DATA-DRIVEN TRANSPORTATION SYSTEMS

BEST PRACTICES

Smart City
MISSION TRANSFORM-NATION

सत्यमेव जयते

Ministry of Housing and Urban Affairs
Government of India

ROCKY MOUNTAIN INSTITUTE

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

सत्यमेव जयते

Ministry of Housing and Urban Affairs
Government of India

ROCKY MOUNTAIN INSTITUTE

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

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 it's 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.


[OUTGS]
AIHOAHDAO220156
KOADJOAJ0983
56168-0024866
AOISAPONLKKDA
120
89
205
DATA
23233-5675
2336997
360
CITY
KAOSKASH POWEQA SKAOKAOS DAOJSA
ASKSAOK SKOAKA
13255-31464
123954-36997412-27901200
125455-3369520-36992

The project was designed and managed by the IBM Smarter Cities[3] 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 Project[7] 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.

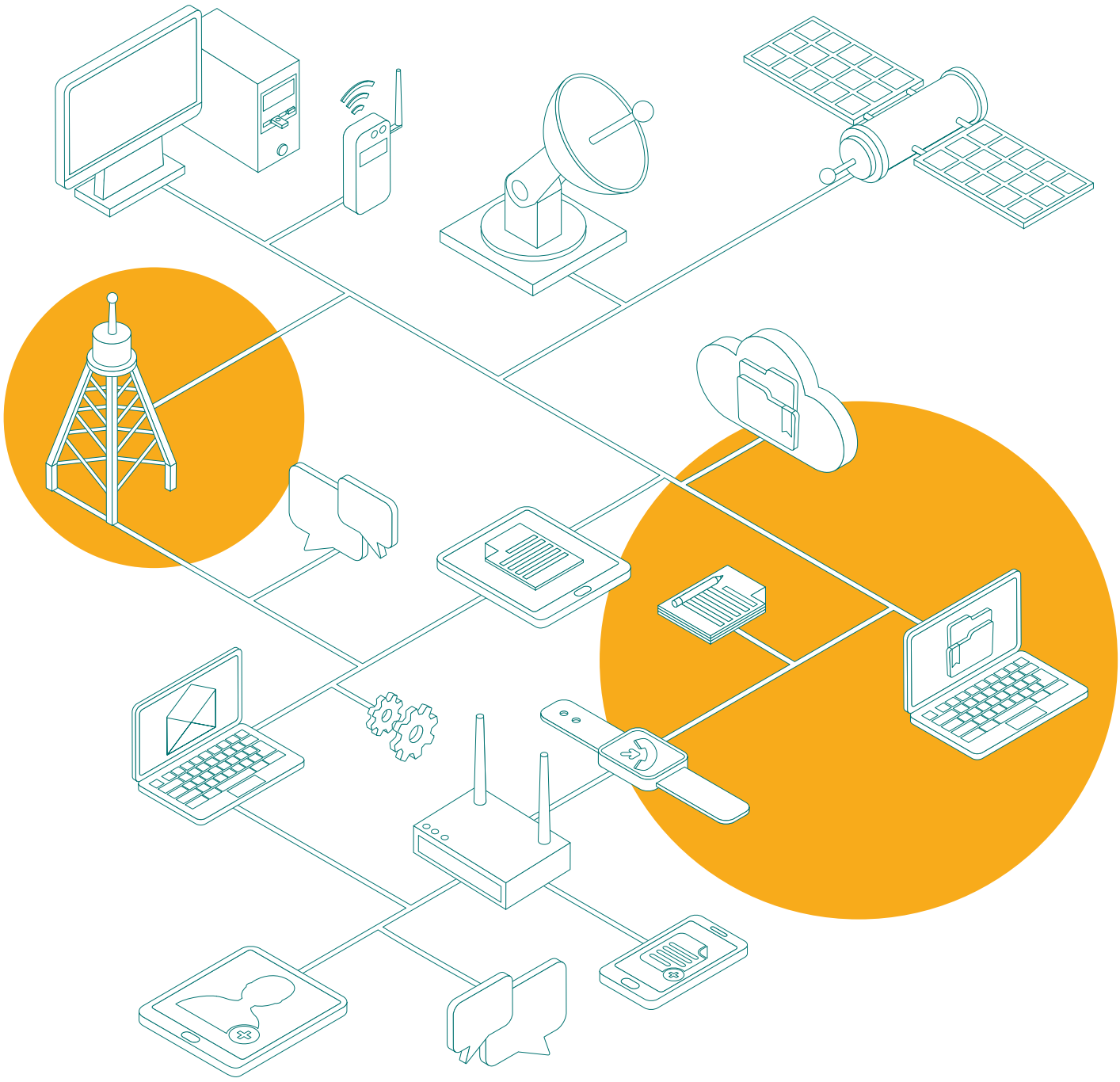
The data then needed to be cleaned and formatted to General Transit Feed Specification (GTFS), a common format for public transportation schedules, so that it could be used more easily with mapping tools. This proved challenging as several typically required data points for the standard did not exist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

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.

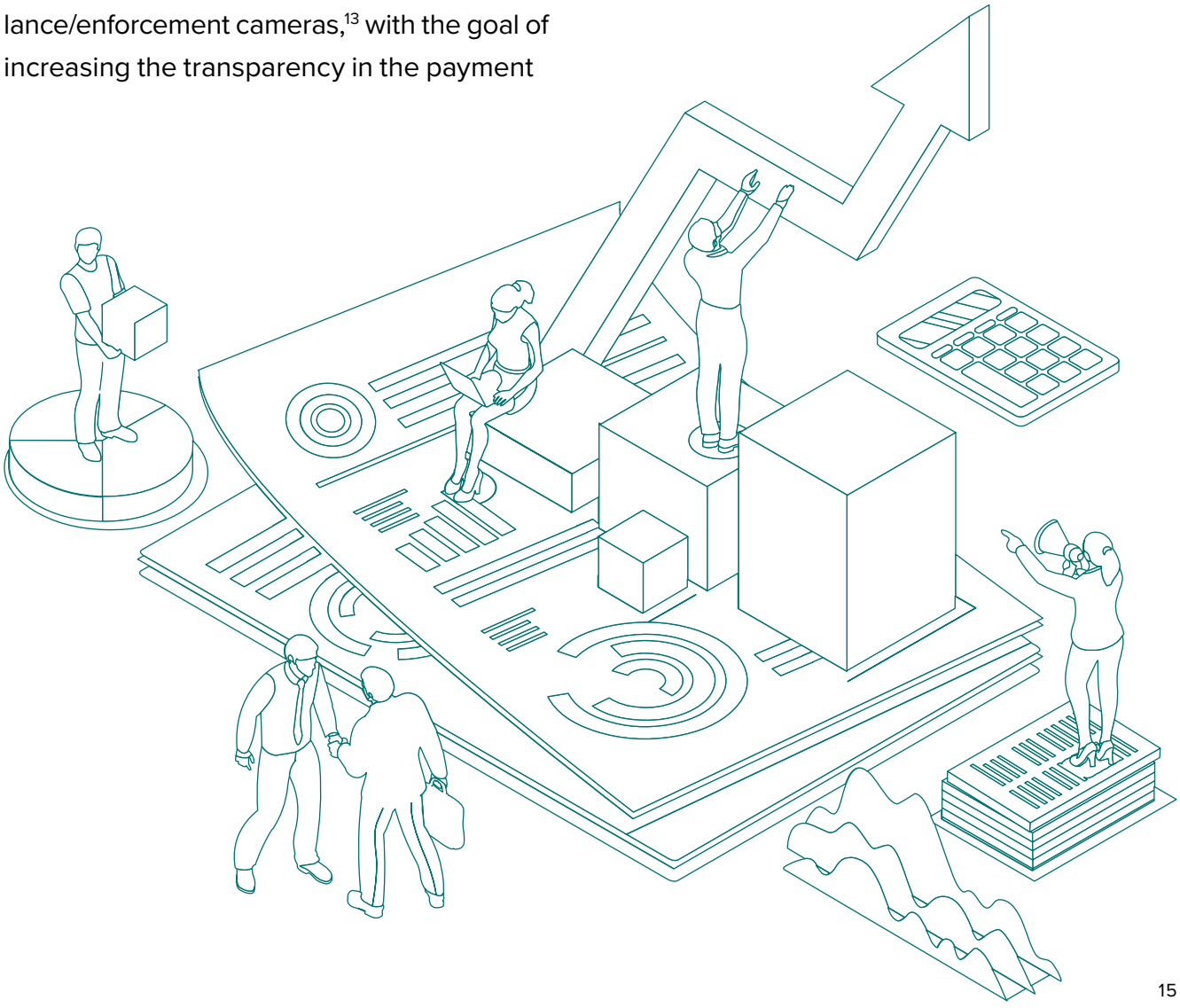
4.0 Enforcement and regulation: Bangalore B-TRAC

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.

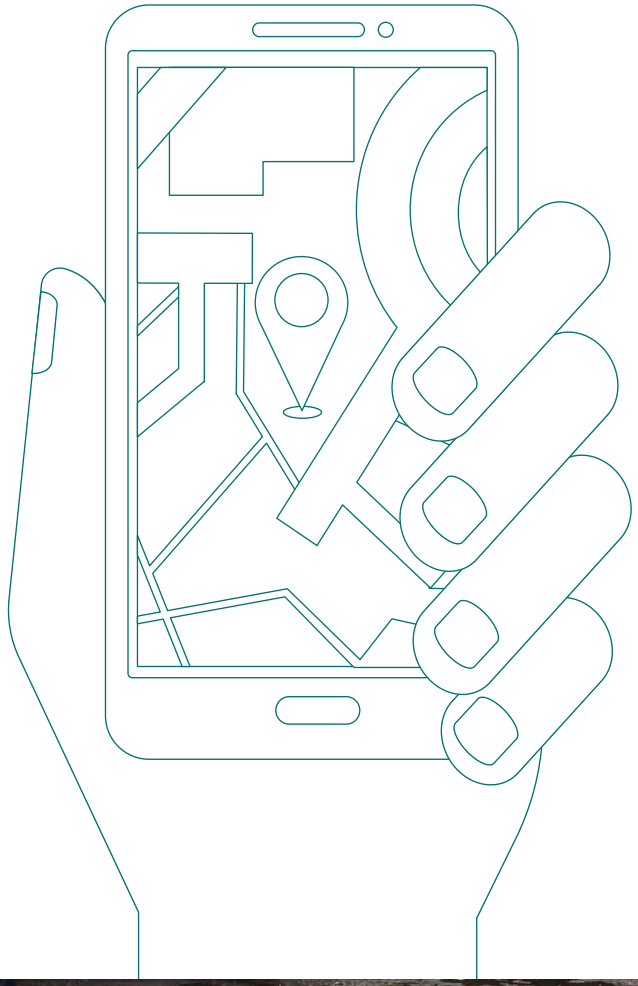
» The Connected Citizens Program allows city and state governments to expand their view of the transportation system, without having to invest in road sensors and traffic cameras. «

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 construction 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 million[21] 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=Vol11elZ5sg

» www.cor.rio

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

Case study

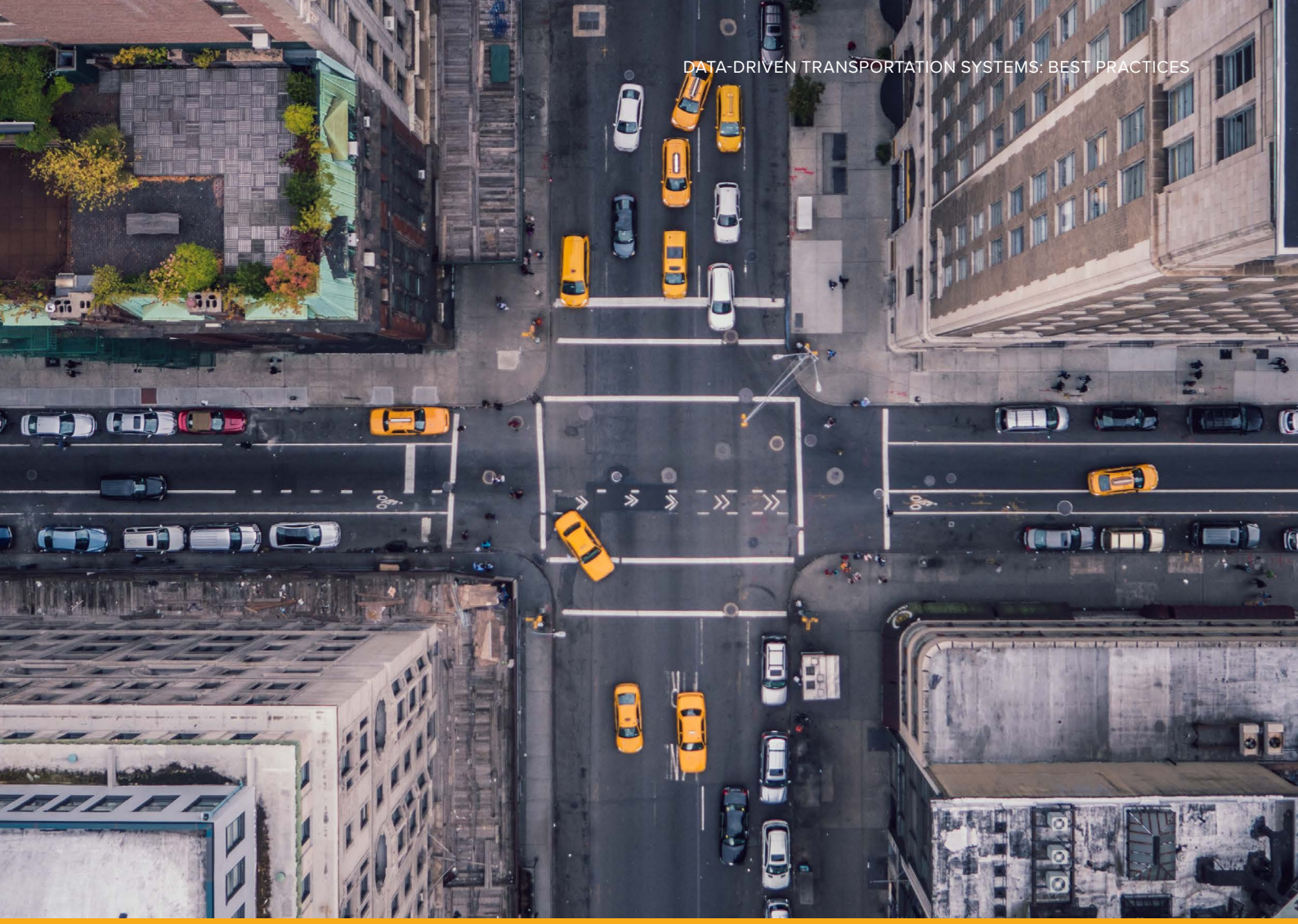
» Nairobi, Kenya: Digital Matatus

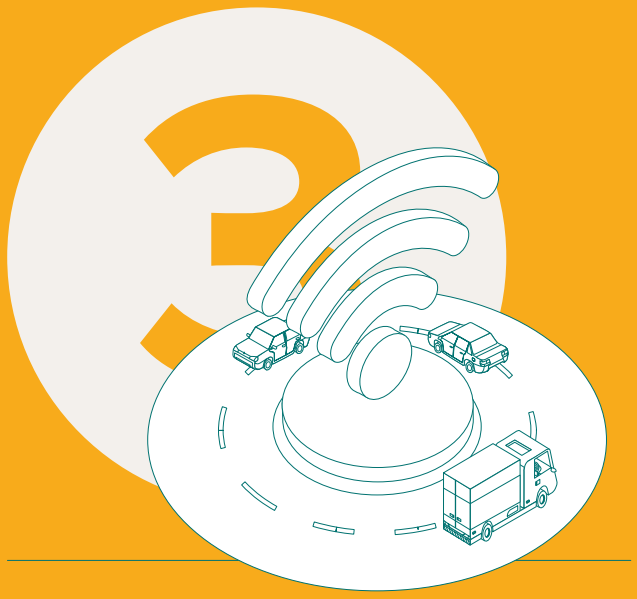
Takeaways

» 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 management

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

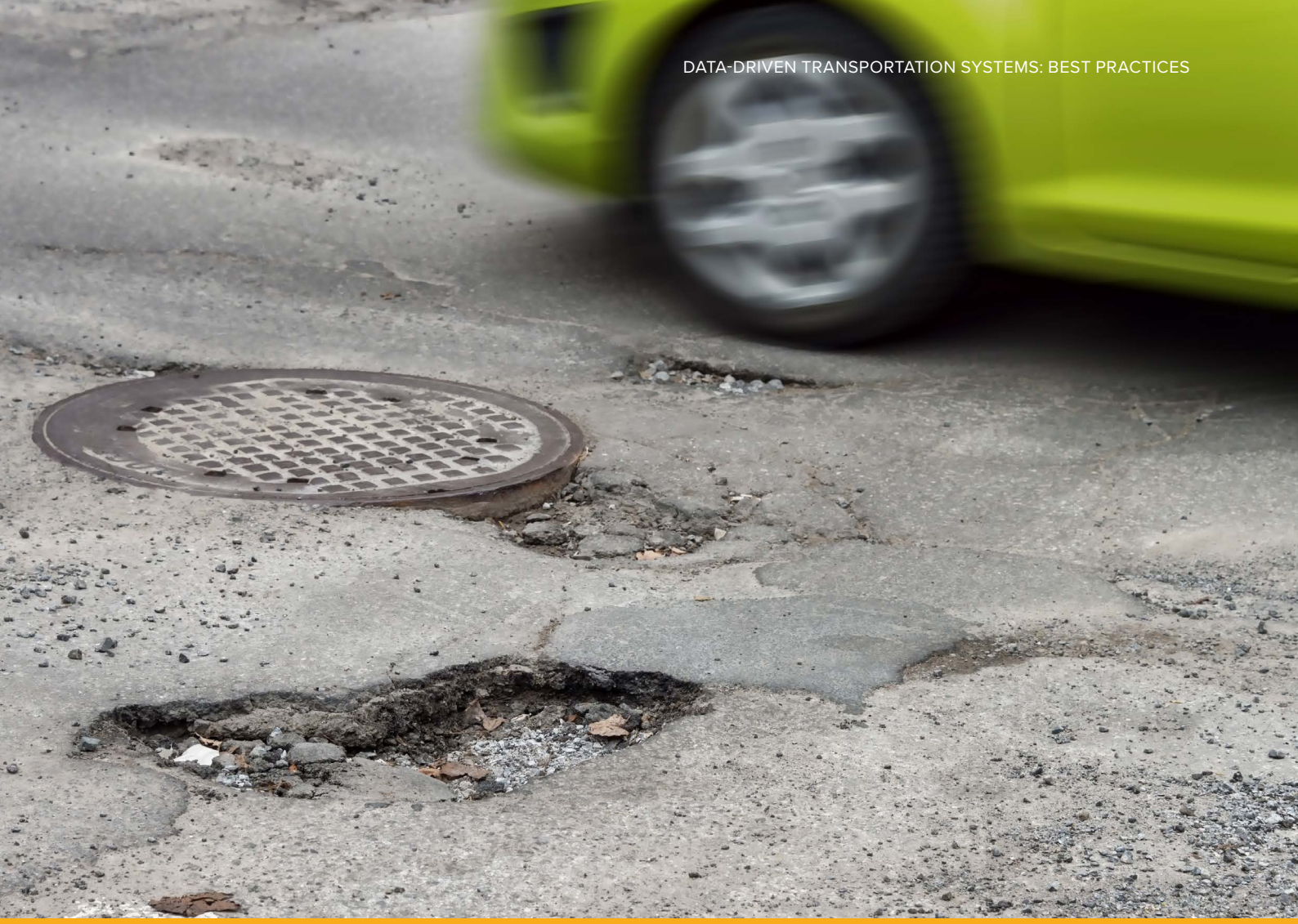
» Bangalore, India: B-TRAC

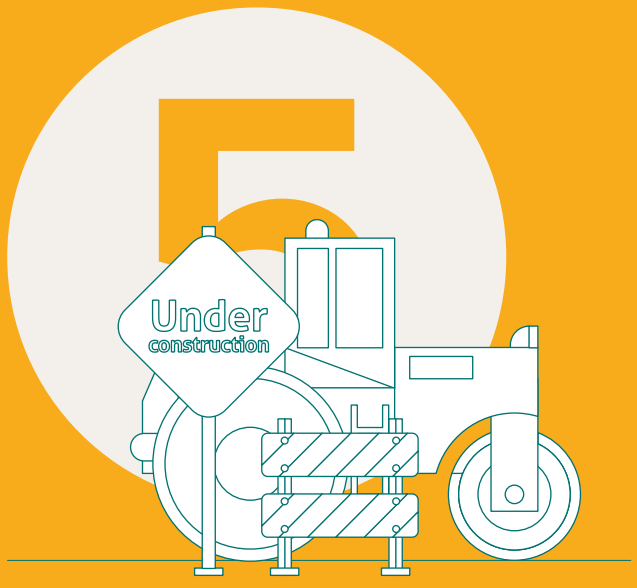
Takeaways

» 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)

» 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

6.0 References

1. “4 Inspirations for Sustainable Transport from Rio de Janeiro,” World Resources Institute. Link.
2. “Why Rio’s citywide control center has become world famous,” Smart Cities Council. Link.
3. Smarter Cities, IBM. Link.
4. “Mission Control, Built for Cities,” The New York Times. Link.
5. “The Digital Matatus Project.” Link.
6. “Mapping Matatus,” National Geographic. Link.
7. Digital Matatus, 2018. Link
8. “Inside NYC’s Traffic Management Center,” Fox News. Link.
9. “Inside NYC’s Traffic Management Center,” Fox News. Link.
10. “Midtown in Motion and NYC DOT Traffic Management Center,” National Association of City Transportation Officials. Link.
11. “BTRAC- Strategy,” Bengaluru Traffic Police. Link.

12. “B-TRAC improves travel time in Bangalore, nails traffic violators,” The Hindu Business Line. Link.

13. “BTRAC- Components,” Bengaluru Traffic Police. Link.

14. “B-TRAC improves travel time in Bangalore, nails traffic violators,” The Hindu Business Line. Link.

15. “Bengaluru: Smart signals get green light, 100 more to be equipped with sensors,” Deccan Chronicle, 2018. Link.

16. “Bengaluru: Soon, CCTV at all major junctions,” Bangalore Mirror, 2018. Link.

17. “Potholes claimed 6 lives a day in India”, 2016, Times of India.

18. “Waze Partners With Local Governments to Enhance Mobility,” Digital Communities.

19. “What is Oyster,” Transport for London. Link.

20. “TfL Oyster Card,” Living Rail. Link.

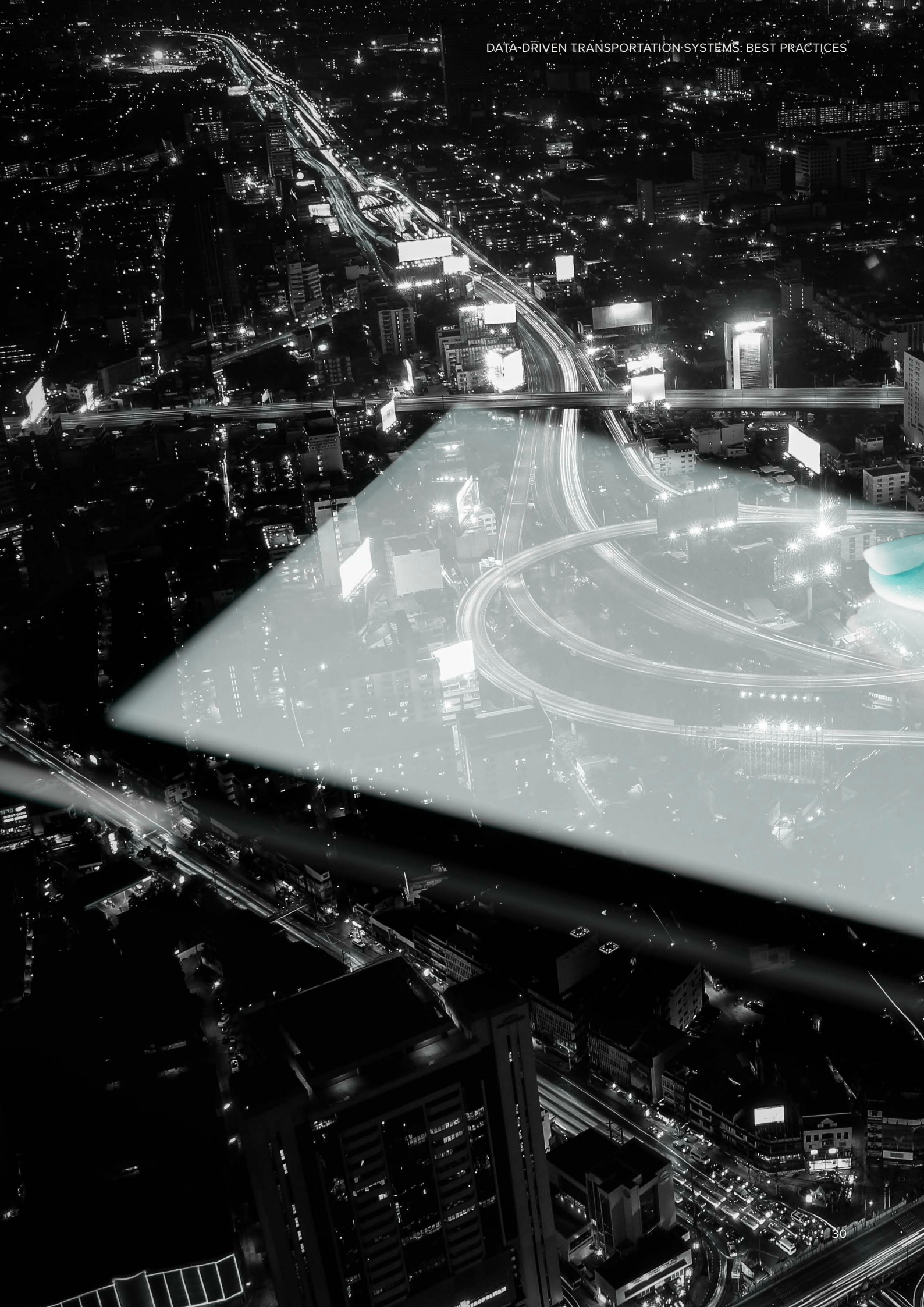
21. “TfL Oyster Card,” Living Rail. Link

22. Yearly Average Rates, OFX. Link.

23. “TfL Oyster Card,” Living Rail. Link.

24. Ez link. Link.

25. “Mumbai: Soon swipe credit/debit card for seamless travel,” The Times of India. Link.



AUTHORS AND ACKNOWLEDGEMENTS

SUGGESTED CITATION

Ministry of Housing and Urban Affairs (MoHUA) and Rocky Mountain Institute (RMI). *Data-driven Transportation Systems: Best Practices.* 2019

ACKNOWLEDGEMENTS

Authors:
Emily Goldfield
Akshima Ghate
Clay Stranger

Art Director: Vindhya Tripathi
Designer: P. Pallavi Baasri

Editorial Director: Ashpreet Sethi

Image Credits: Shutterstock

CONTACT

For more information, please contact:
RMI: india_contact@rmi.org