TRANSFORMING MOBILITY IN INDIAN CITIES

INSIGHTS FROM INDIA'S FIRST URBAN MOBILITY LAB IN PUNE

ABOUT PUNE MUNICIPAL CORPORATION (PMC)

The Pune Municipal Corporation (PMC) is the civic body that governs Pune, the second largest city in Maharashtra. It is responsible for the civic needs and infrastructure of the metropolis, which covers an area of over 330 square kilometers and has 3.4 million residents. The PMC has been administering Pune and serving its citizens since 1950.

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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“India is poised to lead the world in advanced passenger mobility. It can leapfrog the traditional paradigm of privately-owned, underutilized, fossil fuel-powered vehicles to a future of shared, clean, connected mobility. We at Rocky Mountain Institute are honored to support India’s mobility transformation through testing and scaling mobility solutions in cities. Pune can set the pace for cities across India and around the world to shift to clean mobility—thus accelerating the global energy transition.”

— Jules Kortenhorst, Chief Executive Officer, Rocky Mountain Institute

ABOUT THIS REPORT

Pune, Maharashtra was selected in June 2018 as India's first Lighthouse City for mobility solutions in response to NITI Aayog and Rocky Mountain Institute's "Grand Challenge." NITI Aayog and RMI developed the concept of Lighthouse Cities in their May 2017 report, *India Leaps Ahead: Transformative Mobility Solutions for All*, with the idea of creating several leading geographies to serve as test-beds for the implementation of new, innovative, and integrated urban mobility solutions. The Pune Municipal Corporation and Rocky Mountain Institute hosted India's first Urban Mobility Lab 15–17 October 2018 to work with government, industry, and civil-society leaders to collaboratively design such mobility solutions for implementation in Pune.

This report is a reflection of the discussions and work that took place at the Urban Mobility Lab in Pune. It aims to share experiences, key insights, and valuable lessons learned from the Urban Mobility Lab in order to support the adoption and scaling of mobility solutions that were developed in Pune, both in India and around the world.

> *"Whatever solutions have come out of this lab should move forward to create a proper ecosystem that the whole country can follow. We are coming up with a Urban Green Mobility Scheme—where we look at solutions for cities. We will have more Grand Challenges and we will use the inputs from the Urban Mobility Lab to inform our urban planning solutions. We look to create more Lighthouse Cities in Maharashtra and beyond."*
>
> *— Durga Shanker Mishra, Secretary, Ministry of Housing and Urban Affairs, Government of India*

Although this report focuses on Pune, many of the insights contained within are applicable to other Indian cities and relevant to India's broader mobility system. By sharing this information, we aim to foster further dialogue on key challenges and opportunities in India's urban mobility transformation, inspire new collaborations within and across government and industry to design and implement solutions, and generate greater alignment among all stakeholders on key opportunity areas to accelerate India's shift to a shared, clean, and people-centric mobility future.

OPPORTUNITY AND NEED

An urban transformation is underway in India at an unprecedented scale. Estimates suggest that the urban population could grow to 600 million people by 2030, compared to 450 million today.[1] This projected growth represents a unique opportunity for India to fuel social and economic progress in the coming decades. As inferred by the World Bank, "No country has grown to middle income without industrializing and urbanizing. None has grown to high income without vibrant cities. The rush to cities in developing countries seems chaotic, but it is necessary."[2] A high urban-growth trajectory for India, hence, seems critical for transitioning to higher levels of socio-economic development.

The urban transition in the last two decades has already started showing the benefits of economies of agglomeration in concentrated geographies. Indian cities' contribution to the national GDP is projected to increase from 60 percent to 75 percent by 2030.[3] Cities are becoming hubs of job creation, innovation, and entrepreneurship. They generate revenue for governments that can be fed back into the economy, fueling growth and development. While urban transformation may be an engine of economic growth, it has come with many challenges. Increasing pressure on basic infrastructure and services, in particular in the transportation sector, has led to issues such as increasing congestion and vehicular emissions. As mobility demand in cities continues to grow, these challenges could worsen, especially considering a number of current trends that are dominated by the increasing use of private vehicles, declining shares of public and non-motorized transport (NMT) systems, and unplanned growth in goods movement.

FIGURE 1A

Two-wheelers and cars have experienced 3x growth in million-plus cities over the past decade

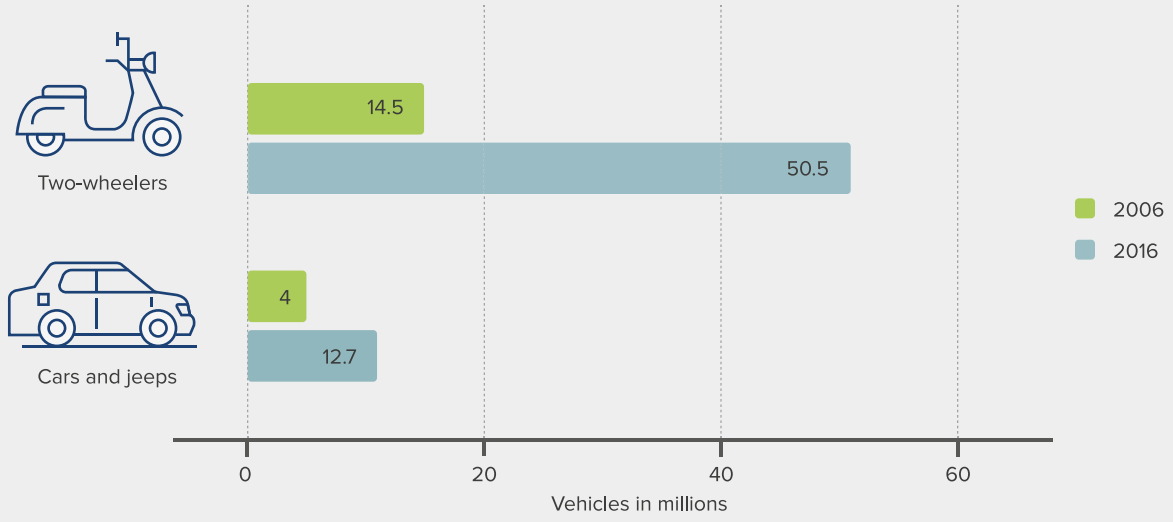


FIGURE 1B

City bus fleets have been experiencing slow or negative growth since 2010

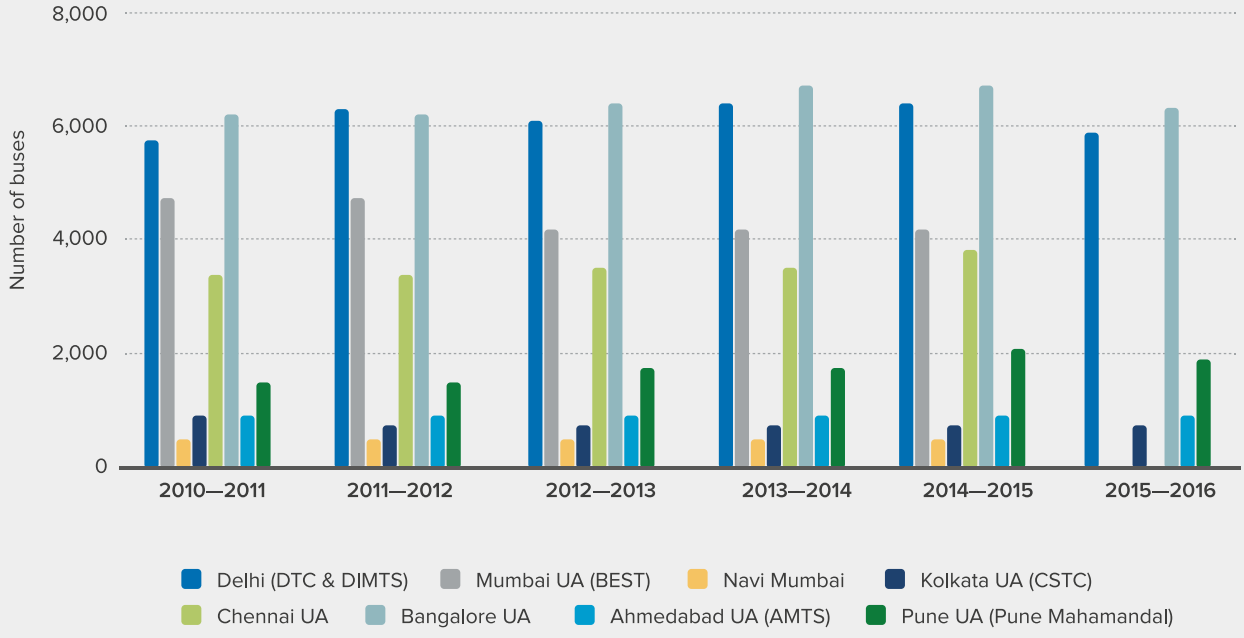
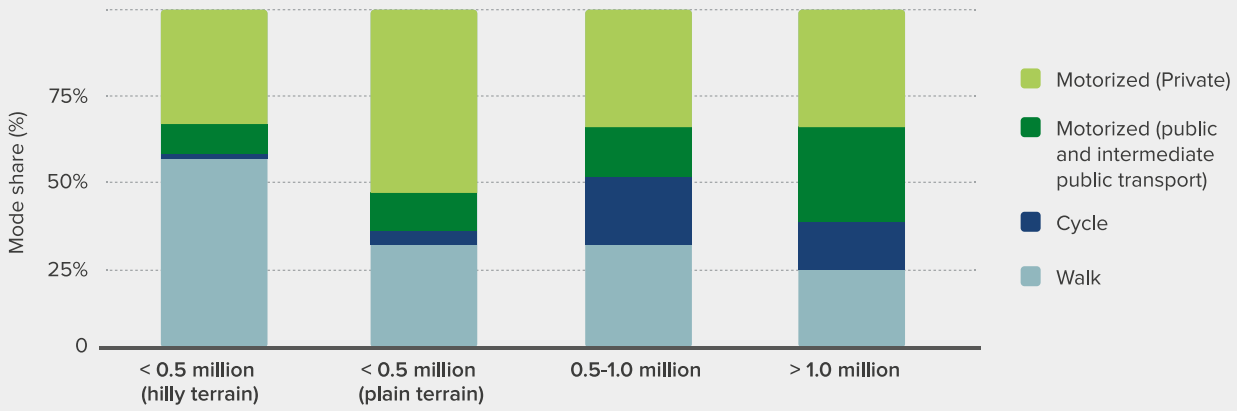


FIGURE 1C

Motorized vehicles dominate the mode share in Indian cities, while cycles make up a small fraction



Average trip length (km)			
2.3	2.6	3.5	7

FIGURE 1D

More than two dozen Indian cities exceed the World Health Organization's standard for $PM_{2.5}$

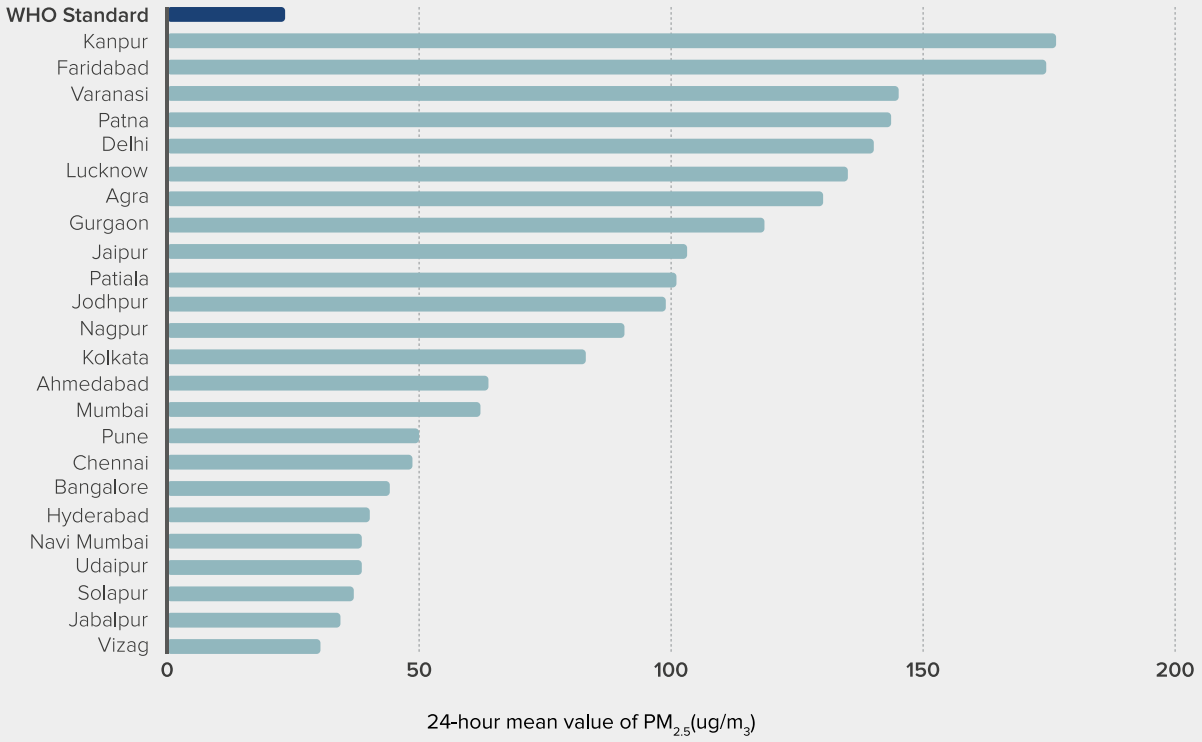


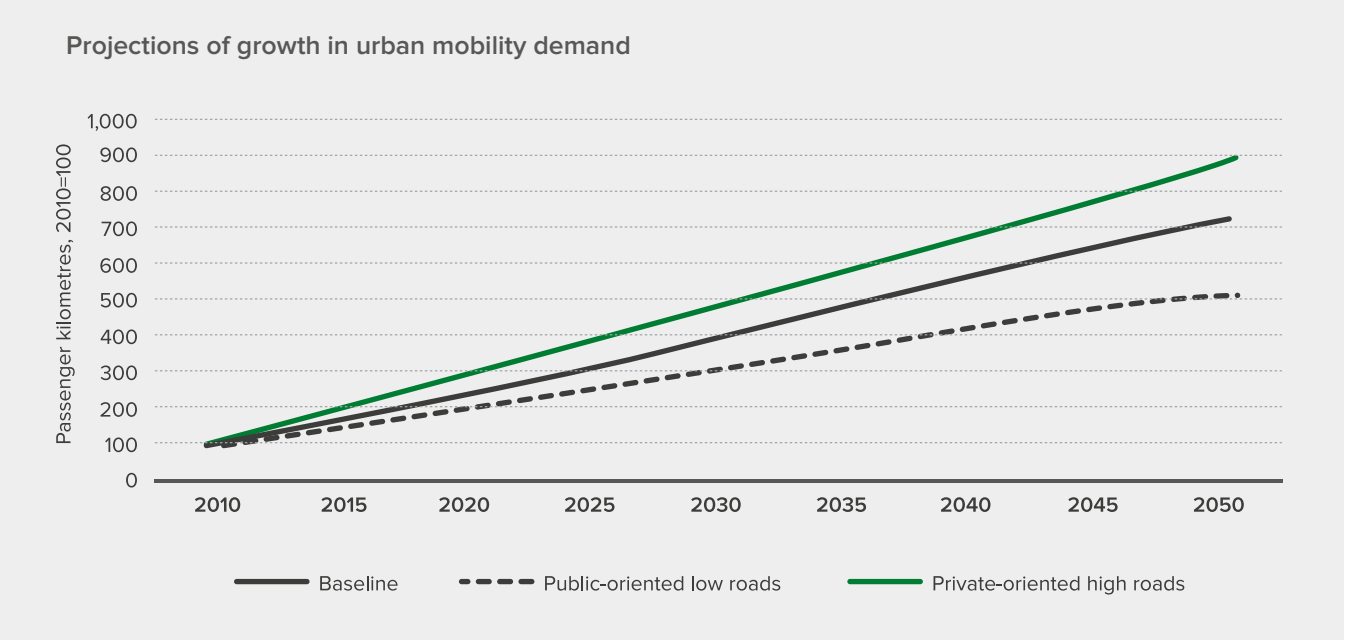
Figure 1A–D: Trends in urban mobility.
Figure 1A shows that two-wheelers and cars have experienced 3x growth in Indian cities over the past decade, whereas Figure 1B shows that city bus fleets have been experiencing slow or negative growth since 2010. These two trends and cycles' small fraction of Indian cities' mode share compared to the high share of motorized vehicles (Figure 1C) have social, economic, and environmental impacts on Indian cities, such as high levels of $PM_{2.5}$ (Figure 1D) and the fact that about 20 percent of road and traffic related accidents occur in India's million-plus cities.
Sources: Figure 1A-Ministry of Road Transport and Highways (MoRTH; various years); 1B-Data compiled from MoRTH and State Road Transport Undertakings websites; 1C-Ministry of Urban Development (MoUD) and Wilbur Smith Associates (2018); 1D-World Health Organization (2018)"

The current trends in mobility suggest a growing need for urgent action to shift from:

> Private-vehicle ownership to shared usership;
> Internal combustion engine vehicles to electric vehicles; and
> Cities designed for motor vehicles to cities designed for humans.

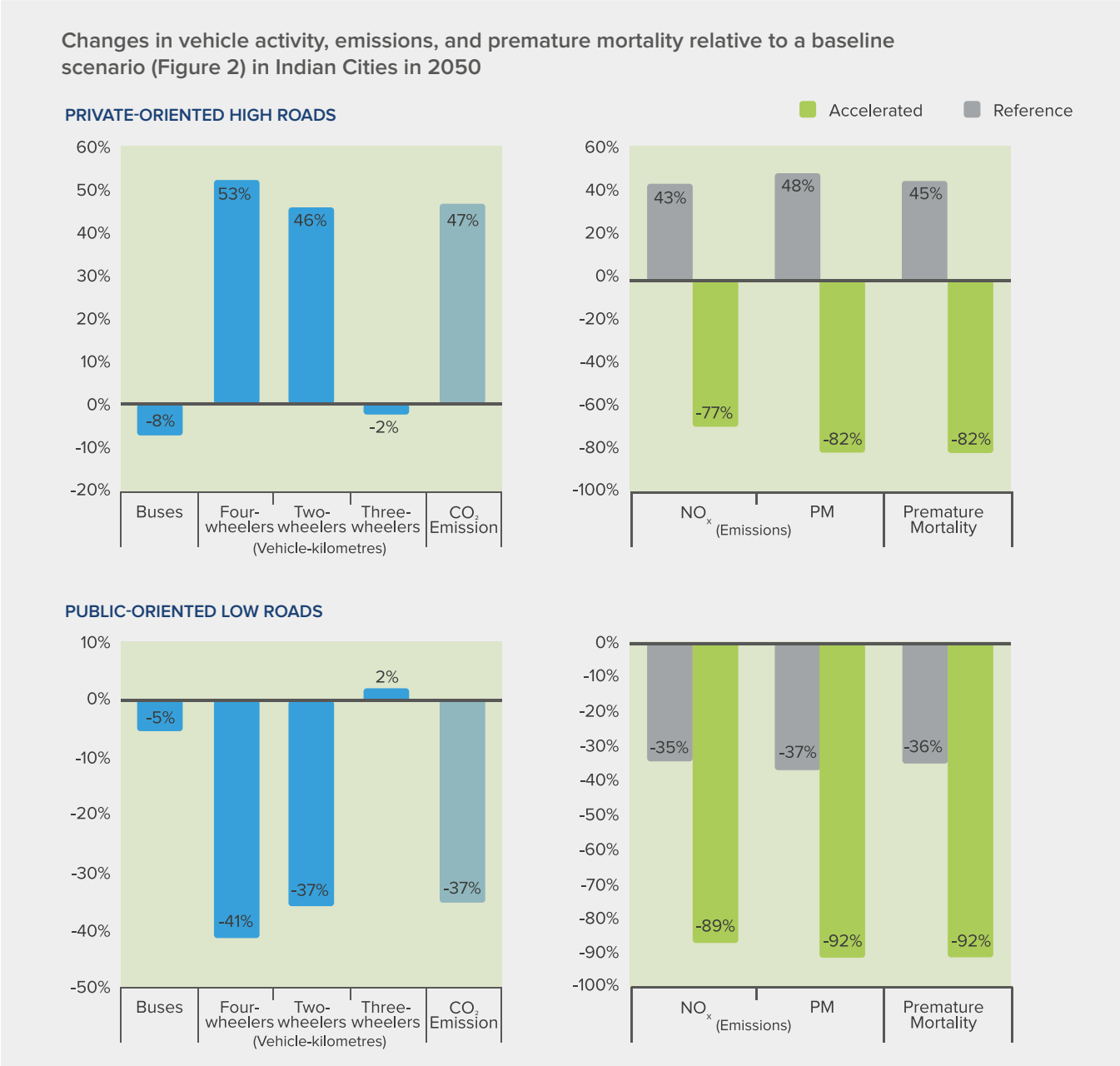
Such a transition can lead to a series of positive impacts, including reduced fossil fuel dependence and vehicular emissions, improved public health, strengthened energy security, and the development of innovative business models. NITI Aayog and RMI's analysis estimates that such a transition could result in cumulative potential fuel savings of 876 million tonnes of oil equivalent (worth US$330 billion) and 1 gigatonne of potential carbon dioxide (CO_2) emissions in India's passenger transportation sector by 2030.[4] Significant portions of these savings can come from cities. International Transport Forum estimates that a scenario which emphasizes public transport and shared mobility has the potential to reduce the total mobility demand and CO_2 emissions in Indian cities by 29 percent and 37 percent, respectively. Vehicle activity and local emissions (i.e., NO_x and $PM_{2.5}$) also decline by nearly 90 percent. In this scenario if India adopts world-class emission-control standards.[5]

FIGURE 2

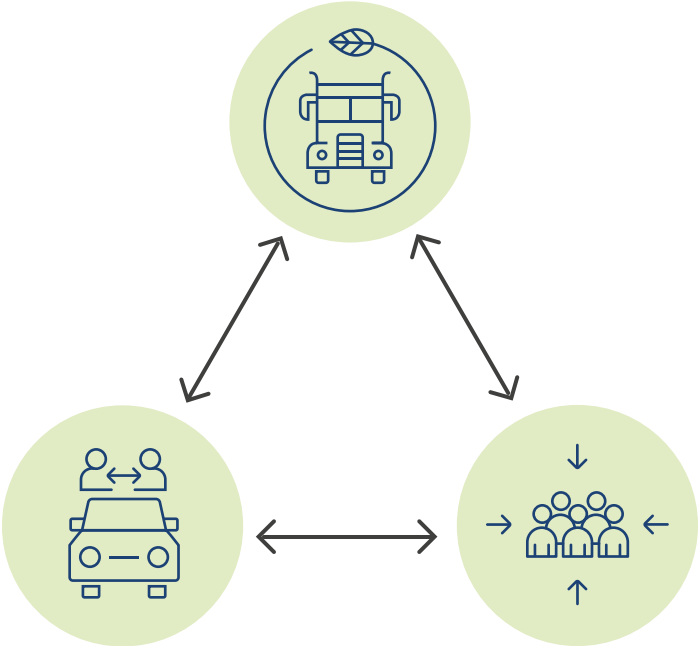


This chart shows an index of total mobility demand in passenger-kilometers in Indian cities under three scenarios, where 2010 is equal to 100. The public-oriented low road scenario lowers India's urban mobility demand in 2050 by about 30 percent from the baseline scenario, whereas the private-oriented high road scenario would lead to an increase of about 25 percent. *Source: OECD (2015), "Evolution of urban mobility in Indian cities under different scenarios: 2010 = 100", in ITF Transport Outlook 2015, OECD Publishing, Paris, https://doi.org/10.1787/9789282107782-graph69-en.*

FIGURE 3



Vehicle activity and outcomes associated with Figure 2's projections. The upper charts show changes in vehicle activity, CO_2 emissions, NO_x, PM, and health impacts in urban India in 2050 for the private-oriented high roads scenario relative to the baseline scenario (Figure 2). The lower charts show the same measures for the public-oriented low roads scenario relative to the baseline scenario (Figure 2). For the charts on the right, the Reference scenario assumes that India makes no additional progress beyond current vehicle emission standards.
The Accelerated scenario assumes that world-class standards equivalent to Euro 6/VI are implemented based on a policy roadmap established by the International Council on Clean Transportation (Chambliss et al., 2013).
Source: OECD (2015), "Changes in activity, emissions, and health impacts from baseline scenario in Indian cities, 2050", in ITF Transport Outlook 2015, OECD Publishing, Paris,https://doi.org/10.1787/9789282107782-graph77-en



Shared, clean, and people-centric are foundational elements of India's new mobility paradigm

Widespread adoption of a shared, clean, and people-centric mobility paradigm in Indian cities will require new approaches for planning and implementation. These approaches will have to harness the opportunities being created by the convergence of new technologies and business models to implement innovative mobility solutions. Solutions that support Mobility-as-a-Service (MaaS) offerings; the adoption of clean vehicles such as electric buses, taxis, and auto rickshaws for both main-haul and first and last mile public transport connectivity; and the sharing and use of data to enhance public transit ridership are examples of solutions that Indian cities must seek to develop and implement in order to make a transition towards a new mobility future.

While several examples of early adoption are emerging across a number of Indian cities, there is a need to concentrate these efforts in a few select urban geographies to harness the integration potential and to realize the cumulative impact of synchronized efforts. These urban geographies can become 'lighthouse' regions and early leading examples that help India learn what it takes to test, validate, and assemble components of a new mobility system. The strategies that develop and the insights that come from an integrated portfolio of pilot projects can accelerate the learning curve for other cities and inform both state and national policy processes on scaling the deployment of new, advanced mobility solutions. The Urban Mobility Lab initiative is working to establish Lighthouse Cities and Regions in India in order to demonstrate the way forward for a shared, clean, and people-centric mobility future for Indian cities.

OVERVIEW OF THE URBAN MOBILITY LAB

BACKGROUND AND CONTEXT

The Urban Mobility Lab is a platform that supports a replicable process for identifying, integrating, implementing, and scaling mobility solutions to transform how people and goods move in Indian cities. It engages cities to develop and implement shared, clean, and people-centric mobility solutions suited to local needs. The experiences and lessons from the Urban Mobility Lab aim to guide and accelerate the scaling of mobility solutions, both nationally and globally.

NITI Aayog and RMI developed the concept of Lighthouse Cities in their report *India Leaps Ahead: Transformative Mobility Solutions for All*[6] published in May 2017. In February of 2017, NITI Aayog and RMI co-hosted a charrette convening 75 leaders from India's public and private sectors to identify and develop transformative solutions to India's mobility challenges. One solution that emerged from this charrette was the idea of developing "Lighthouse Cities" as test-beds for integrated pilot projects in the mobility sector. While Indian cities and companies have launched a number of individual pilot projects, few players are exploring how these projects could integrate to create additional value. Designing pilots with the whole system in mind can result in solutions that are more efficient and effective than pilots that develop in isolation.

To this end, in November 2017 the CEO of NITI Aayog, Mr. Amitabh Kant, announced a "Grand Challenge" to select India's first Lighthouse City for mobility solutions. Following an independent and rigorous selection process, Pune, Maharashtra was selected as India's first Lighthouse City for mobility solutions.

The implementing agency for the Urban Mobility Lab in Pune is the Pune Municipal Corporation (PMC)—the civic body that governs Pune, the second-largest city in Maharashtra. The PMC is responsible for the civic needs and infrastructure of the city, which covers an area of over 330 square kilometers and is home to 3.4 million residents. The PMC and RMI work together to design and implement the Urban Mobility Lab in Pune.

> *"As India's 'most livable' city, Pune is progressing towards becoming India's premiere place to work and live. We are working diligently to drive this progress. However, rapid urbanization poses challenges to the mobility of our citizens. As we pave the way to the future of mobility, from our urban street design guidelines to our BRT system, much work remains to make life easier for the people of Pune. We look forward to supporting the mobility solutions coming out of the Urban Mobility Lab and continuing to establish Pune as a leading example of the future of mobility in Indian cities."*
>
> *– Saurabh Rao, Municipal Commissioner, Pune Municipal Corporation*

The PMC and RMI are also engaging with NITI Aayog, the Ministry of Housing and Urban Affairs, and a network of five Scaling Partner cities to share lessons from the Urban Mobility Lab and to scale the process and viable projects to other cities across India. These Scaling Partner cities are: Visakhapatnam (Andhra Pradesh), Bangalore (Karnataka), Kochi (Kerala), Mumbai (Maharashtra), and Hyderabad (Telangana), all of which applied for the Lighthouse City Grand Challenge. Together, the five states involved in the Urban Mobility Lab's network represent 20 percent of India's population and 30 percent of India's economic output.

Recent progress

NOVEMBER 2018
Ongoing implementation support for PMC, the project teams, and the working groups

OCTOBER 2018
PMC and RMI convened India's first Urban Mobility Lab in Pune with participants from over 75 organizations

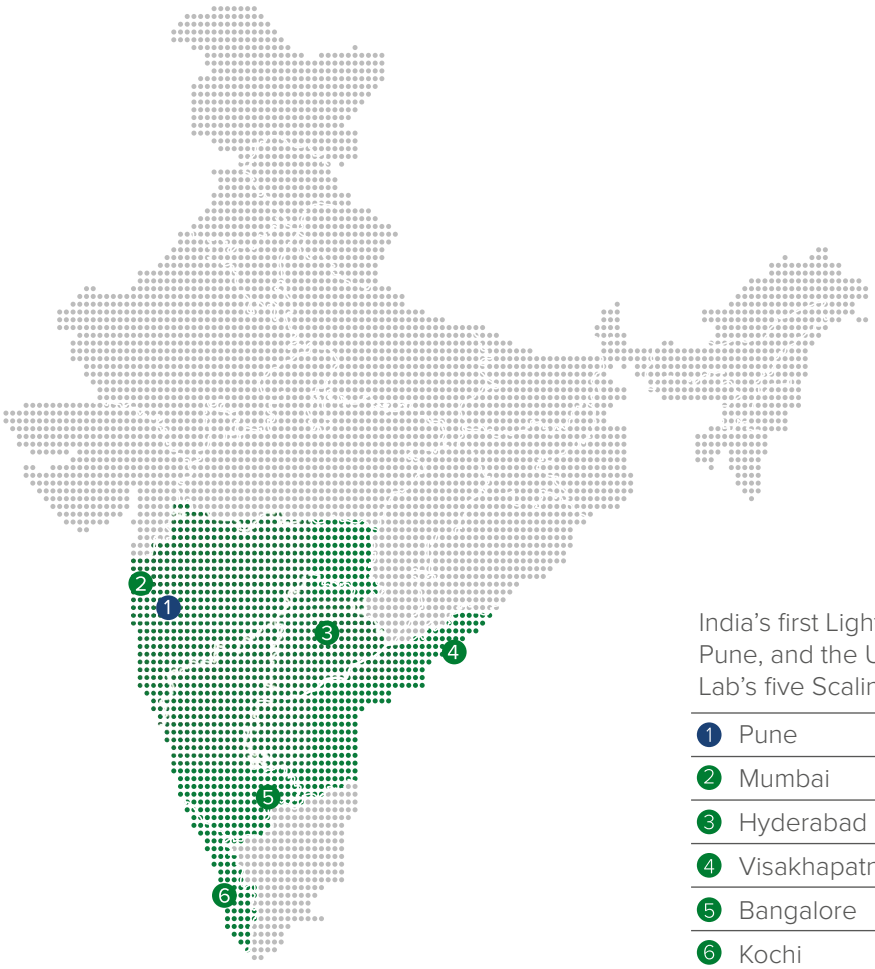
SEPTEMBER 2018
Nine project teams and four working groups were selected for the Solutions Workshop

AUGUST 2018
PMC and RMI engaged city stakeholders through a needs assessment process

JULY 2018
Application was opened for project teams to propose mobility solution for Pune

JUNE 2018
Pune was announced as the first Lighthouse City and the initial host of the Urban Mobility Lab

NOVEMBER 2017
NITI Aayog and RMI announced a Grand Challenge to select the first Lighthouse City



India's first Lighthouse City, Pune, and the Urban Mobility Lab's five Scaling Partner cities

1. Pune
2. Mumbai
3. Hyderabad
4. Visakhapatnam
5. Bangalore
6. Kochi

CHANGE MODEL

The Urban Mobility Lab's replicable process for identifying, integrating, implementing, and scaling mobility solutions adopts RMI's "think-do-scale" strategy through five components: knowledge building, city analysis, solution development, implementation and evaluation, and learning and scaling. These five components address both local needs and conditions and support the rapid deployment of new mobility solutions. The process is replicable and flexible, allowing each city to customize the Urban Mobility Lab to meet its unique mobility needs.

Think:
The think component of the Urban Mobility Lab's process centers on knowledge building. By serving as a resource of best practices and emerging solutions in urban mobility, the Urban Mobility Lab equips public and private sectors actors with a common knowledge base. This shared knowledge base fosters alignment and supports collaboration and peer-learning.

Do:
The do component of the Urban Mobility Lab's process involves city analysis and solution development. By working with city stakeholders to create a set of resources that assess the needs and goals of a city, the Urban Mobility Lab supports cities in identifying key points of leverage in their mobility systems. Understanding the priority, feasibility, and impact of a portfolio of mobility solutions helps cities work with

the private sector through a facilitated process to conceive and implement viable projects. To support this collaborative design process, RMI works with each Lighthouse City to conduct a Solutions Workshop. After the completion of a Solutions Workshop, the Urban Mobility Lab supports the integration and implementation of pilot projects in the Lighthouse City.

Scale:
The scale component of the Urban Mobility Lab's process focuses on supporting the implementation of pilot projects beyond the Lighthouse City and informing the development of smart mobility policies and initiatives through key partners, including the five Scaling Partner cities, state governments, NITI Aayog, and the Ministry of Housing and Urban Affairs.

CORE COMPONENTS OF THE URBAN MOBILITY LAB				
THINK	DO			SCALE
KNOWLEDGE BUILDING	CITY ANALYSIS	SOLUTIONS DEVELOPMENT	IMPLEMENTATION & EVALUATION	LEARNING & SCALING
Tools: • Interactive online forum • Insight briefs and other reports	**Tools:** • City needs assessment	**Tools:** • Team recruitment and engagement • Solutions Workshop • Follow-up convenings	**Tools:** • Implementation support • Follow-up convenings	**Tools:** • Follow-up convenings • Scaling Partner cities network • Reports for government, business, and civil-society leaders
Partners: • Interactive online forum • Insight briefs and other reports	**Partners:** • City government • State government • Civil-society groups	**Partners:** • City government • State government • Private-sector companies • Civil-society groups	**Partners:** • City government • State government • Private-sector companies • Civil-society groups	**Partners:** • City government • State government • Private-sector companies • Civil-society groups

In Pune, through the Urban Mobility Lab's process, the PMC and RMI have:

> Conducted a city needs assessment to identify key opportunity areas for new mobility solutions for Pune City;[7]

> Run a team recruitment and engagement process to select and prepare solutions providers to offer such solutions; and

> Convened a multi-day Solutions Workshop to discuss and advance these solutions in a collaborative, facilitated environment.

The Urban Mobility Lab supports the PMC and the solutions providers in their collective effort to accelerate the implementation of new mobility solutions in Pune by serving as an ongoing platform for coordination and guidance related to project selection, financing, evaluation, learning, and scaling. To accelerate India's broader mobility transition, the Urban Mobility Lab will also document key insights from the process and support the scaling of viable solutions through partners across the private sector and city, state, and central government.

PROCESS

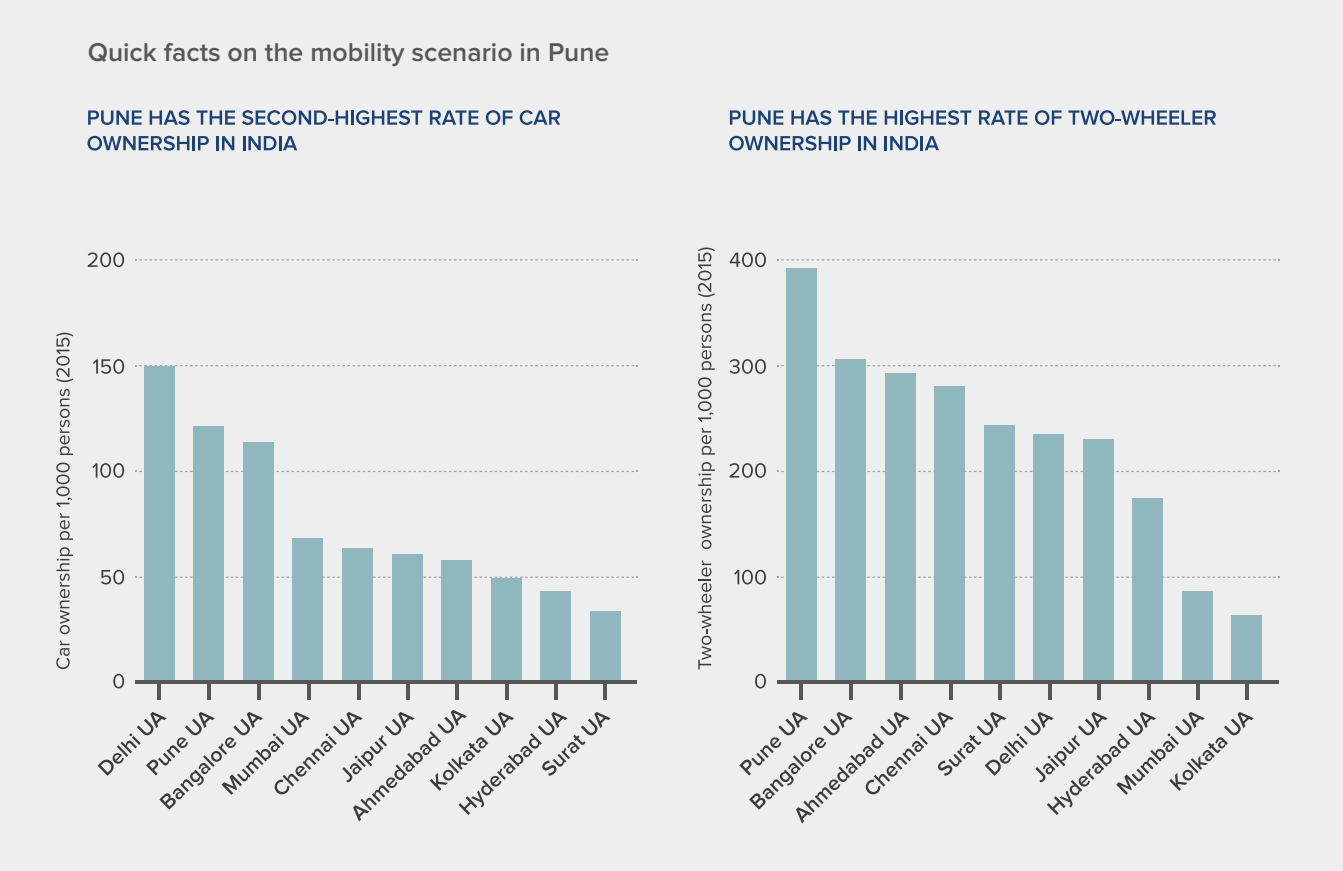
City selection

Pune was selected as India's first Lighthouse City for mobility solutions out of a competitive applicant pool of cities that responded to NITI Aayog and RMI's Grand Challenge. Pune stood out for its strong government support and leadership; its demonstrated action on key aspects of urban mobility, in particular non-motorized transport; and its progress on India's Smart Cities Mission—an urban renewal and retrofitting program by the Government of India with the mission to develop 100 sustainable, citizen-friendly cities across the country. In June 2018, Pune was announced as India's first Lighthouse City for mobility solutions and the initial host of the Urban Mobility Lab.

Quick facts on the mobility scenario in Pune:

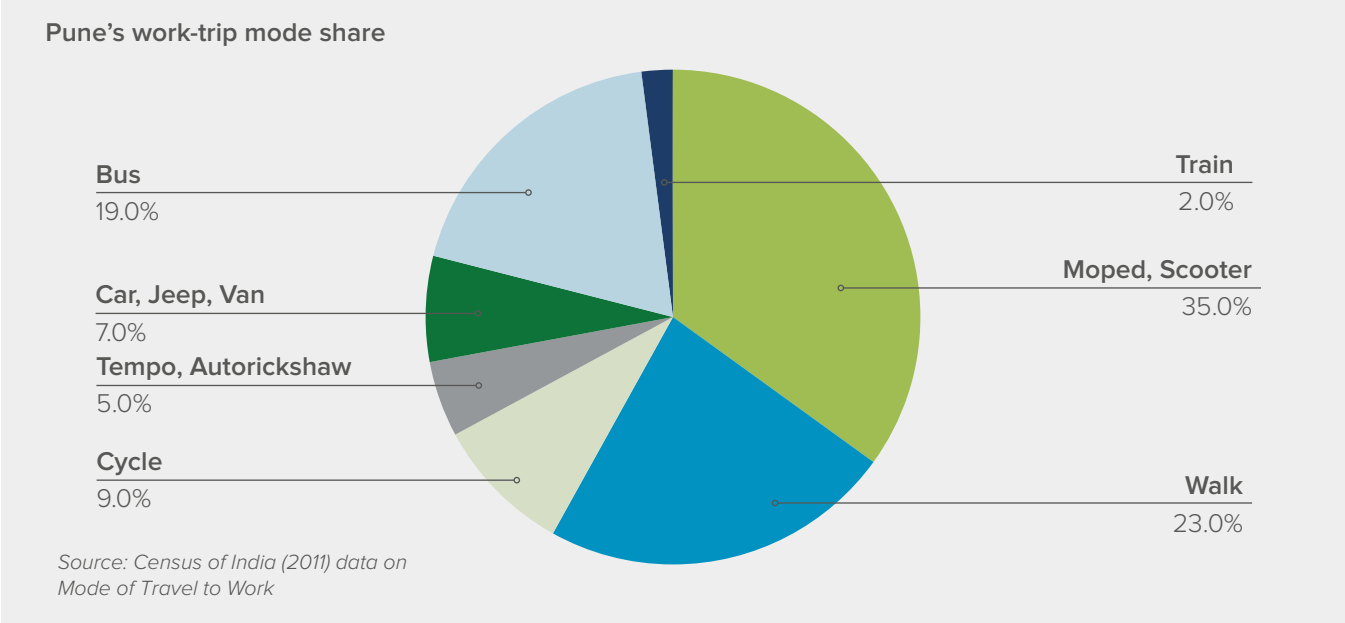
With a population of 3.1 million, Pune is India's ninth-largest Municipal Corporation and has the fourth-highest per capita income among Indian cities.[8] It has one of the highest rates of two-wheeler and car ownership—400 two-wheelers per 1,000 people and 124 cars per 1,000 people among Indian cities.[9] The city has about a half million registered cars and 1.9 million two-wheelers.[10] The mode share of work trips in the city indicates high dependence of Pune citizens on two-wheelers; two-wheelers serve 35 percent of the city's work trips.[11] The city's non-motorized mode share (31 percent for walking and cycling) has been declining, and its public-transport mode share (19 percent) is relatively low among India's most-populous cities.

FIGURE 4A and 4B



Source: Car and two-wheeler ownership estimated based on household two-wheeler and car ownership published by Census of India (2011).

FIGURE 4C

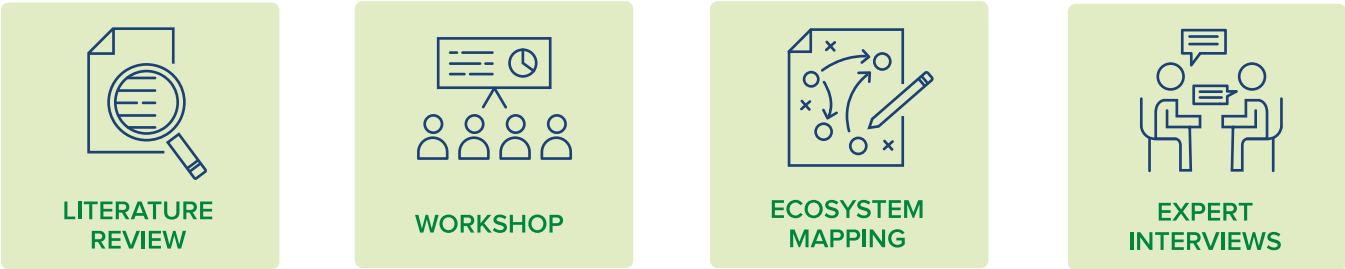


Pune mobility statistics. Figure 4A and 4B show Pune's relatively high rate of car ownership and two-wheeler ownership, respectively. Figure 4C shows the mode share of work trips in Pune. Source: same as Figures 4A and 4B.

City needs assessment

In preparation for the Urban Mobility Lab, the PMC and RMI conducted research and interviews to review, understand, and document aspects of Pune's mobility ecosystem. This process is known as a city needs assessment. The summary document, *An Introduction to Pune City's Mobility Ecosystem* (August 2018),[12] offers an overview of mobility plans, policies, and projects within and around Pune. In doing so, it aims to support a shared awareness and understanding of Pune's mobility ecosystem across the participants and projects involved in the Urban Mobility Lab.

FIGURE 5
City needs assessment process



The city needs assessment for Pune consisted of four parts: a literature review of key planning and policy documents, a multi-stakeholder workshop, an ecosystem mapping exercise to understand the players across all levels of Pune's mobility system, and expert interviews with local government officials and civil society groups.

Key insights from the needs assessment include:

> Public transport and non-motorized transport have been identified as a strong backbone of Pune's transportation system and represent a significant opportunity for continued improvement and potential integration with new mobility solutions.

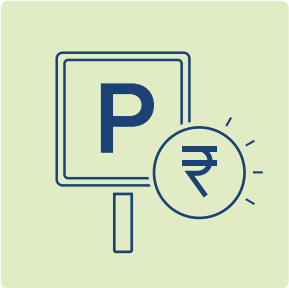
> Pune has a portfolio of thoughtfully designed and detailed policies and plans. There is an opportunity to support the timely implementation of proposed solutions through a structured and purposeful integration framework.

> With policies, plans, and funding existing at all levels of governance (i.e., city, state, center), there is an opportunity to improve the alignment, coordination, and integration of these items both within and across each level.

The city needs assessment also helped identify the key opportunity areas that the PMC and RMI used to seek solutions providers to participate in the Urban Mobility Lab. These included seven themes: traffic management; parking management; urban freight; non-motorized transport; public transport; transportation data for seamless multimodal routing, booking, and payment; and shared electric mobility for first and last mile connectivity. While this collection of themes is a product of the city needs assessment for Pune, they are relevant to many Indian cities.

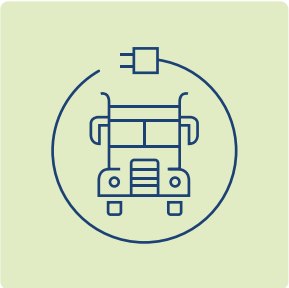
FIGURE 6
Key themes identified through the city needs assessment in Pune.

TRAFFIC MANAGEMENT

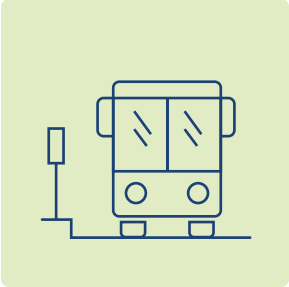


PARKING MANAGEMENT

NON-MOTORIZED TRANSPORT



URBAN FREIGHT



PUBLIC TRANSPORT

TRANSPORTATION DATA FOR SEAMLESS MULTIMODAL ROUTING, BOOKING, AND PAYMENT

SHARED ELECTRIC MOBILITY FOR FIRST AND LAST MILE CONNECTIVITY

These seven themes were identified as key opportunity areas for accelerating Pune's transition to shared, clean, and people-centric mobility.

Team recruitment and engagement

The PMC and RMI recruited solutions providers to participate in the Urban Mobility Lab in Pune and advance mobility solutions related to the seven themes identified through the needs assessment process. Eight leading solutions providers from across India were confirmed as participants to develop innovative mobility solutions for Pune City through the Urban Mobility Lab. The eight solutions providers that participated in the Urban Mobility Lab were: Ashok Leyland, Lithium Urban Technologies, Mahindra & Mahindra, Ola Cabs, Ridlr, SUN Mobility, Tata Motors, and Transit Intelligence. In addition to the eight solutions providers, the PMC and RMI assembled four multi-stakeholder working groups to develop solutions for traffic management, parking management, non-motorized transport, and urban freight.

Solutions providers that participated in the Urban Mobility Lab made a commitment to actively engage before, during, and after the Solutions Workshop in order to drive projects from idea to implementation. They also committed to collaborate with other solutions providers to share knowledge and provide support where appropriate. This active and collaborative style of engagement supports the Urban Mobility Lab's goal of encouraging the integration and implementation of pilot projects over a period of six to 18 months.

VISION FOR SCALING

In addition to Pune serving as the first Lighthouse City, the Urban Mobility Lab is engaging additional cities as Scaling Partners. The goal of the Scaling Partner model is to accelerate the ability of projects to scale to new regions, and to increase the impact of the Urban Mobility Lab by extending its benefits and support to more cities sooner.

Representatives from a number of these Scaling Partners participated in the 15–17 October 2018 Solutions Workshop in Pune to learn from the process and cultivate new relationships and partnerships. During the Solutions Workshop, they exchanged experiences and best practices among city leaders, global experts, and solutions providers.

Beyond establishing the first Lighthouse City, the engagement with the state government, NITI Aayog, and the Ministry of Housing and Urban Affairs represents a scaling pathway that can enable solutions to scale from the first Lighthouse City to the Scaling Partner cities over time. Based on lessons learned in the initial iteration of the Urban Mobility Lab, RMI will review and refine the Urban Mobility Lab's replicable process as it expands to other cities. Viable solutions and insights from the Urban Mobility Lab's work with the Scaling Partners will inform plans within state governments and at the center, in particular through the policy frameworks developed by NITI Aayog and the Ministry of Housing and Urban Affairs.

PUNE: INDIA'S FIRST URBAN MOBILITY LAB

The Urban Mobility Lab in Pune convened the eight selected solutions providers, four multi-stakeholder working groups, and over 75 organizations through 15–17 October 2018 for a Solutions Workshop. The aim of the Solutions Workshop was to advance a portfolio of mobility solutions through a collaborative, facilitated process led by the PMC and RMI.

The objectives of the Pune Solutions Workshop were to:

> Build alignment and shared understanding among key stakeholders and solution providers in Pune's mobility ecosystem;

> Advance pilot projects to test new mobility solutions on the ground;

> Explore new solutions in areas where collaborative action is needed; and

> Generate insights to inform state and national policy frameworks.

The Solutions Workshop used a collaborative approach to work towards achieving these objectives. The process involved four key components:

> **Solution development:** Project teams and working groups advanced their solutions from ideas to implementable projects through a pre-designed, facilitated process.

> **Coaching and feedback through 'coaching clinics':** City and state level public agencies and industry experts provided coaching and feedback to the project teams and working groups on how to make their solutions relevant to the city's needs and how to address the barriers and challenges expected during implementation.

> **Peer-to-peer learning and collaboration through 'integration clinics':** Project teams and working groups engaged with each other to provide feedback, explore

integration potential across mobility solutions, and identify system-level barriers that can benefit from collaborative action.

> **Vision setting:** Policymakers at the state and central level of government provided a vision and a call for action for transformative mobility solutions that could accelerate the deployment of shared, clean, and people-centric mobility solutions for urban India.

The Solutions Workshop helped the project teams and working groups advance their projects to the next level by identifying and discussing key barriers; engaging with critical stakeholders, especially relevant government agencies; and exploring ways to move their projects work forward. It also created an environment to:

> Foster joint ownership of solutions between public and private stakeholders;

> Promote integration and collaboration for addressing common barriers and achieving common objectives, beyond creating new partnerships;

> Engage the private sector in the design of urban mobility solutions; and

> Create momentum to address mobility challenges by acting as a catalyst for existing and new initiatives.

Moving forward, the mobility solutions that were developed through the Solutions Workshop will be cultivated to support their on-ground implementation. The lessons learned from Pune are expected to help similar efforts with the Scaling Partner cities and accelerate national level efforts to implement shared, clean, and people-centric mobility solutions in Indian cities.

Honorable dignitaries and participants working together at India's first Urban Mobilty Lab through 15–17 October 2018 in Pune, including the signing of a Memorandum of Understanding between the Pune Municipal Corporation and Rocky Mountain Institute.

THEMATIC SUMMARIES AND SYSTEM-LEVEL INSIGHTS

INTRODUCTION

The Urban Mobility Lab convened leaders from across Pune's and India's mobility ecosystem for the 15–17 October 2018 Solutions Workshop. Given the diversity and depth of the participants, their perspectives offer valuable insights into the rapidly evolving nature of India's mobility system. What follows is a summary of the key discussions and work that took place at the Solutions Workshop across the themes identified during the city needs assessment.

While the insights generated at the Urban Mobility Lab are specific to Pune, they contain valuable lessons for cities across India. Each summary provides an overview of the opportunities, solutions, and ideas that were developed at the Solutions Workshop. They intend to serve as entry points for further discussion and action across these themes in Pune and beyond.

Planning and implementation is underway for many of the solutions and opportunities described below.

Thematic summaries

The nine project teams and four working groups that participated in the Urban Mobility Lab developed mobility solutions across seven themes: traffic management; parking management; urban freight; non-motorized transport; public transport; transportation data for seamless multimodal routing, booking, and payment; and shared electric mobility for first and last mile connectivity. Table 1 offers an abbreviated summary of the solutions discussed and developed through the Urban Mobility Lab. Following this summary table are detailed overviews of the discussions and solutions for each of the seven themes.

TABLE 1

Summary table of proposed solutions by thematic area

THEME	PROPOSED SOLUTIONS
Traffic Management	• Improve the collection, aggregation, and analysis of traffic data to aid city-wide network design through an assessment of data needs and the establishment of a traffic data consortium. • Improve traffic efficiency with effective signal management systems while also creating systems that encourage non-motorized transport, access to public transport, and safety. • Increase engagement and coordination among stakeholders to design better junctions, educate users of traffic etiquette and laws, and improve enforcement of laws.
Parking Management	• Improve street design for parking and the use of other modes, including allocating and clearly marking parking spaces and placing parking spaces in proximity to other modes of transportation (e.g., parking at a public transport station). • Develop new solutions that support parking management, including fee collection, real-time tracking of available parking, trip planning, and data analytics. • Enhance enforcement capabilities through capacity building (e.g., training and personnel) of enforcement agencies and distribution of responsibilities.
Urban Freight	• Design and manufacture fit-for-purpose electric vehicles (EVs) for urban final-mile delivery. • Explore new fleet-as-a-service business models in which system components (i.e., driver, vehicle, charging/swapping infrastructure, etc.) are packaged as a pay-per-use model. • Create a multi-stakeholder body (e.g., the Freight Steering-to-Action Committee, F-STAC), to help inform policy makers at central, state, and city levels and bridge the gap between policy formulation and on-ground implementation. • Aggregate data from vehicles and supporting infrastructure on an open-source data platform.
Non-motorized Transport	• Develop a three-part public engagement strategy for NMT planning and design, involving a guidelines document, facilitated convenings, and demonstration projects. • Form a steering committee, with a nominated coordinating officer, for coordinating all city-level agencies and activities related to NMT and its connection to public transport.

THEME	PROPOSED SOLUTIONS (Continued)
Non-motorized Transport	• Create a process for allocating a fixed budget and timeline for implementing NMT projects.
Public Transport	• Pilot a data-driven analytics approach to optimize bus route and service operations on selected city routes. • Pilot electric buses on selected city routes to help inform electric bus development, acquisition, deployment, and operations.
Transportation Data for Seamless Multimodal Routing, Booking, and Payment	• Host a workshop to identify available data and align on procedures and best practices for data collection and sharing. • Develop a multimodal transit app that integrates various modes of transport and provides real-time information to commuters. • Enable booking and payment functionality on the multimodal app to create a one-stop resource for commuters to plan their journeys.
Shared, Electric Mobility for First and Last Mile Connectivity	• Update policy to support shared, electric mobility and explore opportunities to simplify registration/permits and financing for EVs. • Develop infrastructure to support EV charging, including renewable energy supply. • Engage and educate critical stakeholders on the benefits of shared, electric mobility.

Traffic Management

Objective

To identify opportunities and explore next steps for implementing traffic management solutions to improve traffic flow.

Overview

Many Indian cities are upgrading their traffic management systems. With new analytical techniques, software, and hardware, these systems can better manage heterogeneous traffic (e.g., issues with lane discipline, a diversity of vehicle sizes and types) in real-time (i.e., adaptive). Yet even as advanced traffic management solutions deploy at city junctions, congestion continues to grow—estimated at about 1.5 lakh crore per year in just four Indian cities (Delhi, Mumbai, Bangalore, Kolkata),[13] creating a need for a more holistic approach to traffic management. Such holistic solutions could lead to lower congestion and accidents by improving traffic flow at a city level.

TABLE 2

Traffic Management

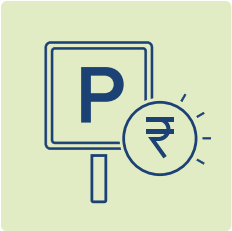
CHALLENGES PRESENT IN THE CURRENT SYSTEM		
Data and technology • Insufficient data collection and use of data analytics to make informed decisions in planning and management of traffic management systems.	**Junction management** • Traffic junctions do not favor all modes of transport; they are designed from a vehicle-centric perspective. • Limited coordination between junctions disrupts network flow.	**Public awareness and stakeholder engagement** • Coordinated action is difficult due to the siloed nature of various agencies and players. • There is a disconnect between planning and enforcement agencies. • In some cases, citizens are not engaged in traffic planning, potentially leading to systems that do not adequately consider the interests and needs of a wide range of users.

SOLUTIONS TO OVERCOME CHALLENGES		
Data and technology Improve the collection, aggregation, and analysis of traffic data to aid city-wide network design through an assessment of data needs and the establishment of a traffic data consortium.	**Junction management** Improve traffic efficiency with effective signal management while creating systems that encourage non-motorized transport, access to public transport, and safety.	**Public awareness and stakeholder engagement** Increase engagement and coordination among stakeholders to design better junctions, educate users of traffic etiquette and laws, and improve enforcement of laws.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES		
Implementation considerations • Assess data needs for traffic management, collaborate with other mobility actors to understand their data needs, and identify common data collection points. • Assess current gaps in available data relative to traffic management needs.	**Implementation considerations** • Retrofit pre-timed traffic-controller systems with adaptive systems. • Retrofit and install new hardware where appropriate, at traffic junctions to: ◦ Increase the safety of non-motorized traffic (e.g., walk/do not walk signals, audio signals for visually impaired); and	**Implementation considerations** • City governments could form multi-stakeholder working groups comprised of all agencies involved in traffic management to improve communication and coordination of efforts, including citizens and local NGOs focused on sustainable transport issues.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES (Continued)		
• Identify new sources of data (e.g., electronic fare data from public transit, surveys, Transportation Network Companies, parcel delivery services, etc.) and install infrastructure (e.g., cameras, counters, others) to collect these data. • Aggregate data in a central database and/or portal that is managed by a coordinating agency or a consortium of stakeholders. • The coordinating agency or consortium of stakeholders could also be responsible for: ◦ Suggesting data standardization formats; ◦ Assisting in the collection of data from public and private sources; ◦ Verifying if the data are of good quality and anonymous; and ◦ Identifying potential business models to generate revenue to support the program.	◦ Build enforcement capability through remote and automatic monitoring and enforcement systems. • Research global best practices and examples set by other Indian cities (e.g., Bangalore's B-TRAC) in traffic management system deployment.	• Create educational campaigns to increase citizen awareness.
Potential outcomes • Comprehensive datasets with accurate and up-to-date information. • Improved analytics to help city officials make informed decisions regarding short- and long-term traffic planning and management.	**Potential outcomes** • Improved traffic efficiency and reductions in congestion, accidents, and emissions. • Improved safety for non-motorized transport modes. • Adaptive, centralized control systems.	**Potential outcomes** • Coordinated efforts across agencies. • Services that are more comprehensive and meet the diverse needs of citizens.

Parking Management



Objective

To develop a cost-effective action plan for implementing Pune's recently released parking policy.

Overview

Many cities are in the process of implementing parking management policies. In March of 2018, Pune approved a parking policy to charge for on-street parking with the intent of improving traffic flow. Implementation of the policy remains a challenge and is still in progress, creating a need for solutions that help accelerate the cost-effective implementation of this policy. Such solutions could support efforts to encourage citizens to follow parking laws, help the city collect parking fees, and decrease congestion on city streets.

TABLE 3

Parking Management

CHALLENGES PRESENT IN THE CURRENT SYSTEM		
Infrastructure	**Management**	**Adherence to laws and enforcement**
• Limited signage and markings on streets to identify parking zones, spaces, and other important information. • There is a mismatch of demand for and supply of parking spaces. • Parking locations do not support public transport or first and last mile solutions. • Limited electric vehicle (EV) charging at parking spaces hinders EV adoption. • There is limited infrastructure for collecting parking fees.	• Different agencies manage rates in different areas, leading to variable rates and potential confusion. • Limited data collection limits knowledge of parking space availability and the ability to conduct analysis that supports in planning and the evaluation of system performance.	• There is limited enforcement capacity to increase adherence to parking laws (e.g., no double parking, or parking on footpaths) and fee collection.

SOLUTIONS TO OVERCOME CHALLENGES

Infrastructure

Improve street design for parking and the use of other modes, including allocating and clearly marking parking spaces and placing parking spaces in proximity to other modes of transportation (e.g., parking at a public transport station).

Management

Develop new solutions that support parking management, including fee collection, real-time tracking of available parking, trip planning, and data analytics.

Adherence to laws and enforcement

Enhance enforcement capabilities through capacity building (e.g., training and personnel) of enforcement agencies and distribution of responsibilities.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES

Implementation considerations

- Deploy "on-the-fly" guidance through such methods as digital signage; these signs can be low-cost and both quick and easy to deploy in the near-term.
- Capture on-street parking data for better decision making, first with field staff and eventually with technology-based solutions that interface with databases and applications.

Implementation considerations

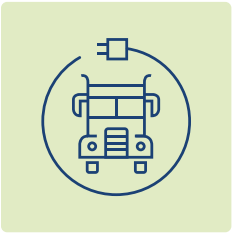
- Develop tools (e.g., phone application and/or database) that help:
  - The city tracks various parking parameters, including space availability, violations, payment systems, etc.; and
  - Users identify real-time parking space availability near their trip destinations.
- This system can also be a centralized payment system to collect parking fees and/or fines, simplifying payment and revenue collection.
- Use field staff to help with managing parking, including tasks such as:
  - Collecting data (e.g., parking space availability, infractions);
  - Enforcement, as appropriate; and
  - Collecting payment.

Implementation considerations

- Parking management contractors should be empowered, with appropriate authorization, to immobilize or tow offending vehicles and collect payment to release vehicles.
- Utilize field staff to "soft manage" violations.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES		
Potential outcomes • More informed use of available parking spaces by drivers. • Improved data collection to inform additional parking management or enforcement related decisions.	**Potential outcomes** • Real-time availability and tracking of parking spaces. • Improved park-and-pay systems (cash and cashless) that are easier for customers to use. • Revenue collection for the city. • Improved end-to-end trip planning (i.e., knowing available parking spaces near destination).	**Potential outcomes** • Better adherence to parking laws. • Collection of revenue, both from parking fees and fines.

Urban Freight



Objective

To identify opportunities and system requirements and explore next steps for the electrification of cycles and two-, three-, and four-wheel vehicles (inclusive of light-duty vehicles) for last-mile urban delivery (i.e., deliveries within the city core).

Overview

Urban freight is an important aspect of the mobility ecosystem in Indian cities as it boosts economic growth, social development, and employment. As e-commerce grows, so too will demand for urban final-mile parcel delivery (i.e., the last step in the shipping process when the parcel is delivered to the consumer). Given the short haul lengths and lower speeds and power duty cycles of final-mile delivery, purpose-built electric vehicles (EVs) (e.g., pedal-assist cycles, two and three wheelers) offer an alternative to polluting internal combustion engine (ICE) delivery trucks. Yet, there are few designs for purpose-built vehicles and a limited ecosystem to support electrification, creating a need for solutions that accommodate the needs of electric final-mile delivery providers, shippers, consumers, and city officials. Such solutions could support a shift to EVs in the freight segment, while ensuring final-mile delivery remains economic and reduces both pollution and congestion.

TABLE 4

Urban Freight

CHALLENGES PRESENT IN THE CURRENT SYSTEM			
Electric Vehicles • Limited purchase options exist for EVs specifically designed for urban final-mile delivery;	**Business models** • Required charging and/or battery swapping infrastructure is an additional asset that	**Policy** • Policies do not set a clear long-term vision for the electrification of urban freight, including	**Infrastructure** • Limited charging and battery swapping infrastructure standards.

CHALLENGES PRESENT IN THE CURRENT SYSTEM (Continued)			
current vehicles do not meet the requisite design specifications of solution providers. • EVs have high upfront costs and there is limited access to financing. • There are compliance issues with state or city vehicle regulations (e.g., some electric two-wheelers cannot reach posted speed limits; as a result, they have issues with certification).	companies may need to invest in to operate EV fleets; this investment is particularly challenging to take on during pilots, when companies are testing new business models. • EVs are viewed as a new technology; fleet operators may be hesitant to or not want to assume risk in operating EV fleets.	the final-mile delivery component. • Current regulations prevent companies from using the same vehicles in multiple applications (e.g., freight and passenger pick-up), thereby decreasing utilization. • The current policy ecosystem offers limited supply and demand side incentives, phase-out strategies for ICEs and lead-acid batteries, and supportive electricity tariffs for EVs and charging and/or swapping infrastructure.	• Intermittent power outages. • Limited real-estate for charging stations. • Low penetration of renewably sourced energy.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES			
Electric Vehicles	**Business models**	**Policy**	**Infrastructure**
Design and manufacture fit-for-purpose EVs for urban final-mile delivery.	Explore new fleet-as-a-service business models in which system components (i.e., driver, vehicle, charging/swapping infrastructure, etc.) are packaged as a pay-per-use model.	Create a multi-stakeholder body (e.g., the Freight Steering-to-Action Committee, F-STAC), to help inform policy makers at central, state, and city levels and bridge the gap between policy formulation and on-ground implementation.	Aggregate data from vehicles and supporting infrastructure on an open-source data platform.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES (Continued)

Implementation considerations

- Explore and pilot the following fit-for-purpose vehicles:
  - Two-wheelers with swappable batteries (desired specifications—range of ~60 km and average speed of ~25 km/h); and
  - Electric three-wheelers with pedal-assist systems and modular freight storage (desired specifications—range of ~100 km and average speed of 50 km/h).
- In designing fit-for-purpose vehicles:
  - End users and vehicle manufacturers should co-develop a design concept and prototype; and
  - Incorporate the following considerations: duty-cycle requirements, deployment geography and climate, and government vehicle requirements.

Implementation considerations

- Parking, operation, and maintenance can all be provided in the pay-per-use model.
- Assess the demand for packaged fleet management and identify service providers that can supply services.
- Bring in clients through innovative business models.
- Explore incentives to support early providers of EV infrastructure.

Implementation considerations

- Create the F-STAC; this committee could help support and/or be responsible for the following:
  - Developing strategy and roadmaps to achieve 100 percent electrification of final-mile urban logistics; and
  - On-the-ground implementation of policy through such actions as goal setting, identifying key performance metrics, and monitoring and evaluating performance.
- In creating the F-STAC, start by creating the charter (roles and responsibilities, objectives, governance, participation, etc.), identifying an oversight organization, and recruiting members.

Implementation considerations

- City governments can aggregate and host vehicle data (e.g., vehicle specifications, location) and infrastructure data (e.g., type, location, availability, power supply) on an open-source platform.
- Analyzing the data can help:
  - Inform urban planners and policymakers on routes and required infrastructure to develop; and
  - Optimize vehicle movement and infrastructure siting and use.
- To aggregate and host data:
  - Coordinate with Chief Data Officer and other city-level local bodies;
  - Employ data privacy protocols as needed; and
  - Follow accepted standard formats.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES (Continued)		
Potential outcomes • More efficient urban delivery due to purpose-designed vehicles that are designed for last mile delivery on urban roads (i.e., small, maneuverable, low fuel consumption vehicles). • Reduced delivery costs. • Accelerated electrification of vehicles.	**Potential outcomes** • Improved communication and coordination across many agencies, including among private and public entities and city, state, and central-level government agencies. • Informed policymaking. • Accelerated electrification of vehicles.	**Potential outcomes** • Improved data analytics and more optimized system. • Information for the F-STAC to make data-driven recommendations for execution of an electrification roadmap.

Non-motorized Transport

Objective

To identify and prioritize impactful opportunities and explore next steps for implementing solutions that improve non-motorized transport (NMT).

Overview

Pune has historically been known as the cycling capital of India. The current mode share of non-motorized transport (walking and cycling) in Pune is 31 percent and to date, Pune has allocated about 300 km of dedicated cycle track in the city. Yet, as with many cities in India, the mode share of non-motorized transport has been declining, as has the size of the public bus fleet, creating a need for non-motorized transport solutions that bolster access to public transport, decrease congestion, encourage safety, and promote health and well-being. Such solutions could support efforts to increase the mode share of both non-motorized transport and public transit in Pune.

TABLE 5

Non-motorized Transport

CHALLENGES PRESENT IN THE CURRENT SYSTEM		
Public awareness and stakeholder engagement • The existing mindset of the public does not prioritize NMT options; it prioritizes car ownership. • Misconceptions exist about public engagement (i.e., in some cases, past efforts have not met expectations) and whether cities have the capacity to conduct effective engagement. • There is a lack of structured, inclusive, transparent, effective, and consistent ways of engaging people in NMT planning and design. • The public needs are not fully understood or adequately represented in NMT planning and design, leading to suboptimal awareness and sense of ownership in the outcomes.	**Interagency capacity and coordination** • There is lack of intra and inter-agency capacity and coordination. • Oversight, monitoring, and evaluation are consistent challenges in implementation of NMT projects. • There is a need for more opportunities (e.g., literature review, visiting and/or communicating with other cities) to learn from global best practices.	**Financial** • There is a lack of adequate, sustained funding for NMT projects. • NMT-related departments within the Municipal Corporation (e.g., Cycle Department) have been charged with ambitious plans yet sometimes lack the resources to operationalize those plans.

SOLUTIONS TO OVERCOME CHALLENGES		
Public awareness and stakeholder engagement Develop a three-part public engagement strategy for NMT planning and design, involving a guidelines document, facilitated convenings, and demonstration projects.	**Interagency capacity and coordination** Form a steering committee, with a nominated coordinating officer, for coordinating all city-level agencies and activities related to NMT and its connection to public transport.	**Financial** Create a process for allocating a fixed budget and timeline for implementing NMT projects.

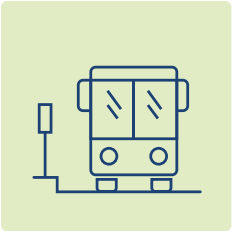
IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES

Implementation considerations	Implementation considerations	Implementation considerations

• **Part 1:** Guidelines document – A compendium of global best practices for public engagement related to NMT infrastructure buildout and use, including how to conduct design workshops, public outreach, media campaigns, and demonstration projects, as well as examples of key performance indicators, survey forms, etc.
• **Part 2:** Facilitated convenings – Training for local officials and other players to conduct facilitated design workshops and public outreach efforts related to NMT projects.
• **Part 3:** Demonstration projects – Coordinated demonstrations in the city (e.g., tactical-urbanism interventions, odd-even scheme, no car day, cycle to office/school day, etc.). Identify and prioritize interventions based on feasibility, impact, and scalability.
	• Form a steering committee for agencies and activities related to NMT and its connection to public transport, headed by the Municipal Commissioner; the role of the steering committee would focus on policy advisory, department coordination, oversight, monitoring, and evaluation
	• The steering committee could also prepare a Standard Operating Procedure (SOP) for NMT planning, design, and implementation to offer a step-by-step manual that supports rapid implementation.
	• Conduct a steering committee meeting every three months, with a monthly review meeting in the nodal department to review plans, incorporate suggestions, and prepare an implementation and monitoring schedule
	• Continue to strengthen NMT-related departments
	• Nominate a coordinating officer in PMC for NMT to support the steering committee and its work.
		• Create a process for allocating a fixed budget and timeline for implementing NMT projects.
		• Add a Budget Head (i.e., line item) for NMT in the PMC Budget Book.
		• Determine an appropriate annual budget based on existing and future NMT project plans.
		• In general, cities should also:
		  ◦ Work with local officials to dedicate funding for NMT projects on a regular basis;
		  ◦ Make funding available to prioritize NMT as the first and last mile of commuting journeys; and
		  ◦ Explore whether private-sector companies have interest in contributing to the city's NMT projects.

Potential outcomes	**Potential outcomes**	**Potential outcomes**
• Higher awareness and public acceptance of NMT projects • Interest in NMT as a preferred mode of transport. • NMT infrastructure that suits the needs of citizens. • Increased mode share of NMT.	• More coordinated action planning and accountability for NMT planning, design, and implementation.	• Predictable, sustained funding for NMT-related projects.

Public Transport



Objective

To refine, contextualize, and explore pathways to operationalize (1) analytical approaches to system optimization (i.e., routes and service) and (2) deployment of electric mobility pilots for public transport.

Overview

Public transport is an important mode of transportation in Indian cities. It provides efficient, accessible, and affordable mobility for urban citizens. Yet, the mode share of public transport is declining in many Indian cities due to a number of factors, including increasing wealth, aging bus fleets, and a mismatch between bus supply and citizen demand for mobility. A need exists for public transport solutions that both optimize the operation and use of the public transport system and promote the adoption of clean-fuel vehicles. Such solutions can make the system more efficient, more reliable, and less polluting, which in turn will make public transport a more attractive mobility option, potentially leading to an increase in mode share.

TABLE 6
Public Transport

CHALLENGES PRESENT IN THE CURRENT SYSTEM	
Public transport route and service optimization	**Adoption of electric buses**
• Limited data availability, inconsistent reporting standards, and lack of data in electronic form are hindering advanced analytics. • Many actors in the system create challenges in implementing recommendations of pilot studies/ projects, reducing impact.	• There are limited electric bus pilots due to such challenges as limited charging infrastructure and reliable power, limited financing options for buses and ancillary infrastructure, and limited availability of operation and planning data from existing fleet. • Policy and regulatory support is limited to full-scale electric bus deployment (i.e., all city routes). Such support mechanisms could include restrictions on private ICE registrations, dedicated bus lanes, restrictions on entry for private internal combustion engine (ICE) vehicles in certain zones, etc.).

SOLUTIONS TO OVERCOME CHALLENGES	
Public transport route and service optimization	**Adoption of electric buses**
Pilot a data-driven analytics approach to optimize bus route and service operations on selected city routes.	Pilot electric buses on selected city routes to help inform electric bus development, acquisition, deployment, and operations.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES	
Implementation considerations • Coordinate with the public transport agency to acquire available data (e.g., static and real-time data for routes, schedules, bus locations via GPS, ticketing/occupancy), etc.). • Assess data quality to help inform the scope of the pilot (i.e., understand which routes have available data to perform analytics). • Coordinate with the public transport agency to identify a select number of routes on which to test/perform analytics. • Explore and test methods (e.g., training manuals, standard operating procedures, workshops, etc.) to build capacity of system players, such that on-ground implementation of recommendations occurs.	**Implementation considerations** • Coordinate with public transport agencies and appropriate city government officials to develop a pilot that will provide valuable information for both Original Equipment Manufacturers (OEMs) and the city. ◦ Some factors to consider/discuss for a pilot include: route selection, pilot duration, number of electric buses to operate, availability of land (i.e., for parking and charging infrastructure) and supporting infrastructure (e.g., charging infrastructure, power), and financing mechanisms. • Leverage existing data to help inform planning and evaluate the performance of the pilot. • Identify and share best practices, based on the pilot, to support/inform: • Additional electric bus procurement in the city and also for other cities; and • Policy development and long-term vision setting for electric bus adoption in India.
Potential outcomes • Data-based recommendations for public transport agencies to make adjustments/improvements to bus routes and operation. • Additional revenue and lower operating costs for public transport agencies. • More efficient and reliable public transport that matches ever-changing travel patterns of citizens.	**Potential outcomes** • Lesson learned (i.e., a set of best practices) from the pilots can inform electric vehicle tenders and large-scale electric vehicle and charging infrastructure deployment in Indian cities. • Lower local emissions as electric buses are deployed along more routes.

Transportation Data for Seamless Multimodal Routing, Booking, and Payment

Objective

To explore opportunities in which aggregating open mobility data can enable seamless multimodal routing, booking, and payment.

Overview

The use of data in the mobility sector can increase the efficiency, ease, and interconnectedness of travel. One way of unlocking the benefits of data and creating a more efficient, interconnected transport system is by aggregating information from various modes of transport onto a single application. This solution is being piloted to varying degrees in several locations around the world, yet no solution has yet integrated multimodal routing, booking, and payment components in a single application. Such a solution could make multimodal transit more attainable and promote the use of public transport and shared vehicles, a multimodal transit application could help to alleviate congestion in cities by reducing travelers' dependency on private vehicles.

TABLE 7

Transportation Data for Seamless Multimodal Routing, Booking, and Payment

CHALLENGES PRESENT IN THE CURRENT SYSTEM		
Data availability and quality	**Information available to commuters**	**Booking and payment**
• Limited availability of data, especially real-time. • Poor quality and incomplete data. • Inconsistent reporting standards and lack of electronic records.	• Limited discoverability of modes of transport. • Difficulty in accessing and using real-time information. • Lack of reliability in current transport system.	• Lack of integration between modes of transport. • Limited convenience and efficiency in the current system (e.g. needing change for fares, waiting for each passenger to provide the right amount, etc.).

SOLUTIONS TO OVERCOME CHALLENGES		
Data availability and quality	**Information available to commuters**	**Booking and payment**
Host a workshop to identify available data and align on procedures and best practices for data collection and sharing.	Develop a multimodal transport app that integrates various modes of transport and provides real-time information to commuters.	Enable booking and payment functionality on the multimodal app to create a one-stop resource for commuters to plan their journeys.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES		
Implementation considerations • Data is a key enabler of many mobility solutions (beyond just the multimodal app). Building a strong data collection and sharing ecosystem is critical to a city's success in implementing innovative mobility solutions. • Include all critical stakeholders in the mobility data ecosystem (e.g. city government, transit agencies, private companies, app developers, etc.). • Clarify current data available and work collaboratively to determine how to obtain missing data. • Align on data structures/formats. • Clarify rules and protocols for data access.	**Implementation considerations** • Start with a pilot with a clearly defined scope (e.g., location, duration, phasing). • Begin by integrating public transport data; start with static data, then move to real-time data. • Consider focusing on public transport as the core, and then ensuring adequate first and last mile connectivity. • May require investment in additional infrastructure by the city government or transit agencies, such as GPS tracking in buses or non-motorized transport options for last-mile connectivity (e.g., public bike share).	**Implementation considerations** • Integrate booking and payment in a second phase after building the foundation of the multimodal app with real-time data. • This phase of the app can be launched initially as a pilot on a limited set of public transport routes. • Transit agencies and app developers will need to work together to integrate necessary hardware to implement this solution. • Once public transport payment has been integrated, the next step can be integrating payment for non-motorized transport and private transport.
Potential outcomes • Improved data collection and sharing practices across key stakeholders. • Increased access to data to enable innovations like the multimodal app. • Better alignment and communication across stakeholders in the ecosystem.	**Potential outcomes** • Better predictability/ dependability of public transport through availability of real-time information, leading to increased use of public transport and reduced congestion. • Easier, more reliable, more efficient transport experience. • The data collected by the application can be used to provide insights to the city government and transit agencies about transport patterns and trends, to inform planning.	**Potential outcomes** • Integrated booking and payment in the multimodal transport app, resulting in a comprehensive, easy-to-use resource for commuters to plan, book, and pay for a journey.

Shared, Electric Mobility for First and Last Mile Connectivity

Objective

To identify system requirements and pathways to electrify two, three, and four-wheel vehicles operating in a shared paradigm (i.e., mobility-as-a-service applications) for first and last mile mobility.

Overview

Both globally and in India, shared mobility is on the rise given a convergence of new business models, new technologies (e.g., deeper penetration of smartphones and phone applications, rapidly falling battery costs and solar electricity tariffs), and supportive conditions (e.g., an increasingly younger population). In a high-mileage, shared operating paradigm (i.e., mobility-as-a-service applications), vehicle electrification is beginning to make economic sense. Today, drivers can already benefit from the lower operating costs of electric vehicles. Yet, many barriers still exist to the widespread adoption of shared and electric mobility, creating a need for solutions to help inform policy, develop infrastructure, power EVs with renewable energy, and increase access to financing. Such solutions could develop a supportive ecosystem for shared and electric mobility in Indian cities, leading to accelerated, full-scale adoption.

TABLE 8

Shared, Electric Mobility for First and Last Mile Connectivity

CHALLENGES PRESENT IN THE CURRENT SYSTEM		
Policy/regulatory and finance	**Supporting infrastructure**	**Public awareness and stakeholder engagement**
• In some cases, private players cannot own vehicle fleets—a challenge in piloting early stage solutions for companies. • Policies do not clearly articulate the sourcing of renewable power for EV charging. • EVs have high upfront costs and there is limited access to financing which makes purchasing a challenge for individual drivers/owners (i.e., to work for a Transportation Network Company such as Uber or Ola).	• Limited providers of EV services (e.g., charging and maintenance) exist in Pune and other cities. • There is limited availability and quality of power from the grid. • There is limited availability of affordable land for charging infrastructure.	• There is limited public knowledge on the benefits of shared and electric mobility. • Some players may find the conversion to electric (either through retrofits or the procurement of new EVs) burdensome, especially if they have recently made conversions from diesel to compressed natural gas (CNG).

SOLUTIONS TO OVERCOME CHALLENGES

Policy/regulatory and finance

Update policy to support shared, electric mobility and explore opportunities to simplify registration/permits and financing for EVs.

Supporting infrastructure

Develop infrastructure to support EV charging, including renewable energy supply.

Public awareness and stakeholder engagement

Engage and educate critical stakeholders on the benefits of shared, electric mobility.

IMPLEMENTATION CONSIDERATIONS AND POTENTIAL OUTCOMES

Implementation considerations

- Review and update policy to clarify licensing and regulation of shared vehicles operating on fixed and dynamic routes.
- Streamline process with single-window registration for shared and electric mobility.
- Explore and institute exemptions from local permitting requirements.
- Build on current incentives for EVs and charging and/or battery swapping infrastructure deployment.
- Cities may be able to offer short-term preferential electricity tariffs to drivers operating EVs to support technology adoption.
- Develop regulations to support 100 percent renewably powered charging stations.

Implementation considerations

- Develop physical infrastructure to support 100 percent renewably powered charging stations.
- Build infrastructure (e.g., charging and swapping stations) at EV specific pickup and drop-off locations in major transit hubs (e.g., bus and metro stations).
- Identify and set aside public and private land for EV parking and publicly accessible charging infrastructure.
- Create a city-level capacity-building program (e.g., training to ensure best practices followed for charging infrastructure siting and grid integration).

Implementation considerations

- Create awareness campaigns (e.g., road shows, signage) to educate consumers, drivers, corporations, and government officials on the benefits of shared and electric mobility.
- Engage with critical stakeholders, including unions, to ensure that their interests and needs are met.

Potential outcomes

- Reduced congestion and local air pollution
- Positive impact on employment opportunities and earning potential for drivers, charging infrastructure business providers, and maintenance services
- Increase in adoption of public transport because of better integration with first and last mile connectivity

SYSTEM-LEVEL INSIGHTS

By convening government, business, and civil-society leaders to collaboratively design actionable solutions, the Urban Mobility Lab provides a lens into system-level opportunities for implementation. These insights can help guide the work of stakeholders, in particular city governments, in planning and implementing shared, clean, and people-centric mobility solutions.

Key system-level insights from the Urban Mobility Lab in Pune highlight the importance of following areas for adopting shared, clean and people-centric mobility solutions.

INTER-AGENCY COLLABORATION AND COORDINATION

> Successful implementation of new mobility solutions requires collaboration across government agencies responsible for planning, implementation, and enforcement. Many of the solutions developed at the Urban Mobility Lab identified the need for institutional frameworks that promote such cross-disciplinary collaboration. Interdepartmental committees and working groups can be institutionalized on specific topics such as non-motorized transport, parking management, traffic management, and urban freight. These committees and working groups can benefit from the involvement of local NGOs and citizen engagement.

INDUSTRY COLLABORATION

> Many opportunities exist for industry to collaboratively advance urban mobility solutions. The 'integration clinics' at the Solutions Workshop highlighted that a number of opportunities for collaboration exist among industry players. Several industry-level barriers—for example, access to open

transportation data or the investment in and siting of charging and/or battery swapping infrastructure can be addressed by industry consortiums coming together to work with government agencies to create change that benefits all parties. Mobility-as-a-Service providers, public bike share providers, and app developers working together to create seamless multimodal routing, booking, and payment options for cities and e-commerce companies, OEMs, charging infrastructure providers, and Mobility-as-a-Service providers working together to electrify final-mile delivery are examples of potential opportunities emerging from the Urban Mobility Lab that can benefit from industry collaboration.

PEOPLE-CENTRIC SOLUTIONS

> In their efforts to adopt new mobility solutions, cities should prioritize solutions that cater to the mobility needs of people. Solutions for promoting non-motorized transport such as improving access to public-transport stations or enhancing the safety of all road users, including pedestrians and cyclists, should be prioritized at a micro level (e.g., junction improvement) and a macro level (e.g., mobility planning). When it comes to motorized transport, solutions should keep all end-users in mind. For example, discussions at the Urban Mobility Lab highlighted that parking solutions not only offer valuable parking options to drivers, but also play a critical role in traffic demand management—making streets safer for pedestrians, cyclists, drivers, and passengers. Keeping customer experience at the center of the stage in the shift to sustainable modes of transport (i.e., non-motorized transport, public transport, and shared mobility) will be critical to a city that works for all citizens.

CITIZEN AWARENESS AND ENGAGEMENT

> Citizens are critical stakeholders to engage at all stages of the design and implementation process. Their aspirations, behaviors, expectations, perceptions and their abilities to modify each of those aspects should be considered in order to achieve the desired transition. For example, engaging with citizens to understand their preferences for non-motorized vs. motorized and private vs. shared mobility options is an important part of planning for a city's future mobility needs. Effective public engagement strategies and training, as well as regular citizen awareness and engagement activities are an essential part of designing and implementing new mobility solutions.

UNLOCKING THE POTENTIAL OF MOBILITY DATA

> Data is emerging as the key integrator and enabler in the shift to shared and connected mobility. There are many types of players generating and collecting diverse types of data in urban mobility ecosystems. Standardizing, aggregating, and sharing open data will create many benefits for cities and their citizens. City governments have the opportunity to make data more interoperable by establishing clear policies for data standards, aggregation, and sharing transit data.

Engaging public and private players will be critical to unlocking the potential of mobility data. Harnessing the power of data will require cities to:

> **Identify new sources of data:** Data being generated by mobile phones, electronic fare-collection systems, Transportation Network Companies, e-commerce deliveries, etc., has the potential to revolutionize the way cities and businesses plan and provide mobility services.

> **Build capacity to be able to generate and use data effectively:** Cities should identify a coordinating agency to serve as a data champion and create an institutional framework at the city level to prioritize and work on various mobility use cases. Discussions at the Urban Mobility Lab in Pune suggested that creating a consortium of stakeholders may be an effective way to operationalize this idea.

> **Establish policy frameworks:** These policy frameworks should address barriers related to data use and sharing and encourage the adoption of an open data policy.

ELECTRIFYING URBAN FREIGHT

> Cities should explore opportunities to electrify final mile delivery and invest in the planning and management of urban freight systems. In particular, solutions for improving last mile urban freight delivery need to be focused upon with an objective to reduce congestion, freight-related emissions and cost to users.

Electrification of last mile delivery in urban freight needs to be promoted along with new solutions and business models like fleet-as-a-service to enhance urban freight efficiency. As e-commerce continues to grow, electrifying urban final-mile parcel delivery could support a shift to electric vehicles in the freight segment, providing economic and environmental benefits. Cities can start planning for and supporting this shift by acting as testing grounds for electric freight solutions.

NON-MOTORIZED TRANSPORT AND PUBLIC TRANSPORT

> Walking, cycling, and public transport should continue to be a priority for cities and their mobility plans. As cities look to adopt new business models and technologies to support their mobility goals, it will be important to maintain a focus on prioritizing non-motorized transport and public transport. Continued investment in and optimization of existing and new walking, cycling, and public transport assets will be critical to cost-effectively decarbonize the mobility sector in cities while ensuring they remain accessible, livable, and safe for all citizens.

ENHANCED USE OF TECHNOLOGY IN CITIES

> New technologies and business models can help to address critical mobility challenges in Indian cities. These challenges include enforcement of traffic rules, collection of parking fees, and managing network flows. Cities should experiment with and adopt these new technologies and business models to meet existing and future mobility needs.

REVIEW AND REVISION OF REGULATORY AND POLICY FRAMEWORKS

> Existing regulatory and policy frameworks will have to adapt to meet the rapidly evolving system requirements that come with new mobility solutions. State and central governments should engage city government officials, industry players, and civil-society groups to inform the modification of existing frameworks and the creation of new ones. For example, there may be opportunities to clarify permit system and related regulations for shared vehicles operating on fixed and dynamic routes and to address compliance issues with state and city vehicle regulations that prevent some electric two-wheelers from achieving certification for freight applications.

PATH FORWARD

India's first Urban Mobility Lab was launched in Pune with the October 2018 Solutions Workshop. Since the Solutions Workshop, the Urban Mobility Lab has been serving as a platform for providing post-workshop implementation support for Pune City, as well as the project teams and working groups. Moving forward, it will also support the collection and sharing of lessons learned related to system-level challenges and opportunities. In addition to this support, the Urban Mobility Lab will apply its approach in more Indian cities over the next several years.

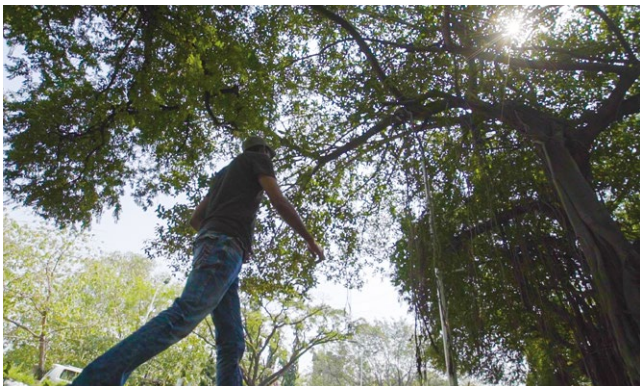
> *"I am delighted to participate in India's first Urban Mobility Lab in Pune. The Government of Maharashtra is playing a leading role in the transition to shared, connected, and electric mobility. It is our consistent endeavour to improve access, affordability, congestion, pollution, and safety. I look forward to the outcomes of the Pune Urban Mobility Lab, and to seeing how solutions can be scaled up across the state."*
>
> *– Ashish Kumar Singh, Principal Secretary, (Transport & Ports), Home Department, Govt. of Maharashtra*

> Supporting the implementation of mobility solutions: Moving forward, the PMC and RMI will continue working together in support of the mobility solutions developed through the Urban Mobility Lab by coordinating the implementation of select new mobility solutions, working with and facilitating partnerships among a diverse set of stakeholders across the private and public sectors, and collaborating across the Urban Mobility Lab's network to scale mobility solutions beyond Pune.

> Supporting the collection and sharing of lessons learned: The Urban Mobility Lab convened a microcosm of Pune's mobility ecosystem for the Solutions Workshop. The perspectives of the participants offer valuable insights into the rapidly evolving nature of India's mobility system. The work that the participants intend to carry forward also represents a number of key opportunities for accelerating the country's mobility transformation. RMI will continue to collect these insights, as well as lessons that will be learned through the process of implementing solutions on the ground in Pune, in order to support public and private sector efforts to foster integration of systems, alignment of policies, and coordination of decision makers.

> Hosting the Urban Mobility Lab in more cities: In the coming year, RMI will host the Urban Mobility Lab in additional cities. RMI is also expanding the change model of the Urban Mobility Lab by convening cohorts of cities in order to support the identification, integration, implementation, and scaling of new mobility solutions more quickly.

As India continues to urbanize and its cities continue to establish themselves as economic growth drivers, players across the ecosystem must recognize the critical role that mobility systems play in sustaining cities. They are the hearts of cities—moving the people and goods that serve as the building blocks of India's economy and society. For India to leapfrog the Western mobility paradigm and become a global leader in shared, clean, and people-centric mobility, its cities, policymakers, and business leaders must experiment with, learn from, and scale new, innovative, and integrated mobility solutions—and they must do so quickly. By offering a process for working collaboratively across India's public and private sectors to rapidly identify, integrate, implement, and scale mobility solutions that transform how people and goods move in Indian cities, the Urban Mobility Lab can accelerate India's mobility transformation—and build a replicable model for other countries to follow.



END NOTES

[1] United Nations. "World Urbanization Prospects - Population Division." https://population.un.org/wup/Country-Profiles/.

[2] World Bank. World Development Report 2009: Reshaping Economic Geography. World Bank Publications, 2008. http://documents.worldbank.org/curated/en/730971468139804495/pdf/437380REVISED01BLIC1097808213760720.pdf.

[3] Ministry of Urban Development. "Smart Cities - Mission Statement and Guidelines." June 2015. http://smartcities.gov.in/upload/uploadfiles/files/SmartCityGuidelines(1).pdf.

[4] NITI Aayog and Rocky Mountain Institute. India Leaps Ahead: Transformative mobility solutions for all. May 2017. http://niti.gov.in/writereaddata/files/document_publication/RMI_India_Report_web.pdf.

[5] OECD. International Transport Forum. ITF Transport Outlook 2015. Chapter 4, "Urban Passenger Transport Scenarios for Latin America, China and India." OECD Publishing, 2015. https://www.itf-oecd.org/urban-passenger-transport-scenarios-latin-america-china-and-india

[6] NITI Aayog and Rocky Mountain Institute. India Leaps Ahead: Transformative mobility solutions for all. May 2017. http://niti.gov.in/writereaddata/files/document_publication/RMI_India_Report_web.pdf.

[7] Pune Municipal Corporation and Rocky Mountain Institute. An Introduction to Pune City's Mobility Ecosystem. August 2018. https://www.rmi.org/wp-content/uploads/2018/09/Introduction-to-Pune-Mobility-Ecosystem.pdf.

[8] Per capita income data based on district-level urban Net District Domestic Product (NDDP).

[9] Estimated based on data on household two-wheeler and car ownership published by Census of India (2011).

[10] Ministry of Road Transport and Highways. Road Transport Yearbook, 2015.

[11] Census of India (2011). Data on "Mode of Travel to Work."

[12] Pune Municipal Corporation and Rocky Mountain Institute. An Introduction to Pune City's Mobility Ecosystem. August 2018. https://www.rmi.org/wp-content/uploads/2018/09/Introduction-to-Pune-Mobility-Ecosystem.pdf.

[13] Dash, Dipak K. "Traffic congestion costs four major Indian cities Rs 1.5 lakh crore a year." Times of India. 26 April 2018. https://timesofindia.indiatimes.com/india/traffic-congestion-costs-four-major-indian-cities-rs-1-5-lakh-crore-a-year/articleshow/63918040.cms.

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