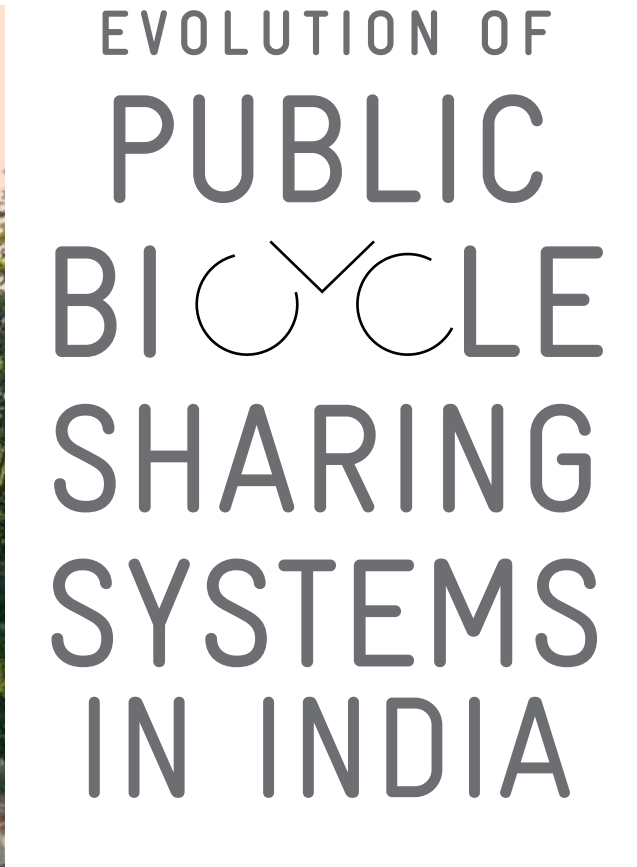


EVOLUTION OF PUBLIC BI CYCLE SHARING SYSTEMS IN INDIA





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ABOUT THIS REPORT

The report has been prepared as a part of bilateral technical cooperation project "Integrated Sustainable Urban Transport Systems for Smart Cities (SMART-SUT)" commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and jointly implemented by Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ) GmbH and Ministry of Housing and Urban Affairs (MoHUA), Government of India. The objective of the project is to improve the planning and implementation of sustainable urban transport in selected Indian cities.

The report aims to capture recent developments and trends in domain of public bicycle sharing (PBS) focusing on Indian context. Many cities in India are operating PBS schemes with each city having adopted different model of planning and operation. Introduction of supportive policies from government towards sustainable modes of transportation has also helped in enabling private sector participation in providing these bicycle sharing services. Over last few years, many of the Indian cities like Bengaluru, Delhi, Chennai, Pune, Ahmedabad, Bhopal, Bhubaneswar, Indore etc. have not only witnessed entry of global bike sharing companies but also handful of local start-ups like Mobyicy, Yulu and Zoom car have started providing these services. While some of these programs have been successful, others have struggled to sustain operations.

The report collates experiences from five Indian cities (Bhopal, Bengaluru, Pune, Ranchi, and Mysuru) as well as international case studies and attempts to investigate overall planning and policy framework including designing parameters, business models and regulatory aspects. The key outcome of the report is to bring out issues and challenges in operation of public bike sharing and to develop recommendations for improving existing PBS systems in Indian cities.



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1

INTRODUCTION TO THE STUDY

With more cities keen on adopting PBS systems, the study seeks to understand why and how cities in India have planned and implemented these systems? What are the benefits and outcomes of such a system? Should more cities in India implement PBS systems? What is the role of electric bikes and scooters in PBS?



CONTEXT

The first Public Bicycle Sharing (PBS) system in India was launched in 2017 in Mysuru. Within three years, fourteen cities implemented PBS systems and many more are in the planning stage. Policies and funding schemes like the National Urban Transport Policy (NUTP), Jawaharlal Nehru National Urban Renewal Mission (JnNURM), and Smart City Mission emphasised implementation of Non-Motorised Transport (NMT) infrastructure. These, coupled with interest of global operators to expand their operations in India, led to a conducive environment for uptake of PBS systems. While new cities are planning to adopt the system, Kolkata, Mumbai, Pune, and Bengaluru withdrew or reduced operations. Ridership stagnated after the initial boost. At this juncture, as more cities plan to implement PBS, it is important to build on the learnings of existing systems.

Existing systems have adopted different business models, planning and design parameters, and system technology. The study aims to identify factors affecting the performance of PBS systems and draw key learnings from Indian and global systems. This shall be helpful for cities with existing PBS system as they can adopt these learnings from the study to overcome existing challenges and improve system performance. New cities can refer to this study and learn from experiences of other cities to understand dos and don'ts for successful implementation of PBS.





DEFINING PBS

Ministry of Housing and Urban Affairs (MoHUA) defines PBS as “a high-quality bicycle based public transport system in which bicycles, stored in a closely spaced network of stations, are made available for short-term use.”

The World Resources Institute (WRI) defines PBS as “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.”

The Institute for Transportation and Development Policy (ITDP) defines PBS as “a system where anyone can pick up a bike in one place and return it to another, making point-to-point, human powered transportation feasible.”

While organisations have used different terms (bike-share, PBS, cycle share), all definitions focus on three key characteristics – shared use, availability of bicycles at multiple locations, and human powered fleet.

For the purpose of this study, PBS system is a non-motorised or partially motorised, human powered, public transport system that allows bicycle sharing through a network of stations spread across the city with a nominal usage charge.



ABOUT THIS STUDY

There are various guidelines and documents available for planning, designing and implementation of PBS systems, both in global and Indian context. ITDP has published a guide for planning bike sharing systems. The Sustainable Urban Transport Project (SUTP) under MoHUA has published development guidelines for Transit Oriented Development, NMT and PBS. MoHUA also published a toolkit for PBS systems for Indian cities. Though this study refers to the recommendations from these guidebooks, it intends to take learnings from the assessment of existing systems and develop a way forward for PBS systems in India.



STUDY OUTCOMES

The key findings of the study are classified into four categories – planning and policy framework, system planning and design parameters, business models, and regulatory framework. The key outcomes are summarised below:

- PBS has the potential to serve both as a last-mile mode and as an independent mode. The role is

The study recommends that only cities willing to invest time and resources with a long-term intent and commitment for cycling should venture into implementing a PBS system.

dependent on how cities plan city-wide integration of PBS with public transport. Existing literature suggests that PBS is more apt as a last-mile mode for rail-based systems compared to bus-based transit systems. Indian PBS systems mostly cater to short trips of 2 – 4 km.

- Cities must have a clear objective for implementing a PBS system. The objective should drive the decision for selection of business model, system planning, and allowable form factors (pedal bicycle, pedal assist, electric powered bicycle etc.) within the PBS framework.
- PBS is not a silver bullet to increase the mode share of cycling. It is one of many strategies to encourage cycling, including the development of cycling infrastructure.
- Large scale and densely connected systems with an aim for a city-wide expansion are necessary to realise substantial benefits of PBS and achieve viable system performance.
- Indian PBS systems observe benefits like congestion reduction and emission reduction due to unique mode shift from two-wheeler to bicycle.
- Financial support from the public sector in the form of subsidy or Viability Gap Funding (VGF) is critical.
- Most cities show substantial economic benefits from implementing the PBS systems.
- Several Indian cities have introduced e-bikes without pedal within the regulatory framework of bicycles. While these modes do serve as an innovative mobility solution for last-mile connectivity, cities need to align their choices with their intent to implement PBS.

2

LITERATURE AND METHODOLOGY



LITERATURE IN A NUTSHELL

The research team reviewed publications, research reports and articles to develop an overall understanding of the prevalent PBS ecosystem. Key findings from the literature review are presented under five categories -

Benefits and outcomes: The intended benefits of a PBS system are emission reduction, health benefits, saving in fuel consumption, saving in travel cost, and provision of flexible mobility. Benefits pertaining to the former factors assume that there is a mode shift from motorised vehicles to bicycles. A case study from London and China, concludes that the shift from private motor vehicles to PBS has been disappointing (Tang, Pan and Shen, 2010). A survey undertaken by Transport for London (TfL) found that only 1 percent of the 3500 surveyed members shifted from private cars. The shift in Chinese cities of Beijing, Shanghai, and Hangzhou are 5.2, 0.46, 4 percent, respectively (Tang, Pan and Shen, 2010). The overwhelming substitution has come from walking and public transit.

Planning and policy: Encouraging sustainable transport has emerged as a ubiquitous response of cities to address mobility challenges. PBS has emerged as one of the many initiatives. Enabling policies aligned with city's transport vision have played a key role in adoption of PBS systems. New York identified PBS as part of city-level vision and strategy, whereas in London, it was part of Mayor's Transport Strategy in 2008 and 2019. The EU funded

European Cyclists' Federation (ECF) developed and implemented a policy framework where PBS was identified as a critical component to the city's public transport system. ECF further emphasised the need for strategic policy and regulatory framework to allow the PBS eco-system to evolve.

System planning and design: In terms of system usage, high performing PBS systems achieve 3 to 8 trips per cycle per day. Factors affecting system usage are trip distance, travel time, and level of service (Fishman, Washington and Haworth, 2013). The study found that residents living within 250 m of stations have a higher propensity to use the system as compared to residents living farther away.

Business models: In the past two years, many service operators withdrew PBS services. MoBike withdrew from Manchester. Ofo withdrew from London and Bluegogo, the third-largest bicycle-sharing company in China with more than 20 million users, also withdrew its operations (Nikitas, 2019). Low profits from subscription and rental revenue along with the lack of long-term financial viability were the key reasons for withdrawal (Nikitas, 2019). In the longer term, cities will need to identify additional funding sources as revenue from subscriptions will not be sufficient to cover operation and maintenance costs (Christopher Moon-Miklaucic, Anna Bray-Sharpin, Ivan De La Lanza, Azra Khan and Maassen, 2019). The European Commission asserts that PBS programs are not self-sustainable and sources for additional funding are limited (European



Commission, 2011).

Regulatory framework: Safety concerns are a major barrier to bicycling. Globally, out of 28 countries with enabling bicycle helmet law, nine countries have bicycle helmet laws that apply to all users irrespective of their age. Furthermore, some US cities, half of the Canadian provinces, interurban travel in Israel and Spain, urban travel in Chile and Slovakia also have helmet laws that apply to all ages. To tackle such issues, some cities have started providing helmets to their PBS system users.

SUMMARY OF LITERATURE REVIEW

The review of relevant literature provides insights on different parameters of the PBS system. Insignificant mode shift from private vehicles to PBS appears to be a key challenge for cities. Travel convenience emerged as a fundamental enabler for the uptake of PBS systems. While some cities expanded their systems, operators have withdrawn in other cities. There is a lack of clarity on the impact of business models on the financial viability of the systems. The system has attractive intended benefits but there is little empirical evidence of PBS contributing to emission reduction and increasing the ridership on bus systems.

KEY QUESTIONS

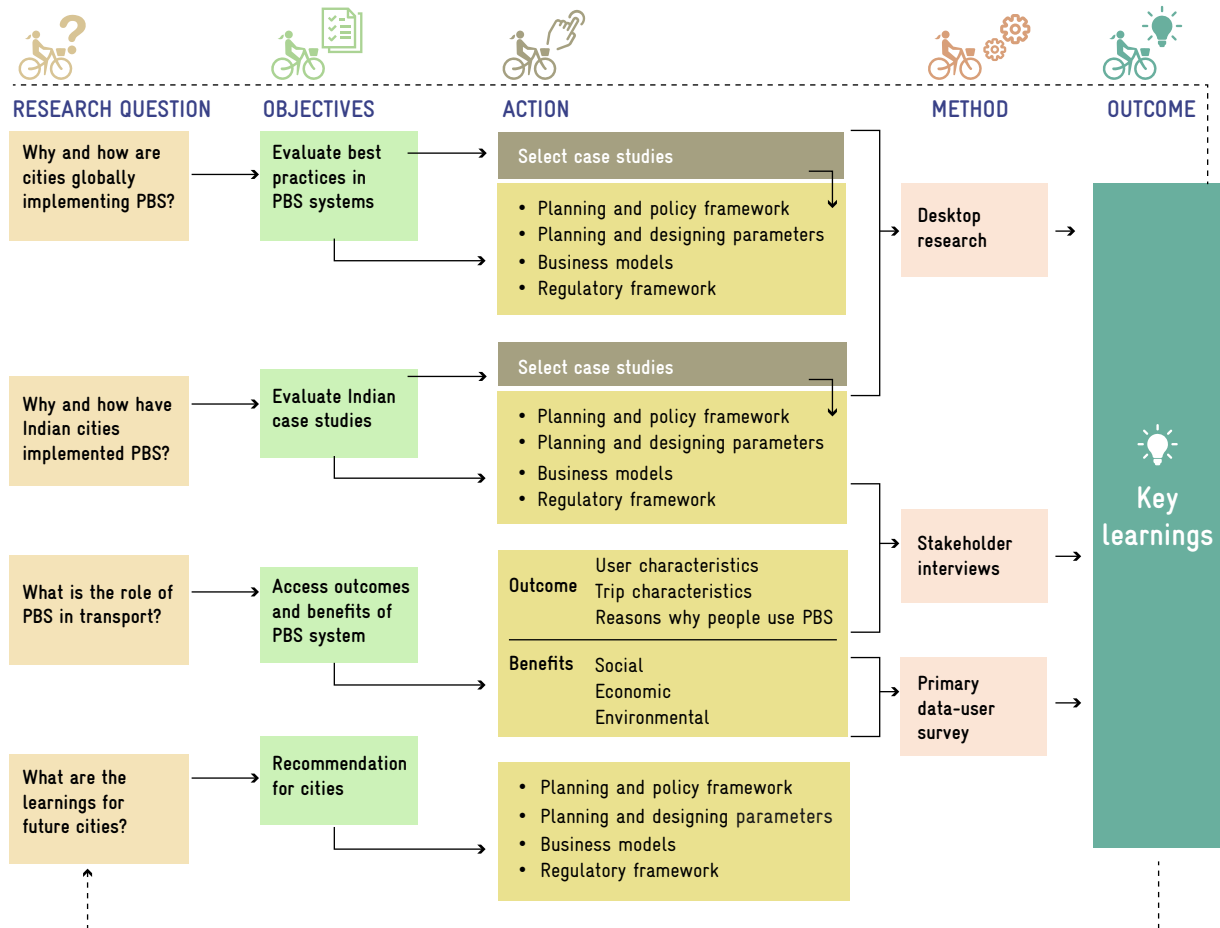
Based on the learnings from global literature and study of Indian case studies, the study aims to answer the following questions.

1. What should be the **objective** of cities behind implementing the PBS?
2. **How** are cities implementing PBS?
3. What is the **role of a PBS** system in city's mobility landscape?
4. What are the **learnings for cities** planning to implement or improve PBS systems in India?

STUDY FRAMEWORK

The study adopted a macro to micro level approach. The design of the study framework addresses each question with a specific action plan as shown in Figure 1. The research team conducted a thorough literature review to understand key parameters that enable and affect the performance of PBS systems. The study derived key parameters to evaluate the PBS systems of international best practices and Indian case studies.

Figure 1: Study framework



The outcome of the study encompasses key learnings to answer each research question and recommendations for cities under four categories -

- Planning and policy framework
- Planning and designing parameters
- Business models
- Regulatory framework



CASE STUDY SELECTION

Case studies were selected to ensure a diverse combination of the influencing factors identified through literature review. Table 1 outlines the parameters considered for selecting case studies.

Table 1: Parameters for case study selection

Demography of the city	Financing mechanism	System capacity
Existing mode share	Contracting model	Usage
Business model	System planning	Cycling infrastructure
System design	Project ownership	Institutional structure

Figure 2 outlines the method adopted for selecting case studies. Considering all the selection parameters, selected case studies as **best practices in PBS systems** were Citi Bike (New York City), Santander Cycles (London), Bycyklen (Copenhagen), Hangzhou Public Bicycle (Hangzhou), and Velo Antwerpen (Antwerp). Based on similar parameters, the selected Indian case studies were Chartered Bikes (Bhopal), Trin – Trin (Bengaluru), PBS Pune (Pune), Chartered Bikes (Ranchi), and Trin – Trin (Mysuru).

PBS systems in Bhopal, Ranchi, and Mysuru have a proportion of subsidy built-in while all financing and revenue risks are taken by the private operator in Bengaluru and Pune. In terms of technology, Mysuru and Bhopal are a dock-based model whereas Bengaluru and Pune have dockless systems. Bengaluru has electric and non-electric bicycle fleet whereas all other cities have pedal bicycles. The city sizes and mode of public transport are also varied. Bengaluru has an operational metro and city bus system, whereas Bhopal, Pune, and Mysuru only have city bus services. Ranchi does not have city-level bus services.



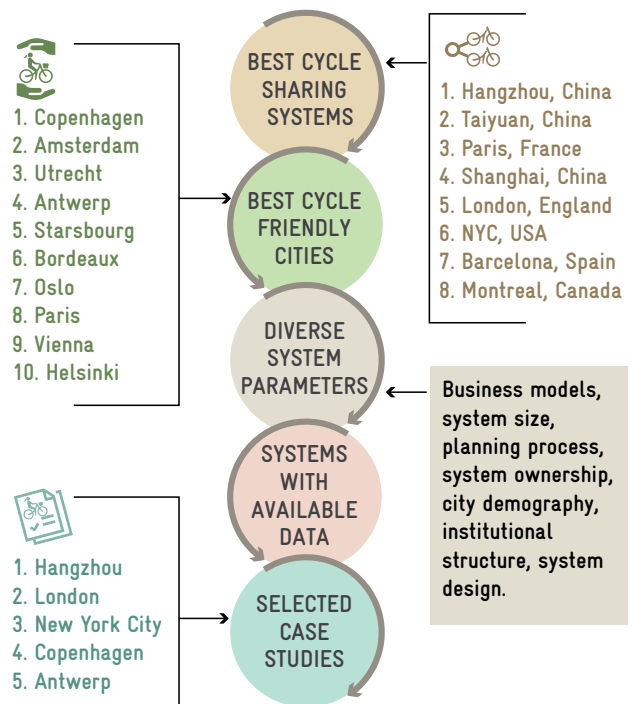
DATA COLLECTION

Desktop research: International best practices were evaluated through desktop research. Key learnings derived for each component were used to identify broad themes and questions for semi-structured interviews for evaluation of Indian PBS systems.

Semi-structured stakeholder interviews: Indian PBS systems were evaluated through semi-structured interviews. The team conducted stakeholder interviews of decision makers, service providers, advisors, and non-governmental organizations (NGOs) involved in planning and implementation of the PBS system.

User-survey: User survey captured the perspective of PBS users, PBS non-users, and users using their own bicycles. A total of 500 survey samples were collected in each of the selected Indian cities. Survey samples collected were unique and non-repetitive.

Figure 2: Method for case-study selection





3

PLANNING AND POLICY FRAMEWORK



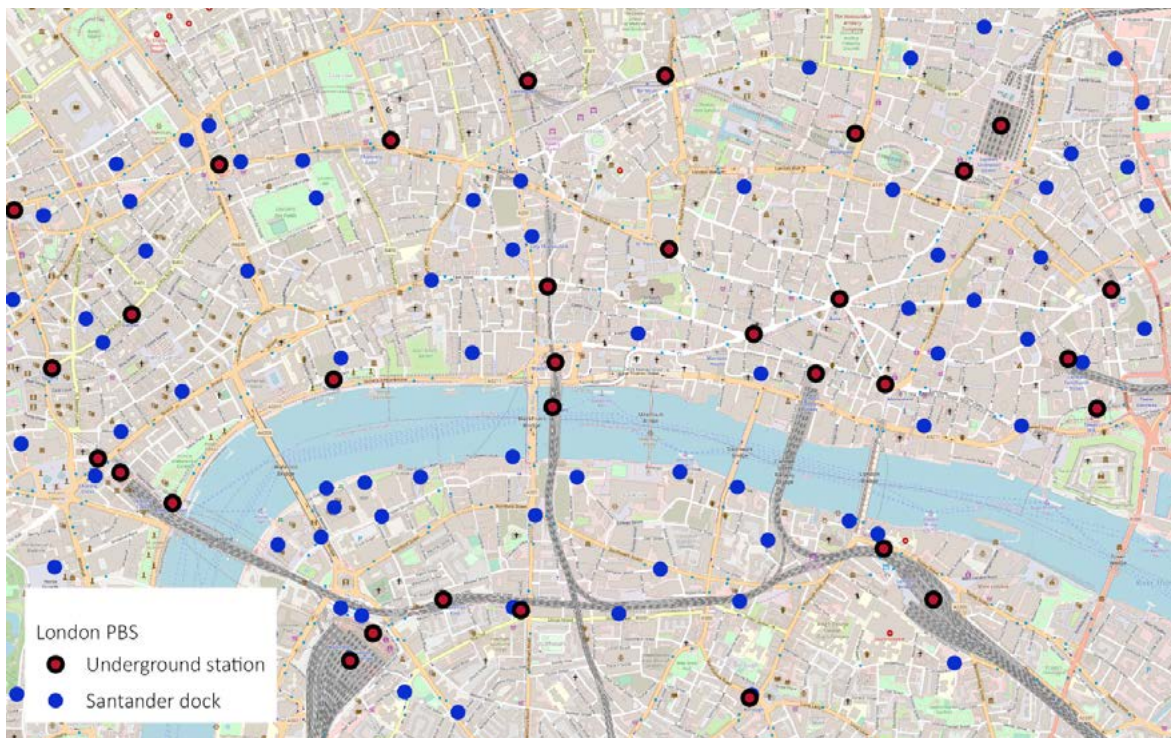
Globally, cities have adopted a range of planning and policy frameworks for implementing PBS systems. The section compiles learnings from various international case studies and attempts to draw a comparison with selected Indian case cities.

ROLE OF PBS

PBS as part of political agenda for cycling

The first-generation bicycles in Amsterdam were introduced to draw the attention of city authorities

Figure 3: Proximity of bicycle station and tube stops in London





towards the negative impacts of increasing car ownership. It intended to shift people to a greener mode of transport. Many cities during the post-World-War II period became increasingly dependent on car use (Fishman, Washington and Haworth, 2013). Gradually, the negative impacts of car use emerged as cities faced congestion, air and noise pollution, safety issues, and reduction in physical activity (Fishman, 2016). Political leaders promoted sustainable transport as part of their political agenda against these rising concerns. Boris Johnson, as Mayor of London, launched his political agenda to bring a 'cycling revolution in London'. The London PBS system, popularly known as Boris Bikes, was a key initiative under the roadmap to cycling revolution. Likewise, Anne Hidalgo, Mayor of Paris focused on creating a network of cycle lanes and was re-elected as Mayor in 2020.

PBS as a first/ last-mile mode

The experiments of Copenhagen helped in identifying PBS as a mode for first/ last-mile connectivity. This model was widely accepted, and most cities located bicycle docks along transit stations. Figure 3 represents an example of London with PBS docking stations placed near transit stations. Literature suggests that PBS systems contribute to an increase in transit ridership of rail-based transit systems. It may, however, have a negative impact on bus systems (Graehler and Mucci, 2019). Graehler and Mucci's study found that PBS led to an average 1.8 percent decrease in bus ridership. However, the subway ridership in cities increased by an average of 6.9 percent and light-rail ridership increased by 4.2 percent after introducing the PBS program (Graehler and Mucci, 2019). A similar study of PBS in Washington, D.C. concluded that a 10 percent increase in annual PBS ridership contributed to 2.8 percent increase in average daily metro ridership. As per an impact study in New York City (NYC), it was observed that for every thousand PBS docks along a bus route in Manhattan and Brooklyn, there was 2.4% decrease in daily unlinked bus trips. (Campbell and Brsakewood, 2017).

PBS to increase cycling in cities

PBS contributed to reviving the cycling culture in many European cities. In Barcelona, the share of cycling increased from 0.75 percent in 2005 to 1.76 percent in 2007. In Paris, it increased from 1 percent in 2001 to 2.5 percent in 2007 (Ma, Liu and Erdoğan, 2015).

PBS contributing to cycling reforms

As a green mode of transport, cities also envisioned the role of PBS in improving the air quality and mobility experience in the city. Mexico City adopted such a vision for PBS scheme – ECOBICI. The program called for the opening of 10 km of streets on Sundays exclusively to people on non-motorised

The role of PBS has evolved over the years. Cities have primarily implemented it to increase cycling. PBS systems have the potential to serve both as a last-mile mode and act as an independent mode depending on a city's transportation system and city size. A PBS system positively impacts the ridership of a rail-based transit system, but similar impact is not visible for bus-based system. In the latter case, PBS acts as an independent alternate mode, especially for short trips. Before implementing a PBS system, cities should set a clear objective about the expected role of PBS in city's transport system. The role of PBS must guide the decisions regarding system design, system planning, appropriate business models, and necessary regulatory framework.

vehicles, encouraging citizens to connect with their community in a variety of ways. In Europe, cycling foundations like the European Cyclists' Federation (ECF) promote cycling as a sustainable and healthy means of transport. In addition, cities also envision PBS as a measure to reduce traffic congestion in the central city area (Wang and Zhou, 2017).

Normalising the image of cycling

PBS also played the role of normalising the image of cycling in cities like London (Goodman, Green and Woodcock, 2014). The wide-spread availability of PBS in the city led to increased visibility of people cycling in everyday clothes. This has helped in normalising the perception of cycling beyond an activity for sports enthusiasts. With the increasing popularity of PBS systems, cities are also keen on the system as a tourist attraction. Tourist destinations like Seattle benefit substantially from having a good PBS that is used by both residents and visitors (Lee, 2013).

THINK LONG-TERM AND THINK BIG

International best practices with successful PBS systems have a long-term vision for cycling.

Cities with successful PBS systems have put continuous efforts for over a decade to make cycling more attractive and convenient. Figure 4 and Figure 5 map the two-decade long effort of NYC and the evolution of PBS. Copenhagen implemented the Traffic and Environment plan in 1997. By then, the city already had 200+ km of bicycle track. Cycling was the key focus of the plan. The plan was followed by 'Green Routes' and cycle priority that outlined infrastructure improvement for the next 11 years. Alongside this, the city had a PBS system since 1995. By the end of 1996, the city had 1500 bicycles. Similarly, in New York City, the Department of Transportation (DOT) introduced the first bicycle program as early as 1997. Initiatives to increase cycling were emphasised in PlanNYC 2007, a strategic plan developed at the city level. In London, the 2010 strategy by the Mayor declared a cycling revolution. In the next ten years, the city developed six cycle superhighways. The Mayor's 2019 transport strategy for London outlined the aim to double the bicycle trips in the city from 0.7 million per day to 1.3 million by 2024.

New York and London identified PBS under a city-wide strategy. Antwerp and Copenhagen initially introduced PBS as an individual project and later incorporated the expansion within the Bicycle Action Plan and Mayor's Transport Strategy, respectively.

International best practices aimed for large scale and city-wide network expansion.

All five international cities implemented phase-wise expansion of the bicycle plan. New York, Hangzhou, and London identified the expansion plan from the inception. Hangzhou system increased its bicycle fleet from 2800 bicycles in 2008 to 90,000 bicycles in 2015. Their vision is to deploy nearly 2,00,000 bicycles in Hangzhou by the end of 2020. In London, fleet size increased from 6,000 bicycles in 2010 to 11,700 bicycles by the end of 2019. In Antwerp, the fleet size increased from 1,350 in 2015 to 4,500 in 2019. In New York, the fleet size increased from 6,000 in 2013 to 12,000 in 2019.

New York and Hangzhou planned borough wise expansion. Antwerp adopted a radial expansion strategy from the city centre towards the periphery and London adopted expansion in the inner London urban area.

None of the Indian case studies have a long-term vision for cycling and PBS.

In Ranchi and Bhopal, PBS was identified and funded under the Smart City Mission. The initiatives are not part of a city-level transport vision to increase sustainable modes in the city. In Bengaluru, Directorate

of Urban Land Transport (DULT) commissioned the development of 45 km of cycle lanes as an attempt to increase cycling. Users found lack of bicycle parking as a deterrent to cycle in the city. DULT introduced PBS as their next strategy to increase cycling. Pune is the only city to have a comprehensive bicycle plan in place, but the plan was never implemented on ground.

Indian cities did not expand beyond the pilot project.

Indian cities did not aim for large scale or city-wide network. There was no phase wise plan for expansion beyond the pilot stage. Ranchi, Bhopal and Mysuru started with 500 bicycles and the numbers have not increased since then. Bengaluru started with four operators providing service in individual clusters. Three operators withdrew within the first six months. Although the fleet size increased from 1000 to 3000 bicycles over two years, the service area reduced from four to one cluster. Similar to Bengaluru, Pune provided permits to four bicycle sharing operators. Three of them withdrew, reducing the service area of the system.

PBS IS NOT A SILVER BULLET

No PBS system was implemented in isolation.

International best practices envisioned PBS as one of the many strategies to overcome transport challenges or considered it an extension of public transport system. In New York, the PlanNYC is a city level strategic plan. Transport is one of the nine sectors identified for improvement and reforms. A key target for transportation is reduction of congestion and emission. PBS is one of the many strategies adopted to achieve this target. In the case of London, PBS was part of the Mayor's transport strategy in 2010 and 2019. Along with PBS, the strategy proposed implementation of cycling superhighways. Antwerp, a city with an extensive bicycle network also identified PBS as part of the Bicycle Policy Plan and Action Plan. The plan simultaneously proposed construction of missing links in the cycling network, active and proactive bicycle parking, and safety measures for cycling. PBS is designed to act as a 'superlink', that can improve the connectivity of outer districts to the central city by acting as a last-mile mode to access public transport in outer districts. In Hangzhou, the system was implemented as an extension to existing public transport with a purpose to provide last-mile connectivity to public transport.

International cities had extensive bicycle network before implementing PBS or they invested in developing cycling infrastructure and PBS simultaneously.

Copenhagen had 285 km of segregated cycle lanes in 1995, prior to implementing PBS system. In London, between 2010 to 2014, the PBS system expanded by two folds and six bicycle superhighways



Figure 4: Evolution of PBS in New York City

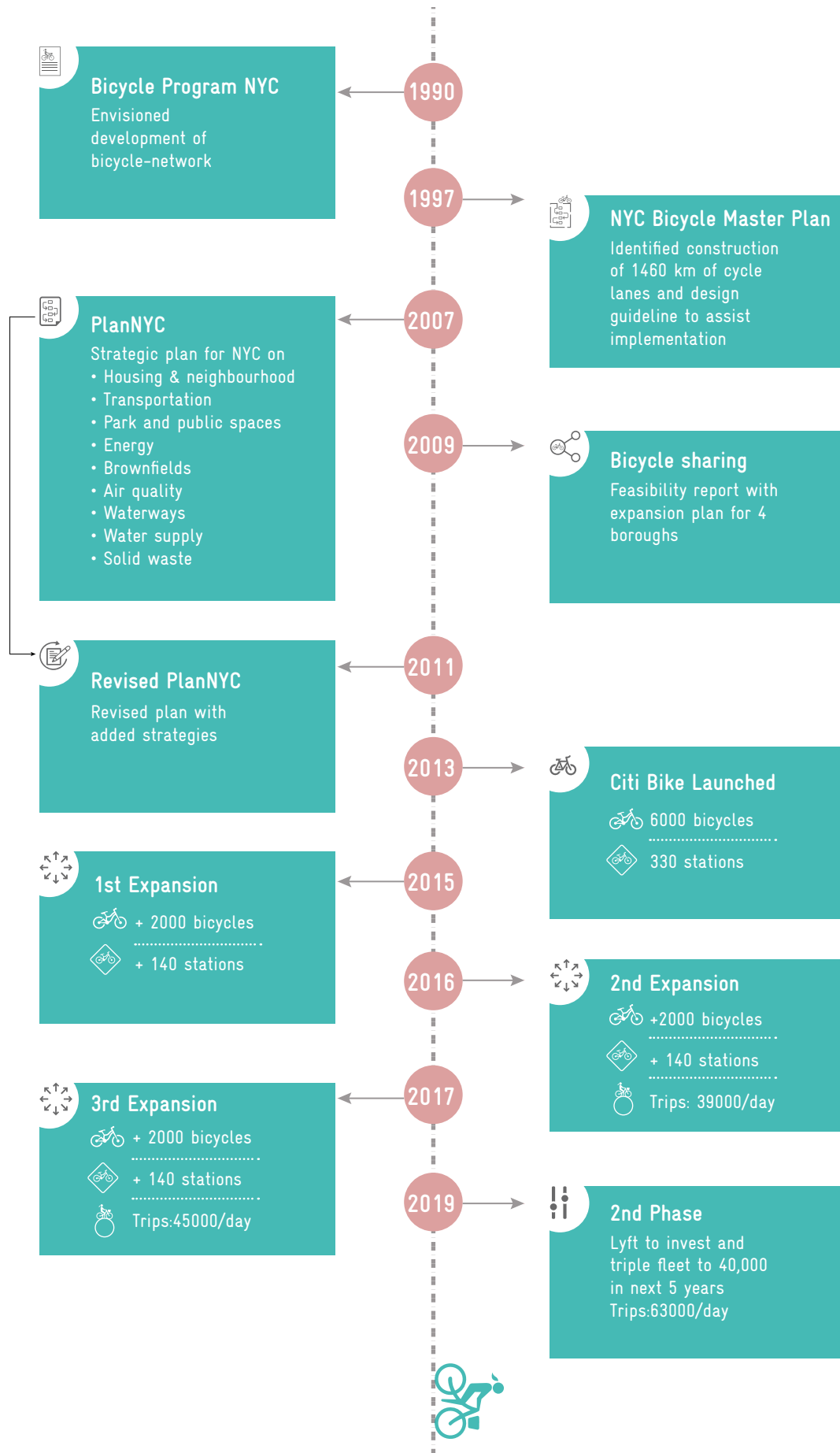
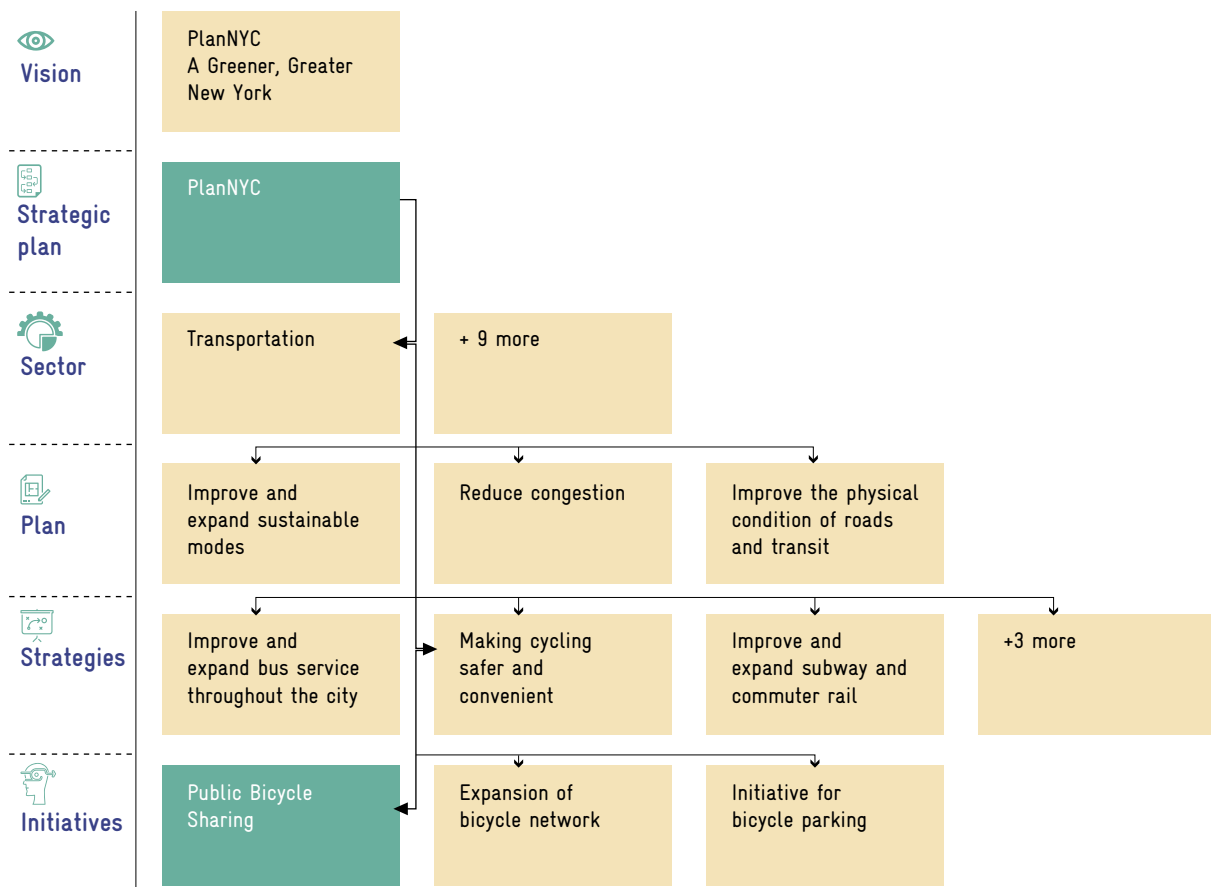


Figure 5: Policy Framework of New York City



became operational. In New York, the Department of Transportation identified 1462 km of bicycle network under the Bicycle Program in 1997. In 2007, PlanNYC, the strategic plan identified completion of this network and planning for PBS system. Antwerp and Copenhagen are amongst the most bicycle friendly cities. Both the cities have invested in increasing cycling for more than two decades.

Indian cities introduced PBS as a standalone project.

There is no city level transport strategy and bicycling strategy in Bhopal, Ranchi, and Bengaluru. Pune has a Comprehensive Bicycle Plan that proposed 300 km of integrated city-wide tracks. However, only a small percentage of the network is implemented on ground. Pune also formed an NMT cell in 2009 but there has been no serious attempt to put back bicycles in clusters that were abandoned by the initial operators.

Literature highlights that there is a significant statistical relationship between PBS usage and the presence of cycle lanes. Indian PBS systems do not have comprehensive network supporting cycling infrastructure.

Only a small percentage of total cycling trips are catered by PBS system.

In the case of New York, PBS trips contributed to less than 10 percent of the total cycling trips. On average, only 63,000 of the total 4,90,000 bicycle trips are made on PBS. In the case of London, PBS contributes to only 4 percent of the total bicycle trips. The contribution is even lower in Copenhagen. In 2016, Bicyklen contributed to less than 1 percent of the total bicycle trips.

PBS alone cannot increase cycling in the city. It is one of the many strategies that cities need to adopt. Cities with existing PBS systems should plan and develop cycling infrastructure to support PBS network. Future cities should plan PBS and cycling infrastructure simultaneously as a single integrated project.



INTEGRATION IS THE WAY TO GO

International best practices executed integration at all levels—policy, institutional framework, and physical planning.

London and New York implemented PBS as part of the city's transport strategy. Antwerp and Copenhagen introduced it under the cycling policy and action plan. In Hangzhou, the service is operated by Hangzhou Public Transport Group Co. Ltd., a state-owned limited liability company responsible for transport services in the city. Similarly, in London, TfL is the implementing agency for PBS. Policy and institutional integration with other transport strategies led to converting the vision into physical integration.

Cities physically integrated PBS schemes with public transport.

In Antwerp, Bicycle Policy Plan identified PBS as a last-mile mode to bus, tram, and car journey offering connections between the districts and the inner city as an extra, quick, and accessible means of transport. 46 out of 130 stations are placed at the regional train station (DSB) and metro stations. Hangzhou has a 'five-in-one' strategy where PBS is identified as a last-mile connecting mode for the city bus transport system.

Indian cities have also executed some integration with transit stops. This is evident in Mysuru, Bhopal, Bengaluru, and Pune. In the case of Pune and Bengaluru, integration with public transport is limited to a small pocket in the city. While developing the system, Pune's Comprehensive Mobility Plan (CMP) proposed PBS as a feeder and NMT mode.

However, Indian cities have not achieved integration at policy and institutional levels. In Bhopal and Ranchi, PBS project is under Smart City Corporation whereas public transport is under City Municipal Corporation. In Mysuru, the city bus service is under Mysore City Transport Division (MCTD), part of Karnataka State Road Transport Corporation (KSRTC) whereas the PBS system is owned by Mysuru City Corporation. In Bengaluru, the city bus service is operated by Bengaluru Metropolitan Transport Corporation (BMTCL). Bengaluru metro is built and operated by the Bangalore Metro Rail Corporation Limited (BMRCL) whereas the PBS is operated by a private entity and only monitored by DULT. Unlike the international systems, PBS in Indian cities is not built as a part of a larger city level transport system with an aim to resolve the mobility challenges.

■ Best practices envisioned PBS as part of an integrated transport strategy. The systems are planned to complement the existing transit service. Integration at policy and institutional level enabled cities to implement projects that align with the city's priority and vision.



4

SYSTEM PLANNING AND DESIGN PARAMETERS



The section assesses impact of various planning and design parameters on the system usage. It highlights the key factors that affect the system performance and create a conducive environment for uptake of the PBS system.

PLAN BIG – PLAN DENSE

Large scale systems achieve higher daily trips per cycle.

The number of bicycles per square kilometre represents the spatial distribution and level of access to the service. Copenhagen system has 53 bicycles per sq. km. followed by Antwerp with 20 bicycles, New York with 15 bicycles, and London with 7.3 bicycles. The level of access impacts the trips per cycle per day. Copenhagen system, with dense spatial distribution, achieves 7 trips per cycle per day. Trips per cycle decline with lower level of market penetration as represented in Figure 7.

The number of bicycles per 1000 population represents the level of market penetration. Cities with higher market penetration achieve higher trips per cycle per day. Copenhagen and Antwerp have 6.5 and 8.1 bicycles per 1000 population and achieve 7 and 5.6 trips per cycle per day as shown in Figure 6 and Figure 7. Metropolitan cities like New York and London have a lower level of market penetration at 1.4 and 1.3 cycles per 1000 population.

Length of cycle lane per sq. km. represents the density of bicycle network in a city. Literature suggests that there is a significant statistical relationship

between PBS activity and the presence of cycle lanes. International best practices with higher density of bicycle network have higher trips per cycle per day. Copenhagen has the densest bicycle network with segregated lanes and highest trips per cycle per day.

Figure 6: Bicycles per 1000 population

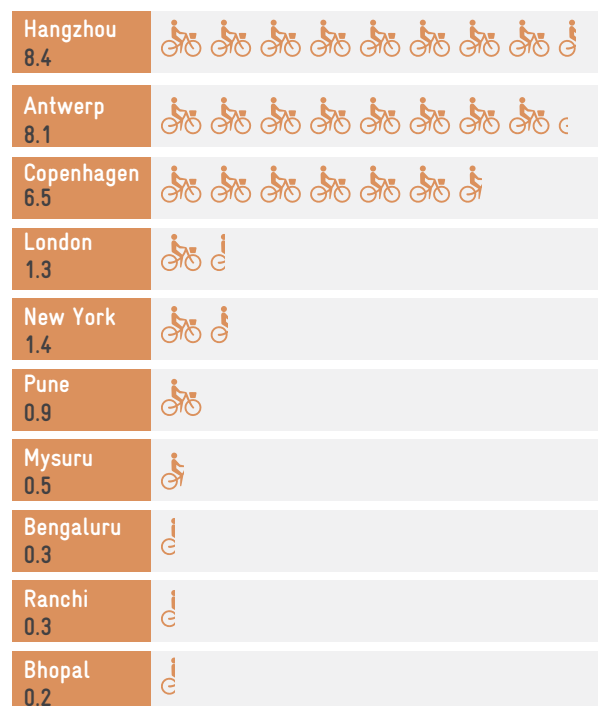




Figure 7: Bicycles per sq. km. and corresponding daily trips

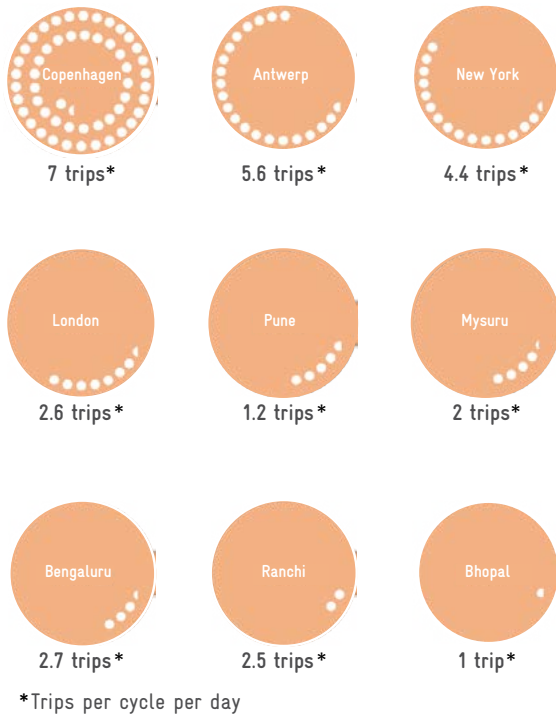


Figure 8: Bicycle network density

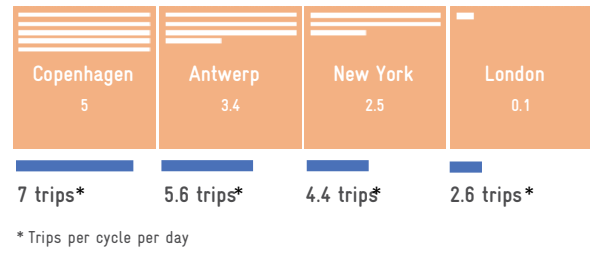


Figure 8 shows that number of trips per cycle per day decreases with decline in density of bicycle network.

Indian PBS systems are small scale and have limited spatial coverage.

As compared to international best practices, Indian PBS systems have less number of bicycles per sq. km. Mysuru has 4 bicycles per sq. km. as shown in Figure 7, followed by Bengaluru and Pune with 3, Ranchi with 2, and Bhopal with only 0.7 bicycles per sq. km. The low spatial distribution of cycles is on account of small scale systems densely confined to a small area as in the case of Ranchi as shown in Figure 9 or small scale system sparsely spread over a large area as in the case of Bhopal shown in Figure 10.

Figure 9: Ranchi PBS network

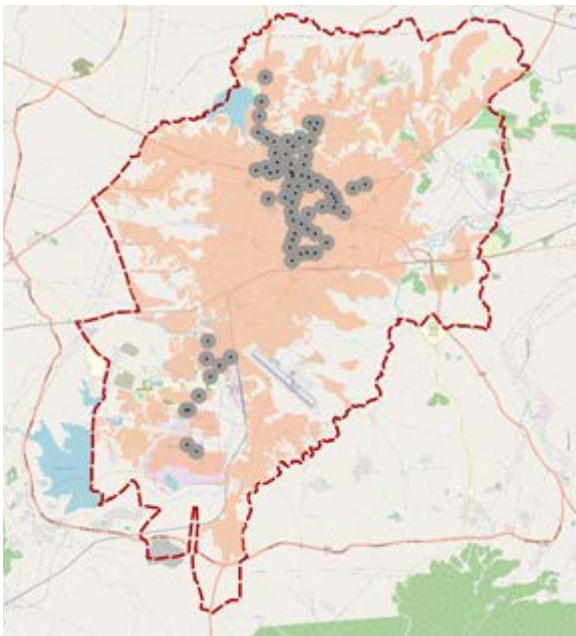
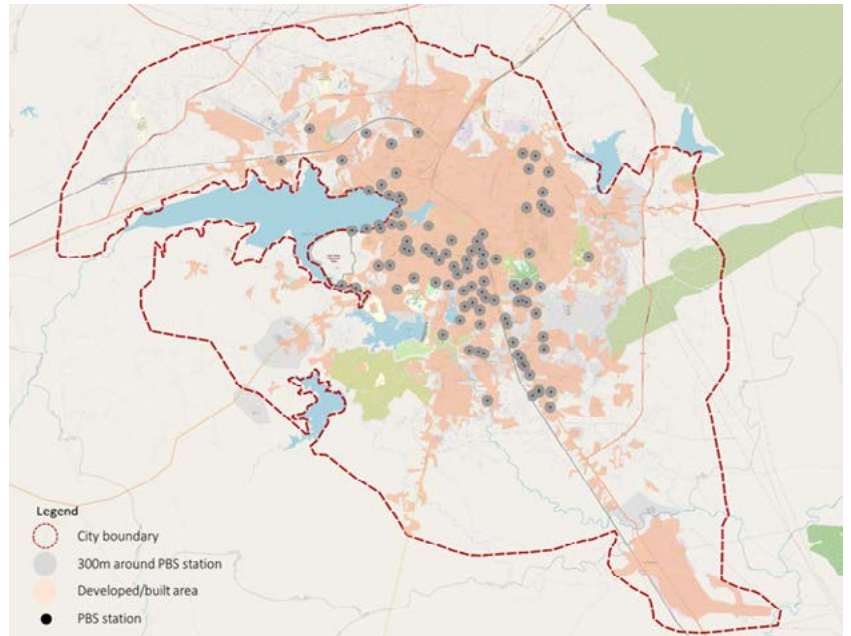


Figure 10: Bhopal PBS network

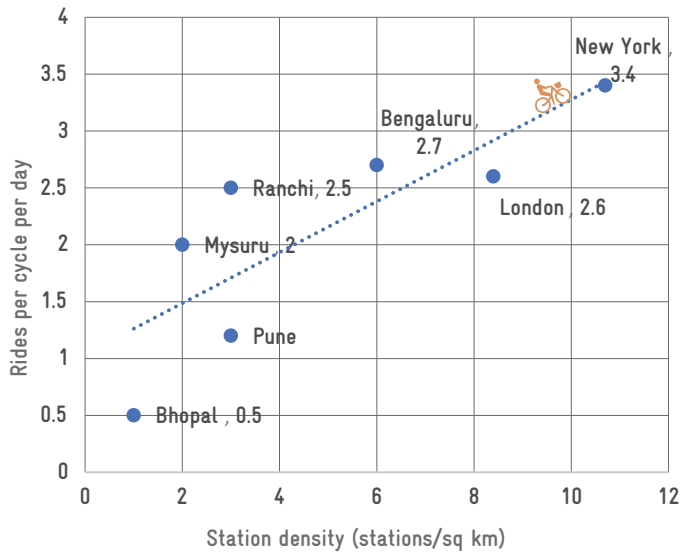


Higher station density results in higher daily trips per cycle.

The number of stations per sq. km. represents the ease of availability of a bicycle. A PBS system largely serves users residing within walking distance from a PBS station. Closely placed stations increase the accessibility of a system. A higher station density

correlates with higher trips per cycle per day as shown in Figure 11. Although Bengaluru and Pune have higher station density, the system is limited to few pockets. Figure 12 outlines limited coverage of Bengaluru's PBS system.

Figure 11: Relation between station density and rides



THE VALUE OF TIME

Time saving and ease of availability are the primary reason for using PBS.

The user survey highlights that users value time saving. Forty percent of users across the five cities opined that they use PBS because it saves time and nearly 35 percent choose PBS because a shared bicycle is easily available. Ease of availability of a bicycle reduces door-to-door trip time.

MODE CHOICE FOR SHORT TRIPS

PBS is a mode choice for trip range of 2 to 4 km.

The largest share of modal shift is observed from public transport and walk (Figure 14). The shift from public transport to PBS for shorter trips (2-3 km) is likely due to saving in waiting time. Frequent riders (more than four days a week) saved between 10 to 20 minutes in Bhopal, Bengaluru, Pune and up to 10 minutes in Mysuru for trips between 2-4 km.

Figure 12: Bengaluru PBS zones

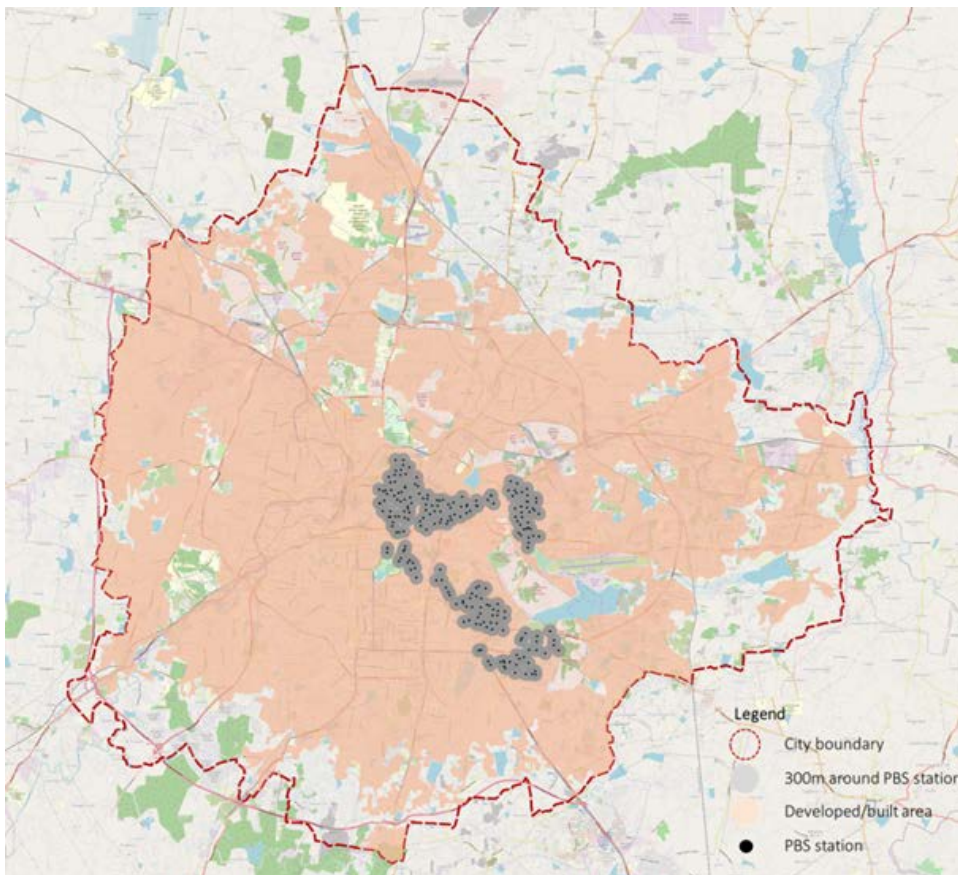




Figure 13: Reasons to use PBS

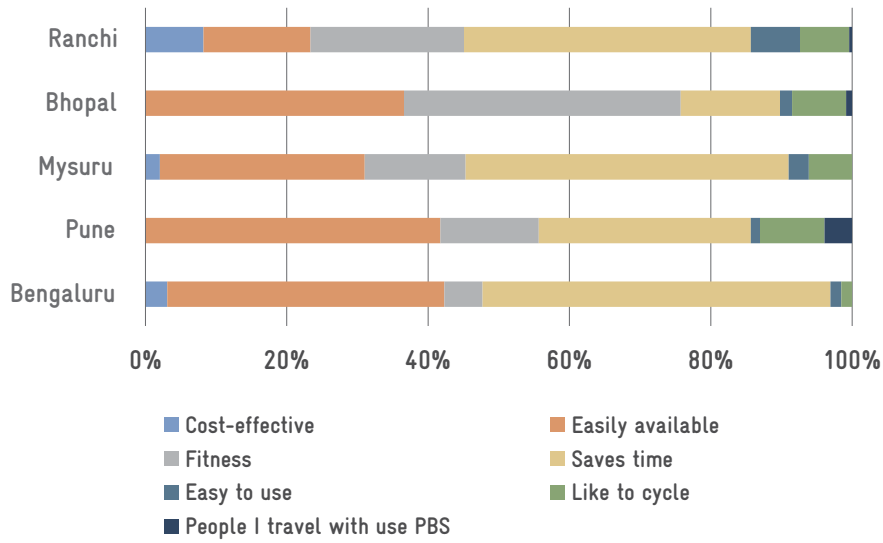


Figure 14: Percentage of modal shift to PBS with corresponding trip ranges

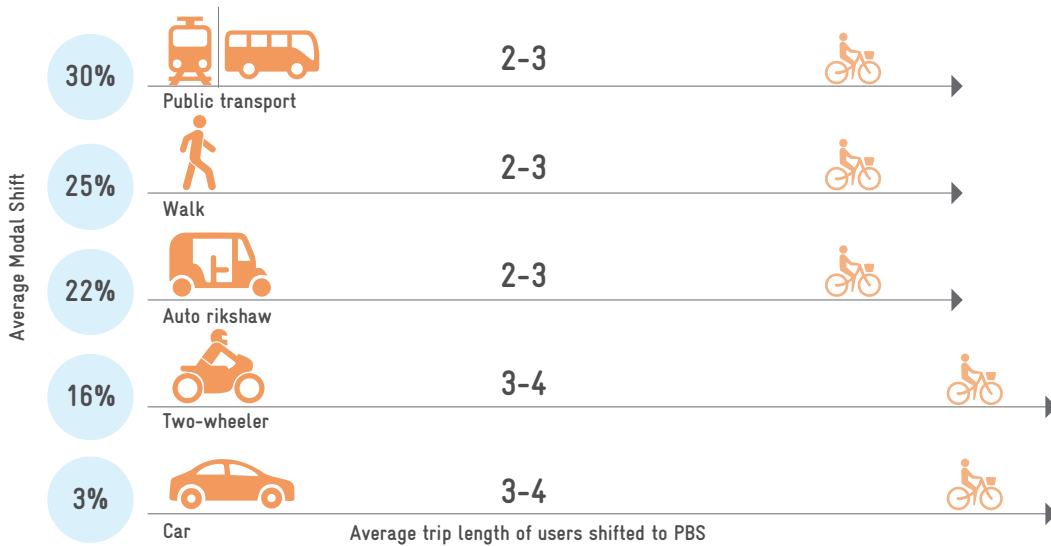
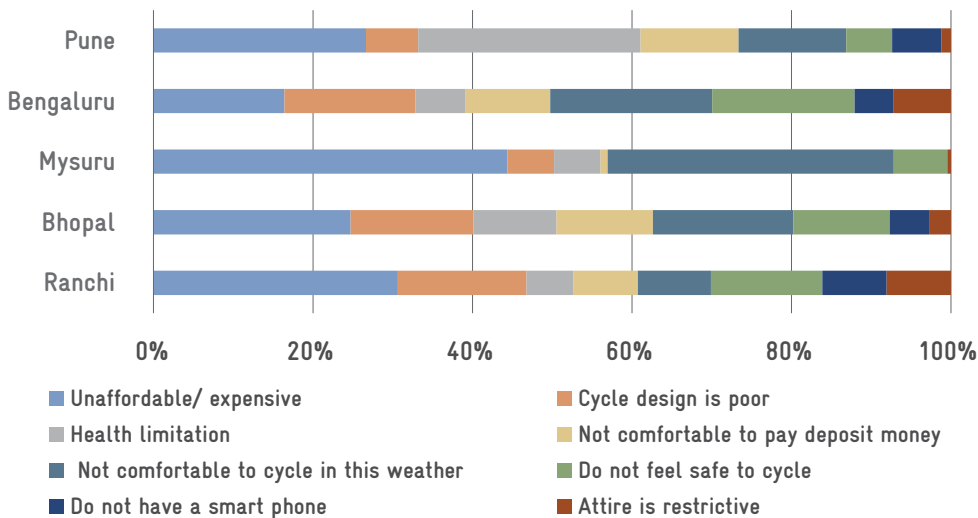


Figure 15: Deterrents for non-users



PBS enables mode shift from private modes.

Shift from car to PBS is not significant and is in line with international experiences. Indian PBS systems observe mode shift from two-wheelers. The phenomenon is unique to India. Two-wheeler users choose to cycle because it is easily available. Time saving is also a key factor in congested cities like Bengaluru and Pune. Fitness is a key factor in Bhopal.

DETERRENDS AND PERSUADERS

Unaffordable rates and inadequate cycling infrastructure deter non-users.

Users with no or low-income (mostly students) and cyclists with own bicycle, find it expensive to use PBS as shown in Figure 15. In terms of infrastructure

availability, lack of street lights and segregated lanes are strong deterrents to use of PBS as shown in Figure 16. Provision of segregated bicycle tracks and bicycle friendly infrastructure can further enable time saving and attract new trips on PBS.

Factors enabling time saving are the key persuaders

As shown in Figure 17, non-PBS users said that ease of availability of bicycle within walking distance (5 to 10 mins) and convenient payment options will be an incentive for them to use PBS. Both factors are linked to time saving in the overall trip. Secondly, the availability of bicycles within walking distance also emphasises the need to implement dense station network spread over an urban area with adequate bicycles per sq. km.

Figure 16: Deterring Infrastructure conditions for non-users

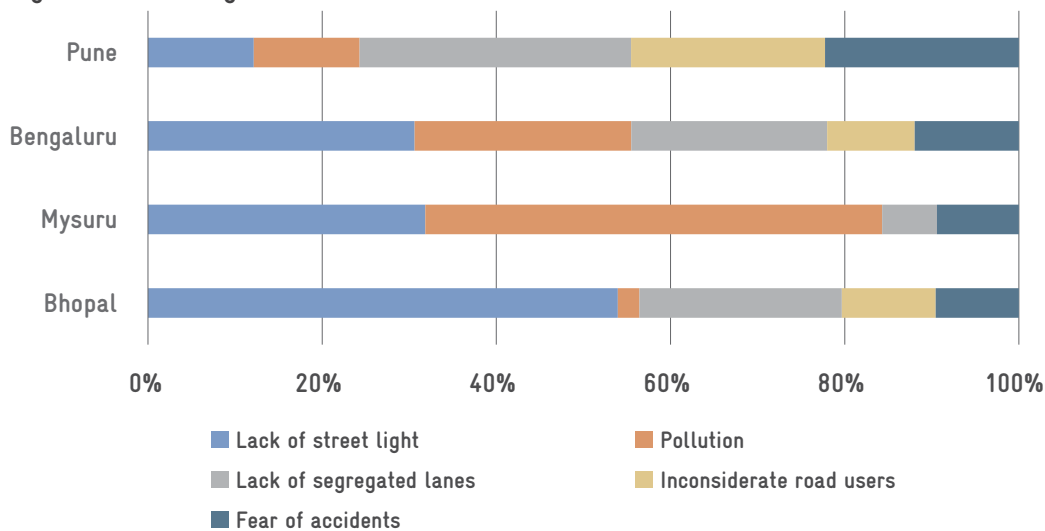
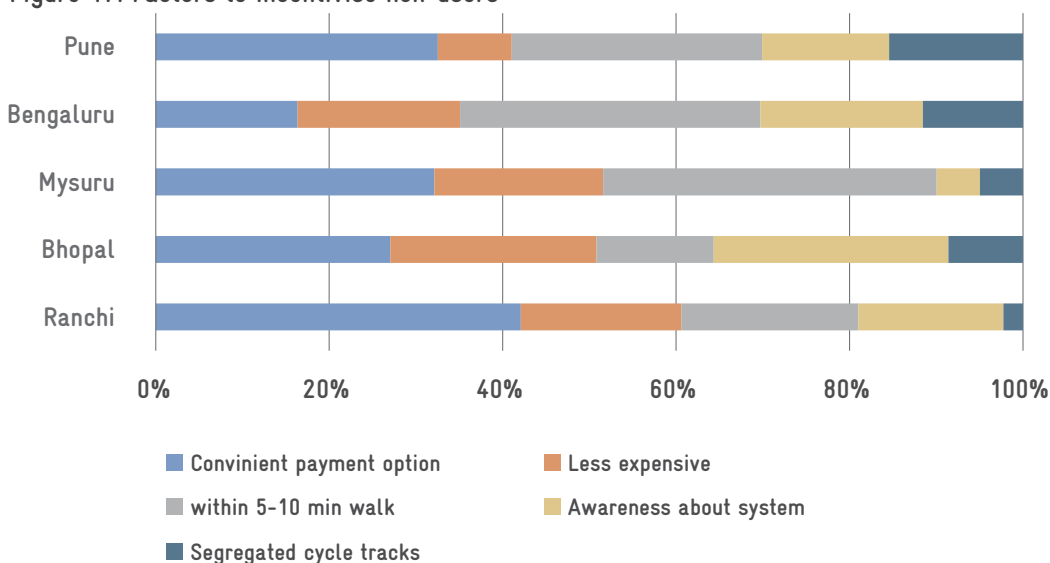


Figure 17: Factors to incentivise non-users



Both PBS users and non-users value time. Cities intending to improve the performance of the existing system must implement strategies to enhance time saving. This includes provision of cycling infrastructure, dense PBS network accessible within walking distance, and quick payment options. Cities with low station density and stagnant ridership must add stations in areas devoid of access within walking distance from PBS stations to attract new users.



5



BUSINESS MODELS

Business models adopted in PBS systems across the globe vary from city to city. The roles, responsibilities, and accountability of the system is distributed differently between the stakeholders. The section attempts to assess prevailing business models and outlines a viable business model for PBS in Indian context.



BUSINESS OR PUBLIC UTILITY?

Core assets of PBS include station infrastructure, electronics, and fleet. Responsibilities include financing and construction of the system, its operations, and maintenance. The stakeholders are the public city authority and private operator. The business model of a PBS system involves choices about ownership and financing of system assets and the sharing of revenue between stakeholders. Decisions are finally tied up through the contracting structure that allocates risk and responsibilities amongst stakeholders.

Globally, the types of business models observed in PBS systems are publicly owned and operated, publicly owned and privately operated, privately owned and operated, and non-profit owned and operated. In Indian cities, systems are either publicly owned and privately operated or privately owned and operated. In the first model, revenue risk is taken by the public sector while in the second model, the private sector takes the revenue risk. The first model is known as the Gross Cost Contract (GCC) and the second as the Net Cost Contract (NCC) model.

Preference for Gross Cost Contract models in PBS systems.

The study of international case studies reveals that most operational PBS systems are publicly owned and privately operated as shown in Table 2. The authority outsources the operations through GCC to a private player while retaining financing responsibilities and design decisions for core assets. Fares and advertisement revenues flow directly to the authority and the operator is reimbursed for capital and operating costs. The NCC model leaves the design, financing, and operations to the operator, while allowing it to collect and retain fares and advertisement rights.

In addition to membership and user fare, advertisements and branding rights are significant sources of revenue globally and banks have emerged as one of the common purchasers of naming rights (London, Singapore). Authorities have additionally also accessed state funding and grants, often as part of some state sponsored scheme (Ranchi, Bhopal, and Bhubaneswar under Smart City program) or multilateral assistance (Mysuru).

Some private players pursuing the NCC model have been successful in accessing venture capital. However, these are limited to the larger metros like Bangalore and Pune due to the venture capital's search for autonomous, scalable, and higher market potential models.



Table 2: Business models of PBS systems

PBS Systems	Contracting structure	Contract type	Funding source	Revenue source
London	Publicly owned Privately operated	GCC	Sponsorship and municipal funds	Subscription fee; User fees
New York	Privately owned and operated	NCC	Sponsorship from Citibank and Mastercard	Membership fee; User fees
Hangzhou	Publicly owned and operated	-	Capital cost funding - CPC Hangzhou Municipality and Hangzhou Government	Advertising revenue, user fees
Copenhagen	Non-profit owned and operated	GCC	Municipal funds	User fee (Top-up packages)
Antwerp	Publicly owned Privately operated	GCC	Subsidy from city of Antwerp Funding from public transport agency - de Lijn	Membership fee, User fees
Paris	Publicly owned Privately operated	GCC	Municipal funds	Subscription fee; User fees
Montreal	Publicly owned and operated	GCC	City authority funding; sponsorships	Membership fee; User fees
Washington DC	Publicly owned Privately operated	GCC	Govt Funding - US DOT and National Region Transportation Planning Board	Membership fee; User fees
Mysuru	Publicly owned Privately operated	GCC	World Bank, DULT and Municipal funds	Advertising; Membership fee; User fees
Bhopal	Publicly owned Privately operated	GCC	Smart Cities Mission, capital subsidy by Bhopal Municipal Corporation	Advertising; Membership fee; User fees
Ranchi	Publicly owned Privately operated	GCC	Smart Cities Mission	Advertising; Membership fee; User fees
Bengaluru	Privately owned and operated	NCC	Venture capital	User fees
Pune	Privately owned and operated	NCC	Venture capital	User fees

Within the GCC model, the payment terms differ for each system. For instance, Mysuru reimburses both capex and opex through pre-fixed periodical payments to the operator selected through competitive bidding. However, in Bhopal, 50% of the Capex is reimbursed along with VGF on Opex. The balance 50 percent capex is borne by the operator. Another variant is the Ranchi model where the operator receives payment as a service charge (Rs. per cycle per day), which includes capex and opex. In all systems, initial capex is made by the private operator.

The appointment of an operator in the GCC model is through competitive bidding while it is permit or MoU based in NCC model. Thus, while the PBS operators in Mysuru, Bhopal, and Ranchi are appointed through a tendering process, Bengaluru and Pune used a permit-based system. The Bengaluru Operator – Yulu – pays a permit fee of INR 50 per cycle per year to DULT. The NCC loads all business

risks on the operator. According to some operators, a system based on bicycles alone is not viable as the fares are not enough to generate a sustainable system. Their current strategy, therefore, revolves around introducing value-added form factors such as the electric scooter, which, given higher speeds and absence of pedalling effort, can attract a large number of trips and provide a bigger scale at a more rewarding fare.

Roles and responsibility allocation in Indian PBS systems

Each contract of the project outlines the level of involvement of the stakeholders at different stages such as planning, implementation, and operations. In the Indian PBS systems, the involvement of state nodal agency and advisors is perceived to be significant. For instance, DULT played a critical role in conceptualising and rolling out the Mysuru and Bengaluru systems. It was involved in system

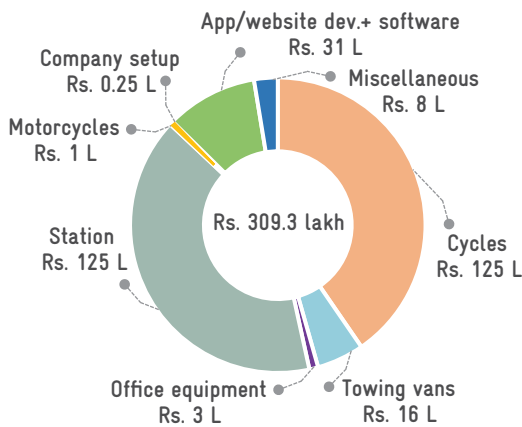
planning, procuring, funding, Detailed Project Report (DPR) preparation, and site selection for the docking stations. Further, in GCC models, state nodal agencies (often through external advisors) have played vital roles at planning stages and in supporting operations. Also, in smaller cities such as Bhopal and Ranchi, the involvement of external advisors was observed to be considerably higher.

VIABILITY GAP IS INEVITABLE

Assessing the financial viability of a PBS system is critical to the selection of business model. The study looked at a typical financial model of the Indian PBS system, taking inputs principally from Ranchi's PBS system.

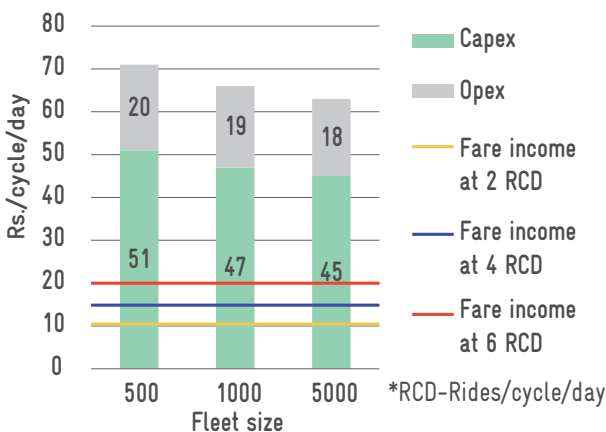
The initial expenditure of the system includes the cost of bicycles, stations, IT development, company setup, etc. as exhibited in Figure 18.

Figure 18: Capital cost distribution (in lakhs INR)



As per estimates, the total capital cost for a system size of 500 bicycles works out to be around INR 309 lakhs (30.9 million) at 2020 prices. This translates to a capex of about INR 60,000 per cycle or INR 50 per cycle per day including capital servicing cost (assuming asset life of 5 years).

Figure 19: Income vs expenditure



The results from Indian case studies revealed that PBS systems are not viable on their own and need a VGF to remain sustainable. However, like public transport, this gap is almost impossible to predict. NCC models based on promised gap funding would ultimately unravel. GCC models, therefore, could be preferred with incentives to operators for higher ridership during operation. Opex should be supported through advertisement or sponsorship, though unfortunately, these revenues are insufficiently explored. The authority must include departments with responsibility of advertisement management and street infrastructure during planning and implementation of PBS to ensure easy exploitation of promised advertisement rights by removal of conflicts between multiple contracts.

In the Indian PBS systems, farebox is the most common source of revenue. The first 30 mins are offered free of cost to the system users who have registered by paying a membership fee. An attempt by the Mysuru system to charge a fee for the first 30 minutes led to a drop in ridership. The decision was reversed. An analysis of primary data revealed that approximately 80 percent of the PBS users' trip time is within 30 mins. Thus, the proportion of revenue generated from fares is usually smaller than that required to recover even the operating expenditure. Supporting income such as advertisements on the station panels could yield income equalling fares (Bhopal) but exploitation of these rights, even when allotted through the contract is fraught with institutional difficulties as they compete with street advertisement rights already awarded to other agencies (Ranchi) or a city level prohibition (Mysuru).

PBS systems cannot recover capex through usage revenue.

The financial modelling from Indian case studies revealed that capex is not recoverable in a PBS project, while opex is only partly recoverable from fare as the only source of revenue. Figure 19 brings out that cost reductions that can be achieved by scaling up the system size from 500 to 5000 bicycles are not substantial and cannot be recovered at the existing



ridership level of 2-3 rides per cycle per day. Only when ridership levels hit 6 rides per cycle per day, can opex be recovered through fare revenue. Moreover, the viability is not substantially influenced by the change in ridership levels because fare income is not significant.

PBS SYSTEMS BENEFIT CITIES

The operation of PBS systems accrues benefits to society – socially, environmentally, and economically. PBS systems provide people with an alternative option of choosing a greener mode of transport over fossil fuel-based vehicles. The modal shift towards PBS can have potential benefits like reduction in use of non-renewable fuel, reduction in congestion, reduction in GHG emission, health benefits, saving in travel time, saving in operating cost, etc. To understand these impacts, the following benefits accruing from the project are determined:

Environmental benefits

- Reduction in GHG emission

Social benefits

- Productivity improvement through health benefits

Economic benefits

- Benefits from saving in Travel Time
- Benefits from saving in Vehicle Operating Cost

The benefits are analysed with respect to change in ridership levels. It was observed that the benefits incurred from savings in travel time and vehicle operating costs were significantly higher in comparison to other benefits.

As Table 3 exhibits, except for Bengaluru and Pune, in all three cities, the benefits surpassed the costs at a ridership level higher than 3 rides per cycle per day. In Bengaluru, the benefits surpassed the cost even at 1 ride per cycle per day. This is due to the less capital-intensive dock-less technology in Bengaluru and Pune.

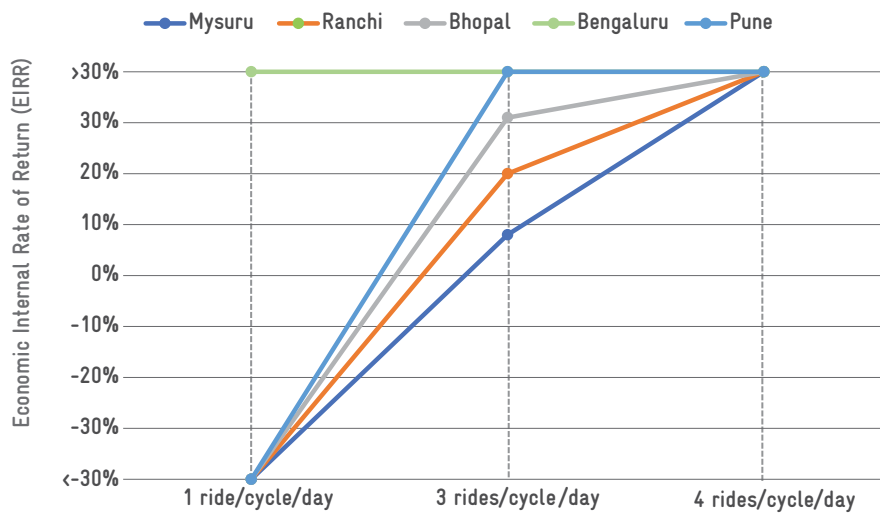
Table 3: Economic cost-benefit estimation (in terms of benefit to cost ratio)

Ridership levels	Mysuru	Ranchi	Bhopal	Bengaluru	Pune
1 RCP	0.3	0.4	0.4	1.6	0.7
3 RCP	1.0	1.1	1.2	4.7	2.1
4 RCP	1.3	1.5	1.6	6.2	2.8

*RCP – Rides per Cycle per Day

The sensitivity analysis revealed that economic viability is highly sensitive to ridership levels. As shown in Figure 20 a change in ridership from 1 to 3 rides/ cycle/ day will alter the Economic Rate of Return (EIRR) significantly.

Figure 20: Sensitivity analysis



Metro rail projects provide larger economic and social benefits to the society but provide poor financial returns. Earlier, the Government of India used Financial Internal Rate of Return (FIRR) of 8 percent and above as the project approval criteria. The Metro Rail Policy 2017 has now replaced this threshold criteria as Economic Internal Rate of Return (EIRR) of 14 percent and above. This change represents that the social and economic benefits accrued from the project are more important than mere commercial returns. Likewise, PBS systems have low financial gains but can provide substantial economic and social benefits. Cities willing to implement PBS system must appraise the project based on economic returns.

6



REGULATIONS

The section evaluates regulatory framework pertaining to bicycles in India. An attempt has been made to analyse impact of various emerging form factors on existing regulations related to PBS and cycling in general.



INTRODUCTION OF DIVERSIFIED FORM FACTORS UNDER PBS SYSTEMS

Indian PBS systems are experiencing penetration of various form factors such as completely battery-operated vehicles (e-scooters) and pedal-assisted bicycles (e-bikes) in the system. Other motorised form factors such as segways, hoverboards etc. could also emerge. As a transport mode, all these form factors will have a role to play in overall urban mobility eco system, particularly since feeder systems to public transport or options for shorter trips are not fully evolved in Indian cities. However, they may not provide similar health and environmental benefits associated with pedal-based cycling.

E-Bikes and other form factors

In India, vehicles powered exclusively by an electric motor are categorised as Battery Operated Vehicles (BOV) under Central Motor Vehicles Rules (CMVR), 1989 and are liable to comply with all extant rules and regulations related to motor vehicles but BOVs with

following conditions fall under exempted category -

(i) the "thirty minutes power" of the motor is less than 0.25 kW

(ii) the maximum speed of the vehicle is less than 25 km/h

(iii) bicycles with pedal assistance which are equipped with an auxiliary electric motor having a thirty-minute power (as per AIS 043: 2003) less than 0.25 kW, whose output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h

On account of power less than 0.25 kW and maximum speed less than 25 km/h, e-bikes and e-scooters under existing PBS systems do not fall under ambit of motor vehicles. Hence the transport rules such as mandatory registration, use of driving license, road tax, insurance etc. are not applicable to them.

These regulatory exemptions for something like bicycles may not be concerning but with e-bikes and e-scooters, due to relatively higher speeds they add to other concerns such as safety and in some cases, competition with public transport modes.

Discussions with start-ups offering services such as e-scooters on sharing basis revealed that they do not see any need for major revisions in



There is need for framing a uniform policy, covering various aspects related to active mobility (walking and cycling), BOVs and other emerging form factors. Framing any such policy would, however, require a comprehensive understanding of the role these modes play in the overall mobility ecosystem accompanied by balancing the need for encouraging innovation and ensuring “ease of business” for new entrants covering various aspects (safety, quality, usage and age restrictions, infrastructure, modal integration etc.). Adopting such a national policy framework would go a long way towards guiding states and cities in India looking to integrate various urban mobility options including PBS.

regulations related to cycling or PBS. They fear that such provisions might lead to restricting the growth of this sector. However, more complex regulatory challenges could emerge when advanced form factors with battery powered traction (such as segways, motorised boards etc.) hit the market.

Learnings from international experiences

Internationally, regulations and legislation measures related to shared e-scooters and e-bikes vary from country to country.

In Jakarta, Singapore and Shanghai, e-scooters are banned on roads and pavements entirely, while Paris has banned riding and parking them on pavements¹.

¹ <https://www.bbc.com/future/article/20200608-how-sustainable-are-electric-scooters>

The major reason behind these regulations or restrictions was safety concern as these vehicles silently glide through streets and can be potentially dangerous for small children and people who are differently abled, such as blind and partially sighted people.

For e-bike users, some countries like the United Kingdom and the United States have age limits while other cities have restriction on speed limits (often 25 km/ h with a power output of 0.25 kW to 0.4 kW) or rules regarding where they can be used and parked.

In US, the e-bikes have 3-tier classification: (i) Class-I: 32 kmph - no throttle, (ii) Class-II: 32 kmph - throttle and (iii) Class-III: 40 kmph - no throttle. According to these classifications, other rules in terms of use of helmet and bicycle tracks are delineated for each class. However, different states in the US have adopted different rules on e-bikes from this base, differing in terms of motoring classification, helmet and age restriction, licensing, registration, infrastructure use and insurance.

Therefore, in order to encourage innovations in various form factors and to provide conducive and safe environment for different modes, it is imperative to have a national level policy which is uniform in nature across all states/cities in the country.



NEED FOR NATIONAL POLICY FRAMEWORK ON ACTIVE MOBILITY

Active mobility refers to human-powered forms of travel such as walking, cycling etc. As mentioned earlier as well, with emergence of advanced form factors like e-bikes and segways, many countries and cities globally, have started implementing specific policy interventions to address issues pertaining to these modes. For example, Singapore has a specific Act, the Active Mobility Act 2017 for establishment and regulation of public paths for walking, cycling and use of Personal Mobility Devices (PMDs). The Act collectively refers to walking, cycling and PMDs as forms of ‘Active Mobility’. It covers bicycles and all related form factors such as Power Assisted Bicycles or e-bikes, Motorised or non-motorised PMDs (e.g. hoverboard/manual kick scooter) or a Personal Mobility Aid for disabled or old people. The Act is comprehensive and defines all types of vehicles and respective standards in detail and provides conditions and places for their usage. There are stringent fines for violating these requirements which are displayed on streets and parks. Countries like USA, Canada and Australia have also implemented specific regulations for the use of these modes.



BICYCLE REGULATIONS IN INDIA

Administratively in India, bicycles fall under Light Engineering Industry and policies related to this industry are framed by Department of Promotion of

In India, strengthening bicycle standards, R&D, training facilities, testing, and certification is essential. Policies are required to promote “Make in India” in PBS. As a promotional measure, the GST on ordinary bicycles can be reduced, which will assist the PBS operators as well as bicycle users (especially in rural areas and economically weaker sections). Secondly, cheap Chinese imports routed through Bangladesh and Sri Lanka by taking advantage of the zero import duties under the South Asian Free Trade Agreement (SAFTA) have created a crisis in Indian bicycle Industry². This can be mitigated by modifying the existing rules of origin of SAFTA and imposing sourcing restrictions on SAFTA’s signatory countries like Bangladesh and Sri Lanka so that Chinese imported products are not pushed into the Indian market by them during any stage of production. These policy changes can be tied with Government of India’s initiatives like Make in India and AatmaNirbhar Bharat Abhiyaan.

Industry and Internal Trade (DPIIT), Ministry of Commerce, Government of India. The regulatory framework of bicycles comprises of manufacturing standards, certifications, provisions related to safety, usage, age restrictions and infrastructure use. Manufacturing standards are framed by Bureau of Indian Standards (BIS) empowered under BIS Act 2016. Regarding safety and usage, Motor Vehicle (MV) Act regulates all aspects of road transport vehicles. Bicycles however do not fall under its definition of a vehicle and hence owning a bicycle does not require licencing, registration, road tax, insurance etc.

Recent trends in bicycle manufacturing shows unprecedented growth of unorganized bicycle suppliers which has led to substandard bicycles endangering safety of cyclists (NITI Aayog, 2020). Therefore, in order to improve overall value chain for bicycle manufacturing, regulatory gaps in following areas need to be addressed -

i) Safety Standards: Are safety standards affecting bicycles stringent enough? In India, standards related to manufacturing and certification of goods are framed by Bureau of Indian Standards (BIS) empowered under BIS Act 2016. A report published by NITI Aayog states, “BIS has around 30 bicycle standards in India but all of them are voluntary in nature” (NITI Aayog, 2020). This lack of quality control calls for a mandate from government to make bicycle standards compulsory. Further, in terms of certification, there is principally only one agency in the form of R&D Centre, Ludhiana, and institutional capacities in this area need to be strengthened/ broad based.

ii) Infrastructure: Is adequate infrastructure available for cyclists? While many standards and manuals are available in the country on how to make good NMT infrastructure, access to safe cycling infrastructure remains a distant reality in most of the Indian cities. Making funding, approval and clearance of urban road projects conditional on provision of safe cycling infrastructure (bicycle friendly streets, segregated lanes, bicycle parking etc.) would be strong step in direction of encouraging cycling and PBS.

(iii) Taxation: Bicycle use is promoted by several ministries but ordinary bicycles (pedal-based), which are mostly used by people with relatively lower income, are covered under 12% GST slab. On the contrary, electric bicycles are charged under a lower GST slab of 5%. Since bicycles, irrespective of whether they are electric or pedal-based, provide similar environmental benefits, reducing taxation on ordinary bicycles to lower GST slab needs to be explored by government.

² <https://www.thehindubusinessline.com/opinion/cheap-imports-threaten-bicycle-industry/article29291592.ece>





7



CONCLUSION

Cities need to articulate their cycling strategy clearly. PBS will not start a cycling revolution. It must be part of larger transport vision and strategy. They need to translate their vision into concrete plans and projects with dedicated institutional support and funds. There is an increasing trend to outsource operations and the revenue risk to the private sector. PBS, as the name suggests, is *'public'* in nature and must be a public sector funded initiative. If seen from this perspective and integrated with other public transit systems in the city, it has the potential to increase ridership across public transit. Since Indian cities report trip lengths of 2-4 km on PBS, with good density of stations and high-quality infrastructure, there is tremendous potential to shift many short-motorised trips to the bicycles.

The COVID-19 pandemic has seen a cycling resurgence around the world. Paris, London, and New York are seeing massive investments in upgrading and creating new bicycling infrastructure.

India too is seeing a renewed interest in bicycles. There is an increase in bicycle sales. PBS operators are offering bicycles on long-term rentals (daily, monthly, quarterly, yearly). However, PBS itself has seen a declining ridership. In Mysuru, the daily ridership decreased from 1200 trips before the lockdown to 200 trips after the lockdown. Clearly, people are still wary of sharing bicycles. However, this could be a temporary phenomenon and rides would increase once the world returns to normal. This is an opportunity for cities to plan and invest in cycling infrastructure. In the long-term, this would benefit PBS.

Above all, Indian cities need to be patient with PBS. It will require attention and care, mid-course corrections and a long-term vision. The results and conclusions from this study is an opportunity for decision makers at national, state, and local level for course correction and to reinvent the implementation of PBS in India.



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Standards/references used for benefit calculations:

1. Average saving in time – from PBS user survey
2. Benefits from saving in time – value of time (from the extracted per capita income of users from survey)
3. Pollution emission reduction and its benefits - Volume of pollutants emitted (gram per km) for different modes and treatment cost per ton
Document: Appraisal Guidelines for Metro Rail Project Proposals by MoHUA
4. Benefits from productivity improvements - Average 1.3 days less absent in a year due to sickness than those who do not cycle to work
Document: (1) Hendriksen, I., Simons, M., Garre, F., & Hildebrandt, V. (2010). The association between commuter cycling and sickness absence. *Preventive Medicine*. (2) Neun, M. and Haubold, H. 2016. The EU Cycling Economy – Arguments for an integrated EU cycling policy. *European Cyclists' Federation, Brussels, December 2016*
5. Benefits from saving in VOC – Unit VOC cost is calculated using the equations and guidelines given by Indian Road Congress (IRC) Document: (1) "Manual on Economic Evaluation of Highway Projects in India, 2009" by the Indian Road Congress (IRC) (2) Appraisal Guidelines for Metro Rail Project Proposals by MoHUA



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