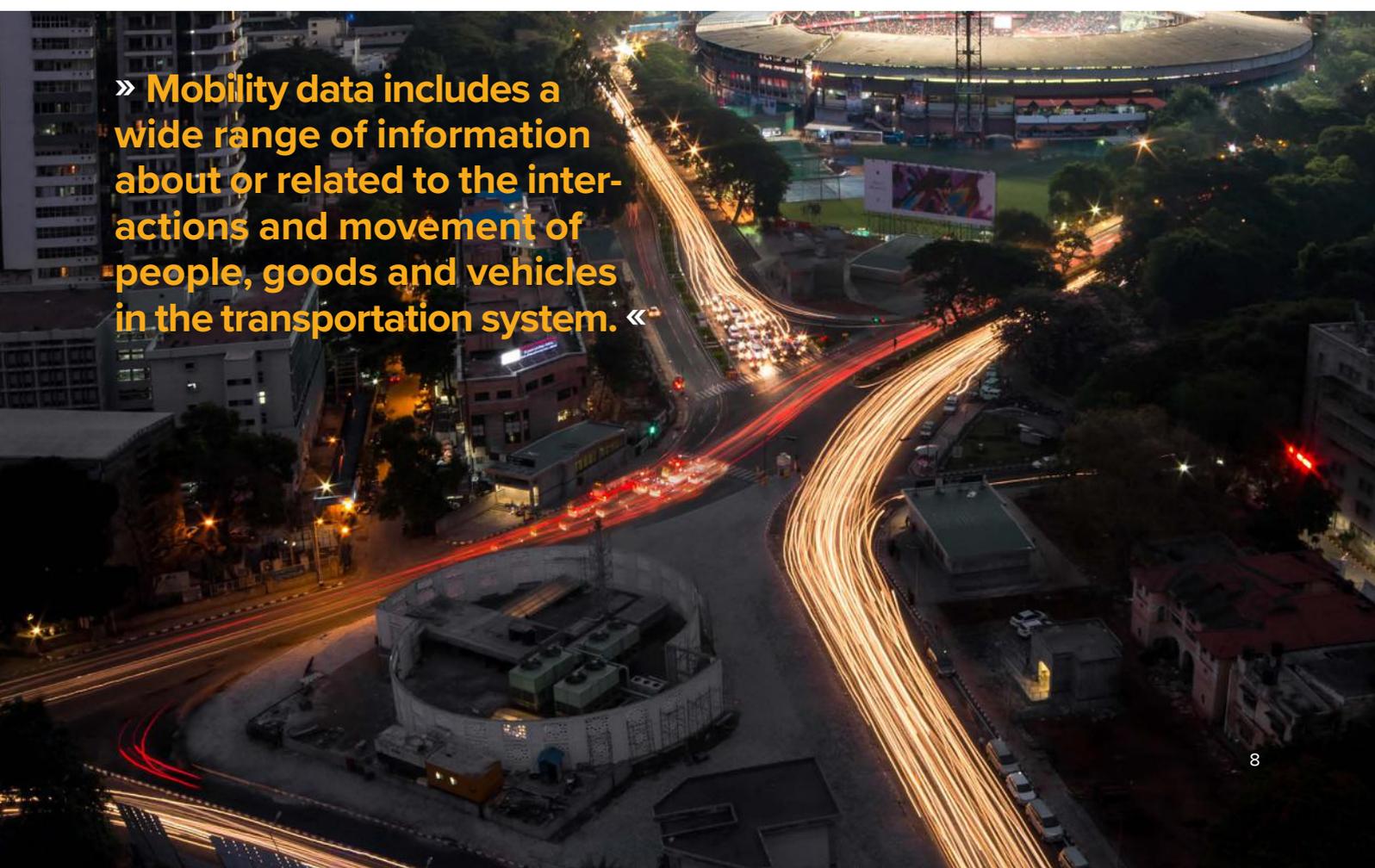
1.0	What is data?	06
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1.2	Who owns, uses and regulates mobility data?	08
2.0	Why is data useful in the mobility sector?	10
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1.0 What is data?

Data is any sort of information, both qualitative and quantitative. Data can be measured, collected and reported by a number of means and then analyzed to provide insight into a situation. The Government of India's Personal Data Protection Bill (2018) defines data as "representation of information, facts, concepts, opinions, or instructions in a manner suitable for communication, interpretation, or processing by humans or by automated means".¹

1.1 What is mobility data?

Mobility data includes a wide range of information about or related to the interactions and movement of people, goods and vehicles in the transportation system. Mobility data is collected and generated in a number of different manners by a number of different parties. For example, data can be collected using physical infrastructure such as sensors and cameras, mobile applications and surveys. This data is often generated by the movement of vehicles or individual travelers. It may be created and collected by public transit agencies, private companies and individual citizens.



» **Mobility data includes a wide range of information about or related to the interactions and movement of people, goods and vehicles in the transportation system.** «

Examples of types of mobility data

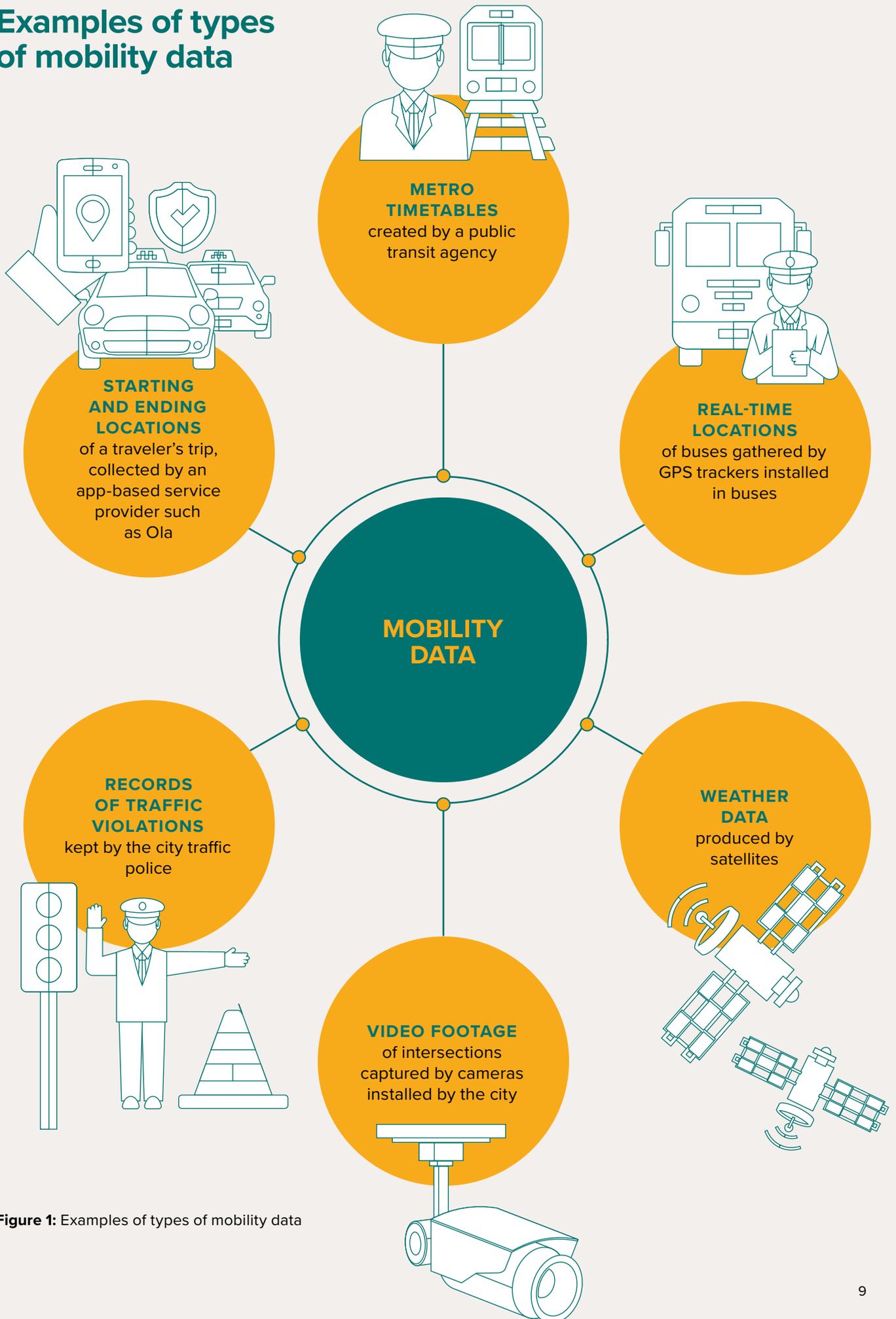


Figure 1: Examples of types of mobility data



1.2 Who owns, uses and regulates mobility data?

Three categories critical to the stakeholder landscape for mobility data are data owners, beneficiaries and government.² Data can flow from owners to beneficiaries but it can also flow within each category. Many organizations and individuals function as both data owners and beneficiaries.

» **Data owners:** Data ownership can typically be divided between two categories: public data, which is freely available (though not always accessible) and private data, which is generally kept within an organization. A single data owner may have both private and public datasets. Another key distinction is that of open data—this falls under the

category of public data because it is freely available to the public. But the term specifically refers to data that is typically well-structured, maintained and published on portal to make it easier to access and use. According to Ministry of Electronics and Information Centre, “a dataset is said to be open if anyone is free to use, reuse, and redistribute it—open data shall be machine readable and it should also be easily accessible”.³

» **Data owners:** Within the category of data beneficiaries for passenger mobility, there are three primary sub-groups: cities and governments, travelers, and researchers. Each of these beneficiary groups correlates with a set of use cases (i.e. end goals of collecting and analyzing mobility data), which are outlined in more detail in the Policy Workbook document.

Data owners

Companies, organizations and individuals that produce and own datasets

» **Public Data:**

Freely available (though not always accessible)

» **Private Data:**

Generally kept within an organisation

↔ Beneficiaries

Any group or individual that benefits from using mobility data

» **Cities & Governments:**

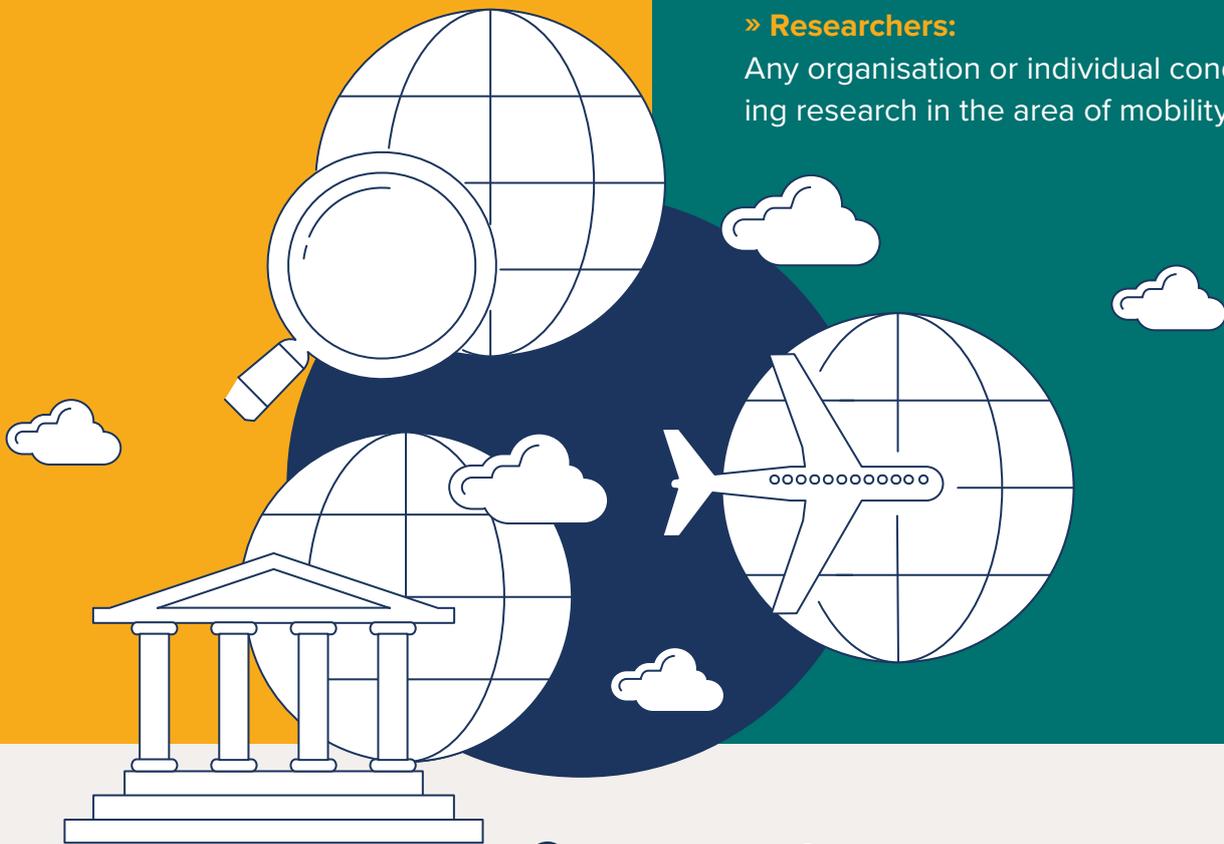
Includes regulators, planners and operators responsible for system-level design, operations and policy

» **Travelers:**

Any individual moving from one location to another

» **Researchers:**

Any organisation or individual conducting research in the area of mobility



Government

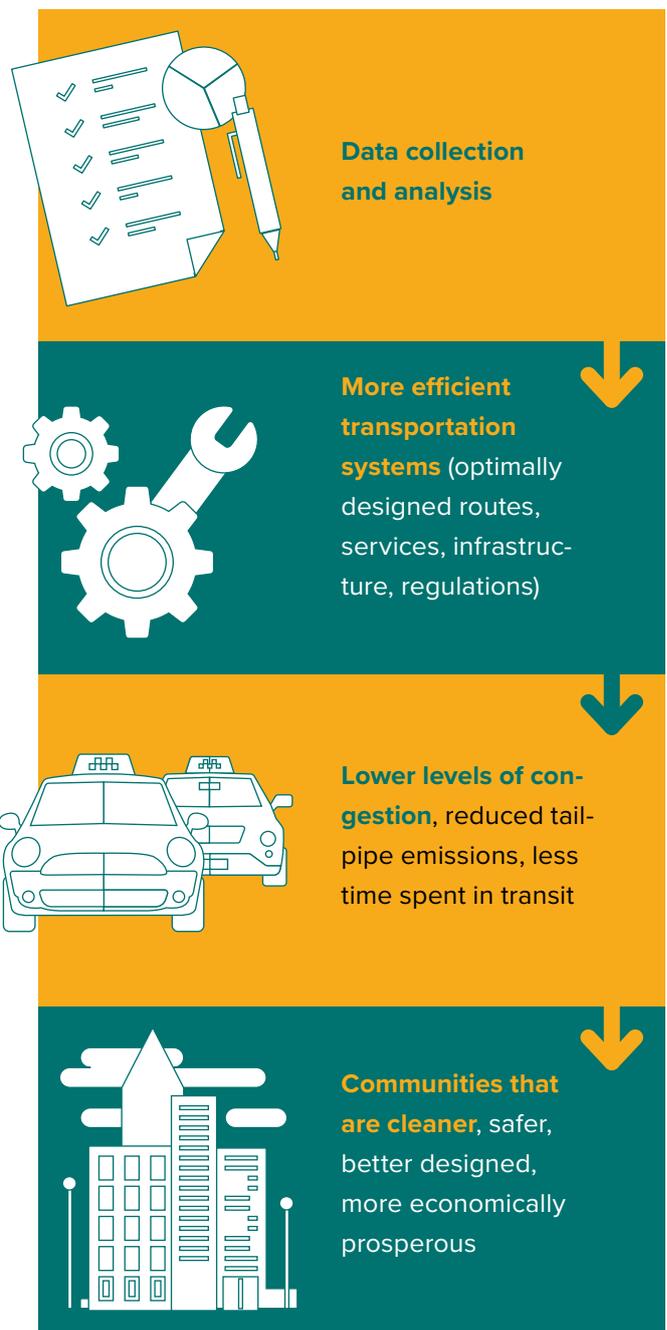
In addition to owning and benefitting from data, governments can play a role in enabling interactions between data owners and beneficiaries and protecting their interests.

Figure 2: Summary of key stakeholders in the data ownership, use, and regulation ecosystem for passenger mobility

2.0 Why is data useful in the mobility sector?

Data analytics can help unlock tremendous value in the transportation system by providing governments and organizations with the data they need to create more efficient transportation systems, with optimally designed routes, services, infrastructure and regulations. Doing so will lead to lower levels of congestion, reduced tailpipe emissions and less time spent in transit, resulting in communities that are cleaner, safer, better designed and more economically prosperous.

More and more transit organizations, both public and private, as well as individuals are collecting significant amounts of transit-related data. The range, scope, and volume of data collection are expanding. This increase in data presents a massive opportunity to better integrate components of existing transport systems, optimize transit options to users' needs and plan and regulate cities to match mobility patterns. The potential value that mobility data can unlock has led some analysts to dub data "the new form of oil"⁴ for transport systems.



3.0 What are the key ways in which mobility data can benefit a city?

Using data analytics in the mobility space has the potential to create more efficient commutes and allow for the optimized

design of city infrastructure and regulations. Taken from a societal perspective, this should lead to cities that are:

» **Cleaner:**

Using data to optimize commutes and goods transport will lead to fewer cars on the road, which means less tailpipe emissions.

» **More economically prosperous:**

Less time in transit means citizens have more time to contribute to economic activities.

» **Better designed:**

Planners armed with historic mobility data can better optimize infrastructure design to meet typical transport patterns, or recognize areas that need to be re-designed to minimize commutes.

» **Safer:**

Improved monitoring will lead to quicker emergency response times and better understanding of pain points will allow cities to address underlying causes to reduce accident rates.



The use of data can allow for mobility assets to be better utilized and integrated and boost economic growth while building cleaner and more livable communities. The benefits of using data analytics for mobility

can be further examined from the perspectives of various beneficiaries for passenger transport. A summary of the benefits specific to the perspectives of travelers, cities and researchers is outlined on pages 10 and 11.

Stakeholder-specific benefits

These benefits map to various use cases for data, which in turn require different types of data. For example, a traveler needs data that will help him optimize his trip to his destination, which may only require real-time data or potentially short-term projections of his transport options when he chooses to depart. In contrast, a city planner, who is designing infrastructure for the future would benefit from historic transit data so that he/she can examine past trends. These use cases are outlined in the Policy Workbook document.



Travelers

Visibility of options:

Easier to discover and compare transit options

Coordination between modes:

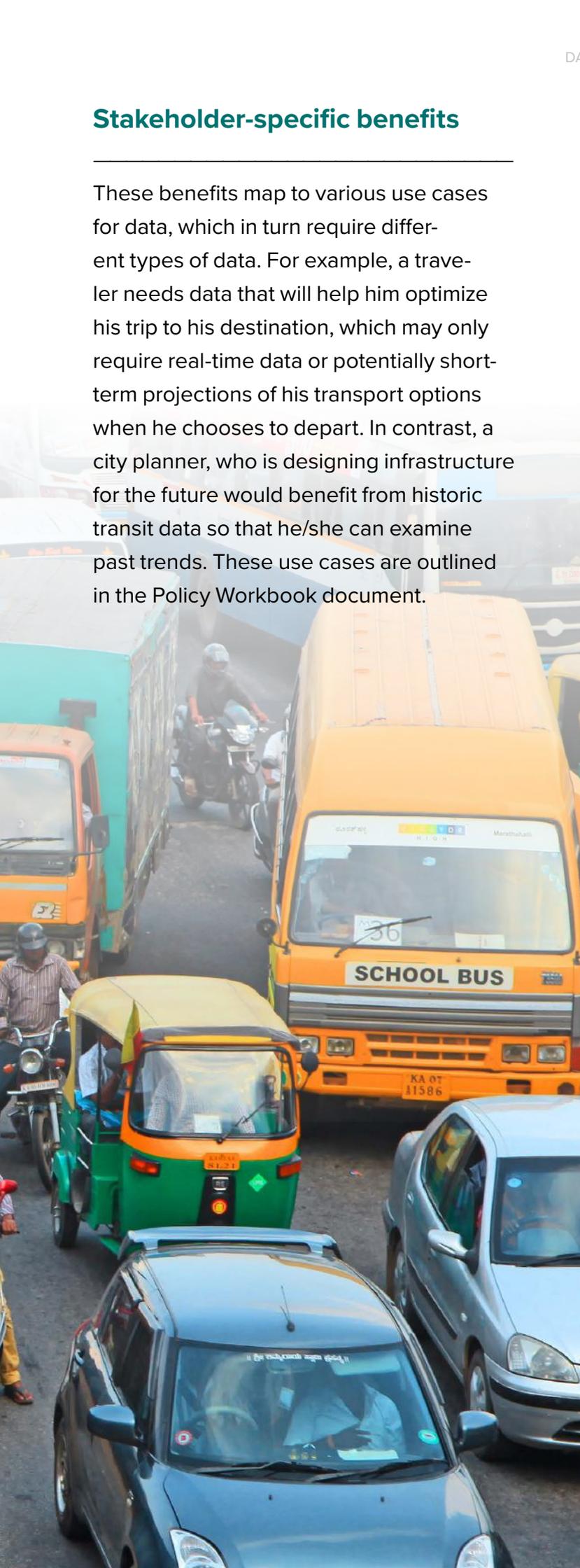
Easier to coordinate between different modes of transit required to reach a final destination

Accessibility:

Smart mobility services, enabled by open data, can meet the diverse needs of travelers and provide easier access to mobility

Better experience:

Integrated and multi-modal transit platforms would increase ease of transport, as well sense of security, given that transport providers are tracked and their location is known





Researchers

Improved data analytics capabilities:

Greater ability to conduct in-depth analysis in order to draw conclusions and make recommendations for the mobility system



Cities

Transit planning:

Using historic traffic patterns to better understand the best corridors to build new public transit routes and non-motorized transport infrastructure to meet commuter needs

Improved monitoring:

Better understanding of how the mobility system is being used, in order to identify where greater enforcement is required or where new regulations may be needed to help the system function smoothly

Reliability:

Ability to manage traffic incidents better and use data analytics to build a reliable transport system

Urban design:

Understanding commute patterns and areas of concern in the system would allow designers to create cities that support mobility better

Figure 2: Summary of stakeholder-specific benefits

4.0 How can a city unlock these benefits?

There are a number of actions a city can take to build a strong data collection and sharing ecosystem in order to unlock the benefits of mobility data and implement a set of data use cases. In order to do this effectively, the proper institutional framework must be laid, beginning with the implementation of the structure outlined in the Data Smart Cities strategy. This strategy is still in draft form

but is set to be released soon. (See the final section on current data-related policies and initiatives for more detail).

Once a city has appointed a City Data Officer and begun to create a City Data Alliance, as per the DataSmart Cities strategy, this structure can be used as the foundation to take steps towards implementation of transpor-

1

Appoint a transport data champion and allocate appropriate resources (e.g., staff) for the Champion to develop initiatives



Responsibilities of the Transport Data Champion include:

- » Prioritizing transport data use cases and initiating the design of initiatives and policies accordingly (steps 2–4)
- » Communicating with and convening key stakeholders
- » Working closely with the City Data Officer and Mission Data Hub to develop and maintain a data-sharing platform for the city and ensure appropriate safeguards for privacy and security



2

Prioritize transport data use cases, based on the city's goals and challenges



Consider:

- » What are the most pressing challenges to be addressed within the transportation sector?
- » What transportation goals does the city have?
- » Does the city have funds to invest in the initiatives and infrastructure?



tation-specific use cases. A Transport Data Champion should be appointed to lead all mobility data-specific initiatives of the city. Depending on the size of the city, the capacity of the city government and the complexity of its transport system, the City Data Officer could also play the role of Transport Data Champion.

Once this individual has been appointed, he/she can lead the process of evaluating the city's transportation needs and goals, prioritizing transport use cases for data, developing initiatives and acquiring the necessary data to support the selected use cases. A high-level overview of this process is summarized in Figure 3. Each of these steps, along with additional recommendations for supporting a data-driven transportation system, is outlined in more detail in

the Policy Workbook. The Evaluation Metrics document provides more details on reaching key benchmarks and monitoring continued progress in building a strong ecosystem for data collection, sharing and use.

Promoting data sharing between parties is key to maximizing the benefits of mobility data. Many public transit agencies, private companies and individuals are generating and collecting transport data. However, this data tends to be siloed between organizations and individuals and often recorded using different standards and formats. A city can play a key role in convening the relevant stakeholders and providing a platform for data-sharing in order to build an effective data-sharing ecosystem and practice to increase the amount of data available for planning, decision-making and innovation.



Establish a baseline for the city's current data collection, availability, policy, and stakeholder landscape as a starting point for each selected use case

Evaluate:

- » Stakeholder ecosystem and current relationships
- » Data collection, availability, and quality
- » Policy and government landscape
- » Current initiatives




Acquire the necessary data and/or develop a repeatable process/means for acquiring the necessary data to support the selected use cases

To acquire data for specific use cases:

- » Identify the necessary data
- » Determine what data is available and what gaps remain
- » Obtain remaining data, either by acquiring from other data owners (if the dataset already exists) or primary data collection



Figure 3: High-level steps for a city to take to implement transport data use cases (i.e. end goals of collecting and analyzing data), building on the DataSmart Cities strategy framework

5.0 How can a city monitor progress with respect to data collection, sharing and use?

Cities can play a critical role in supporting the development of an effective data collection and sharing ecosystem that involve both public and private entities. There are a number of steps that a city can take to build and strengthen this data collection, sharing and use ecosystem.

This checklist provides an introduction to these actions, which are described in more detail in the Policy Workbook and Evaluation Metrics documents.

While it is difficult to design Key Performance Indicators (KPIs) in the traditional sense for building a data collection, sharing and use ecosystem, a city can think of its progress with respect to the steps it has taken and the improvements it is making in strengthening the ecosystem, such as the level of buy-in from various stakeholders and the success of

specific use cases the city chooses to implement. The improvement in data collection will in turn enable monitoring and tracking KPIs in other areas (e.g. electric vehicles and freight efficiency).

The checklist comprises a set of benchmarks aimed at building and strengthening a city's data collection, sharing and use ecosystem. Achieving each of the checklist items at a basic level will ensure that the city develops a foundational data capability and capacity. However, many of the checklist items are ongoing and should be periodically revisited.

The Evaluation Metrics document provides more detail on how to reach these benchmarks and monitor continued progress with respect to each as the ecosystem continues to develop and strengthen.

CHECKLIST FOR MONITORING PROGRESS IN IMPROVING DATA COLLECTION, SHARING AND USE

DOES THE CITY HAVE...

- 01** Institutional framework outlined in the DataSmart Cities strategy, including a City Data Policy
- 02** An appointed transport data champion
- 03** Clarity and communication around the purpose and value of data collection and sharing
- 04** Defined and prioritized transport data use cases
- 05** Sufficient data collection mechanisms
- 06** Appropriate safeguards for data privacy and security
- 07** A participatory framework for transport data stakeholders
- 08** A city-level data-sharing platform
- 09** Investment in mobility data initiatives

6.0 What current data-related policies and initiatives already exist at the national level?



The Government of India has several relevant policies in place or drafted that pertain to data (though not specific to mobility data). Numerous states and cities also have their own data policies and guidelines. Relevant policies at the central government level:

National Data Sharing and Accessibility Policy (NDSAP)⁵:

This policy was approved in February 2012 and applies to all shareable non-sensitive data, in either digital or analog form, which are generated using public funds by various ministries, departments, subordinate offices, organizations and agencies of Government of India and state governments. The goal of the policy is to promote data-sharing and enable access to Gov-owned data for national planning, development and awareness. NDSAP aims at providing a platform for proactive and open access to data generated by various Gov entities, in machine-readable form through a wide area network, to permit a wider accessibility and usage by the public.⁶

» **Open Government Data (OGD) Platform in India⁹:** Government of India has launched Open Government Data (OGD) Platform (data.gov.in) to support Open Data Initiative for nation-wide data-sharing. OGD platform provides open access to datasets, documents, services, tools and applications collected by various ministries/departments/organizations of Government of India for public use.



Data smart cities¹¹:

The draft of this strategy document was released in December 2018 by the Smart Cities Mission under the Ministry of Housing and Urban Affairs (MoHUA). The goal of the strategy is to improve the culture and ecosystem around data collection and use across all relevant sectors, so that Smart Cities can use data to resolve critical problems. The document outlines the technical infrastructure and institutional framework to be developed at the central and city levels, as well as an index for measuring city data maturity.

» **At the Central level:** A Mission Data Officer will be appointed and a Mission Data Hub will be created within the Smart Cities Mission of MoHUA to lead all data efforts across Smart Cities. The Mission Data Officer will convene a Smart Cities Data Network, consisting of select City Data Officers and representatives

from additional ministries, to act as an advisory group to the Mission Data Officer and act as a peer learning network across Smart Cities. The Mission Data Hub will also be responsible for setting up and maintaining the technical infrastructure for cities to share data.

» **At the City Level:** Each Smart City will be required to appoint a City Data Officer responsible for the implementation of the Smart Cities data strategy and the creation of a City Data Policy. The City Data Officer will set up a city data page on the central-level Data Platform. Additional Data Champions and Data Coordinators will be appointed within each relevant department/organization to champion and coordinate the implementation of the City Data Policy in their respective department/organization. Each city will additionally develop a City Data Alliance, comprising key stakeholders within that city.



Personal Data Protection Bill¹²:

The draft of this act was released in July 2018 by the Ministry of Electronics and Information Technology. The act focuses on the fair and reasonable processing of data. The Draft Act specifies that there must be a clear, specific

and lawful purpose behind data processing and stipulates that only necessary data should be collected. Sensitive personal data may be processed on the basis of explicit consent. The Act is currently under the Ministry of Electronics and Information Technology's review.¹³

A Free and Fair Digital Economy¹⁴:

This report was released in draft form in July 2018, under the chairmanship of Justice BN Srikrishna. The report recommends that a data protection law should be set up, which will be responsible for the enforcement and effective implementation of the definition of personal data and sensitive personal data, legal affairs, policy and standard setting, research and awareness.

Srikrishna's report outlines seven key principles for effectively designing a privacy policy. At a high level, the principles are that the policy should be technology agnostic; holistic; include language on informed consent; recommend data minimization; assign controller accountability; structure enforcement and include deterrent penalties. The draft is currently under the Ministry of Electronics and Information Technology's review.

One Nation One Card¹⁵:

Government of India is soon to release a one-nation-one-card policy for public transit, which will mandate a single payment card across the country that works for all forms of public transit such as buses, metros, trains and toll payments. The goal of the card is to provide seamless connectivity across various modes of transport, and promote the use of public transport. NITI Aayog made the announcement¹⁶ in September 2018. The timeline for implementation has not yet been clarified. The government held a contest open to the public for the naming of the card, which closed at the end of August. Delhi has been running a pilot project for a common travel card for metros and public buses since January 2018.



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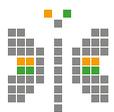
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DATA-DRIVEN TRANSPORTATION SYSTEMS

POLICY WORKBOOK



Smart City
MISSION TRANSFORM-NATION



Ministry of Housing and Urban Affairs
Government of India





Ministry of Housing and Urban Affairs
Government of India

ABOUT MINISTRY OF HOUSING AND URBAN AFFAIRS (MoHUA)

The Ministry of Housing and Urban Affairs is the apex authority of Government of India to formulate policies, coordinate the activities of various central ministries, state governments and other nodal authorities and monitor programs related to issues of housing and urban affairs in the country. The Smart Cities Mission was launched by the Ministry in 2015 to promote sustainable and inclusive cities that provide core infrastructure and give a decent quality of life to its citizens, a clean and sustainable environment and application of ‘Smart’ Solutions.

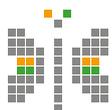


ABOUT ROCKY MOUNTAIN INSTITUTE (RMI)

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing. RMI has been supporting India’s mobility and energy transformation since 2016.

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Document outline

This document builds on the Policy Framework to guide city managers in understanding various ways in which data can be used in the passenger transportation sector and what steps to take towards implementing and supporting these use cases.

Instituting the framework outlined in the Data Smart Cities strategy and appointing a Transport Data Champion are key first steps in developing a data-driven transportation system. After understanding what use cases for data in the transportation sector are possible, a Transport Data Champion could consider three primary steps:



Prioritizing transport data use cases by identifying challenges and goals to address



Establishing a baseline for the city by understanding the current status of the city in terms of data collection and availability as well as related policy and stakeholder landscape.



Acquire the necessary data and/or develop a repeatable process for acquiring the necessary data to support the selected use cases. This document aims at supporting this process.

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Appoint a Transport Data Champion

Allocate appropriate resources (e.g., staff) for the Champion to develop initiatives

Responsibilities of the Transport Data Champion include:

- » Prioritizing transport data use cases and initiating the design of initiatives and policies accordingly (steps 2–4)
- » Communicating with and convening key stakeholders
- » Working closely with the City Data Officer and Mission Data Hub to develop and maintain a data-sharing platform for the city and ensure appropriate safeguards for privacy and security



Prioritize transport data use cases based on the city's goals and challenges

Consider:

- » What are the most pressing challenges to be addressed within the transportation sector?
- » What transportation goals does the city have?
- » Does the city have funds to invest in the initiatives and infrastructure?



Establish a baseline for the city's current data collection, availability, policy, and stakeholder landscape as a starting point for each selected use case

Evaluate:

- » Stakeholder ecosystem and current relationships
- » Data collection, availability, and quality
- » Policy and government landscape
- » Current initiatives



Acquire the necessary data

Develop a repeatable process/means for acquiring it to support the selected use cases

To acquire data for specific use cases:

- » Identify the necessary data
- » Determine what data is available and what gaps remain
- » Obtain remaining data, either by acquiring from other data owners (if the dataset already exists) or primary data collection

1.0 Identifying uses of data in the transportation sector

This section describes potential use cases for mobility data for passenger transport.¹ These use cases are organized by the three primary categories of beneficiaries outlined in the Policy Framework document: cities and governments, travelers, and researchers. While a city may primarily focus on the use cases for cities and governments, it may also play a role in supporting and enabling the traveler and researcher use cases.



Cities and governments

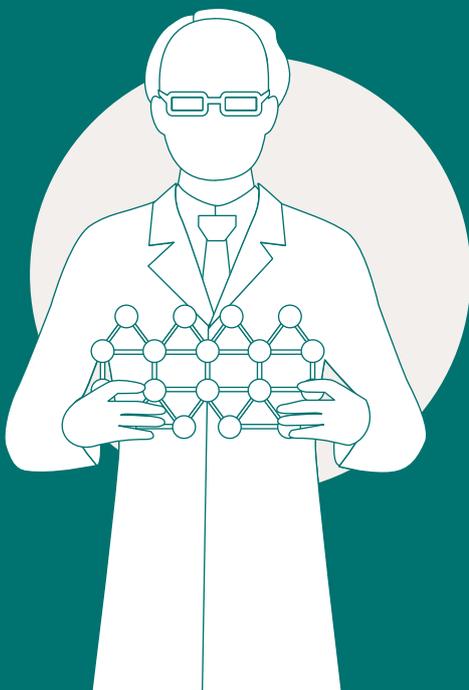
- » Safety and security
- » Transportation, route & infrastructure planning
- » Road and infrastructure maintenance
- » Real-time system and maintenance
- » Enforcement and regulation

Travelers

Mobility as a service:

- » Multimodal trip planning
- » Seamless payment
- » Real-time mode connectivity and optimization

Ancillary trip information



Researchers

Mobility research and analysis

Figure 02: Summary of the primary mobility data use cases

1.1 City and government use cases

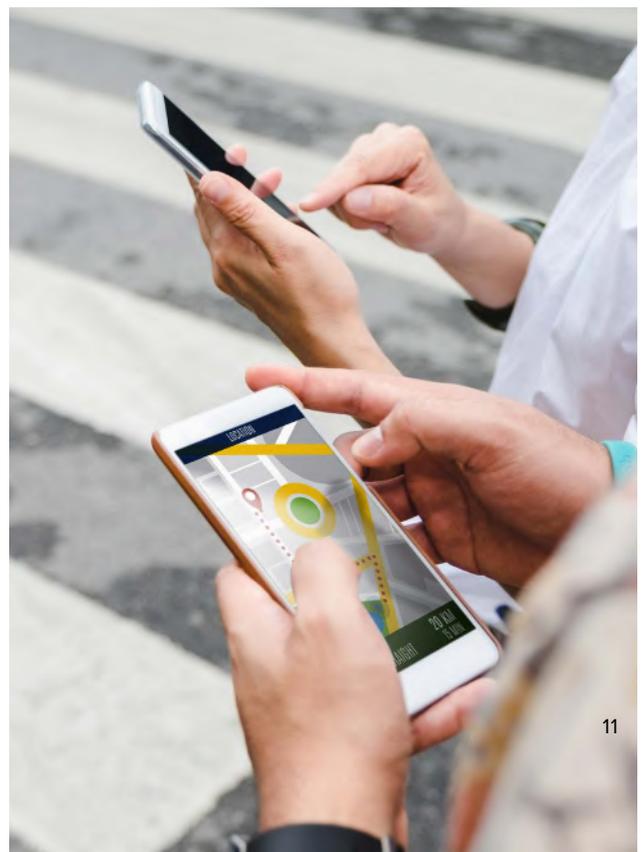
Cities and governments around the world are realizing the value of using mobility data to improve system safety and optimize transit planning and city design around the efficient movement of people and goods. Some of these use cases are discussed below.

» Analyzing traffic and commute patterns allows planners to understand where to build infrastructure and add transit routes to ease stress in highly-trafficked areas. «

» **Safety and security:** Data can enable improved safety and security within the transportation system in a number of ways. For example, increased access to data allows cities to see where accident hotspots are, thus enabling them to respond more quickly and also understand the issues in those areas. With increased understanding of when and how accidents occur, cities can ensure a greater level of safety for their citizens by responding faster when incidents occur and developing solutions to systemic concerns. One particular area of concern in India is women's safety in the transportation sector. Many women feel unsafe traveling alone and frequently avoid using public transport.² Improved tracking of vehicles and verification of drivers and vehicles that are deemed safe are some examples of how data may allow women to feel safer using transportation.

» **Transportation, route and infrastructure planning:** Transportation planners can leverage data analytics to better design and maintain routes, public transit and mobility infrastructure. For example, analyzing traffic and commute patterns allows planners to understand where to build infrastructure (including non-motorized transport infrastructure) and add transit routes to ease stress in the most highly-trafficked areas. Data analytics can aid planners in minimizing congestion in cities by identifying the primary cause (like poorly-timed signals, insufficient parking, etc.).

» **Road and infrastructure maintenance:** Access to data can allow cities to see when, where and what maintenance is required for roads and various infrastructure. Doing so can allow cities to prioritize maintenance, in order to manage resources more effectively and know when to act to prevent excess damage, which may lead to greater costs than addressing weak points early on.





» **Mobility data—as well as organizations’ willingness to share data—is the key to unlocking MaaS.** «

» **Real-time system management:** Data can aid in the real-time functioning of the mobility system. Operators can remotely monitor the transportation system and manage system operations. Increased access to data will give operators more real-time information that will help them ensure the smooth functioning of the transportation system.

» **Enforcement and regulation:** Increased access to data gives regulators better visibil-

ity into the transportation system, allowing them to improve the enforcement of regulations and develop new or modify existing regulations to ensure a smooth system.



1.2 Traveler use cases

There are many potential use cases that apply to improving transportation efficiency for individual travelers. Many of these can be grouped under the general category of “mobility as a service”.

» **Mobility as a service:** Mobility as a service, or MaaS, refers to the technology-enabled, on-demand availability of multi-modal trip options, including multimodal trip planning and seamless payment.⁴

Mobility data—as well as organizations’ willingness to share data—is the key to unlocking MaaS. There are several data-supported

elements that go into MaaS, many of which are described in more detail below.

Multimodal trip planning: A primary element of MaaS is the ability to see all available modes of transport and choose the mode that is most optimal for the situation and be able to easily link various modes of transport to get to the destination. For example, a traveler could go onto a single platform and enter her destination and be shown the best option for getting there, which may include a portion of the trip using one mode and another portion using a different one.

Seamless payment: Enabling travelers to seamlessly pay various transportation providers



through a single portal could increase the accessibility of transport options and promote multimodal trips. Implementing seamless payment requires collection and integration of transit data and also relies on transit companies' willingness to share data.

Real-time mode connectivity and optimization: Mobility data can enable the real-time optimization of travel plans around changing factors such as weather and traffic as well as travelers' preferences (e.g. least expensive, shortest time, etc.).⁷

1.3 Researcher use case

The researcher use case includes organizations, groups and individuals conducting mobility-related research, such as academic institutions and think tanks. Increased access to data gives these groups and individuals a greater ability to conduct in-depth analysis

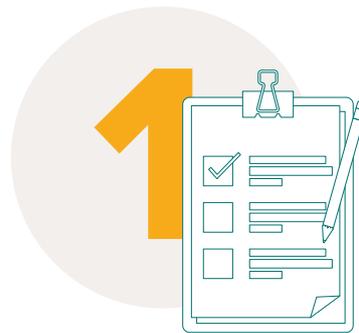
on the passenger transportation system, in order to draw conclusions and make recommendations for the mobility system.

Which use cases a city decides to prioritize depends on its starting point, priorities and goals. The next section outlines how a Transport Data Champion can evaluate the city's starting point and begin to prioritize data use cases.

» **Ancillary trip information:** In addition to MaaS, there are a number of other services that access to data can provide to increase the efficiency and ease of a traveler. This could include accessing data on real-time conditions (i.e. traffic, weather, accidents, etc.), information about interesting landmarks along the route or any other sort of ancillary information to enhance a trip.

2.0 Prioritizing data use cases and evaluating city baseline

To implement the use cases outlined above and benefit substantially from the use of data in the passenger mobility sector, it is critical for a city to consider its goals and challenges and use this framework to prioritize a few use cases on which to focus. A city should consider following three primary steps towards implementing data use cases. This section outlines the first two steps in this process.



Prioritizing transport data use cases by identifying challenges and goals to address



Establishing a baseline for the city by understanding the current status of the city in terms of data collection and availability as well as related policy and stakeholder landscape.



Acquire the necessary data and/or develop a repeatable process for acquiring the necessary data to support the selected use cases. This document aims at supporting this process.



2.1 Prioritizing transport data use cases

The use cases for mobility data can support larger goals for the transportation sector while addressing pressing challenges. In order to prioritize mobility data initiative and policy developments, a city should consider its goals and challenges before deciding where to put its efforts.

In order to identify the transportation goals and challenges that the city wants its data efforts to serve, a city manager could consider the following questions.



What transportation goals does the city have? What are the citizens' transportation priorities?

For example, if a city has a high demand for affordable public transit and/or the city has set a goal of increasing public transit ridership by X% by 2030, they could prioritize analyzing data to plan transit routes and improving GPS tracking of buses so that riders could better plan around and rely on the bus system.

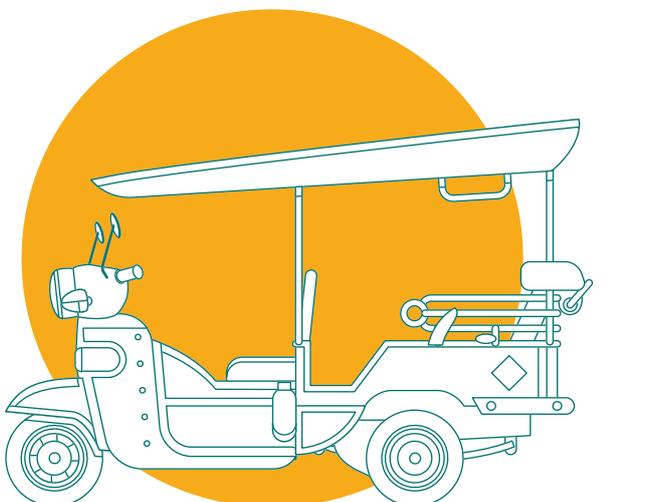
Does the city have funds to invest in initiatives and infrastructure? To what extent?

To determine whether the city should prioritize initiatives that may require government investment (e.g., installment of additional monitoring infrastructure) or those that require less or could be funded using innovative business models.



What are the most pressing challenges to be addressed within the transportation sector?

For example, if a city struggles with a high rate of road accidents, they could prioritize road safety as the transportation goal/challenge on which to focus its data efforts. There could be one or more challenges on which the city could decide to focus.





2.2 Evaluating the city's starting point

After selecting the use cases on which to focus, the Transport Data Champion should establish a baseline for the city's current status and landscape with respect to data as a starting point for understanding what actions will need to be taken to implement the selected use cases. To do this, the city manager should explore questions across four primary areas:

» **Stakeholder ecosystem and current relationships:** To understand the players involved and how to engage them

» **Data collection, availability and quality:**

To identify what sort of data are already being collected, who it is available to and what quality it is (e.g. frequency, accuracy, etc.)

» **Policy and government landscape:**

To identify what additional policies and guidelines may exist at the city and state levels and which government entities should be involved in developing mobility data initiatives

» **Current initiatives:** To understand how the city is currently using data and what relevant plans might already exist

Below is a sampling of questions across each of these categories to understand the baseline situation. The Transport Data Champion may use these as a starting point and

dig deeper with follow-up questions as they arise to ensure as complete an understanding as possible. The questions should be asked with the prioritized use cases in mind.



GTFS—General Transit Feed Specification—defines a common format for public transportation schedules and associated geographic information; it is a standardized format widely used around the world.⁸

An API—application program interface—is a set of programming standards and instructions for accessing a web-based software application⁹; making an API available allows software developers outside the organization to design products that incorporate that API's data and functionality.

Do transit operators in the city (public or private) collect data in GTFS format? Do they publish their GTFS feeds to make their APIs available?

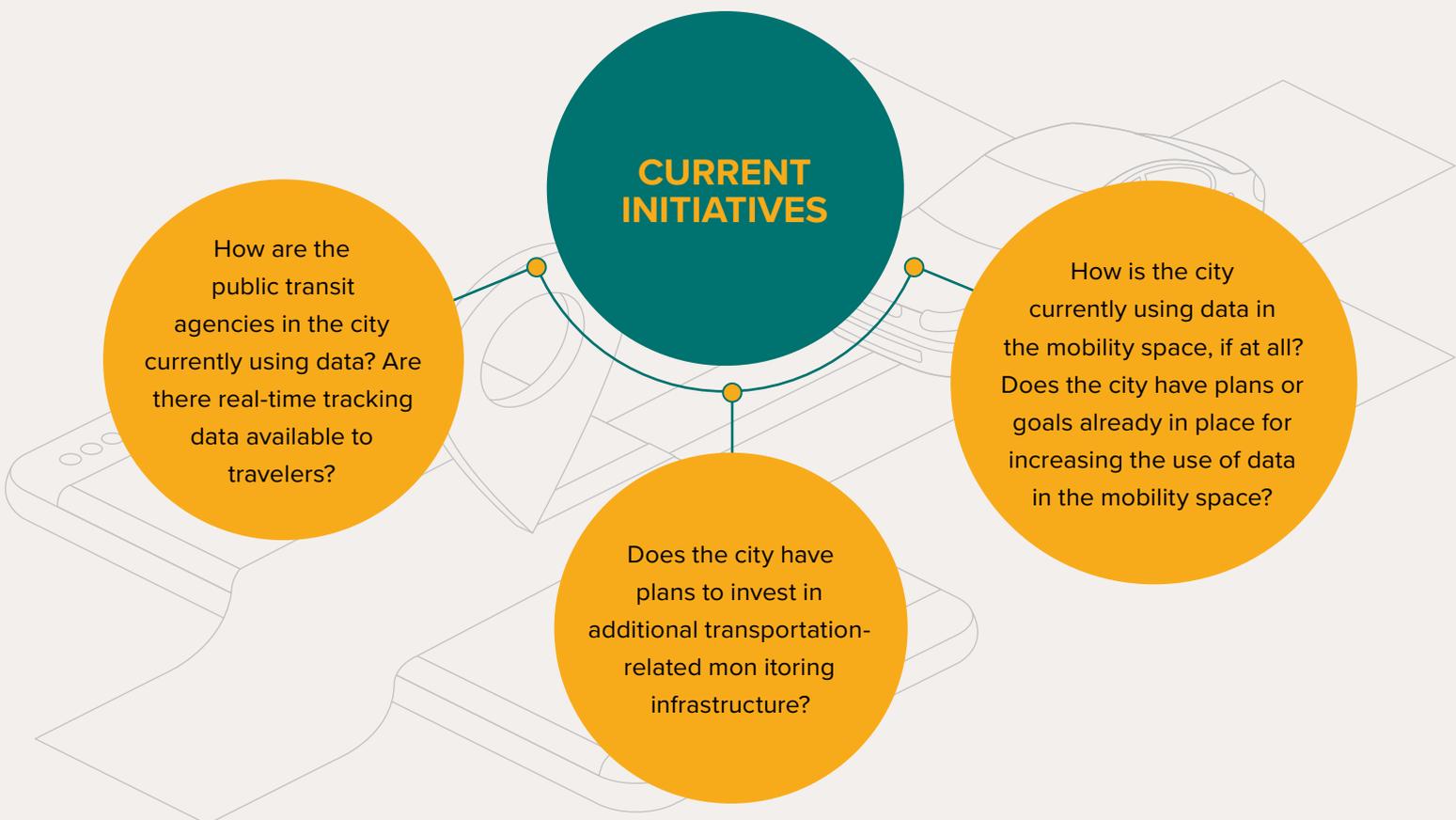
What are the primary modes of transit in the city? (Depending on the use case, this question may be important to understand which providers are most critical to get information from first.)

What sort of data collection and monitoring infrastructure does the city currently have, relevant to the use cases? Is it functioning and accurate?

DATA COLLECTION, AVAILABILITY & QUALITY

What type of data is being collected and what is the frequency with which it is collected and published? Are these data being shared with other public agencies/corporations? Are these data made available publicly?





Some of these questions may be easily answerable while others will require greater time and effort to answer fully. One potential approach to thoroughly answering these questions could involve two parts:

1. Stakeholder interviews: Reach out to all stakeholders involved in the ecosystem (including various government departments, public transit agencies and private transit companies) to understand how they are collecting data and what they are willing to share.

2. Literature and policy review: Review all available policies and recent reports related to this topic.

3.0 Process of data acquisition for specific use cases

Once use cases have been prioritized, there are three primary steps for acquiring the necessary data for each: identifying the sources for the required data; surveying

what data are available and identifying what gaps remain; collecting additional data or acquiring data from other data owners to fill those gaps.¹⁰



Identifying necessary data

The first step is to identify what sort of data are needed to fit the desired use case. This is an essential step—thoroughly analyzing what types of data sets are needed and conversely, what are not needed, will allow the city to efficiently collect or obtain the needed data. Doing so will also allow the city to make more effective and specific requests for data if a data owner already has some of the necessary data.

» Example: route planning

After evaluating the city’s goals and challenges, a Transportation Data Champion decides to use data to inform public transit route planning. To do this, he/she works with a team of transportation planners and together they determine that they want historic data on commute patterns in order to identify the most highly-trafficked routes to determine where new mass transit routes can be developed to meet the needs of commuters and ease congestion. They recognize that they do not need real-time data or ancillary data such as weather information, trip fare, etc.



Determining what data are available and what gaps remain

Once the necessary datasets have been identified, the organization can survey which data are already available to them, either through data that they already own or have access to or through publicly available data. There are already many sources of open

data. Surveying all the data that are already available will prevent an organization from collecting redundant data or making unnecessary data requests. Once the organization has determined which of the datasets are already available to them, they can identify where gaps still exist and what sort of data could be acquired to fill these gaps.

» Example: route planning

The team notes that they have open access to historic data on the ridership of current public transit options from the public transit agency. They also have data on traffic patterns from the several traffic sensors that have been installed throughout the city. Then they determine that their existing traffic pattern data do not have as much detail as they would like and leave off a few key areas of the city. They decide to acquire additional data for commute and traffic patterns in the city.



Collecting remaining data

To fill in the gaps identified, an organization or individual has two options:

1. Acquire the data from another data

owner: One option is to acquire the needed data from someone who already owns it.

2. Collect the data: If no one owns the needed data, or if the data owner is unwilling to share it, the organization must devise a way to collect it themselves.

» Example: route planning

The team evaluates the options of installing more traffic sensors to collect their own data on commute and traffic patterns or approach other data owners to acquire data that already exist. They decide to take a combined approach of installing additional sensors as well as working with shared mobility providers to acquire existing data-sets.



4.0 Common challenges in collecting and sharing data

Despite the numerous benefits that come from collecting and sharing mobility data, there are many challenges to it. Acquiring data can prove difficult; even once this is accomplished, often the data are incomplete, of poor quality and lack standardization. Some of the biggest challenges and barriers are outlined below; recommendations on how to minimize these challenges are addressed in the guidelines in the following section. Some challenges and barriers include:

» **Acquiring data from private data owners:**

Private data owners are often concerned with jeopardizing competitive advantage by sharing data and are wary of blanket requests for their data without a clear outline of how it will be used or a value proposition to the data owner for sharing it. This can be addressed by cities making very clear and specific requests for data as well as being transparent about how the data will be used. See recommendation 2 in the following section.

» **Poor quality and incomplete data:** Existing data are often of poor quality or incomplete—for example, inaccurate, published infrequently or missing for certain days or services.

Setting best practices for data collection and hosting capacity-building opportunities for transit organizations can help address this barrier.

» **Lack of data standardization:** Commonly used standards for many modes of transport don't exist while for other modes the standards are incomplete. The lack of data standardization makes it challenging to aggregate data from different sources and use them in an efficient manner. Creating and publicizing data standards or best practices can help address this challenge.

» **Privacy/cyber security:** Data must be reliably scrubbed of personal identifiers so that an individual's privacy is not compromised. Both individuals and companies are often concerned that sharing data openly might be a breach of their privacy. This challenge can be addressed by creating policies to ensure appropriate safeguards for data privacy and security.

» **The lack of data standardization makes it challenging to aggregate data from different sources and use it efficiently.** «



5.0 Recommendations for supporting data-driven transportation systems

This section outlines six key actions that a city can take to develop and strengthen the data collection and sharing ecosystem to enable the use cases described above.

These actions correspond to benchmarks outlined in the Evaluation Metrics document and overlap with and build on the ground-work laid by the DataSmart Cities strategy:



Implement DataSmart Cities framework and formulate a City Data Policy



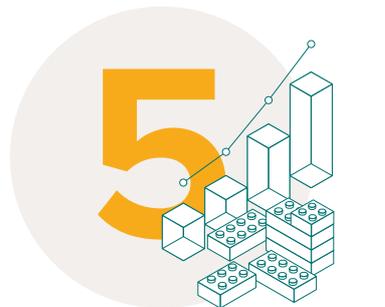
Appoint a Transport Data Champion



Clarify and communicate the purpose and value of data collection & sharing



Ensure appropriate safeguards for data privacy and security



Build a participatory framework for transport data stakeholders



Develop and maintain a city-level data-sharing platform



Implement DataSmart Cities framework and formulate a City Data Policy

Before taking steps to promote transport-specific data use cases, a city should develop or begin to develop the foundational framework for supporting data-related initiatives. The DataSmart Cities strategy outlines the framework that every Smart City must put in place to support the development of a culture of data-driven governance.

Appointing a City Data Officer to be responsible for the implementation of the Smart Cities data strategy.

Appointing Data Champions and Data Coordinators within each relevant department or agency to champion and coordinate the implementation of the City Data Policy in their respective organization, such as identifying and publishing datasets from their organization.

Developing a City Data Policy, which would include proposed smart solutions/projects, an assessment of current IT systems, a list of datasets of interest and a road map with milestones for publishing datasets.

Developing a City Data Alliance, which would be a network of government departments, agencies, private sector companies, community organizations, city policy-makers, domain and legal experts, researchers, academic institutions, incubators, entrepreneurs, etc., within the city who come together to advise on the development of the City Data Policy, identify data use cases to address key challenges in the city and promote education and awareness about data in the community.



Appoint a Transport Data Champion

The Transport Data Champion will lead all transport data efforts—evaluating the current city status, choosing use cases on which to focus and supporting the development of data initiatives for selected use cases. Depending on the size of the city, the capacity of the city government and the complexity of the transport system, the City Data Officer (per Data-Smart Cities strategy) or Chief Data Officer (per the NDSAP implementation guidelines) could also play the role of the Transport Data Champion.

The Transport Data Champion should be given the mandate and authority to work with the City Data Officer to launch initiatives and draft policy to support the development of an effective data collection and sharing ecosystem in the city. The Transport Data Champion should be allotted the necessary resources (e.g., staff, funding as available) to achieve the goals decided upon by the city. The size of the team required to support the Transport Data Champion will vary depending on the city's size, avail-

ability of resources and complexity of its transport system.

With many stakeholders involved in the mobility data landscape—public transit agencies, private service providers, travelers, etc.—municipal corporations and Smart City SPVs can play a key role as conveners to get the relevant parties on board with standardizing and sharing data.

Responsibilities of the Transport Data Champion may include:

- » Identifying priorities for data use for the passenger mobility sector and initiating the design of initiatives and policies accordingly
- » Ensuring the City Data Plan supports the needs of transport data goals
- » Working closely with the City Data Officer and Mission Data Hub to develop and maintain a city-specific data-sharing platform and ensure appropriate safeguards for privacy and security
- » Managing relationships with other entities, including private data owners
- » Convening stakeholders in the system to address common challenges and opportunities when appropriate
- » Tracking the city's progress in developing and strengthening transport data initiatives
- » Communicating with Transport Data Champions of other cities to learn from their progress and challenges, as well as coordinate initiatives as transportation crosses city boundaries



Clarify and communicate the purpose and value of data collection and sharing

An important step is for the city to understand the purpose and value of data collection and sharing and align its priorities with respect to data collection and use cases. Doing so will also allow the city to focus its efforts, using resources efficiently to successfully implement the selected use cases, as well as to communicate more effectively with data owners.

Though this may seem like an obvious point, a common downfall for cities is to try to do too much without a sense of prioritization around which data are going to unlock the most value. This lack of focus also prevents cities from being able to clarify the data's use to those from whom they are requesting it. Clarifying the city's overarching goals and using that as a framework to understand the purpose in collecting and using data will help a city avoid this common challenge.

Being able to clearly articulate the purpose and value of data collection and use will allow the city to:

- » Align internally with the many government agencies and departments to support a common goal
- » Communicate more effectively with the private sector, resulting in greater participation in data-sharing initiatives
- » Promote a data-sharing platform and other data initiatives more effectively

» **Communicating effectively with data**

owners: To develop a successful practice of sharing open mobility data, the private and public sectors must collaborate effectively. As described in the challenges section, bringing private companies onboard sharing data can prove challenging to building a robust data-sharing ecosystem. Many companies are concerned that sharing proprietary information may jeopardize their competitive advantage. One pitfall of cities is to make a request for all data from private companies—this approach tends to be ineffective as many organizations are wary of these blanket requests for their proprietary information without sufficient justification. This can be avoided by city governments by being specific and judicious with the types of data they are requesting and making clear exactly why they need it and how they plan to use it.

While promoting open data sharing has many benefits, not all data need to be made open to support a certain use case. There may be

instances where a city government could form a partnership with an organization to acquire data for a specific use, without that data being made publicly available. Involving private data owners through a participatory framework—such as the City Data Alliance outlined in the DataSmart Cities strategy—will help build relationships and convince participants of the value of sharing data. In addition, there may be a need to engage data owners individually and make specific requests for data. In these cases, how the data owner is approached and the nature of the request can greatly impact a data owner’s willingness to share his/her data.

When making a data-sharing request to a data owner:

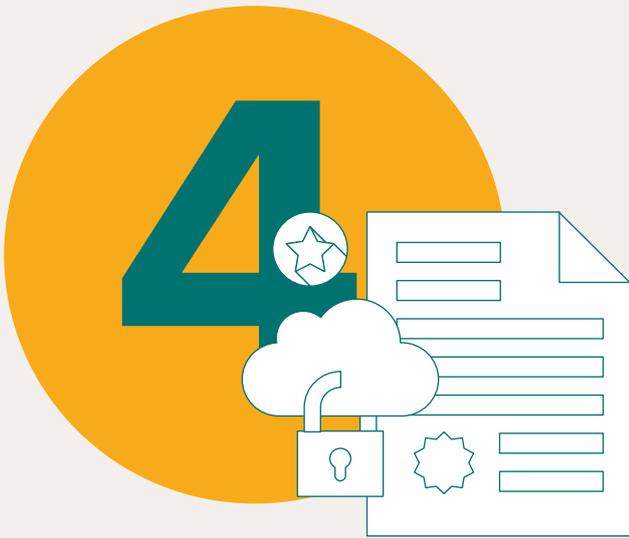
- » **First understand the use case** and determine what kind of data are needed for it
- » **Request only the data that are needed** to support the use case, rather than making a blanket request for all available data

» **Be clear and transparent** with exactly how the data will be used

» **Make a value proposition** to the data owner of how they will benefit from sharing the data and/or offer to trade data (if the city has access to information that could benefit the private data owner)

The example of Waze’s Connected Citizens Program—detailed in the Best Practices document—demonstrates a private company being willing to share data when the use case is very clear and the use is transparent. In this case, the value proposition to Waze for sharing its data was clear, as the private company benefits from receiving information from the city in return for the data it provides.





Ensure appropriate safeguards for data privacy and security

To ensure that the privacy and security of citizens and organizations are not compromised through data sharing, appropriate safeguards must be in place. As outlined in the Policy Framework, there are several draft policies at the national level, which provide guidelines for processing personal data and outline requirements for data privacy. Additionally, several states and cities may already have privacy policies in place.

The city should make sure there are adequate protections in place to protect citizens' privacy and security and supplement with additional policy and guidelines if necessary. These privacy and security policies/guidelines should be embedded in the City Data Policy and developed in consultation with the Mission Data Officer, as outlined in the DataSmart Cities strategy.

The proposed Personal Data Protection Act of 2018, prohibits the processing of sensitive personal data without explicit consent. It means that any organization that has access to mobility data for specific individuals must do one (or both) or two things:

» **Remove any PII from the data** before allowing it to be used publicly. In this case, personal identifiers must be reliably removed from the data so that an individual's privacy is not compromised

» **If data are to be transferred, ensure that those containing PII** (or ideally, all data) are sent through secure channels so that PII remains only in the possession of the parties that have been authorized to own or access it

Data shared on the city-wide data-sharing platform or other public forums must be adequately processed to ensure that the privacy of an individual is maintained and the security of the city, state or country is not compromised.



Build a participatory framework for transport data stakeholders

A participatory framework for transport data stakeholders should be developed, through which stakeholders can surface shared challenges and help develop solutions as well as provide input on the development of policies and initiatives.

This transport stakeholder network may be developed as a subgroup of the City Data Alliance (as per the DataSmart Cities strategy) focused specifically on transport data or as a separate entity. This framework could take many forms, ranging from less involved—for example, an online forum—to more involved, such as an organized consortium that meets regularly. The format may depend on the city’s capacity as well as the level of interest of its stakeholders.

The key actors involved should include both public transit agencies and private transit companies and any other relevant stakeholders.

The Transport Data Champion may be responsible for developing the framework and convening/soliciting input from stakeholders and the resulting feedback and ideas generated should be used to inform the design of initiatives and policies. Where appropriate, the stakeholder group should be in contact with similar organizations in other cities to maximize knowledge-sharing.

The participatory framework should aim at harnessing the collective expertise of the many stakeholders involved to support the development of effective policy and best practices that are in line with industry consensus and technology trends. If the city has a strong existing City Data Alliance, it would be a logical platform on which to develop a transport-specific convening framework.

The functions of the stakeholder engagement platform may include:

- » Internally aligning the value of data-sharing and promoting this beyond the participants of the framework

- » Identifying critical stakeholders in the transit data and shared mobility ecosystems and creating a framework for sharing data among different players
- » Co-developing best practices and recommendations for collecting and sharing transport data
- » Providing input and feedback on the development of policies and initiatives
- » Periodically reviewing policy and recommending updates as the new mobility ecosystem evolves
- » Identifying incentives and producing road maps for transit agencies and other mobility service providers to provide higher-quality mobility data
- » Assisting public agencies to build capacity (e.g., through skills training)
- » Creating action plans for piloting various projects to test critical elements of the shared mobility system





Develop and maintain a city-level data-sharing platform

A city-level data-sharing platform will support the development of transport data use cases, as well as innovations beyond the selected use cases. This platform should endeavor to support the transparent sharing of open data as well as the transfer of private data between certain parties.

The DataSmart Cities strategy outlines a plan for implementing a three-part platform for data sharing: an Open Data Platform, for providing free and open data sets in consumable and machine-readable format; a Data Exchange Platform to allow stakeholders to publish and consume free and open data via a secure platform and act as a Data Broker to create partnerships between data producers and consumers and a data marketplace, to allow for the sale and purchase of data between two parties via a secure platform. This platform would be created at the central level. The City Data Officer for each Smart

City would create and steward a unique page for his or her city on the platform.

The city should ensure its participation in the central-level portal or otherwise develop its own data-sharing mechanisms. If a city already has an Open Data Portal or is looking to develop one, it should be updated to reflect the data standards and guidelines decided upon through the City Data Policy and include guidelines for publishing data on the portal. NDSAP provides some guidelines on developing effective open data portals. Additional cities around the world may provide examples to use as a model (for example, the US cities of Austin and Chicago) for well-organized and easy-to-use platforms hosting a wide range of data.

Once the Open Data Portal has been successfully implemented and updated, the city could consider adding another layer to facilitate the transfer of private data between certain parties (as opposed to making it open on the site).

Currently, if a city wants to acquire data from private owners, it must approach each owner and build a separate agreement/relationship with him/her. There may be value in standardizing and streamlining this process and this could be supported by an added layer on the base functionality of a data-sharing portal. This may include a set of transactional tools that allow for more efficient but individual agreements between the producers and consumers of data, such as a template for a data-sharing agreement. This would allow the portal to become a marketplace to facilitate

transactions of private data, in addition to hosting open datasets.

Whether the city develops its own data portal or uses the central government’s platform, the portal should be updated frequently and monitored to maintain the quality of datasets. The city government should ensure that government entities contribute to the portal and encourage other organizations and

companies to contribute as well. The portal needs to be promoted appropriately, so that it may be used to spark innovation and support data-driven developments in the transportation sector, developing the portal alone will not incentivize people to add data to it or utilize it as a resource. The Transport Data Champion should be responsible for promoting the participation of key transport stakeholders in the portal.



6.0 References

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