WRI INDIA

WORKING PAPER

Public bicycle sharing in India: Lessons learned from implementation in three cities

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CONTENTS

Working Papers contain preliminary research, analysis, findings, and recommendations. They are circulated to stimulate timely discussion and critical feedback, and to influence ongoing debate on emerging issues.

HIGHLIGHTS

- Public bicycle-sharing (PBS) systems are flourishing worldwide as city authorities embrace low-carbon transport.

- In India, several cities introduced PBS, most of which followed a rental model with no, or very limited, bicycle sharing. Mysuru, Bhopal, and Pune were the first Indian cities to implement PBS.[1] These systems, however, could not offer large bicycle fleets and coverage.

- These cities offer important lessons to Indian cities. In fact, Bhopal and Pune learned from the Mysuru system and introduced the country's first PBS systems featuring public-private partnerships, smart technology, and incentives for quality service.

- PBS faces several challenges in India, such as high dependence on motorized two-wheelers, lack of dedicated cycling infrastructure, limited cross-agency coordination, lack of political understanding, and lack of user interest/education.

- This paper highlights the financial, business, and operating models created by these three cities to implement PBS, common factors that led to their initial success, and the challenges to sustaining and expanding their systems.

EXECUTIVE SUMMARY

Context

Close to 2,000 PBS systems are operational around the world, providing flexible mobility as users can pick up and drop off bicycles at any location in the network. Combining a centuries-old mode of transport with modern technology that provides easy access via smart card and smartphone apps, PBS is benefiting millions while bolstering the transition to low-carbon transportation systems. This approach offers significant promise for India.

India has had a long tradition of cycling. In the 1920s and 1930s, cycles started to appear in the Indian urban landscape as a modern mode of transportation (Joshi and Joseph 2015). However, with rapid motorization in the recent decades, in addition to the economic liberalization in the 1990s, that made two-wheelers in particular, and cars, more accessible with increasing incomes, the national share of cycling as a mode of transportation started declining. Cyclists started disappearing, and over time became invisible in the Indian urban mobility landscape. With the advent of motorization, many cities went through similar processes that marginalized cycling. However, in India, the linkage of cycling with poverty was a distinctive feature. The social stigma of "a poor man's mode of transport" attached to cycling made it much more difficult for cycling to thrive despite the long history of bicycle usage in India. Despite these challenges, with increasing urbanization and the need to improve accessibility for all in India's growing cities, PBS schemes provide a valuable low-carbon transport option that could be scaled up.

Bicycles offer a cheap and sustainable way for citizens to take short trips and access mass transit bus and metro systems from their homes. Yet, in recent decades, the spike in urbanization and cars has not been accompanied by a corresponding increase in the use of bicycles. In contrast, the national mode share (2007) for bicycles decreased to an average of 11 percent from nearly 30 percent in 1994 (Ministry of Urban Development, India 2007). According to a 2010 study, the mode share of cycling was found to be 13–21 percent in most of the medium (1–3 million) and large cities (3–5 million), 7–15 percent in very large cities (population above 5 million), and 7–10 percent in megacities (TERI 2014).

Since 2006, a National Urban Transport Policy that focused on "moving people rather than vehicles" has sought to reverse this trend by encouraging cities to adopt initiatives and projects to promote walking and cycling. Owing to this, many Indian cities piloted PBS systems to improve the cycling mode share. Globally, PBS systems have been around since 1965, when the first PBS system was introduced in Amsterdam. Since then, PBS systems have seen continuous technological innovations. Indian PBS systems were not influenced by global markets until 2006. The systems launched after 2006 used the technologies that were then current in the PBS market. However, initial attempts, including by Mumbai, Delhi, and Bangalore, were based on the rental model, and operations stalled within a few months of the launch because they proved to be economically unviable. These systems were completely private, the only support from the government being the provision of land/space to operate in.

In 2017, three cities—Mysuru (formerly Mysore), Bhopal, and Pune—introduced the country's first PBS systems, which were relatively more successful than the previous attempts. These cities developed business, financial, and operational models using public-private partnerships, deployed smart technology, and introduced incentives for quality service. As India's first PBS schemes that continue to operate today, they have important lessons to offer.

Although each scheme is different, they share some common factors, such as effective use of technology, adoption of basic principles of PBS, and public sector support, among others. The pilot cities have faced challenges in maintaining, sustaining, and expanding these systems. Hence, they offer important lessons to other cities.

About this paper

This working paper aims to provide decision-makers in city agencies and practitioners with key insights into the business, financial, and operational models; implementation mechanisms; challenges faced; and important lessons from the PBS systems implemented in Mysuru, Bhopal, and Pune. Therefore, the primary target audience for this paper includes city decision-makers who are responsible for implementing a PBS system (executive and technical leadership: transport, planning, finance) and consultants who help cities plan bicycle sharing in India. The secondary audience is nongovernmental organizations (NGOs) and bicycle-sharing practitioners and researchers in India.

From the research viewpoint, the paper is important as the existing knowledge base available on the subject in terms of key reference publications is increasingly becoming out of date, and the available material focuses on lessons from developed countries, which does not reflect the recent trends

in operations and business model innovation for the local (Indian) context. The only very recently published reports/papers including Indian case studies are by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), which was published in March 2021 (GIZ 2021), and by Ola Mobility Institute in December 2021 (Mandal 2021). Movement in the space is reflected by a proliferation of blogs and commentary dedicated to the topic, which are typically not peer reviewed, can provide conflicting evidence on trends and can contain potential bias, as many of them are industry sponsored. This paper aims to provide an objective and detailed account based on research performed in a developing country. In addition, with only a handful of large-scale PBS schemes implemented in India, this publication fills an information gap for city administrators, including transport agencies, giving them a resource they can rely on for making informed decisions in the Indian context. The intent is to give readers an insight into the learnings and challenges involved in implementing PBS systems in India and thereby allow them to make informed decisions for future projects.

During the COVID-19 pandemic, interest in cycling has surged, both globally and in Indian cities. In view of this, PBS projects are being encouraged by government and city authorities during this period, and this paper provides key lessons learned from the experience of three Indian cities that can help guide future PBS programs, helping sustain the interest in and usage of cycling in the post-pandemic world as well.

Through detailed case studies, the authors analyze and compare the approaches taken in Mysuru, Bhopal, and Pune to implement PBS systems. Data collection consisted of literature review, desktop research, and consultations with government officials, transport service providers, and PBS operators in each city. Each scheme was documented and analyzed based on seven factors: approach, initial challenges, policy and legal arrangements, business and financial model, implementation mechanism, project impact and usability, and challenges going forward. Since these are the first PBS schemes implemented in India, the findings represent a snapshot of the pioneering/initial efforts in implementing PBS in India. As more cities launch their own programs and confront their unique sets of challenges, further research will be needed.

Challenges to Implementing PBS in India

City authorities in Mysuru, Bhopal, and Pune overcame the initial challenges and obstacles that derailed earlier efforts to introduce PBS systems and succeeded in implementing large-scale PBS systems. These challenges to the successful implementation of PBS in the Indian context generally stem from the lack of a well-thought-out, sustainable business and financial model, which in turn can lead to infrastructural, maintenance, and operational concerns that deter users. In addition, cities often promote cycling to the elite population as a green behavior without doing much to address the needs of captive users, thereby failing to address the social stigma of a "poor man's mode of transport" attached to cycling (TERI 2014).

Table ES-1 summarizes the macro, micro, and user challenges that commonly face municipal authorities in India. Because some or all of these obstacles were not addressed, cities that attempted to introduce relatively small-scale PBS systems before 2017 struggled to sustain their systems beyond a couple of months from the launch date. As stated earlier, many of these challenges continue to jeopardize the three discussed case studies. The challenges have been divided into three categories: macro-, micro-, and user-level challenges. Macro-level issues refer to the large-scale challenges—political, policy, and funding related—and are at the national level. Micro-level issues are challenges that are at the city level and largely concern implementation agencies and service providers. The third category relates to issues at the user level.

Learning from past experiences: A step forward in the right direction

From 2008 onward, many attempts to introduce PBS systems were made in Indian cities. However, because of the absence of a robust business and financial model and a holistic approach, none of the systems could be sustained beyond the pilot stage. They had to shut down operations within a few months of the launch. Also, due to the low initial investment and the small scale at which these systems were piloted, these systems functioned primarily as rental systems, where users had to pick up and return the bicycles at the same location. Such experimental attempts were made in Mumbai, Delhi, Thane, and Bangalore (now Bengaluru) (see Table ES-2).

These systems had the right intent and also demonstrated the potential that bicycle sharing has for urban commuters in India. However, because of the challenges discussed above, they were never able to move beyond the pilot phase. Between 2012 and 2015, several cities floated tenders to implement PBS systems, but because of the previous negative experiences and the absence of robust business and financial models, they were unable to find bidders. In 2013, Raahgiri (car-free day) was launched in India. This helped cities raise awareness of cycling and generate interest in PBS systems. Meanwhile, cities continued to work on

Table ES-1 | Common challenges faced by Indian cities implementing PBS systems

TYPE OF ISSUES	DESCRIPTION
Macro-level issues	• Lack of conceptual understanding in political circles results in lukewarm efforts to promote cycling as an attractive means of transport with the following benefits: 　- Addressing road safety concerns: Cyclists are safer in communities where more people cycle, as motorists tend to adjust their behavior in the expectation of encountering cyclists; i.e., the "safety in numbers" phenomenon. For example, in the United States, New York City, Boston, and Washington, DC, all became certified Bicycle Friendly Communities at the same time that they implemented PBS, as safe cycling infrastructure was created in parallel with the implementation of PBS. 　- Addressing increasing environmental risks such as pollution. 　- Improving health and physical well-being. • Lack of cycling infrastructure and know-how.
Micro-level issues	• Lack of coordination across concerned agencies on policies and permissions for promoting nonmotorized transport (NMT). • Failure of cities to assist PBS program service operators by providing financial assistance in the form of subsidies. For example, every PBS that Alta Bike Share (now called Motivate) operated (except Citi Bike in New York City) was subsidized. To succeed, PBS needs to be developed in the same way as highway and transit systems. • Lack of clarity on revenue streams for nonmotorized vehicles. • Need for bicycle manufacturers and PBS operators to develop more sophisticated, proprietary systems. • High operational and capital costs and higher security threats. • Lack of sufficient volume in user ridership by all income groups. • Management of waste created by damaged cycles. Some NGOs specialize in recycling bicycle parts. This can also be explored as a potential partnership opportunity to address waste management.
User-level issues	• Lack of investment in educating potential users to view cycling as an attractive and sophisticated means of clean transport. • Need for attitudinal change among potential users regarding environmental concerns due to rising greenhouse gas (GHG) emissions. • Lack of surveys to understand user needs and preferences. • Limited access to smartphones among bicycle commuters. • Potentially limited educational levels among riders, requiring appropriate language to present and advertise PBS apps.

Note: PBS = Public Bicycle Sharing.
Source: Authors' interpretation based on discussions with stakeholders in the three case study cities.

creating a business and financial model that would work in the Indian context. All these efforts led to bidders becoming interested in PBS, and from 2015 onward, operators started bidding.

In 2017, PBS systems were launched (became operational) in Mysuru, Bhopal, and Pune. These three systems were an improvement over the previous systems in terms of size, coverage, and financial and business models. Mysuru, Bhopal, and Pune moved ahead of the previous examples and developed the business and financial models needed for large-scale systems.

They brought public-private partnerships into the picture. The government authorities in these three cities also worked closely with citizens to ensure a successful launch and to attract a significant customer base for the operators to start with. In addition, the three cities adopted differing system designs. Mysuru and Bhopal chose dock-based systems. Mysuru opted for a semi-automatic system,[2] whereas Bhopal introduced India's first fully automated system. Pune became the first Indian city to implement a large-scale dockless PBS system (see Table ES-3).

Table ES-2 | **A glance at the early attempts**

CITY	YEAR OF LAUNCH	SYSTEM	SIZE OF THE SYSTEM	COVERAGE AREA
New Delhi	2008	GreenBIKE	8 stations, 80 cycles	Docking stations placed only along the bus rapid transit (BRT) corridor
Mumbai	2009	CycleChalao	2 Stations, 30 cycles	Connectivity only between Mulund Railway Station and Vaze Kelkar College (2.5-km stretch)
Thane	2009	FreMo (Freedom to Move)	5 stations, 100 cycles	Providing connectivity to train stations
Bengaluru	2011	ATCAG (Automated Tracking and Control of Green Assets)	9 stations, 45 cycles	Located at Metro stations and in the city center
	2012	Namma Cycle	4 stations, 150 cycles	Operational only inside a campus (Indian Institute of Science)

Source: Authors, based on case study research and consultations held in 2016–17 with experts from the respective cities.

Table ES-3 | **At a glance: India's first PBS systems**

CITY	EXTENT OF COVERAGE	SCALE OF BICYCLE FLEET: NUMBER OF BICYCLES IN THE SYSTEM	TYPE OF BICYCLE SHARING SYSTEM	BICYCLING INFRASTRUCTURE
Mysuru	Focus on city center and tourist attractions	450	Mysuru has a dock-based system. This allows users to pick up and drop off bicycles at any of the docking stations in the city. There are 48 docking stations in Mysuru, operated by public-private partnership.	A 4-km bicycle track close to the city center is in use. Another 28.8 km of potential dedicated bicycle tracks in the areas served by the docking stations has been identified. The state agency has forwarded its proposals to the Mysuru City Corporation for implementation. On-ground implementation has not begun.
Bhopal	Focus on Bus Rapid Transit System (BRTS) catchment area	500	Bhopal has a dock-based system. This allows users to pick up and drop off bicycles at any of the docking stations in the city. There are 50 docking stations in Bhopal, operated by public-private partnership.	12 km of dedicated bicycle lanes have been built along the BRTS corridor, and construction is under way for more cycle tracks in the Smart City Area of the city. Another 55-km nonmotorized transport (NMT) network plan is under consideration for approval by the Bhopal Smart City Development Corporation Limited.
Pune	Parking locations spread across the city, including BRTS locations	2,500	Dock-less system with 800 parking locations allows users to pick and drop bicycles at any location; operated by multiple private firms.	Bicycle lanes exist but require renovation to be usable. Under the city's Bicycle Master Plan, the proposal consists of the following: ▪ 531 km of segregated cycle track ▪ 154 km of marked or painted cycle lanes ▪ 75 km of independent cycle ways/greenways ▪ 54 km of currently existing cycle tracks that are to be retrofitted.

Notes: a. Under the Government of India's Smart City Mission, Bhopal will be redeveloping an area of 342 acres, and 2.5-meter-wide cycle tracks are under construction on prominent roads in the area.
Source: Authors, based on case study research and consultations held in 2016–17 with experts from the respective cities.

Common elements of initial success

Although each of the three cities tailored their systems to the local urban context, they exhibit common features that contributed to their initial success on a citywide scale. The authors' analysis of these common elements are summarized below to assist city agencies and private operators working to develop PBS models:

Strategic approach

- All three cities spent many years laying the groundwork for PBS schemes through strategic planning, incorporating PBS schemes into broader urban development plans. In the case of Mysuru and Bhopal, state-level agencies were also involved, whereas Pune received the central government's support.

- All three cities popularized the concept of shared bicycling schemes among their citizens before the launch, which resulted in enthusiastic uptake and high usage. For example, Bhopal initiated Raahgiri Days (car-free days), and Mysuru hosted Cyclothons (cycle rides and races) and cycle awareness days. This led to more than 5,000 and 17,000 registrations (about 0.5 percent and 1 percent of the respective city's population) in Mysuru and Bhopal, respectively, in the first two months of the launch.

Policy and legal framework

- All three cities incorporated plans for PBS schemes within strategic mobility plans that evaluated the need and demand for walking and cycling infrastructure. Bhopal and Mysuru included PBS as a part of their larger mobility goals for the city, whereas Pune formulated a city-level Cycle Plan and included PBS in it.

- This helped bring city government stakeholders and the public on board, while enabling financing from city and state agencies and other sources, including the World Bank (Mysuru). This was an important factor that was missing in earlier attempts.

Business and financial model:

- All three cities had laid out comprehensive business and financial models with clear revenue, financials, and responsibility sharing along with clearly defined service-level benchmarks.

- Mysuru and Bhopal opted for public-private partnerships (PPPs)[3] with single operators, with the scheme's financial burden and management being shared.

- Pune opted for an open contract model with multiple firms, which requires operators to bear all costs, enabling wide service coverage.

Implementation

- All three cities launched their ventures with a sizable service coverage (more than or equal to 10 sq. km), attracting high ridership numbers from the outset.

- Service coverage was targeted to maximize ridership. Bhopal and Pune prioritized service near BRT stops, whereas Mysuru focused on tourist areas with high-volume traffic.

Usability

- All three cities employ user-friendly smart technologies, set fees at attractive levels for users, and provide long durations of service: 16 hours a day.

- All three cities laid the groundwork for high-quality service. Mysuru and Bhopal included service benchmarks—such as bike availability and maintenance—in contracts, tied to operator payments. Pune requires operators to report service metrics monthly, and competition among four PBS providers incentivizes quality service.

With increasing urbanization and the need to improve accessibility for everyone in India's growing cities, PBS schemes provide a valuable low-carbon transport option that could be scaled up. The three PBS schemes discussed in this paper provide useful models and lessons for national and municipal decision-makers as they plan and implement such schemes.

INTRODUCTION

With a majority of the world's population now living in cities, national and municipal governments are seeking to promote sustainable forms of urban transport. Public bicycle sharing (PBS) systems offer a clean and healthy mode of public transport and are being adopted around the world. In addition, with advancements in the micro-mobility sector, electric-powered micro-mobility, in the form of electric bicycles, offers significant potential too. Nearly 2,000 systems are operational worldwide now (Meddin et al. n.d.), providing tens of millions of residents and visitors in cities across the world a dense network of bicycle rental stations accessible via smart card, smartphone app, and/or registration centers. This approach offers significant promise for India, which has a long tradition of cycling and a rapidly growing urban population.

In context: PBS in India

PBS schemes offer a huge opportunity for India's cities and citizens, for a variety of reasons. Up to 30 percent of journeys in the country are still made either on foot (the majority) or by cycling (Manish n.d.), especially by low-income families. This 30 percent figure is a significant number from the low-carbon perspective and provides an opportunity for India to be seen as a world leader in car-free transportation. Although the largest proportion of cycling trips is in the range of 2–5 km (Gupta and Puntambekar 2016), it is also interesting to note that barring the metropolitan cities, the majority of Indian cities have average trip lengths below 5 km (G. Tiwari 2011). Thus, cycling is also ideal for replacing short motorized-vehicle trips, bringing health and environmental benefits by reducing congestion, pollution, and greenhouse gases (GHGs). In this way, PBS systems in cities can provide an efficient "first and last mile" feeder service, connecting commuters to mass public transport systems such as Bus Rapid Transit Systems (BRTSs) and Metro services. Beneficiaries of such systems include not only users but also public transport operators, city authorities, the bicycle industry, and the local and global environment. PBS systems therefore also offer cities a means of encouraging individuals to use bicycles for urban transport. Globally, PBS has helped overcome many of the barriers to using bicycles as a mode of transport, including safety concerns, space for storage, maintenance, weather, travel patterns, and overall cost (Moon-Miklaucic et al. 2019). All these reasons make PBS a potentially worthwhile public city investment and an important means of promoting and supporting cycling in cities.

Unfortunately, between the 1980s and the mid-2000s, the increase in urbanization and the number of cars was accompanied by a drop in bicycle use in Indian cities (TERI 2018). Although small-scale bicycle rental systems operated in a few cities such as Indore prior to 2006 (EMBARQ India, The World Resources Institute, n.d.), India fell behind its global counterparts in embracing large-scale urban PBS. In 2006, the Indian government introduced a paradigm shift with the new National Urban Transport Policy, which focused on "moving people rather than vehicles." Under the auspices of the Ministry of Housing and Urban Affairs, the legislation promoted sustainable transport by reorienting planning processes to discourage driving and encourage walking and cycling. Its provisions included specific goals for urban authorities to support nonmotorized transport (NMT) in cities, including by equitable allocation of travel space among all road users, including private car owners, public transit users, pedestrians, bicyclists, and taxi/auto-rickshaw users. In 2009, the National Mission on Sustainable Habitat, approved under India's National Climate Change Action Plan, further boosted the momentum for cycling by supporting NMT as a key strategy for reducing India's GHG emissions.

As a result, a number of Indian cities, including the major population centers of Mumbai, Delhi, and Bangalore, began experimenting with PBS systems. These pilot schemes included Planet Green Bikes, launched in Delhi in 2008, and Cycle Chalao, which operated for two months in 2009 in Mumbai with 30 bicycles (Mead 2014; Parameswaran 2011). Bangalore briefly operated two small-scale systems in 2011 and 2012: ATCAG BikeShare with nine stations operational for three months in 2011 and Namma Cycle with four stations housed inside a university campus in 2012. All these schemes were funded completely by private operators, with no funding support from the government. Thus, due to the small scale and the low initial funding, they failed to become economically viable in the long run—despite interesting many users. These systems did not have a financial model in place, which led to a low initial investment. This led to the systems being small in both size and coverage, resulting in low ridership. Because of this, the operators were unable to scale up and sustain the system. In addition, the schemes encountered challenges such as low-quality bicycles, lack of cycling infrastructure, lack of technology support to sparse networks of stations, maintenance and operational problems, and the social stigma around cycling as a "poor man's mode of transport."

This series of unsuccessful experiments perplexed the authorities in Indian cities, who were seeking sustainable transport solutions: how should they pursue PBS systems? In 2017, this stalemate was broken with the emergence of India's first three large-scale PBS systems in Mysuru, Bhopal, and Pune. These cities made improvements in the areas where previous systems fell short, starting with locally tailored business and financial models that draw on private as well as public sector support and effectively harnessing technology for ease of operations and maintenance. Further, these cities utilized the Indian government's new Smart Cities Initiative and the availability of national funding from sources such as the Atal Mission for Rejuvenation and Urban Transformation (AMRUT).[4]

This working paper provides key insights to city administrators, transport authorities, and other players (such as the private sector, NGOs, and philanthropists) involved in PBS development in India by drawing on learnings from the PBS projects in Mysuru, Bhopal, and Pune. Although some aspects of these systems could be improved, we focus here on the valuable lessons learned from their implementation experience and the challenges faced by them in launching the service and staying operational for a longer duration in comparison to the previous attempts.

Approach

This paper first provides an overview of the macro, micro, and user challenges Indian cities face in adopting PBS systems as part of a sustainable transportation strategy. It then provides a detailed discussion of the elements that led Mysuru, Bhopal, and Pune to launch larger systems harnessing PPPs and concludes with a comparison of key common elements and lessons learned from the three city schemes. The research is a result of the authors' engagement with the WRI Ross Center for Sustainable Cities network and was conducted within the framework of WRI India's engagement with these cities on sustainable transport planning and implementation.

The paper's objective is to provide city decision-makers with insights into different PBS implementation mechanisms, business and financial models, operational and maintenance features, impacts, and the challenges that lie ahead. Technological innovations (such as the dockless bike), tendering processes, and business and financial models in this emerging field create some planning and implementation concerns, as well as opportunities, and the authors aim to shed light on both aspects.

With only a handful of large-scale PBS schemes implemented in India, this publication fills an information gap for city administrators, including transport agencies, who can rely on it to make informed decisions in the Indian context. The intent is to give readers insight into the learnings from, and challenges

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Box 1 | **Methodology**

To understand the evolution of PBS systems in India and the trends in their implementation, we start with a brief analysis of the initial small-scale attempts by Indian cities and the reasons for their failure. To facilitate deeper insights into, and learnings from, PBS, we have analyzed in detail the first three large-scale PBS systems. Two are dock-based systems, and one is a dock-less system. Hence, we provide information on, and insights into, implementing both types of schemes.

The three case studies are documented under seven components:

- Approach: The process followed to establish the need for PBS systems as a sustainable mobility solution to improve urban mobility.
- Initial challenges: Implementation hurdles faced by the city authorities.
- Policy and legal arrangements: Policy frameworks, ownership structures, and contracts.
- Business and financial model: Funding and financing mechanism, including revenue sources and revenue sharing criteria, incentives, and penalties.
- Implementation mechanism: Roles and responsibilities of public and private agencies.
- Project impact and usability: Usage rates and the public response to the project.
- Challenges going forward: Challenges faced going forward in implementing and operating successful PBS systems in India.

Data collection consisted of literature reviews and desktop research, including reports and project briefs published by city governments and operators. These included the Comprehensive Bicycle Plan for Pune, blog posts, and government- and operator-managed web pages. In addition, the authors consulted government officials, transport service providers, and PBS operators in Bhopal, Mysuru, and Pune.

In choosing PBS schemes to highlight and analyze learnings in detail, case studies were selected based on four parameters: 1) sizable intervention (around 500 cycles); 2) coverage area >=10 sq. km; 3) the operational model should be a bicycle-sharing system and not just a bicycle rental system (i.e. the system encourages shorter trips and allows for sharing of bicycles among users rather than bicycles rented to a single user for a longer duration); and 4) an operational period of more than a year.

The three case studies draw out notable elements, implementation mechanisms, and approaches that cities have put into practice to move beyond bicycle rental systems and adopt PBS systems in the Indian context. The research documents key learnings from these three cities and the challenges that they continue to face. Together the insights provide valuable lessons for Indian cities seeking to implement PBS systems.

Notes: PBS = public bicycle sharing, a service in which bicycles are made available for shared use to individuals on a short-term basis for a price or for free, in which users can pick up and drop off a bicycle at any station/point within the system.
Source: Authors.

of, implementing PBS systems in India and thereby help them make informed decisions for future projects. It builds on another recently published WRI working paper, "The Evolution of Bike Sharing–10 Questions on the Emergence of New Technologies, Opportunities, and Risks" (Moon-Miklaucic et al. 2019), which discusses the Bhopal and Mysuru schemes within the context of the global evolution of PBS schemes.

Box 1 describes the methodology used to identify and document the city case studies and to understand the learnings from each of the three cities. Rather than aiming to be a comprehensive "how-to" guide, this paper provides insights into the changing panorama of, and recent developments in, PBS systems in India, and the challenges that continue to plague successful implementation, to help city officials navigate key high-level decisions when considering their own PBS scheme (Moon-Miklaucic et al. 2019).

IMPLEMENTING PUBLIC BICYCLE-SHARING SCHEMES IN INDIA: KEY CHALLENGES

To understand the success stories of Mysuru, Bhopal, and Pune, it is imperative to understand the hurdles faced by the cities, both surmountable and insurmountable. Multiple challenges and problems at the macro, micro, and user levels derailed the earlier attempts by Delhi, Mumbai, Thane, and Bangalore, among other cities; they prevented scaling up of the systems. As a result, PBS functioned as bicycle rental systems instead of bicycle-sharing systems, and operations were discontinued within a few months of their launch.

The projects launched in Mumbai, Thane, Delhi, and Bangalore were manually operated, covered a small area, and were sparsely distributed (see Table ES-2). These projects operated either within college campuses or served a limited number of public transit stations. The implementation model adopted by these systems worked on a partnership basis in which the operators shouldered all responsibilities, including planning, designing, funding, implementation, operations, and maintenance, and government support was typically limited to providing permission for operations and land for stations. In Thane, the operator had to pay for using government land. Although they bore all the expenses, the private operators raised revenue from advertising companies that displayed ads at the bicycle stations. The schemes were not service oriented: the schemes did not use service level benchmarks to ensure quality of operations and maintenance, and roles and responsibilities of the agencies involved were not clearly demarcated. Most of these operators halted operations within a few months due to financial difficul-

ties, lack of adequate government support, limited and unsafe cycling infrastructure, and the additional obstacles summarized in Table ES-1.

To move beyond the bicycle rental approach and ensure the success of PBS programs in India, it was critical for municipal authorities to consider and respond to the advantages and disadvantages of the earlier systems and develop models that addressed the pitfalls that derailed the attempts made in Mumbai, Thane, Delhi, and Bangalore, while meeting the specific needs and goals of their cities. Learning these lessons entailed understanding the concerns of PBS operators and manufacturers and incorporating their perspectives in framing new systems, alongside high-quality standards and customer service. It also required city planners to become well versed in choosing the most suitable bicycling technology.

Bicycle-sharing systems came into existence in the 1960s in Amsterdam, as a scheme of unlocked and free-use bikes in several unregulated areas of the city. These were the first-generation systems. In 1995, the second generation of bicycle sharing was introduced in Copenhagen, Denmark, where riders were required to insert a coin deposit to unlock the bicycle. In 1998, the technology advanced to include automated options such as credit cards and smart cards to access bicycles and track information (i.e., embedded GPS), and the bicycles were station based. This was termed the third generation. The most recent innovations in the bicycle-sharing market, generally referred to as the fourth generation, include bicycles with automated locking (without the need for a dock). These dockless bicycle-sharing systems have expanded (from 2015 to 2017) from small, campus-scale schemes in China to more than 17 million bicycles worldwide (Moon-Miklaucic et al. 2019). These advances made the choice of bicycling technology and plans for safe infrastructure key components of implementing PBS systems in India.

Looking at the state of the initial PBS attempts in India, Mysuru, Bhopal, and Pune developed business and financial models with shared funding and operational responsibilities among private and government entities and thus implemented comparatively large-scale systems that operate on the bicycle-sharing concept. The three systems enjoyed initial success and were also able to garner high ridership numbers in the initial months of the operation. Though all three systems remain operational, challenges have emerged, as is evident from the low ridership in the second year of the operations. However, the systems are currently operational. The following section discusses in detail the experience of the three cities, the strategies responsible for their initial success as India's first PBS systems, and the challenges that continue to plague the implementation of PBS systems in India.

To maximize the usefulness of our material for the decision-making audience, each example begins with a city and project summary (see Tables 1, 3, and 5 for the project and city summaries) followed by an in-depth discussion of the PBS scheme's approach, the initial challenges, policy and legal framework, business and financial model, implementation mechanism, and impact/usability results and metrics. The challenges and problems faced by all three cities going forward have also been discussed under each case study.

CASE STUDY 1: MYSURU

Table 1 | At a glance: Trin Trin dock-based PBS program

TYPE OF INFORMATION		
City information	City name	Mysuru
	Population (2011)	1 million
	Area (sq. km, 2011)	128.42
Mode share	Two-wheelers	30%
	Private cars	7%
	Public transport	18%
	Walking	23%
	Cycling	10%
	Intermediate public transport	12%
	Average trip length	7.43 km
PBS information	System name	Trin Trin
	Launch date	June 3, 2017
	No. of operational bicycles	450 bicycles across 48 docking stations
	Hours of operation	6 AM–10 PM (16 hours)
	Fare structure	First half hour is free; the minimum fare is INR 5 (for 30–60 min). Thereafter: 1–2 hr: INR 15; 2–3 hr: INR 35; 3–4 hr: INR 65; 4–6 hr: INR 95; 6–8 hr: INR 120; 8–12 hr: INR 145; >12 hr: INR 245. Users register online through the Trin Trin smartphone app, in one of six designated registration centers, or in any MysoreOne center (registration centers are present at various locations across the city), by paying INR 360. This includes a refundable security deposit of INR 250 and processing fees of INR 50. Both cash and credit/debit cards are accepted for payments.
	Coverage	28 sq. km, with the focus on key city center and tourist destinations
	Subscribers	Over 14,000 (pre-COVID)
	Average no. of rides/bicycle/day	2.0 (2021)

Table 1 | At a Glance: Trin Trin Dock-Based PBS Program (contd'd)

TYPE OF INFORMATION		
Technical information	System type	Semi-automated third-generation bicycle-sharing system
	Technology/PBS type	Dock-based system: bicycles have radio frequency identification device (RFID) tags (no GPS) and are activated by users via smart card and smartphone app
	Bicycle type	Two options: single speed (430 bicycles) and geared (20 bicycles)
	Docking station type	1. Parallel to the road, 35 ft × 6 ft (10 m × 1.8 m) in size, accommodating 16 bicycles
		2. Perpendicular to the road, 50 ft × 6 ft (15 m × 1.8 m) accommodating 12 bicycles
		All stations have kiosks where users can check information, including account balance, membership expiration date, and bicycle checkout status
	Bicycle specifications	Features: universal design, unique parts; hidden wiring; mudguard; tubeless tires; RFID tracking Manufacture: The aluminum frame made in Mysuru with all other parts imported from China and the bicycles assembled in Mysuru
	Intelligent technology system integration	Smart card, RFID, control center; website and phone apps
Financial information and funding responsibilities	CapX investment and time period	INR 77 million over six years
	OpX costs	INR 128 million for 5.5 years (including a six-month installation period)
	Public sector funding and responsibilities	The project is completely funded by the public sector (i.e., the state and city government) the government in turn has received funding from the World Bank
		The public sector is also responsible for provision of land and legal and institutional support as required by the operator
	Private sector funding and responsibilities	Procure and install all components of the PBS system (bicycles, redistribution vehicles, docking stations, technology setup, etc.); operate and maintain for 5.5 years
	Contract conditions	▪ 100% public sector funding and public sector revenue retention
		▪ Operating and maintenance costs paid to the operator are tied to quality of service against service level benchmarks (SLBs)
	SLBs or performance indicators	Indicators for customer service, maintenance, IT systems performance, bicycle redistribution, and usage (see the case study text)
Policy and legal framework	Financing and implementing agencies	World Bank, Mysuru City Corporation, Directorate of Urban Land Transport
	Monitoring setup	Project Monitoring Committee under state government, chaired by Mysuru district's Deputy Commissioner and including representatives from the city police, Directorate of Urban Land Transport, and Urban Development Authority
	Operator	Green Wheels, India; technical support provided by Tosinta, China
Linkage with other citywide transport initiatives and plans	Comprehensive Traffic and Transportation Plan	The implementation of nonmotorized transport infrastructure, including a citywide PBS system, is included in Mysuru's Comprehensive Traffic and Transportation Plan

Notes: CapX = capital expenditure; GPS = global positioning system; IT = information technology; OpX = operational expenditure; PBS = public bicycle sharing.
a. Only in Mysuru was a local manufacturer used. In the case of Bhopal, all the bicycle parts were imported, and the bicycles were then assembled in India. For Pune's system as well, the bicycles were imported. See Figures 3 and 4, respectively, for the redistribution vehicle and docking station designs.

Sources: Authors, based on Bhattacharya 2017; DULT 2017; Mysuru City Corporation 2015; and consultations held in 2017 with experts from Trin Trin and Mysuru City Corporation.

Approach

Mysuru is the second-largest city and the cultural capital of the state of Karnataka in South India. A historical city with numerous palaces and ancient monuments, it relies on tourism as a mainstay of the economy. However, like many rapidly growing population centers, Mysuru faces traffic and transportation challenges, including in the city's heritage core, which is located fairly close to the central business district. High-density motorized traffic in the area undercuts the aesthetics of the heritage sites and reduces their marketability to tourists while increasing air and noise pollution (DULT and Deloitte 2012). To tackle these issues, the city authorities sought a low-cost and environmentally friendly mobility option, and decided on a PBS transit program designed to reach both city residents and visitors. The focus is on the central city area (including the tourist attractions) which has dense PBS coverage, whereas availability in the other areas of the city is relatively sparse (see Figure 1). The PBS system helps Mysuru achieve its mobility goals, including reduced traffic hazards and a pollution-free transport solution that makes journeys within the city easier and more convenient, public health benefits, and increased environmental aware-

ness (S. Tiwari 2017). In 2012, the Mysuru City Corporation (MCC) had constructed a 4-km bicycle track close to prominent heritage attraction points and the area with dense PBS coverage. After the launch of PBS, MCC and the Directorate of Urban Land Transport (DULT) identified road stretches within the central area to develop bicycle lanes.

The city authorities hope to shift public attitudes and over time foster a resilient community of residents who are proud to pedal bikes (Trin Trin n.d.).

Initial challenges

As the first large-scale bicycle-sharing system in India, Mysuru's Trin Trin project had to break new ground in almost every area. Each stage of implementation required detailed planning, including placement of the docking stations, software and connectivity for data transfer, smart cards, manpower recruitment, training and pilot testing, and marketing. Moreover, there were no funding and business case examples within India that the city authorities could follow.

Figure 1 | **Docking Station Locations in Mysuru**
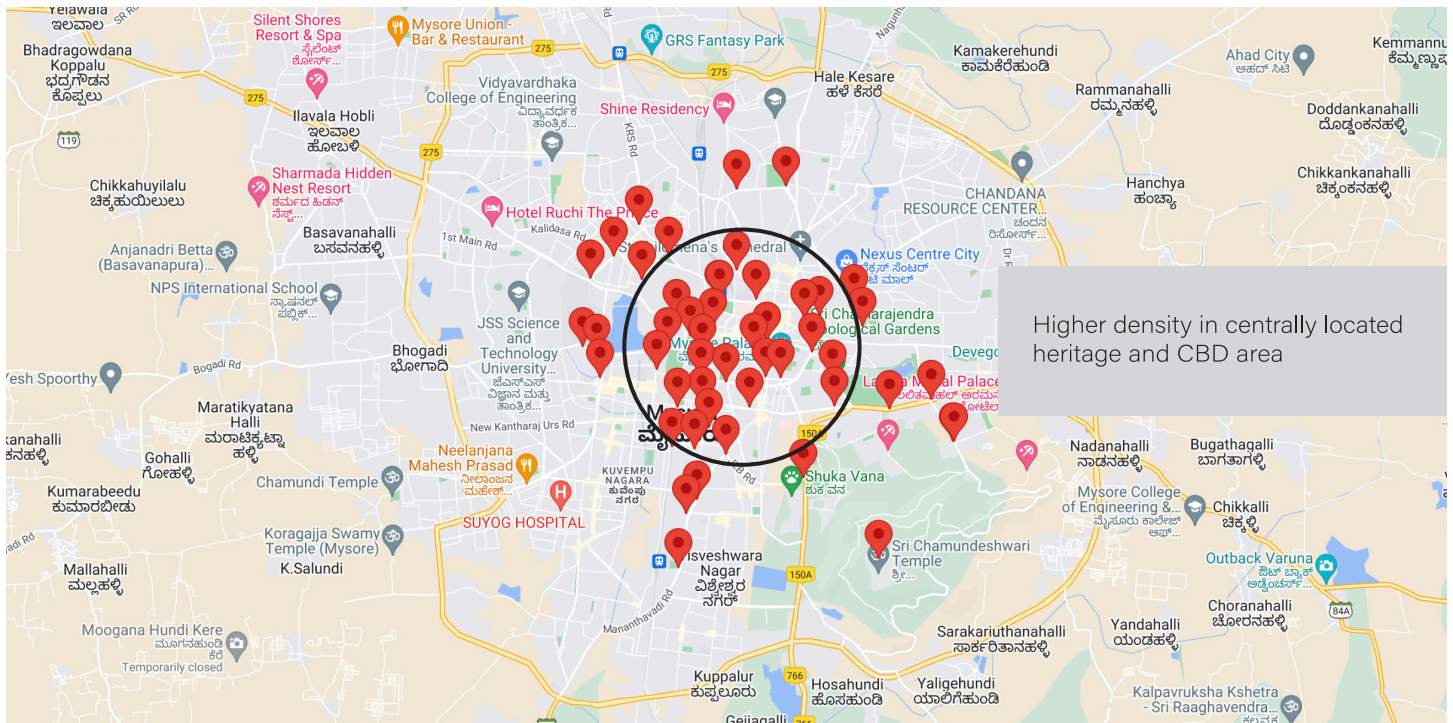
Note: CBD = central business district.

Source: Trin Trin n.d.

In 2012, MCC made its first attempt to implement a bicycle-sharing system, based on a PPP model. However, the tender floated by it failed to generate competitive bidding from operators. This was largely due to awareness of the fate of the previous PBS systems, the absence of a robust business and financial model, and lack of support from the government in shouldering risks and responsibilities to make PBS a success. In its subsequent efforts to get a PBS system off the ground, the city authorities therefore had the challenge of identifying alternative funding sources not only to launch the project but also to generate revenue streams over the long run. In addition, MCC needed to devise a business model that would minimize the burden on the operator, to incentivize a transport provider to get on board. A business model that aligned the operator's motives with the interests and goals of the city authorities was essential to avoid moral hazard, in which the financial outcomes for the operator are not strictly tied to the quality and performance of the bike share system (Delhi's pilot PBS system failed in part because the operator's entire revenue stream came from docking station advertisements, which inevitably led to poor service).

In addition, Mysuru's decision-makers had to factor in the potential impact of the Indian urban context on the utility and performance of bicycle share systems. These factors included, for example, lack of familiarity of the public with using and adapting to bicycle-sharing systems, a predominantly cash-based economy, and the wide range of socioeconomic backgrounds of potential system users. As a result, the authorities had to closely evaluate the city's social and economic landscape and adapt PBS system features accordingly to ensure maximum inclusivity and access (Menon 2015).

Policy and legal framework

Karnataka's Urban Development Department, whose mandate includes planning, designing, and facilitating implementation of sustainable mobility solutions in the state's urban centers, has supported a revival of cycling culture for the past few years. Its DULT, established in 2007, is the state-level monitoring agency for implementing Mysuru's Trin Trin system, in collaboration with the MCC, the city-level monitoring and implementing agency (Trin Trin n.d.). DULT considered a PBS system in Mysuru a feasible proposition as the city is small compared to Bengaluru, the state capital, and its traffic challenges are more manageable. Mysuru's status as a heritage city, and its well-developed cycling culture—bicycles accounted for 10 percent of trips in 2012 (DULT and Deloitte 2012)—also played a role in DULT's decision to plan for a PBS system there (Bhattacharya 2017). In 2012, DULT commissioned a feasibility study on the financial sustainability of a PBS system in Mysuru that paved the way for the Trin Trin scheme.

At the city planning level, the concept worked well with Mysuru's Comprehensive Traffic and Transportation Plan, which focuses on improving the uptake of NMT modes. Moreover, 45 percent of work trips and 42 percent of educational trips within the city cover less than 5 km, presenting enormous potential to convert these car journeys into bicycle trips (MoUD, Government of India 2011).
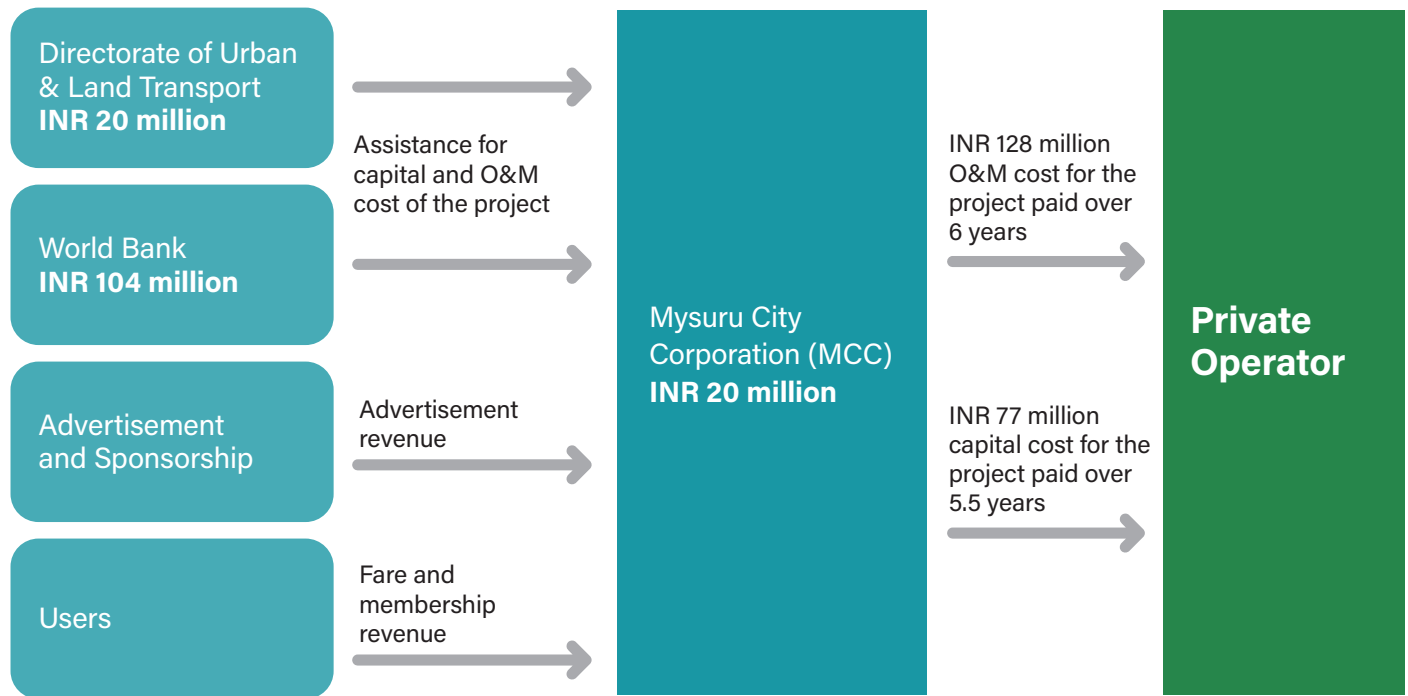
Business and financial model

The DULT-commissioned feasibility study on establishing a PBS system in Mysuru concluded that the city could not sustain a PBS system with revenues generated solely from user charges or from docking station advertisements and that state funding would be needed to meet capital, operational, and maintenance expenditures. Also, the city authorities did not wish to depend entirely on a private operator for funding the project, as past experiments (Mumbai, Delhi, Thane, and Bangalore) had not proved successful. Therefore, the Karnataka government sought a grant from the Global Environmental Fund (GEF) under a Government of India sustainable urban transport program, assisted by the World Bank.

Available GEF funding covered only INR 104 million of the total INR 205 million project cost over 5.5 years, so the city authorities adopted an innovative funding mechanism to bridge the gap. MCC contributed INR 20 million to meet operation and maintenance (O&M) costs and negotiated with DULT to earmark INR 30 million toward capital and operating costs from its State Urban Transport fund. This combined funding from the three agencies (summarized in Figure 2) enabled the city authorities to establish a diverse and viable financing model and attract operators for the Trin Trin PBS program (Bhattacharya 2017).

After obtaining planning approvals, MCC and DULT issued tenders in 2015, and Green Wheel Ride, a Mysuru-based firm, was selected through competitive bidding based on their technical and financial expertise. The bids were evaluated on the basis of organizational strength, technical experience of PBS operations, and the cost of capital, operational, and maintenance expenditure over the 5.5-year contract period (Mysuru City Corporation 2015). The work order was issued in January 2016, and the system became operational in 2017.

The five-year journey by the Mysuru and Karnataka implementing agencies to plan, organize, and implement a sustainable, city-specific PBS system has paid off. Mysuru became India's first city to opt for competitive bidding and successfully launch PBS in India.

Figure 2 | **Business and Financial Model for Mysuru PBS System**

Directorate of Urban & Land Transport INR 20 million

World Bank INR 104 million

Assistance for capital and O&M cost of the project

Advertisement and Sponsorship

Advertisement revenue

Users

Fare and membership revenue

Mysuru City Corporation (MCC) INR 20 million

INR 128 million O&M cost for the project paid over 6 years

INR 77 million capital cost for the project paid over 5.5 years

Private Operator

Notes: PBS = public bicycle sharing. The monetary unit is INR.

Source: Authors, based on case study research and consultations held in 2016–17 with experts from Trin Trin and the Mysuru City Corporation (MCC).

Under the tender, DULT and MCC reimburse Green Wheel Ride for capital costs, pay for operational costs based on service level benchmarks (SLBs) (see Table 2), and collect all the user revenue. This allows the public authorities to regulate the system and hold the operator accountable for maintaining good-quality service. Green Wheel Ride is eligible for incentives for meeting and exceeding the service level standards established by the implementing agencies and faces penalties if it fails to meet acceptable service level standards. The incentives and penalties are linked with the revenue and operation and maintenance (O&M) costs for the particular quarter. Quarterly incentives vary from 10–30 percent of the average rental revenue received, and penalties range from a 5 percent to 15 percent deduction of the O&M costs for that quarter. The operator is also liable for disputes and accidents.

Implementation mechanism

As described earlier, the implementing and monitoring authorities for the Mysuru PBS system are Karnataka's DULT and MCC. The World Bank has provided partial funding for the project. Green Wheel Ride, the private operator selected through competitive bidding, is responsible for procuring, installing, operating, and maintaining the system. MCC has full control over setting fares as the agency receives all the revenue earnings.

The Trin Trin bicycling operations are controlled through a centralized command and control center, with the operator deploying 49 personnel to manage the system. Through IT systems integration, Green Wheel Ride monitors capacities across the PBS stations and redistributes bicycles accordingly to meet the demand. It uses six redistribution vehicles for this purpose.

The state government has also set up a Project Monitoring Committee to periodically monitor Trin Trin's operations, chaired by the Deputy Commissioner of Mysuru District with representatives from MCC, DULT, and the city's police department and Urban Development Authority. MCC has set SLBs (see Table 2) to ensure service quality. Penalties and incentives for the operator are based on these benchmarks, as described above.

Table 2 | SLBs and indicators for Mysuru PBS system

INDICATOR		ACCEPTANCE LEVEL
Customer service	No. of valid customer complaints (received via website)	10 per month
	Percentage of time website is online/working per month	95%
Maintenance	Minimum percentage of total cycle fleet available at 6 AM	95%
	Stations are neither full nor empty for a period longer than two hours	95%
	Bicycle station cleaning	Every three days
	Percentage of cycles repaired within 4 hours of being flagged for repair by a customer	95%
Information system	Smart card performance at the dock (taking out a cycle from docking station)	99% transaction executed in less than one second
	Smart card performance at kiosks	99% of transactions executed in less than four seconds.
	Payment processing (for recharge when debit/ credit card is used)	99% transaction processed on the same day
	Transaction failure at kiosks (debit/credit card gets charged, but money not put on smart card)	Maximum 1% transaction failure is acceptable
Redistribution	Percentage of time that major docking stations are empty during peak hours (8 AM–11 AM & 4 PM–7 PM)	5%
	Percentage of time that major docking stations are empty during off-peak hours	3%
	Percentage of time that minor docking stations are empty during peak hours (8 AM–11 AM & 4 PM–7 PM)	20%
	Percentage of time minor docking stations are empty during off-peak hours	8%
Cycle usage	Average cycle use per cycle/day	3 trips a day in the 1st and 2nd years of operation 4 trips a day from the 3rd year of operation

Notes: PBS = public bicycle sharing; SLBs = service level benchmarks.
Source: Mysuru City Corporation 2015.

Figure 3 | Redistribution vehicle for Mysuru PBS

Source: Directorate of Urban Land Transport (DULT).

Project impact and usability

Mysuru's Trin Trin program garnered a lot of interest as India's first citywide/large-scale PBS system. Its larger scale compared to the previous systems enabled wide public reach, and nearly 5,000 people registered in the first two months after the June 2017 launch. Both MCC and Green Wheel Ride organized Cyclothons and cycle awareness days to promote the system, which was widely welcomed and utilized by both citizens and tourists.

A user survey conducted by DULT in late October 2017 identified 20–30-year-olds as the main converts to PBS, with 34 percent usage, followed by 30–40-year-olds, with 27 percent usage. People aged 40–50 years accounted for 19 percent, and

Figure 4 | **Docking station in Mysuru**

Source: The Green Wheel Ride

those over 50 years made up 9 percent. The usage by the youngest usage group—that is, those below 20 years old—was 11 percent. Almost six in ten journeys—58 percent—were for up to one hour. Work and educational trips accounted for 60 percent of usage, with 25 percent using the PBS for last-mile connectivity to mass transit systems. Among the different usage groups, employees were the predominant user type (35percent), followed by students (30percent). In terms of income groups, people with earnings of less than INR 10,000 per month were the predominant users (61percent). Only 4 percent of the users belonged to the income group with earnings exceeding INR 50,000 per month (DULT 2017). By early 2019, average rides per day had risen to 1,000, with 2.2 rides taken per bicycle.

Based on this initial success, MCC conducted a survey in early 2019 to identify additional docking stations in residential areas and near educational institutes. The agency also received requests from many private companies and organizations to set up bike rental stations in their localities. In addition, the government is working to develop safer cycling infrastructure. The city already has a 4-km bicycle track, but since Trin Trin's launch, DULT, along with MCC, has identified 28.8 km of potential dedicated bicycle tracks in the areas served by the docking stations. DULT prepared a detailed project report (DPR) and forwarded it to MCC for implementation in 2017. The DPR states that an additional INR 26 crores of funds is required for implementation of the project. However, no progress has been made in this regard. A meeting was conducted by MCC in August 2018 to reassess the usability of the proposed infrastructure, but no work has been done on the ground (Milton 2018).

Challenges going forward

Soon after moving into the second year of the operation, the system started facing several challenges ranging from the deteriorating condition of the cycles to theft and vandalism, all of which contributed to decreasing ridership. The city authorities have since then been looking at ways to revive the system and increase the ridership figures.

CASE STUDY 2: BHOPAL

Table 3 | **At a glance: CharteredBike dock-based PBS system**

TYPE OF INFORMATION		
City information	City name	Bhopal
	Population (2011)	1.8 million
	Area (sq. km, 2011)	285.9
Mode share (2012)	Two-wheelers	25%
	Private cars	3%
	Public transport	23%
	Walking	44%
	Cycling	4%
	Intermediate public transport	1%
	Average trip length	7.45 km
PBS information	System name	CharteredBike
	Launch date	June 25, 2017
	No. of operational bicycles	500 bicycles across 50 docking stations
	Hours of operation	6 AM–10 PM (16 hours)
	Fare structure	For members, the first 30 minutes is free, and the minimum fare is INR 5 for 30–60 min. For 60–90 min the fare is INR 20, and after 90 min, INR 15 will be charged for each additional 30 min. Users register as members through the CharteredBike smartphone app or at registration centers by paying a refundable INR 500 security deposit and processing fees of INR 50. Payments can be made by cash or credit/debit cards, in person or through the app.
	Coverage	20 sq. km, with a focus on improving last-mile connectivity and serving and enhancing the Bus Rapid Transit System (BRTS) catchment area
	Subscribers	Over 65,000 (pre-COVID)
	Average no. of rides/bicycle/day	1.0 (2021)
Technical information	System type	Fully automated—fourth-generation bicycle-sharing system
	Technology/PBS type	Dock-based system—smart bicycles with GPS tracking device used via smartphone app or smart card
	Bicycle type	Geared bicycles with 3-speed gears
	Docking station type	Modular docking station of two sizes: 8 pickup/drop-off points of 18 ft × 10 ft. and 20 docking points of 30 ft × 10 ft. The stations do not have kiosks. Instead, the bikes are equipped with all the necessary technology. User information, including account balance, membership expiration date, and bicycle checkout status, can be checked on the smartphone app.
	Bicycle specifications	All parts are imported from China and Germany, and the bicycles are assembled in Ahmedabad and Bhopal. Features: GPS, GPRS wireless communication, on-board computer with NFC (near-field communication) smart card reader, universal design, unique parts, parking functionality, step-through frame, adjustable seat, integrated lock, and front basket.
	Intelligent technology system integration	Smart card, GPS and GPRS, control and command center; website and smartphone apps

Table 3 | At a Glance: CharteredBike Dock-Based PBS System (contd'd)

TYPE OF INFORMATION		
Financial information and funding responsibilities	CapX investment with time period	INR 29.5 million for 7 years (initially for 5 years, with 2 additional years depending on satisfactory operator service)
	OpX costs	INR 0.67 million per month (out of this, up to 40% is reimbursed to the operator by the city agency, subject to SLBs; the rest is borne by the operator)
	Public sector funding and responsibilities	The project is partially funded by the public agency: INR 29.5 million has been paid by the city agency against the CapX, with additional costs borne by the service provider. The public sector is responsible for provision of land and legal and institutional support required by the operator.
	Private sector funding and responsibilities	The operator is responsible for the development, design, procurement, installation, operation, and maintenance of the bicycle-sharing system for six years
	Contract conditions	Apart from providing capital investment support, the public sector reimburses up to 40% of the program's operating costs to the operator if the agreed SLBs have been met
		All revenue generated by the system goes to the service provider to support operating and maintenance costs
	SLBs or performance indicators	Indicators cover bicycle availability and distribution, maintenance, registration, public usage, and awareness
Policy and legal framework	Implementing & monitoring agency	Bhopal Smart City Development Corporation Limited (BSCDCL)
	Operator	CharteredBike, which is a consortium of Chartered Speed (India) and Nextbike (Germany)
Linkage with other citywide transport initiatives and plans	Bus Rapid Transit System (BRTS)	The project was designed to improve last mile connectivity and serve and enhance the catchment area of Bhopal's BRTS

Notes: CapX = capital expenditure; GPS = global positioning system; GPRS = General Packet Radio Service; OpX = operational expenditure; PBS = public bicycle sharing; SLBs = service level benchmarks. See Figures 7 and 8, respectively, for the redistribution vehicle and docking station designs.
Sources: Authors, based on Bhopal Municipal Corporation 2012; Shukla 2017; Bhopal Municipal Corporation 2015; interviews with CharteredBike and BSCDCL in 2017.

Approach

Bhopal is the state capital of Madhya Pradesh in central India. In recent years, the city's fast-growing vehicle population led to a steep rise in road traffic and high levels of noise and air pollution. The rise in vehicle use also converted many public transport trips into private transport ones, a trend exacerbated by Bhopal's low levels of bicycle ridership and the lack of safe cycling infrastructure (J.Dubey and R.Dubey 2017).

To tackle these problems and make the city more accessible for residents, the city authorities developed a blueprint to revive the culture of walking, cycling, and public transport. Investing in a PBS system and dedicated bicycle lanes was seen as a key solution to pollution, congestion, and road safety, which were the concerns highlighted in the blueprint.

The city's goals for the program included carbon footprint reduction, last-mile connectivity, and improved access to the existing Bus Rapid Transit System (BRTS), and converting walking trips into faster travel by bicycle. After trial runs in early 2017 at prominent locations, the city authorities and the operator launched the PBS system in June 2017 with 500 bicycles and 50 docking stations (see Figure 5 for docking station locations).

Initial challenges

The first challenge Bhopal faced was its financial inability to provide the initial capital to cover the proposed public PBS scheme's start-up and development costs. Unlike Mysuru, where the PBS project's financing and scope entirely depended on public-sector-generated funding, the city agencies in Bhopal needed to develop alternative business and financial models. Their response to this challenge was to look for ways to tap into sustainable sources of private sector investment. As happened in Mysuru, Bhopal's first attempt at floating a PBS tender failed. Three city agencies subsequently invested significant time and effort in devising a conducive environment that incentivized bicycle service operators to bid for the program and reduce the risk.

Figure 5 | **Bhopal's PBS station locations**
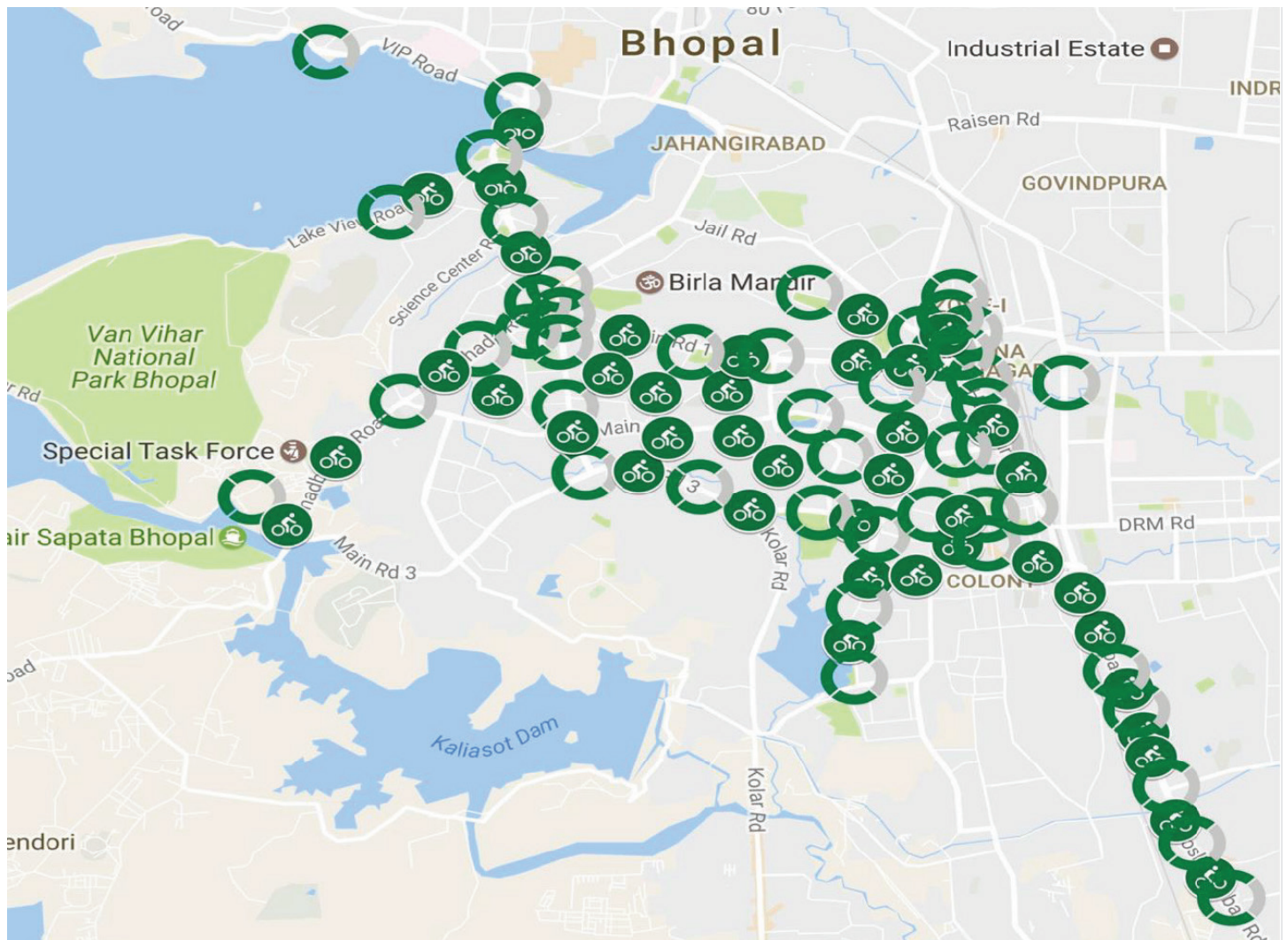
Source: The Green Wheel Ride.

Bhopal was the first Indian city to attempt to diversify funding sources by enlisting private sector participation through sponsorship and strategic partnerships. The resulting business and financial model paved the way for PPPs for PBS systems with shared financial responsibilities.

A second major challenge for the city was to build public awareness and acceptance of bicycling as an efficient and environment-friendly mode of transport. According to the City Mobility Plan for Bhopal, 2012, bicycling had fallen to 3 percent of journeys taken in the city and was limited to users who could not afford or access other transport options: the captive users.

Policy and legal framework

Three public agencies, Bhopal Smart City Development Corporation Limited (BSCDCL), Bhopal Municipal Corporation (BMC), and the Urban Development and Administration Department, have long advocated for improved mobility solutions for the city that address concerns over last-mile connectivity. In 2012, they jointly commissioned an in-depth study on a PBS scheme, and in 2014 launched Raahgiri Day[5] (Car Free Sunday) to generate public interest in cycling. After the first PBS tender, issued in 2014, failed to generate interest from operators, the agencies adopted a more comprehensive and rigorous approach to PBS system planning and design, business model development, and tender documentation.

As part of this process, WRI India, BMC, and BSCDCL held workshops with technology suppliers and financing institutions to shape a business and financial model beneficial to both the public agencies and private operators. This helped build confidence and a conducive bidding environment among potential operators—a concept that was missing in the previous attempts. In July 2015, a tender to implement a PBS system under a PPP model (see Figure 6) received multiple high-quality bids. CharteredBike—a consortium of Chartered Speed (India) and nextbike (Germany)—submitted the highest technical and lowest cost quote and was selected as the operator.

In 2016, Bhopal's Urban Development and Administration Department incorporated a PBS into the development plan for the city. This envisaged 50 bicycle stations with 500 bicycles along the city's wide-ranging BRT corridor, offering a low-cost, eco-friendly option to commuters and other transit users. Work on the ground began in September 2016, and CharteredBike began operating in June 2017.

In parallel, BSCDCL financed the construction of 12 km of dedicated bicycle tracks to provide safe infrastructure and encourage use of the shared bicycle program. The bicycle track was also opened to the public in June 2017.

Business and financial model

The Government of India promotes PPPs that spur private sector investments in new infrastructure, enabling efficient O&M of assets and ensuring a focus on service delivery. Therefore, PPPs were the preferred model for implementing PBS systems in India. Cities worldwide, including Paris, Barcelona, Munich, Berlin, and Frankfurt, also use this model, partnering with large advertising companies such as Cemusa (Spain), Citibank, Nike, and Blue Cross Healthcare & Clear Channel (United States), and JCDecaux (France) on PBS schemes.

Figure 6 | **Financial model for Bhopal's PBS system**
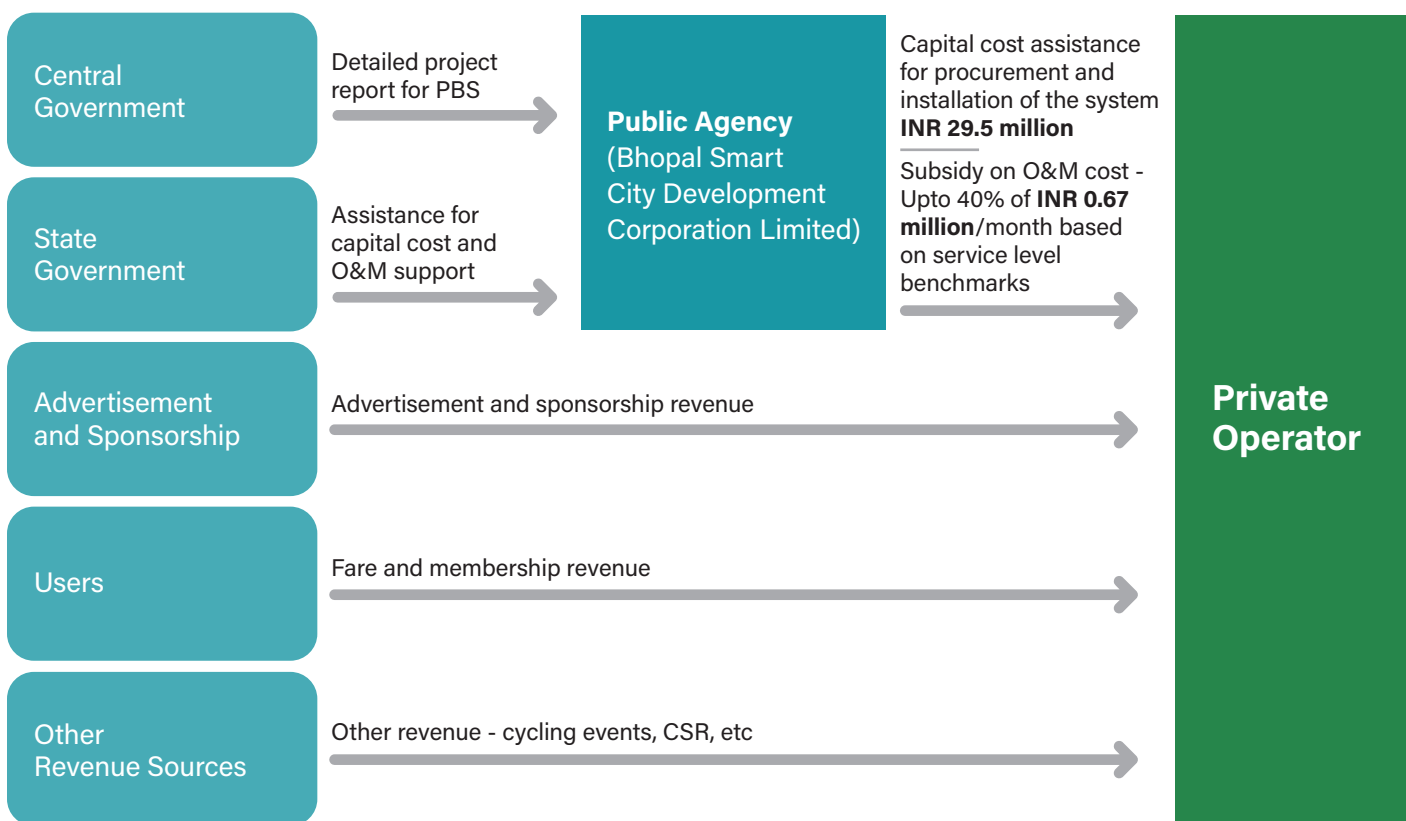
Notes: CSR = corporate social responsibility; O&M = operations & maintenance; PBS = public bicycle sharing.
Source: Authors.

Based on this experience, Bhopal too adopted a PPP approach, while taking steps to avoid the hurdles encountered by other Indian cities. To this end, city authorities worked closely with field experts, researchers, and bicycle manufacturers and operators for close to two years to develop a unique business model. The result was a PPP scheme that does not pass on costs to riders and allows for financial burden sharing based on system performance.

A fully automated system, Bhopal's PBS is implemented under a build-operate-transfer concession model that makes both the city authorities and the private operator accountable for O&M. This is achieved by linking the part of the payment of O&M costs to SLBs and related incentives and by dividing funding for the system's installation and O&M between the public and private partners. Chartered Speed of India and nextbike of Germany formed a new consortium—CharteredBike—to bid for the project.

Through BSCDCL, the government contributed a fixed amount of INR 29.5 million in capital costs. The government, through BSCDCL, also provides 40 percent of the operating costs for 500 bicycles to CharteredBike over the seven-year contract period. Based on the operator's bid, this contribution is billed quarterly, depending on the provider's performance against SLBs set by the BMC. The contract requires the operator to raise the remaining 60 percent of O&M costs from membership, rental income, advertisement revenue, sponsorship contracts, parking fees, and corporate social responsibility funding. All revenue generated by the system goes to the operator (see Figure 6 for details). In case returns on revenue are zero, the operator has quoted a viability gap funding of INR 10 per cycle per day to be paid by BSCDCL.

Learning from the negative experiences of other Indian cities, Bhopal's public agencies introduced checks on the revenue streams to deter the operator from diverting the focus from O&M. These checks take the form of limiting the amount of advertising space that can be rented out at cycle stations. Systemwide sponsorships are available, allowing naming rights on bicycles and stations, but no sponsor has yet been identified.

The unique business and financial model developed in Bhopal resulted in the cheapest life-cycle bicycle cost and highest quality, one of the first fully automated PBS systems introduced in India. In addition, the operator is liable for disputes and accidents.

Implementation Mechanism

BSCDCL was established under the Indian Companies Act with the sole responsibility of implementing the local government's Smart City program, which includes the PBS system. Jointly owned by the Madhya Pradesh Urban Development Company and BMC, BSCDCL's responsibilities include monitoring and oversight of the CharteredBike program. The private operator is responsible for procuring, installing, operating, and maintaining the system.

CharteredBike runs its operations through a centralized command and control center. All bicycles are equipped with an on-board computer and GPS and General Packet Radio Service (GPRS) connectivity, reducing personnel needs. The integrated IT system enables the operator to redistribute bicycles among stations based on capacity, using two dedicated redistribution vehicles (see Figure 7 for the redistribution vehicle design).

SLBs set by BMC and BSCDCL to ensure the quality of the service are shown in Table 4. These are tied to reimbursing operating costs, holding the service provider accountable and keeping them incentivized to abide by them, and keeping users satisfied.

Figure 7 | **Bicycle distribution vehicle for Bhopal PBS**

Note: PBS = public bicycle sharing.
Source: Bhopal Smart City Development Corporation Limited.

Table 4 | SLBs for Bhopal bicycle-sharing scheme

INDICATOR		ACCEPTANCE LEVEL
Bicycle distribution	High-priority stations: empty, peak hours	Less than 5% of total operation time
	High-priority stations: empty, non-peak hours	Less than 10% of total operation time
	Low-priority stations: empty, peak hours	Less than 15% of total operation time
	Low-priority stations: empty, non-peak hours	Less than 20% of total operation time
Availability	Bicycle availability	95% or more of total authorized fleet size
	Service availability	100% of the agreed-upon hours of operation (unless the implementing agency permits alternative availability)
Registration	Registration of members	90% of all valid applications to be processed within 1 day of receipt of application
	Registration of nonmembers, renewal of membership or smart card top-up	90% of all applications to be processed within half an hour
Maintenance	Availability of website and smartphone app	Website and smartphone app to be available at least 90% of the time every month
	Maintenance schedule	Predetermined schedule to be followed more than 90% of the time
Usage	Ridership level	Average system ridership should be more than 4/cycle/day
	Memberships	750 members or more
Awareness	Trial users	More than 500 unique users a month and more than 10 trial sessions a month with different groups

Note: SLBs = service level benchmarks.
Source: Bhopal Municipal Corporation 2015.

Project impact and usability

Bhopal's efforts to create a bicycling culture and develop a workable PBS system produced a strongly positive response from citizens, leading to a successful launch. In the Chartered-Bike program's first two months of operation, 17,255 people registered as members, averaging 1 customer every five minutes, and around 125 customers used bicycles daily (CEO BSCDCL 2017). The PBS system also calculates a carbon emissions offset from the project. According to the methodology adopted by the operator in calculating the carbon emissions offset, from June through August 2017, the program saved an estimated 5,325 kilograms (kg) of CO_2 emissions (Manager CharteredBike 2017).[6]

The system maintained an average ridership of 2.35 rides per bicycle per day for the first year of operation. Riders aged 20–30 are the most common users, and recreational and educational trips make up most of the journeys. The educational trips are primarily taken by students using bicycles to connect to BRTS stations en route to educational institutes. Recreational trips are higher on Sundays, the day the city authorities organize weekly car-free days. Most users in Bhopal are students, followed by recreational users. It is important to note here that due to high membership costs, the system has not found much usage among the lower-income groups (J.Dubey and R.Dubey 2017), but in terms of expenditure, the system still costs the city significantly less than other comparable systems, despite the imported bicycles.[7] As high-end bicycles are used, initially there were concerns regarding theft and vandalism and the upkeep of the fleet. However, there have not been any thefts or major vandalism during the period of operation. This has motivated both the operator and the city agencies to plan for the expansion of the system to more areas.

Figure 8 | **Docking station of Bhopal PBS**

Note: PBS = public bicycle sharing.
Source: Bhopal Smart City Development Corporation Limited.

In 2019, the city began adding new docking stations to satisfy the demand. The initial 50 stations (see Figure 8 for the docking station design) focused on the city center's prime locations and the BRTS catchment area. New docking stations are being introduced in residential areas at the request of citizens and neighborhood organizations. After increasing the number of docking stations to 95 (as of 2021), BSCDCL is undertaking a second-round survey to identify potential additional locations. The walking distance to reach a docking station, which initially was about a kilometer (J.Dubey and R.Dubey 2017) in certain areas, has been reduced by half by increasing the number of docking stations.

Bhopal, too, faced questions about the provision of cycling infrastructure and about the city's intent in keeping the efforts and funds flowing for it (J.Dubey and R.Dubey 2017). One of the major criticisms the city authorities faced was the allocation of space for cycles on the already congested roads. The decision of the city authorities to dedicate substantial road space to cycles instead of widening roads was considered inappropriate in terms of both costs and the city authorities' intent to address traffic problems (J.Dubey and R.Dubey 2017). It is important to note

that the very stretch of road where the 5-meter-wide bicycle track was constructed has in the past experienced the negative impacts of road widening to address congestion. Before the construction of the bicycle track, the authorities had widened the road many times, but there was no respite from the congestion, and the traffic situation deteriorated over time, proving that as roads become wider, more people start driving. The construction of the bicycle track, on the other hand, has not only allowed the residents in nearby areas to use safe cycling infrastructure on an otherwise unsafe stretch, but it has also been inexpensive for the city authorities to implement compared with a similar extent of road widening.

After the construction of the 12-km dedicated bicycle track, to further advance bicycling culture, BSCDCL has simultaneously begun extending the city's 12 km of 5-meter-wide dedicated bicycle track by adding bicycle tracks to the major roads in the smart city development area, work on which is under way. Another 55-km bicycle network plan is under consideration for funding. The city authorities have also initiated work on the construction of a smart road with junction improvements, tactical urbanism, and street design enhancement, to further improve cyclists' safety.

In September 2017, Bhopal conducted a national workshop on PBS systems to share its experience and lessons learned in implementing India's first fully automated PBS system with representatives from more than 35 smart cities, private operators, and transportation experts. Many cities expressed interest in Bhopal's model of implementation, combining private sector innovation and accountability with public sector commitment.

Challenges going forward

Ridership for Bhopal's PBS system declined soon after the second year of its operation. Unlike Mysuru, Bhopal did not face challenges with cycle quality, theft, and vandalism. The primary goal of PBS in Bhopal has been to encourage its usage for commuting. However, usage in Bhopal is now more for recreation than for commuting. This is evident as ridership is higher on weekends, and there are more trips with the same origin and destination. These trips are confined to recreational spots and areas around the 12-km dedicated cycle track (Figure 9 shows the dedicated bicycle track). Residential colonies and educational institutes have expressed interest in housing PBS stations within their campuses for health and recreational purposes, but the usage of PBS for commuting has decreased.

One of the major reasons for this decrease is the lack of safe cycling infrastructure in the city (J.Dubey and R.Dubey 2017). The private operator and city authorities have been working toward this by constructing cycle tracks in the city.

Figure 9 | **Dedicated bicycle track in Bhopal**

Source: Bhopal Smart City Development Corporation Limited.

CASE STUDY 3: PUNE

Table 5 | **At a glance: Pune's dockless PBS system**

TYPE OF INFORMATION		
City information	City name	Pune
	Population (2011)	3.12 million
	Area (sq. km, 2011)	331.3
Mode share (2016)	Two-wheelers	29%
	Private cars	6%
	Public transport	11%
	Walking	47%
	Cycling	3%
	Intermediate public transport	8%
	Average trip length	6.4 km
PBS information	System name	Pune Public Bicycle Sharing System
	Launch date	December 2017
	No. of operational bicycles	Close to 2,500; deployed by 4 operators
	Hours of operation	6 AM–10 PM (16 hours)
	Fare structure	The 4 operators charge different fares. The minimum charge for the first 6 months after launch was INR 2 for 30 minutes. The minimum charge later rose to INR 6 for 30 minutes.
	Coverage	Entire city, through 800 parking locations (see Figure 10 for parking locations in Pune)
	Subscribers	Over 350,000 (pre-COVID)
	Average no. of rides/bicycle/day	1.2 (2021)
Technical information	System type	Fully automated
	Technology/PBS type	Dockless system
	Bicycle type	Smart bikes with in-built locking and unlocking mechanism
	Bicycle specifications	Fourth-generation smart bicycles with on-board computer equipped with NFC card reader, universal design, unique parts, parking functionality, step-through frame, adjustable seat, and integrated lock.
	Intelligent technology system integration	Smart card, website, and smartphone apps.

Table 5 | **At a Glance: Pune's Dock-Less PBS System (contd'd)**

TYPE OF INFORMATION		
Financial information and funding responsibilities	CapX investment with time period	Information on investments not available, as the investment details are the proprietary information of the operators
	OpX costs	
	Public sector responsibilities	The public sector is responsible for: • Designating parking spaces • Installing information display boards • Assisting operators in case of theft • Integrating payment systems with other public transport modes • Making periodic policy revisions as needed • Promoting the system via social media
	Private sector responsibilities	• Private operators bear all the costs associated with procurement, deployment, maintenance, technology, operations, and related human resources. In addition, they are responsible for: - Enforcing strict parking regulations and removing incorrectly parked bikes - Maintaining a comprehensive grievance redress system - Keeping permits and licenses valid at all times - Educating users on riding etiquette and correct parking practices
	Contract conditions	
	Service level benchmarks (SLBs) or performance indicators	SLBs are not defined in the MoU's. However, operators must provide the following information to the city's implementing agencies each month: • No. of operational cycles • No. of trips recorded • No. of subscribers to the system • No. and location of cycles stolen or vandalized • Any other information required to plan for cycling infrastructure and ensure good-quality service to the public
Policy and legal framework	Implementing & monitoring agency	Pune Municipal Corporation (PMC) and Pune Smart City Development Corporation Limited (PSCDCL)
	Operators[a]	PEDL, Yulu, Mobycy, Mobike, Ofo
Linkage with other citywide transport initiatives and plans	Cycle plan	Pune has developed a "Pune Cycle Plan" to improve and promote nonmotorized transport (NMT) services. This includes the development of a shared cycling scheme and details on integrating PBS and other NMT services along BRTS corridors.

Notes: CapX = capital expenditure; MoU's = memoranda of understanding; OpX = operational expenditure; PBS = public bicycle sharing.

a. As of December 2019, YULU is operating in Pune with a fleet of around 2,000 bicycles.

Source: Authors' compilation based on PMC 2017a, 2017b, 2017c, n.d.; and consultations held in 2017–18 with experts from PSCDCL and private operators.

Approach

Pune is the seventh largest city in India, and the second largest in the state of Maharashtra after Mumbai. It was known as a city of cyclists until the 1980s when motorized vehicle use soared along with cyclist fatalities on roads. Safe and sustainable facilities for walking, cycling, and public transport have not kept pace with the city's growth, resulting in transportation becoming a major civic issue for residents and the local government. To address the adverse health impacts from polluted air and traffic accidents, and the time lost due to traffic congestion (PMC 2017a, 2017b, 2017c), Pune Municipal Corporation

(PMC) developed a series of mobility plans from 2008 to 2017 to make walking and cycling safe, comfortable, convenient, and connected. This approach culminated in the first launch of a dockless PBS system by an Indian city, in December 2017. The dockless technology limited the need for parking station infrastructure and enabled the swift rollout of a citywide system by private operators who signed memoranda of understanding (MoUs) with PMC. The operators are responsible for managing the system, which had close to 2,500 bikes and more than 350,000 users as of March 2018. PMC provides oversight and various types of support for the program (see Table 5). A recently published paper (GIZ 2021) has quoted 1.2 trips per cycle per day.

Initial challenges

The main challenge facing the city authorities was the declining public trust and confidence in cycling as a safe and efficient way to travel. Cycling fell from 50 percent of the city's traffic flow in 1981, to about 9 percent in 2012, and to about 3 percent in 2016 (PMC 2017c), due to rising accident rates and inadequate bicycle infrastructure. Pune was one of the few cities in India with existing bicycle tracks, having constructed more than 100 km of dedicated lanes across the city, including the BRT corridor, over the past decade. However, encroachment, bumpy surfaces, and mismanagement had rendered these largely unusable. Enforcement of traffic discipline was also a huge challenge, with 98 percent of road users viewing motorists' behavior toward cyclists as unacceptable (PMC 2017a).

A second challenge, as for all the case study cities, was to develop a financially feasible approach. In 2011, a private venture based in Mumbai obtained a concession from Pune to establish a PBS network in the city. However, the program could not take off due to lack of financial sustainability; that is, lack of funding support from the city's public agencies.

This failure contributed to Pune's decision in 2017 to opt for a dockless model of PBS, even though cities around the world were skeptical of the technology's workability. Hence, Pune's public agencies faced the mammoth challenge of putting together a framework to implement such a system in the face of concerns regarding theft, vandalism, and cycling parking/docking enforcement. Their response was to search for and engage global dockless bicycle-sharing companies (Mobike and Ofo) with on-the-ground experience in the relevant technologies and system management to provide the dockless bicycle share service in the city. However, within six months of the commencement of the service in January 2018, these companies withdrew, citing

sustainability issues. PMC therefore had to quickly find new, local transport operators with more limited experience of dockless technology and sign fresh MoUs.

Policy and legal framework

Long considered progressive and dynamic, Pune has strong administrative systems, a well-educated middle class that is committed to urban sustainability and equity, and vibrant civil society organizations that play an active role in forging innovative solutions for the city's development (Kamath et al. 2018). This support system helped the city develop and implement India's first urban dockless shared bicycle system.

As a first step, PMC established an NMT team in 2008 to evaluate issues related to pedestrians and cyclists, including the provision of footpaths and bicycle tracks. The city then developed and adopted Comprehensive Mobility Plans in 2008 and 2012 that articulated a vision for "moving people safely and economically by emphasizing public transport and non-motorized transport." To help realize this vision, PMC prepared a Comprehensive Bicycle Plan with support from the Government of India's Ministry of Housing and Urban Affairs.

Extensive surveys of Pune residents conducted for the plan found that over 90 percent would be willing to shift to cycling if safer infrastructure were created. In addition, travel pattern studies indicated that at least 10 percent of short (i.e., up to 4 km) trips taken by motorized modes could potentially be converted to bicycle trips (PMC 2017c). The city's bicycling plan set ambitious targets to increase the mode share of walking and cycling to 50 percent by 2031. The plan also includes an enhanced citywide bicycle track network and design guidelines for bicycle-friendly infrastructure including painted lanes, bicycle parking facilities, and a strategy for public awareness campaigns. The Comprehensive Bicycle Plan was approved by the PMC's General Body in December 2017, with a specific Public Bicycle Sharing policy approved simultaneously. The holistic plan also covers the integration of walking and cycling services and infrastructure with the city's BRTS corridor.

Business and financial model

To optimize capital investment and provide PBS options on a citywide scale, PMC and Pune Smart City Development Corporation Limited (PSCDCL) opted for a dockless technology system that required only limited infrastructure to lock bicycles at the station and provide parking docks. PMC opted for an open policy for choosing service providers (no exclusive contracts) and in November 2017 invited private operators to apply to establish and operate fully automated PBS systems in the city.

Companies signed an MoU with the municipal corporation to ensure support for their operations and facilitate coordination with other city agencies.

Under the MoU, operator roles and responsibilities included the following:

- Setting up, operating, and managing all aspects of the PBS service, including maintaining the system in good condition.
- Enforcing strict parking regulations and removing incorrectly parked bikes. This was an innovative approach to tackling the urban clutter issues seen with other dockless systems.
- Employing a comprehensive grievance redress system for users.
- Educating users on riding etiquette and correct parking practices.
- Keeping permits and licenses valid at all times.
- Undertaking marketing and promotional activities.
- Attending periodic meetings with other operators and PMC to reinforce cooperation and fair play and refraining from attempts to harm or sabotage the operations of other PBS service providers.

Under the MoU's, the four operators also agreed to bear all costs associated with procurement, deployment, maintenance, technology, operations, and the human resources required to

run and manage the dockless bicycle-sharing system. In return, PMC assumed responsibility for providing operators publicly accessible spaces to park bicycles free of charge. The public agency also provides policy and institutional support for creating a conducive environment for the PBS operations. This support includes promotional activities, facilitating payment integration with other public transport modes, assistance in cases of bike theft and vandalism, and periodic policy provisions to support ongoing PBS operations as needed (see Figure 10).

In addition, PMC's PBS system policy sets level of service targets at three bicycles for every 100 residents or about 100,000 bicycles citywide (within three years from the launch date), as well as four or more trips per bicycle per day. However, there are no incentives or penalties for the service providers related to these targets, nor are any SLBs included in the MoUs. Every month, operators are required to share service metrics that will help PMC plan cycling infrastructure and ensure good-quality service to the public. These data include the number of bicycles operational, the number of trips recorded, the number of subscribers to the system, and the number and location of bicycles stolen or vandalized (PMC 2017b).

Launched in December 2017, the system had over 2,500 bicycles deployed by four operators—Ofo, Mobike, PEDL, and Yulu—within six months. After Ofo and Mobike shut down their operations in India in July 2018, another operator, Mobycy, came on board.

Figure 10 | **Financial model for Pune's PBS system**
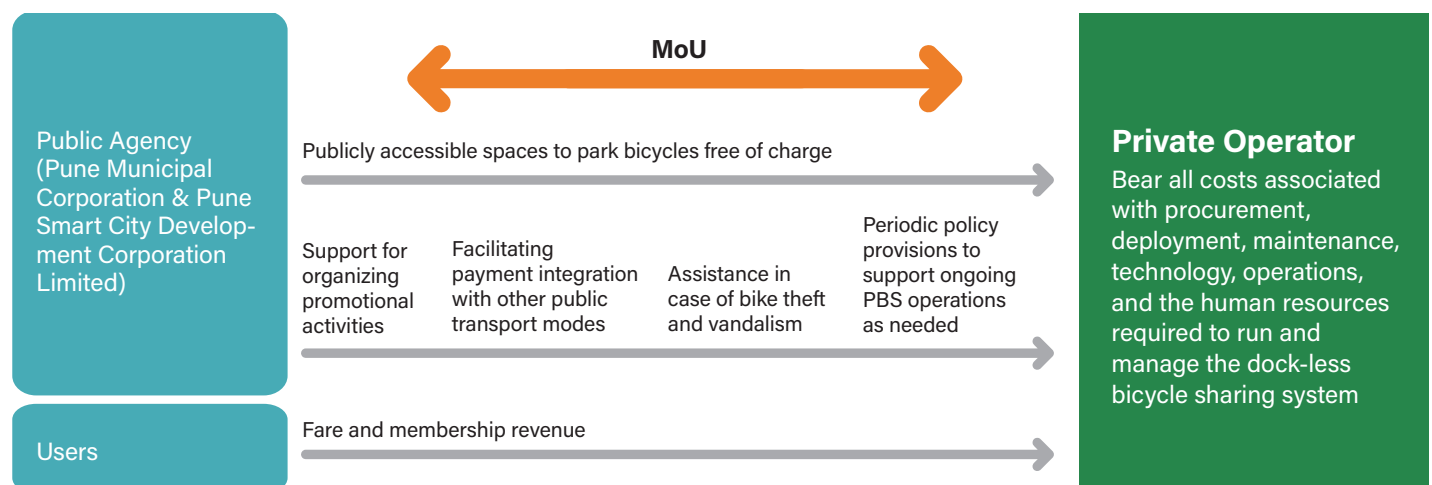
Notes: MoU = Memorandum of understanding; PBS = public bicycle sharing.
Source: Authors.

Implementation mechanism

As of March 2019, there were four operators providing dockless bike share service in Pune, as shown in Table 6, using a range of fees. PEDL was the first company to sign an MoU with PMC, in December 2017, and launched its services in the same month. Initially the number of bicycles was limited to 150, and the fare was kept very low (INR1 for 30 minutes), to allow the implementation and monitoring agencies, PMC and PSCDCL, to gauge user response and behavior as well as to test the technology. PEDL's service has since scaled to 1,000 bicycles, and the city signed MoUs with three more companies in 2018. As of December 2019, one operator—Yulu—is operating with about 2,000 bicycles.

A dense network of around 800 bicycle parking locations have been identified and marked across the city (see Figure 11). Both privately owned and publicly shared bicycles may be parked at these locations free of charge. PMC has set up a bicycle department to ensure implementation and smooth coordination within PMC and with other agencies, including the Traffic Police, PMPML (Pune Mahanagar Parivahan Mahamandal Ltd, the public transport bus service provider for the twin cities of Pune

Table 6 | **Pune PBS Service Operators and Fees**

COMPANY	LAUNCH OF OPERATIONS	FEES
PEDL	Dec 2017	30 min: INR 3
Mobycy	March 2018	15 min: INR 4
Mobike	May 2018	20 min: INR 10 30 days: INR 93
Yulu	Aug 2018	30 min: INR 10

Notes: min = minutes; PBS = public bicycle sharing.
Sources: Authors, based on consultations with operators and officials from Pune Smart

and Pimpri-Chinchwad in the Pune Metropolitan Region of Maharashtra), PSCDCL, and Pune Metro. Weekly meetings are held with all stakeholders and operators to discuss any measures needed to ensure that the Pune City Cycle Plan stays on track. Simultaneously, PMC has initiated public works to meet the plan's infrastructure provision, including construction of bicycle tracks at various city locations.

Figure 11 | **Pune shared bicycle parking locations (as identified in 2017)**
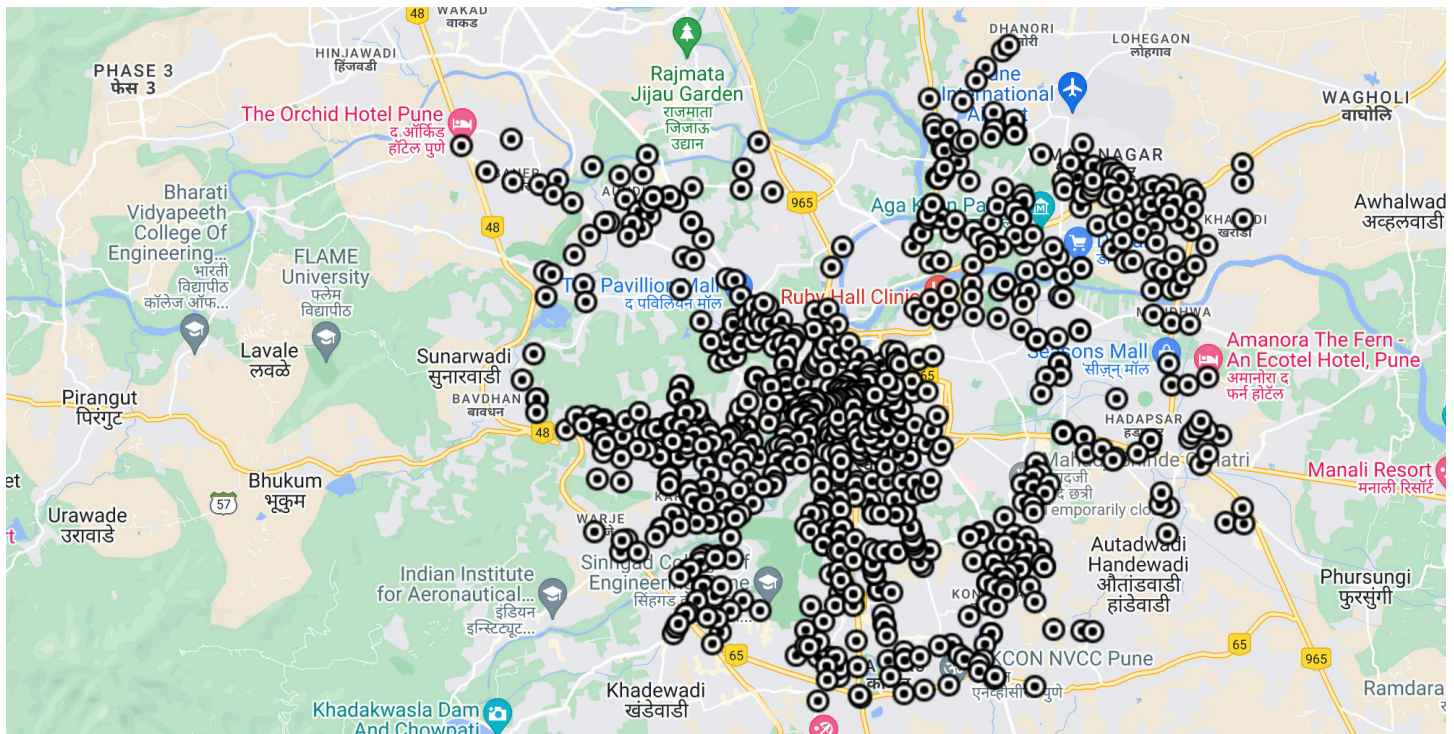
Source: PMC 2017a.

Project impact and usability

Nearly 2,500 bicycles were placed between December 2017 and May 2018 by the four operators around the 800 marked bicycle parking locations. Due to this comprehensive approach, the system became an instant winner among citizens. In its first week of operation in December 2017, shared bicycle users made over 5,000 trips (Kulkarni 2018). According to data collected by operators, the system has recorded as many as five rides per bicycle per day on average. The latest data from PSCDCL shows 10,000–12,000 trips[8] booked every day (as of March 2018). Most of the users belong to the 18–24 age group (Rashid 2018), and 60–65 percent of the users use the system for last-mile connectivity (Dutta 2018).

Based on this encouraging response, the city authorities planned to expand the number of shared bicycles to 8,000, and allocated INR 100 million to develop dedicated bicycle tracks, parking locations, signage, advertising, and citizen engagement programs (Representative from Pune Smart City Development Corporation Ltd 2018).

Beyond its own borders, Pune's PBS scheme made a national impact as it was the first city to implement a dockless PBS model, working with multiple operators. Pune was also the first city to implement a comprehensive city-level bicycle plan and set up a separate department to implement it.

Challenges going forward

The sudden increase in ridership charges by the operators (both the previous operators and the newest one) have posed a major challenge for the city, impacting ridership and user interest. The introductory prices were kept as low as INR 1 per hour, and these were later increased to around INR 20 per hour, which has impacted the ridership. In addition, infrastructure development has not kept pace with the bicycle deployment in the city, which has been cited by users and operators as a major challenge to increasing ridership and usage. This includes the development and construction of parking spaces and dedicated lanes. The operators in Pune are only required to bring in the fleet and operate it.

LESSONS LEARNED

The concept of PBS to provide citizens with healthy and sustainable transport options has gained rapid traction in cities worldwide. In India, this approach remained largely experimental and was confined to rental schemes until 2017, when three cities launched large-scale bicycle-sharing schemes with well-considered business and financial models, utilizing PPP strategy and technology for PBS systems.

Table 7 | **Mysuru's, Bhopal's, and Pune's PBS schemes: Key elements**

CITY	EXTENT OF COVERAGE	SCALE OF BICYCLE FLEET – NUMBER OF BICYCLES IN THE SYSTEM	BICYCLE-SHARING SYSTEM	BICYCLE INFRASTRUCTURE
Mysuru	Focus on city center and tourist attractions	450	Dock-based system allows users to pick up and drop off bicycles at any of 48 docking stations in Mysuru or 50 in Bhopal; operated by public-private partnership	4-km bicycle track built, with another 28 km in pipeline
Bhopal	Focus on Bus Rapid Transit System (BRTS) catchment area	500		12 km of dedicated bicycle lanes built, with more in the pipeline
Pune	Parking locations spread across the city, including BRTS locations	2,500	Dockless system with 800 parking locations allows users to pick up and drop off bicycles at any location; operated by multiple private firms	Extensive bicycle lanes exist but require renovation to be usable; plans are in the pipeline to construct an extensive cycle network

Notes: km = kilometers; PBS = public bicycle sharing.
Sources: Authors, based on consultations with operators and officials from Pune Smart City Development Corporation Limited.

Mysuru, Bhopal, and Pune launched India's first large-scale/citywide PBS systems by developing business and financial models responsive to local needs and generating widespread public interest and a significant customer base, which resulted in initial success. Whereas Mysuru and Bhopal employ dock-based systems requiring smart technology, Pune was the first Indian city to implement a large-scale dockless PBS system. These are India's first PBS launches that have remained viable longer than previous attempts, and they are still operational (see Table 7 for key elements of the three systems). It is too early to say whether the PBS systems in Mysuru, Bhopal, and Pune have been successful in achieving the expected levels of bicycle ridership and increasing access within their cities. This calls for further research and analysis as the systems mature. Yet, these cities have shown improvements, in terms of business and financial models, after previous pilots failed to develop workable models or attract private sector interest. These cities therefore offer valuable lessons for PBS planning and implementation in the Indian context.

This paper highlights their experiences and the models they used, to help other Indian cities make informed decisions relating to replicating, developing, implementing, and scaling citywide and financially sustainable bicycle-sharing projects.

Common planning and implementation lessons from the three cities

Although each scheme is tailored to the local urban context, they exhibit common features that enabled implementation of larger-scale systems with public and private partnerships that have been sustained for almost three years. The common elements of the three schemes are now summarized for the benefit of city agencies and private operators engaged in developing PBS models in the Indian context.

Strategic approach

- All three cities spent up to a decade laying the groundwork for PBS schemes through strategic planning, incorporating PBS schemes into a broader urban development vision. In the case of Mysuru and Bhopal, state-level agencies were also involved, while Pune received support from the Government of India's Ministry of Housing and Urban Affairs.

- All three cities engaged with citizens to create an understanding of the concept of shared bicycling schemes before the launch, which resulted in enthusiastic uptake and sustained usage. Pune surveyed residents before formulating its Comprehensive Bicycling Plan.

Key takeaway: Integration of the PBS scheme into broader urban development plans, support from higher-level government agencies, and early citizen engagement were important in all cases.

Policy and legal framework

- All three cities incorporated plans for PBS schemes that were embedded within statutory citywide strategic mobility or NMT plans that evaluated the need and demand for walking and cycling infrastructure.

- This helped bring city government stakeholders and the public on board and enabled finance to be raised from city and state agencies and other sources, including the World Bank (Mysuru).

Key takeaway: Incorporating PBS into the city's strategic and statutory mobility plans is important as it not only helps bring together all the stakeholders but also ensures the much-needed financial support.

Business and financial model

- Mysuru and Bhopal opted for PPPs with single operators, with sharing of the PBS scheme's financial burden and management as well as oversight responsibility.

- Pune's open contract model with multiple firms, which requires operators to bear all costs, has enabled wide service coverage.

- All three cities laid the groundwork for high-quality service. Mysuru and Bhopal included service benchmarks—such as bike availability and maintenance—in contracts, tied to operator payments. Pune requires operators to report service metrics monthly, and competition among multiple PBS providers incentivizes quality service.

Key takeaway: Business and financial models should be tailored to city- and context-specific needs, while keeping the focus on high-quality service provision. Laying down SLBs early on and linking them with incentives and penalties is crucial for ensuring quality service.

Implementation

- All three cities launched service coverage on a sizable scale that attracted substantial ridership from the outset.

- Service coverage was carefully designed to maximize ridership. Bhopal and Pune prioritized service near BRT stops, while Mysuru focused on tourist areas with high-volume traffic.

> *Key takeaway: It is important to design service coverage for maximum ridership. The following factors proved effective: proximity to public transport networks/hubs and tourist, educational, and commercial centers; tapping the first-and last-mile connectivity gaps; and trips within 5 km.*

Usability

- All three cities employ user-friendly smart technologies.

- All three cities set fees at attractive levels for users—in Bhopal and Mysuru, the first 30 minutes are free for system members.

- Each city also provided long service hours: 16 hours of availability a day.

- Usage across socioeconomic groups: In Mysuru, most users belong to the lower-income strata; that is, with earnings less than INR 10,000 per month. In Pune, most users are using the system for last-mile connectivity to public transport, showing that PBS has a user base among the public transport users in the city, which spans socioeconomic groups. The only exception is Bhopal, where higher fares have kept the usage among lower-income groups to a minimum.

> *Key takeaway: It is important to focus on the end goal: enhancing usability across socioeconomic groups. This can be achieved by employing user-friendly technologies, attractive fare structures, long service hours, and service coverage spanning all socioeconomic population groups.*

It is important to consider what factors worked for these three cities and what are the areas that require further work. The learnings from these three cities can lay the foundation for successful future projects. It is imperative to learn from the early experiences of PBS for effective scaling across India.

CHALLENGES AND NEXT STEPS

Although the PBS systems in Mysuru, Bhopal, and Pune have had successful launches, challenges have continued to arise. Most notably, as these PBS schemes grow in popularity and coverage, the need for infrastructure to support them becomes more pressing. Pune is the only one of these cities with a network of bicycle lanes. The extant lanes in Pune, however, are in urgent need of renovation and expansion to keep pace with the PBS system. For Bhopal and Mysuru, the challenge is much greater. Bhopal has recently constructed a single dedicated and segregated 12-km bicycle track and plans to expand its coverage, but it is both time and money intensive. Mysuru has yet to build any dedicated cycle lanes. In each city's case, the commitment to provide safe infrastructure for bicycling and some investment is required.

The safety of cyclists is linked directly with ridership and the usability of the system in the long run. PBS systems in all the three cities gained popularity in the initial period. However, once the initial enthusiasm plateaus, safety and keeping the public interest alive play a vital role in sustaining ridership increase. This has been a major challenge in all the three cities and became evident with the decreasing ridership in the second year of operations. Both the operator and the city agencies need to work to increase the ridership. Pune has a Comprehensive Bicycle Plan that aims to increase the mode share of bicycling, and other cities also need similar plans to make PBS sustainable over time.

A second significant challenge is ensuring the financial and operational financial viability and operational sustainability of the projects beyond the contract or MoU periods. It is imperative for the cities to sustain the service and keep pace with potential increases in future demand. Maintaining the interest among users as well as operators is of utmost importance and a significant step toward achieving sustainability (both financial and operational). Once the current operating period is over, it would be interesting to see how cities take these next steps.

As the landscape of PBS in India continues to evolve rapidly, other cities are exploring a range of business and financial models to suit their local context and needs. Urban and transport planners in these cities, along with existing and potential bicycling service providers, can draw lessons[9] and insights from the experiences of Mysuru, Bhopal, and Pune. At the same time, more research is needed on both the financial and business models used by these cities—and others—as their PBS schemes mature and on the challenges they face moving forward as they seek to scale NMT as an essential component of modern, environmentally sustainable Indian cities. If PBS is to scale effectively in India, a detailed understanding of the challenges these systems face, and how to overcome them, will be crucial in adapting business and financial models to benefit cities, citizens, and private operators alike.

More recently, during the COVID-19 pandemic, like many cities across the globe, Indian cities also saw a surge in cycling usage. Taking note of this increased interest in cycling, the government is focusing on improving streets for pedestrians and cyclists and has launched two national schemes: Cycle 4 Change (MoHUA 2020a) and Streets for People (MoHUA 2020b). The schemes include quickly built solutions using tactical urbanism to make streets safer and initiatives to promote cycling usage in cities. The intent is to keep the momentum going, while providing safe infrastructure along with a conducive environment and sustain it in the post-pandemic world as well. These two national schemes have the potential to increase interest in PBS systems in the future, as Indian cities become more conducive to cycling, making the lessons offered in this paper even more valuable in this context.

Further research

As more cities launch their own programs and confront their unique sets of challenges, further research will be needed to understand the requirements of successful implementation and sustainability of PBS systems for Indian cities. Examples of some newly (2018–2022) implemented systems include those in Ranchi, Bhubaneswar, Kochi, Indore, Mumbai, and Surat, and many others are in the planning stages. Because these cities are very recent attempts, it is still too early to say whether the attempts made by Indian cities have been successful in achieving the expected levels of bicycle ridership and increasing access within the city. This requires further research and analysis as the systems mature. A future publication is therefore planned on lessons for successful PBS implementation, which will also focus on issues related to cost-benefit analysis.

ABBREVIATIONS

BRTS	Bus Rapid Transit System
CapX	capital expenditure
GPRS	General Packet Radio Service
GPS	global positioning system
IT	information technology
NUTP	National Urban Transport Policy
O&M	operations and maintenance
OpX	operational expenditure
PBS	public bicycle sharing
PPP	public-private partnership (between an agency of the government and the private sector in the delivery of goods or services to the public)
SLB	service level benchmark

ENDNOTES

1. Bicycle sharing systems are a flexible public transport service that involves the creation of a dense network of cycle rental stations. Users can take a cycle from any station and return it to any other station in the system.

2. A semi-automated system combines automation and human intervention. Mysuru uses this technology in the terminals, and the cycles are simple. However, Bhopal uses a fully automated system with smart bicycles.

3. A public-private partnership (PPP) is a partnership between an agency of the government and the private sector for the delivery of goods or services to the public.

4. AMRUT Funding: AMRUT was launched by the government to transform urban living conditions through infrastructure upgrade. It aimed at transforming 500 cities and towns into efficient urban living spaces over a period of five years. The government approved INR 50,000 crore over five years starting in 2015 (i.e., FY2015–16 to FY2019–20). Raahgiri Day was introduced in India in Gurgaon in 2013. When Bhopal implemented it, the concept had already been adopted by more than 10 cities at several locations in India. It has since been adopted by more than 70 cities across India.

5. CO_2 emissions are calculated based on the assumption that the same trip could have been made by car, using a conversion factor of CO_2 emissions of 200 g/km per car run (Manager CharteredBike 2017). The conversion factor is not an exact figure but is based on the average of the CO_2 emission factors of different types of diesel and petrol cars available in India (Mehra 2015; Ramachandraa and Shwetmala 2009).

6. The bicycle parts were imported, and the bicycles were assembled in India.

7. One trip is calculated as 30 minutes, and every additional 30 minutes is counted as a separate trip.

8. An example of collaboration among experts: In North America, The North American Bikeshare Association (NABSA) connects the best minds in bikeshare and shared micro-mobility across North America. NABSA has representation from system owners, operators, cities, equipment manufacturers, and technology providers, thus providing a platform to share experiences and draw lessons to support, promote, and enhance shared alternatives to traditional transportation.

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ABOUT WRI INDIA

World Resources Institute India is a research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

Our challenge

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

Our vision

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision-makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.