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FINANCING SUSTAINABLE CITIES INITIATIVE

WORKING PAPER

THE EVOLUTION OF BIKE SHARING: 10 QUESTIONS ON THE EMERGENCE OF NEW TECHNOLOGIES, OPPORTUNITIES, AND RISKS

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EXECUTIVE SUMMARY

Highlights

- Bicycle-sharing schemes (BSSs) are experiencing a major breakthrough in cities at a global scale. Of the estimated 1,600 schemes in operation in 2017, approximately 95 percent were launched since 2007, with more than 200 in 2017 alone. Recent technological transformations and innovations are dramatically reshaping our cities and increasing their options to introduce and manage bike-sharing services as a new mode of transport.
- The rapid evolution of technological advancements in BSSs, such as dockless bike-sharing schemes, electric bicycles, and increased private sector involvement, are prompting cities to ensure that legislation and regulations are in place to adequately safeguard the efficiency and safety of this mobility option.
- To ensure a safe and sustainably integrated urban mobility network including a BSS, it is essential for local governments and bike-sharing operators to work together.
- The role of public-private partnerships can be important in any public mobility service, particularly in terms of bike sharing. City administrators and private entities must work together to develop appropriate legislation, provide adequate infrastructure, and manage the operation and maintenance of the service.
- To ensure success, the key factors are the scale of and access to BSSs, whereby bike sharing should be at a scale that corresponds to the size of the city and is easily accessible to achieve ridership.

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. Working papers may eventually be published in another form and their content may be revised.

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Context

A BSS allows a user to collect a bicycle on loan from one location and return it at another destination. Bike sharing began in the 1960s in simple form in Amsterdam; it has continued to evolve through technological innovation to a more sophisticated model of bike transportation within cities, and has rapidly expanded over the last decade. The evolution of business models and private investment continues to reshape and widen the reach of bike-sharing services dramatically, so much so that the increased popularity is embedded now in the wider landscape of an emerging sharing economy in urban centers worldwide. Other similar services include Uber and Lyft, which allow users to avoid the high costs of and other barriers to ownership.

About This Working Paper

The objective of this working paper is to provide decision-makers at the city level a series of frequently asked questions and responses in order to assess the adoption and implementation of a BSS. It is not designed to be a comprehensive guide to bike-sharing implementation, nor is it meant to provide prescriptive recommendations; rather, it offers questions and answers objectively in order to assist city officials to navigate through the recent developments and innovations of new and improved technologies, data, and business models relating to bike sharing. The emergence of new technologies, including dockless and electric (e-) bikes, is creating new opportunities, so much so as to raise the interest and risk concerns of city officials around the world. This publication aims to shed light on these.

The Evolution of Bike Sharing: 10 Questions on the Emergence of New Technologies, Opportunities, and Risks

Questions have been formulated to include all phases of a typical bike-sharing project cycle. They have been selected carefully by the authors, based on their expertise in providing technical assistance to local decision-makers whose aim is to implement a BSS in their cities. The World Resources Institute has provided technical support to cities such as Bhopal, India; Mexico City, Mexico; Bogotá and Santiago de Cali, Colombia; among others. The questions explore the role of policy, technology, safety regulations, financing, and monitoring and evaluation (M&E), these key topics having arisen during consultations with city officials regarding the integration of bike sharing into their larger public transit networks. Brief summaries of the questions that will be touched upon in this publication are included below. These are intended to provide context to the relevance of each topic, rather than offer direct answers to the questions posed, which will be elaborated later in the paper in separate sections.

Question 1: What are the characteristics of a BSS?

Bike-sharing technology has continuously evolved over multiple generations, becoming more and more sophisticated. Earlier generations (first generation and second generation) struggled with theft and vandalism, leading to innovations (third generation) that improved user information, payment options, and distribution stations across the city. A fourth BSS generation has now emerged, with dockless and electric bikes coming into the fold. Dockless provides a more flexible solution in terms of the use of public space for the parking and distribution of bicycles. As increasing variations and innovations in BSSs emerge, cities increasingly will be able to adopt and operate the model within a local context. The variety of options today requires more in-depth analysis, dedicated planning, and regulations than what was needed for previous generations, particularly in light of the new business models that are coming to the fore within the private sector.

Question 2: What are key elements to consider in fitting bike sharing into my city's policy and mobility framework?

The type of BSS that best suits a city varies based on a range of specific variables such as city size, geography, safety infrastructure, and legal structure. To ensure smooth implementation of a BSS within the broader urban mobility landscape, for instance, cities should (i) identify the enabling policies currently in place or those that are necessary at the federal, state, and local levels; (ii) ensure integration with public transit networks; and (iii) assess the bicycling objectives of the city. A BSS has many economic, social, and health benefits, including among others an additional transportation option for short trips; enhanced first- and last-kilometer connectivity and integration with the public transport network; reduction of barriers to biking; reduction of greenhouse gas emissions; improvement of local air quality; and increased physical activity for users. There also are costs that are associated with a BSS that are other than financial in terms of implementation; a BSS, for example, often faces opposition from private car owners at the planning and implementation stages, given that docking stations in streets may decrease street width, thus reducing the availability of spaces in which to park cars. Furthermore, the inclusion of dockless bikes within the mobility system may raise the

debate on how public street space should be put to use.

Question 3: What institutional and regulatory frameworks are required for a BSS?

Political will and leadership are essential for the success of any urban transport system. With regard to the BSS, it is evident from many cases that it is essential to form a coordinating team that includes members of various relevant institutions. Effective management and the setting of and compliance with regulatory standards also are crucial to ensure that dock-based and dockless bike-sharing (DBS) models alike will create not only benefits relating to mobility in the short term but also opportunities in the long term. The preparation of regulatory frameworks is especially critical for cities that expect to introduce or expand a DBS scheme. DBS companies and local government authorities (e.g., planning and transport department officials) should work together to put in place permit schemes and set regulatory standards to facilitate implementation as well as provide cities with the ability to control safety, manage public spaces, and plan effectively.

Question 4: What is the planning process to implement a BSS?

The BSS planning process is a significant initial step to creating a beneficial asset to the city and its residents, as well as to the success of the operator. To achieve the necessary ridership rate for long-term success, the scheme must be developed such that it is widely accessible. This will depend, to some extent, on a planning process that is sufficiently robust as to include a prefeasibility study to assess BSS potential; a feasibility study to define the technical components of the project; a detailed project design process; and a competitive tender or permit for implementation. Experience indicates that by integrating BSS stations with public transport and providing sufficient numbers of these across the city will increase accessibility and thus ridership. Also evident is the importance of positioning stations (or service areas for dockless bikes) in mixed land-use zones to ensure short-trip coverage benefits in various directions so as to extend usage from only peak hours to increased usage throughout the day.

Question 5: What are the operations and maintenance strategies for a BSS?

The operations and maintenance (O&M) of a BSS is critical to ensure its long-term success and extended life span as a mobility option. O&M also determine quality and safety to boost user confidence. Cities have adopted various models of O&M, whereby a scheme may be publicly owned and operated, or publicly owned and privately operated, or fully private with a formal alliance at the municipal level. During contracting or permitting, O&M strategies and funding should be clearly defined and allocated, respectively. The structure of the scheme should include a specific bike-sharing agency or authority at the public level to also ensure the sharing of data.

Question 6: What are the available options for BSS financing?

In some cases, schemes have benefitted from commercial loans and guarantees, despite the fact that a BSS, in general, has relatively low upfront capital investment needs compared with other urban mobility options. For the longer term, though, user and membership fees alone are often insufficient to cover the cost of O&M. To bridge the gap, cities should be able to diversify revenue sources to include sponsorship or advertising deals, grants, and general municipal budgets. In terms of the DBS scheme, cities have tended to place the financial burden on the private sector. There is, however, potential to create a hybrid model to include the public and private sector alike—a model yet to be explored.

Question 7: What should be the structure for monitoring and evaluation?

An M&E framework not only ensures that the BSS will function effectively and that it will inform ongoing operations and expansions; it also enables cities to assess the positive and negative impacts on the mobility, health, equity, and quality of life of their societies. A critical characteristic of an M&E framework is the service level benchmark, which measures operations (hardware and software), customer service, maintenance, redistribution, marketing, and reporting of a scheme. Financial reporting, another component, evaluates operating costs such as labor, replacement parts, redistribution costs, and marketing, among others. Understanding the usage, impact, and financial status of a scheme informs decision-making in terms of further expansion and upgrading.

Question 8: Why is the focus on safety a success factor and what elements need to be considered?

The safety of the user depends on the design of the BSS and compliance with regulations, as well as on the design of infrastructure and the management efficiency of street networks. Cities should first conduct a thorough review of the (i) rate and locations of collisions and fatalities and their relationship to road infrastructure design and road safety measures; (ii) current cycling levels and provision

of cycling-related activities; (iii) presence and adequacy of cycling infrastructure and equipment; and (iv) infrastructure and equipment that support cycling, and then create and execute a plan to improve these factors alongside the implementation of a BSS. A network of appropriately designed and located cycling infrastructure will not only improve safety conditions, but also boost the attractiveness of BSS to potential users, motivating more people to take up cycling as a means of transportation.

Question 9: What are the branding and marketing elements of a BSS?

The branding and marketing of a BSS is essential for its success. It provides the scheme its own identity to boost rider usage and rider frequency. Outreach efforts through workshops, training sessions, contests, festivals, and events (e.g., car-free days, cycle days, walk days) can help build the brand and foster the culture of cycling. Harnessing the experiences and connections of local organizations, such as universities and cycling advocacy groups, will extend the scheme's reach and provide access for underrepresented groups (e.g., minority and lower-income populations). Cities also can examine and take advantage, where possible, of branding associations through sponsorships. Creative names, logos, and taglines also strengthen brand identity.

Question 10: What aspects should be considered when integrating the dockless model?

DBS technology will continue to reshape the bike-sharing landscape, catalyzing cities to examine potential opportunities and impacts on the local mobility system and to determine how to accommodate the new BSS generation. It remains unclear how the traditional docked BSS will coexist with one that is dockless, although initial results indicate that there is room for complementarity. Further peer-reviewed research and documentation is required before reaching any conclusion. What does remain certain, however, is that cities must ensure that the BSS planning process is rigorous, as should be its evaluation, permitting, and regulation. This should apply whether they intend to implement a new BSS into the public transit and urban mobility environment or expand an existing BSS or DBS scheme.

Conclusion

Providing an opportunity for safe and convenient bicycling to citizens is a fundamental element in mobility and transport planning and strategizing. The BSS represents a powerful means to consolidate urban bicycle use in cities while integrating it into the wider mobility network. Awareness of these aspects in the decision-making process may contribute to cities finding the means to implement BSSs in terms of planning, regulatory standards, O&M, M&E, financing, safety, and branding. The benefits of this third generation docked BSS are well established. With the rapid evolution of bike-sharing technology, cities must be proactive, not reactive, in the face of new innovations to understand the risks and opportunities they represent. The knowledge they gain as a result of being proactive will equip them not only to identify the need for a BSS but will also facilitate the establishment of one or more within the local context.

Dockless bikes and/or e-bikes are the most significant technological advancements to date in terms of the BSSs and are able to provide a range of benefits to cities. In order to capture these benefits, however, cities must be able to establish the type of regulatory standards that will manage the challenges of, for example, the use of public space, sharing of data, road safety, and financing. While a scheme may be entirely privately operated, cities nevertheless must ensure that private sector companies apply the same planning process that is applied to other modes of transport, taking into account the city's broader mobility and road safety strategy.

INTRODUCTION

Bicycle-Sharing Schemes in Context

In general, bicycle-sharing schemes (BSS) encourage individuals to use bicycles for urban transport. Riders are required to pay a fee to access[1] a collection of bikes, typically for a short, point-to-point journey. Bike sharing has helped overcome many of the barriers to using bikes as a mode of transport, including safety concerns, space for storage, maintenance, weather, travel patterns, and overall cost. Reducing the challenges to biking will motivate more people to take up cycling, thereby contributing to the effort of cities to increase transport accessibility. A BSS can increase the cycling rate in cities; contribute to an integrated multimodal transport system; and help resolve the issues of congestion, poor air quality, high greenhouse gas emissions, and lack of transport options, thus optimizing not only the health of people, but also the local economy. Bike sharing has become part of a wider prospect for a collaborative—or sharing—economy, whereby traditional and dockless bike share (DBS) schemes can partner with transport services such as Uber and Lyft, as well as contribute to overcoming the challenges of first- and last-kilometer connectivity (Laamanen et al. 2018; Chase 2015).

Introduced in a basic form in the 1960s, formal bike-sharing services did not expand at such a rapid pace until recent years. In 2015, there were approximately 1.2 million publicly accessible shared bicycles worldwide (MetroBike 2017), increasing to over 16 million in China alone within the following two years (Rushe 2017). The widely accepted definitions of generations of bike sharing and their evolution is summarized as follows:

- **First generation**: Began in Amsterdam in 1965 as a scheme of unlocked and free-use bikes in several unregulated areas of the city (Shaheen et al. 2010).
- **Second generation**: Launched in Copenhagen, Denmark, in 1995, use of the scheme continued to be free, although riders were required to insert a coin deposit to unlock the bikes (ITDP 2018c).
- **Third generation**: Launched in 1998 in Rennes, France, technology advanced to include automated options (e.g., credit cards, smart cards) to access station-based bikes and track information (i.e., embedded GPS) (Shaheen et al. 2010).
- **Fourth generation**: The bikes have been transformed to have automated locking (without the need for a dock) and on-bike electrification; and docking stations are now able to be equipped with solar panels for bike power. In addition, certain DBS companies now provide bicycles with "lock-to" technology (an integrated U-lock that is holstered to the frame). To use these models, the rider has to lock the bike to a fixed object at the end of a trip. Other modes of transport, such as e-scooters, are being introduced to the DBS family.

Most recent innovations in bike sharing, loosely grouped under the fourth generation, are rapidly reshaping the mobility landscape, given tremendous increase in the number of shared bikes available in cities across the globe. From 2015 to 2017, DBS expanded from small, campus-scale schemes in China to more than 17 million bikes worldwide (The Economist 2017). While the technology continues to evolve, the concept of bike sharing is becoming an essential part of city mobility and sustainability plans and, as such, cycling is steadily increasing at a global scale. In Beijing, cycling mode share rose from 12.6 percent in 2015 to 13.5 percent in 2016, including privately owned and shared bikes (BJT 2017).

This publication discusses 10 key questions that have been drawn from author engagement with the WRI Ross Center for Sustainable Cities network (see Box 1 for more details on methodology). Research was carried out within the framework of the Financing Sustainable Cities Initiative (FSCI), funded by the Citi Foundation, a partnership between the WRI Ross Center for Sustainable Cities and C40 Cities Climate Leadership Group, which helps cities accelerate and scale up investments in sustainable urban solutions.

Objective

The objective of this working paper is to provide city decision-makers a series of frequently asked questions and responses to consider when assessing whether to adopt a BSS. The working paper is not designed to provide comprehensive guidance to bike-sharing implementation, nor does it prescribe any recommendation; rather, it offers questions and attempts to respond to them in an effort to help city officials negotiate the path toward new and improved BSS technologies, data, and business models. New technologies, such as the dockless bike, e-bike, and e-scooter, not only create opportunities but also raise concerns around the world. This publication aims to shed light on them as clearly and concisely as possible.

Box 1 | Methodology

To comprehend current trends in bicycle-sharing schemes (BSSs), 32 case studies (Figure 1) relating to BSSs were selected from 500 catalogued examples across the globe. The selection was based not only on their geographic distribution, but also on a more in-depth review in consultation with experts. Furthermore, they were well documented and system performance data were readily available. A common research approach was then adopted, focusing on the following four dimensions:

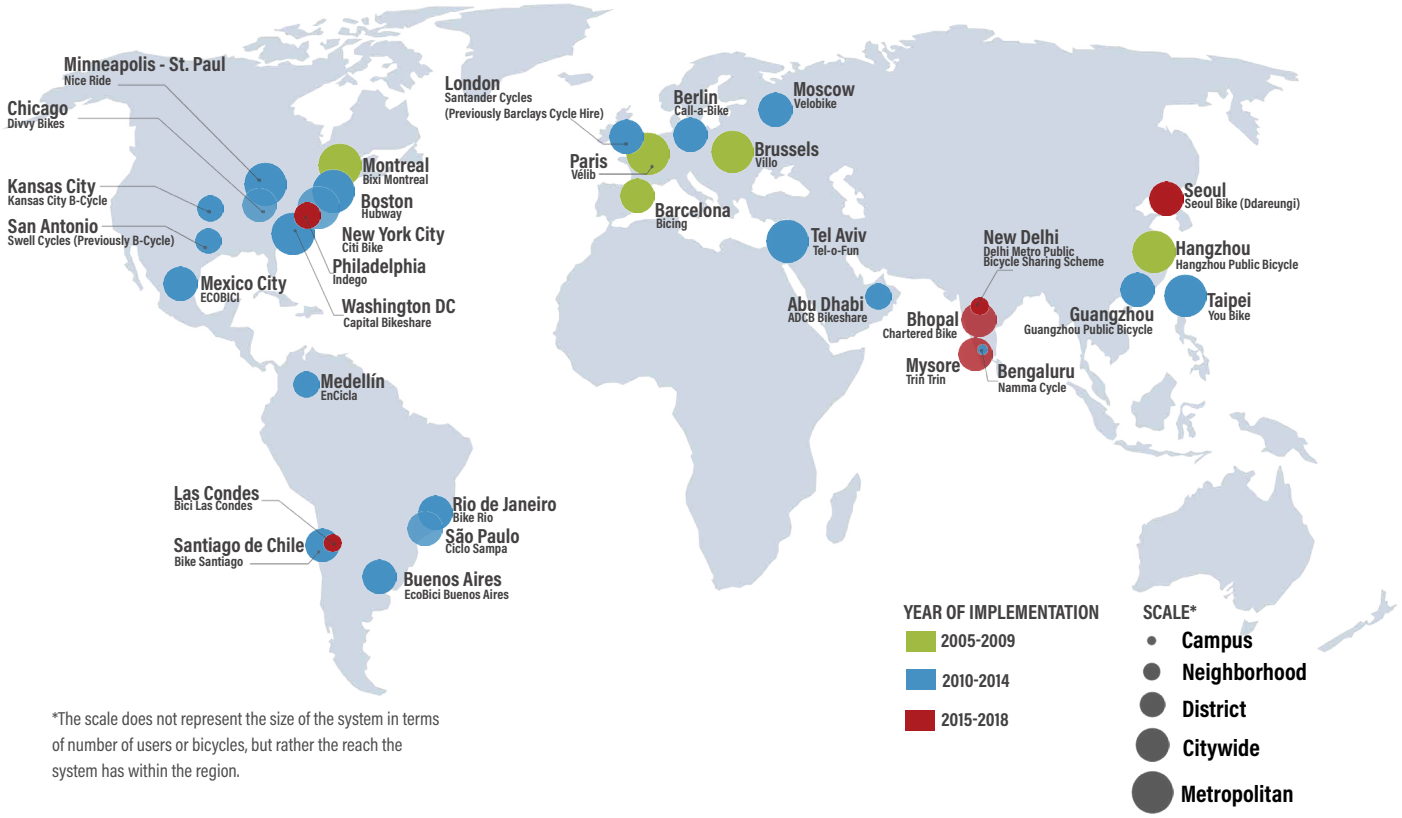
- Technical components: What types of technology and infrastructure needs arose during implementation?
- Funding: What revenues, incentives, and other budgetary allocations were used to cover expenses?
- Financing: If any, what types of capital, investors, and credit-enhancement options were used to mobilize investment capital?
- Legal arrangements: What policy frameworks, ownership structures, and contracts shaped implementation?

Data collection consisted of literature reviews, desktop research, and practitioner consultations, the last of which included experts familiar with schemes such as EnCicla (Medellín) in Colombia; Citi Bike (New York), Capital Bikeshare (Metro Washington, DC), Indego (Philadelphia), and San Antonio B-Cycle (Texas) in the United States; ECOBICI (Mexico City) in Mexico; Guangzhou Public Bike Share and Huangzhou Public Bike Share in China; and Chartered Biked Bhopal and TrinTrin Mysore in India.

The methodology adopted and most of the research for this paper were established and undertaken, respectively, prior to the rapid emergence of the dockless bike-sharing (DBS) model and, as such, it is not represented in this case study. Nevertheless, this fourth generation BSS has been taken into account by the authors to help shape the information provided on this new plane for bike sharing, given the literature reviews, desktop research, and on-the-ground experiences (e.g., Mobike (Beijing) and entry of DBS companies into Mexico City).

Based on the research, every BSS has its advantages and disadvantages; each is unique and can be adapted to local conditions. No effort on the part of the authors has been made to identify exemplary cases or qualify their success or failure. The case studies represented in this publication are simply to showcase the benefits of BSSs and the innovative concepts of cities in relation to them.

Figure 1 | **Overview of Analyzed Bike-Sharing Schemes 2017**



*The scale does not represent the size of the system in terms of number of users or bicycles, but rather the reach the system has within the region.

Sources: Metropolis 2016; Yao and Zhou 2009; SGIAUI 2014; Bixi 2018; VélibSmovengo & SAVM 2018b; Villo 2018; Ajuntamento de Barcelona n.d.a; GoM 2018; GoA n.d.; GoUK n.d.; Nice Ride n.d.; Capital Bikeshare 2017a; Bike Itau n.d.; YouBike 2018; Tel-O-Fun n.d.; Hubway 2018; NammaCycle n.d.; GoCo n.d.; Call a Bike 2018; BikeWalkKC n.d.; GoB 2017; Citi Bike 2013; Divvy Bike Share Program 2018; Mi Bikesantiago n.d.; Velobike 2018; ADCB n.d.; Bici Las Condes n.d.; ITDP & GoIn 2015; Indego Philadelphia 2017; Bike Seoul 2015; Smart City Bhopal 2018; GoIn 2017; Ciclo Sampa 2018; and consultation in 2016 with Paul DeMaio, Manager, Capital Bikeshare, Washington, DC

TEN QUESTIONS ON THE EMERGENCE OF NEW TECHNOLOGIES, OPPORTUNITIES, AND RISKS

Q1: What are the features of a bike-sharing scheme?

BSSs evolved along a continuum of increasing technological sophistication in four distinct generations. The classification of generation refers to the type of technology used. The generations, while neither relevant to specific ownership—whether public and/or private—nor to mode of operation, will be explored in Section Q5 (Shaheen et al. 2010; Fishman 2016; GoIn 2018; Anaya et al. 2012; Montezuma 2015; Schönberg 2015).

Q1.1 First Generation: "Free" Bikes

Launched in Amsterdam, the Netherlands, in 1965, the first generation of BSS reduced the traffic in the city center (ITDP 2013). Bicycles were painted white or a bright color, unlocked, and free to the rider in several unregulated areas of the city (Shaheen et al. 2010). La Rochelle in France and Cambridge in the United Kingdom established similar schemes in 1974 and 1993, respectively. Without the tracking of riders or bikes at the time, bike theft was common, reducing the viability of the BSS (Fishman 2016).

Q1.2 Second Generation: Coin Deposit Stations

A new concept took off in Copenhagen, Denmark, in 1995 as the second BSS generation. It was a free-of-charge scheme, known as ByCyklen (Figure 2), which required the unlocking of the bike by way of a coin deposit. To discourage theft, bikes were designed and built with special components that did not fit a standard bicycle (The Economist 2017). Designated docking stations were introduced, where users could unlock, borrow, and return the bikes. Similar second-generation systems were developed

in Sandnes, Norway, in 1996; Helsinki, Finland, in 2000; and Arhus, Denmark, in 2005. Some of these have evolved into operator-serviced (or manual) systems, whereby the operator manually unlocks the bikes for users (Jennings 2015). The inability to track riders still exposed this generation of BSS to theft (DeMaio 2009).

Q1.3 Third Generation: Automated Stations and Information Technology

As seen in Figure 3, the third generation of BSS technology is characterized by the integration of advanced technologies into docking stations to facilitate accessibility to the station-based BSS, enable information tracking, and reduce the need for labor (e.g., automated credit card payments, smart cards, and embedded GPS) (Shaheen et al. 2010). Bikeabout at Portsmouth University in the United Kingdom, for instance, was the first BSS to pilot an individualized magnetic-stripe card to borrow bicycles, enabling user tracking and reducing theft (Goodyear 2017). The first city-scale example of this generation is SmartBike in Rennes, France, which was launched in 1998, followed by many others. In 2018, this generation of BSS remains the most well-established and widely used in the world (DeMaio 2018).

Figure 2 | **Second Generation Bike-sharing Technology in Denmark, 1993**

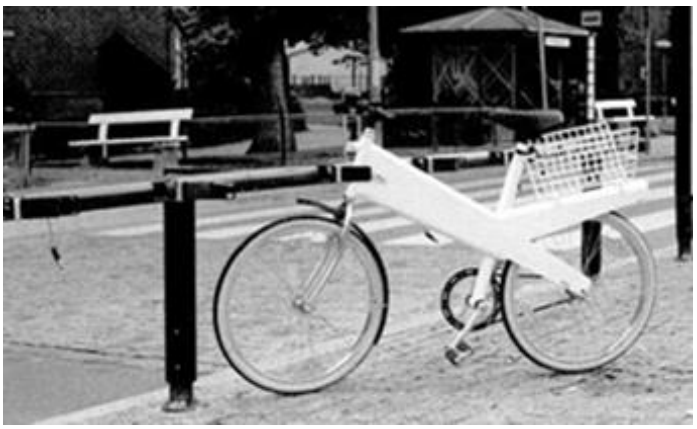


Photo: The Bike-Sharing Blog (Danish Ministry of Transport).

Q1.4 Fourth Generation: Technological Advancements and Dockless Bikes

In recent years, BSSs have been introduced with more flexible bicycle, docking, and charging designs. As opposed to the third generation, which focused on improving docking stations and enabling system access, the fourth generation provides more sophisticated BSS technology. It encompasses advancements to dock-based bike-sharing technology and the emergence of BSSs that do not require station infrastructure, commonly referred to as DBS. Key improvements include the addition of a wheel lock on the bicycle and the ability of the user to access the system through a smartphone application. The proprietorial approach and ownership structure also has shifted toward a more private sector model.

Figure 3 | **Technological Innovation Relating to a Station-Based Bike-Sharing Scheme: Milan, Italy**

**Note: the pedal electric cycle is a recent innovation and is not reflected in this image*

Photo: WRI Ross Center for Sustainable Cities.

Q1.4.1 Fourth-generation BSS innovations: Dock-based innovations

Recent changes have transformed the infrastructure requirements and the ability to access the BSS. Modular or movable docking stations have been introduced, as has off-grid electricity technology (e.g., photovoltaic panels) to power docking stations and smart cards that integrate seamlessly with other public transit modes. In terms of bicycles, the most notable advancements relate to pedelecs (low-power, pedal-assisted bikes), cargo bikes, children's bikes, tandems, and bikes that are adapted (e.g., for people with disabilities). Table 1 lists some of the innovations associated with the dock-based, fourth-generation BSS.

Table 1 | **Technological Advancements Relating to the Fourth Generation of the Dock-Based Bike-Sharing Scheme**

TYPE OF INNOVATION	NAME	DESCRIPTION	NON-EXHAUSTIVE REPRESENTATIVE EXAMPLES
STATION	Modular stations	Easily movable and do not require excavation and trenching, reducing implementation time and costs.	Bixi (Montreal, Canada), Citi Bike (New York City, United States)
	Off-grid electricity technology (e.g., photovoltaic panels)	Solar panels can be used to power bicycle-sharing scheme kiosks, stations, and wireless communications, eliminating the need for (and cost of) excavation to connect the stations to underground power lines.	Bixi (Montreal, Canada), BikeRio (Rio de Janeiro, Brazil), Capital Bikeshare (Washington, DC, United States), Hubway (Boston, United States)
	Integrated smart cards	Rechargeable smart cards can integrate bicycle-sharing schemes into the city's public transport system.	Hangzhou Public Bicycle (Hangzhou, China), Guangzhou Public Bike Share (Guangzhou, China), Vélib' (Paris, France)
ON-BIKE	Pedelecs	Pedelecs, also called low-power, pedal-assisted bicycles, support the rider with electric power when the rider is pedaling.	BikeMi (Milan, Italy), Vélib' (Paris, France), Bicing (Barcelona, Spain), BiciMAD (Madrid, Spain), Capital Bikeshare (Washington, DC, United States)
	Cargo bikes	Cargo bicycles are vehicles designed for urban freight. Nowadays, several versions of cargo bikes are available, including electric ones.	Lastenradkollektif (Vienna, Austria), Kasimir (Cologne, Germany), LondonBikeHub (London, United Kingdom), cambio (Ghent, Belgium), Outspoken Deliveries (United Kingdom), CaKi and Carvelo2go (Switzerland), TINK (Konstanz and Nordersted, Germany)
	Children's bicycles	Children's bicycles with retractable training wheels.	P'tit Vélib' (Paris, France) Mini-Bicicletar (Fortaleza, Brazil)
	Tandem bicycles	Bicycles for two people, designed for in-line or side-by-side riding.	Mi bici tu bici (Rosario, Argentina) Zagster (Various cities, United States)
	Adaptive bicycles	Hand-powered bicycles, tricycles, and side-by-side tandems increase biking access for people with disabilities.	Adaptive Biketown (Portland, United States)
	Hydrogen-powered pedelecs	Pedal-assisted bicycles whose energy is produced by an energy generator from the hydrogen stored in a tank placed in the frame of the bike.	Saint-Lô, France: Hospital and private company pilot program[1]

Sources: ITDP 2013; Navigo 2016; Abagnale et al. 2015; BikeMi 2017; Luciano 2015; Le Parisien 2017; Mini-Bicicletar 2014; Municipalidad de Rosario 2018; VélibSmovengo & SAVM 2018b; Ajuntament de Barcelona 2017; Ajuntamento de Barcelona n.d.b; BiciMAD 2014; Gruber et al. 2013; Zagster Inc. 2018; GoUS n.d.; GoF 2017; Le Monde 2017.

[1] This program is experimental; it is neither an on-demand service nor works as an A-to-B transit system.

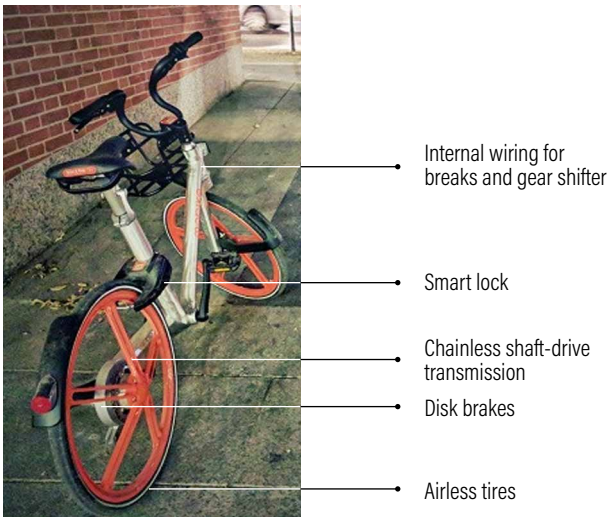
Q1.4.2 Dockless system innovations

There are various subtle technological differences in the dockless BSS. Some schemes rely on a self-unlocking mechanism that does not require a docking station, whereby users physically engage a ring lock to secure the wheel (e.g., MoBike, Limebike, ofo). Others incorporate "lock-to" technology (e.g., JUMP bikes), whereby the bike has to be locked to a fixed object at destination (Shaheen et al. 2010; Montezuma 2015; GoIn 2018; Schönberg 2015; Zimmerman 2016). The emerging popularity of smartphones now plays a crucial role, enabling riders to locate and unlock a bike through an application, and later drop it off at any publicly accessible location within a predefined geographic region (Shaheen et al. 2016).

The introduction of the dockless BSS in cities began in China in 2015 and has grown rapidly. Initial versions were launched as campus-scale pilot schemes. By 2017, more than 17 million DBS bikes were available worldwide, including more than 60 providers supported by venture capital investors. As of that date, the principal players in terms of market value are Chinese companies ofo and Mobike, which offer the service in more than 200 cities (The Economist 2017; Chen 2017). In the short course of 18 months in 2016–17, the DBS industry generated approximately 60 dockless start-up providers. In April 2018, ride-hailing giant Uber bought the dockless e-bike start-up company Jump Bikes. In addition, Lyft acquired Motivate in September 2018, the bike-sharing company that operates Citi Bike in New York City and Ford's GoBike service in San Francisco.

This rapid development in DBS schemes, however, has not come without its challenges. Most systems have permitted users to return their bikes by depositing them anywhere within a geographic delineation (geofencing) in the absence of designated docking stations, bringing about the issues of bike distribution and use of public space (e.g., overcrowding of bikes at popular destinations and presenting obstacle issues for pedestrians and other road users). How DBS providers redistribute bikes depends on company practice and the extent of city regulation. Many cities, therefore, have suffered from clogged sidewalks, piles of broken bikes, and bikes that are parked along highways (Huang and Horwitz 2017; AP+D 2017; Ho 2017). Vandalism, improper use (e.g., parking bikes behind private fences), dumping, and theft—together with the lack of data sharing for decision-makers and the uncertainty of personal data security—are many of the challenges faced by some cities (Graeme 2017; Pidd 2017), highlighting the need for cities to proactively and collaboratively establish DBS regulations.

Figure 4 | **On-Bike Innovations for Dockless Bike-Sharing Schemes**



These technological elements refer to Mobike bicycles. They are not necessarily present in other dockless bicycle schemes. (Photo: WRI Ross Center for Sustainable Cities.)

Q2: What are key elements to consider in fitting bike sharing into my city's policy and mobility framework?

When exploring the appropriate technology and business model for bike sharing, decision-makers, local administrators, and other stakeholders should have a clear understanding of where bike sharing fits within the political framework and mobility landscape of the city. It is essential to comprehend the BSS model to achieve not only broad strategic transport objectives, but also those that are bicycle specific in terms of mobility. Several elements, described in following sections, must be assessed.

Q2.1 Enabling Policy and Planning at the Federal, State, and City Levels

Cities most often include the improvement of pedestrian and cycling infrastructure within their master plans or their plans for sustainable urban mobility and land use. It is possible, therefore, to include the bike-sharing factor in such plans. By understanding the existing political framework at the local, state, or national level, city planners will be able to gain a sense of the political environment in terms of bicycle mobility. They can draw from the local and political context ways in which cities can link the environmental, health, economic, and transportation benefits of increased cycling to policy priorities and expected outcomes of current laws, policies, and programs. Section Q3 illustrates the significance of regulatory and institutional frameworks for bike sharing, as well as of an authoritative entity responsible for this mode of transport.

Q2.2 Integrating with the City's Public Transit Network

BSS stations, or parking locations, and cycling infrastructure are often linked to public transport, physically and operationally. The stations are usually located as close as possible to hubs such as public transit stations, schools, and offices. It is crucial to ensure their integration with public transit systems in order to facilitate access and to guarantee high usage levels, given that the BSS often serves last-kilometer connectivity (Suzuki et al. 2013). It also is essential to place the BSS and DBS stations in diverse areas of the city so that users are able to accomplish short trips in various directions throughout the day apart from the usual peak periods; this also will ensure the self-redistribution of bikes.

With regard to operational integration, the use of a single transport payment card will integrate a BSS with other public transport modes. In Hangzhou and Guangzhou (China) and Mexico City (Mexico), for instance, smart cards are used not only to unlock the bikes, but also to pay public transport fares (GoM 2017).[2] Operational integration also should be included in planning and infrastructure designs to enable the sharing of data between feeders and mass transit.

Q2.3 City Biking Objectives

To fully put in place a bicycle mobility strategy, transit authorities should develop dedicated and integrated biking plans that take into account the necessary infrastructure, as well as cultural and educational programs (GoM 2011).[3] The agency responsible for establishing the BSS usually references relevant bike mobility proposals, regulations, and requirements in its state or local frameworks. The BSS should be aligned with framework objectives, including the rates charged, safety of the user, and the necessary infrastructure (Patterson 2013).

Q2.4 City BSS Objectives

To clearly define where a BSS will fit into a city's mobility framework, it is essential to set specific objectives in terms of the larger vision for sustainability. These can include last-kilometer connectivity, integration with the public transport network, and modal shifts to active and more equitable mobility modes. Other intents include emission reductions and health benefits. The success of the BSS can be achieved only by identifying clear objectives that will ensure that it meets city-wide goals (ECF 2017).

Box 2 | Case Study: Mexico City, Mexico

ECOBICI is Mexico City's bike-sharing scheme (BSS), launched by the city government in 2010. It began with 85 stations and 1,000 bicycles and, as of 2018, it has expanded to over 480 docking stations and 6,800 bicycles, including 340 e-bikes, with an average of 34,000 daily users. ECOBICI is the largest bike-sharing system in Latin America and the model has been replicated in several other cities in the region. It also won the Ciclociudades Award in 2013 for providing an innovative and efficient mobility option for the city (von Ritter Figueres 2017).

The foundation of success for the scheme began with an in-depth review of enabling policies and assurance that the BSS would be designed to help meet the city's goals. The city's Department of the Environment introduced the Plan Verde (Green Plan) in 2007. The plan called for improvements to air quality and mobility in the city, and required the creation of a bicycle mobility strategy that included the Open Streets program, "Muévete en Bici" (get around on a bike) (Delgado Peralta 2017; GoM 2011). The program called for the opening on Sundays of 10 kilometers of streets exclusively to people on nonmotorized vehicles (Reforma Avenue from Lieja Street to the historic center), encouraging citizens to connect with their community in a variety of ways. This idea was inspired by two similar programs, one in Bogotá, Colombia, and the other in Guadalajara, Mexico. The program in Mexico City successfully changed the bicycling culture of the city. Operated by the Bicycle Mobility Strategy Office, it also played an important role in establishing ECOBICI, as well as 40 kilometers of bicycle infrastructure and two large bicycle parking hubs, among other bike-related projects (McConville 2010; Mendez 2014).

Ensuring that ECOBICI was embedded into the larger urban mobility and environmental plan was crucial to its success. As a result, the scheme was not implemented by the city's Department of Mobility (Secretaría de Movilidad, or SEMOVI) but, instead, by the Department of the Environment because of a series of ambitious transportation projects that were being planned at the same time (e.g., new bus rapid transit lines, Metro Line 12) by the former. The bicycle mobility strategy for Mexico City goes beyond bike sharing. It aims to increase bicycle trips by integrating the city's bicycle plan and the BSS with the wider urban transport network (i.e., bus rapid transport and subway) to improve last-kilometer connectivity. ECOBICI has an integrated payment card option, and nine out of 10 trips are intermodal, combining bike sharing with other mobility options such as bus rapid transport, subway, and suburban train (GoM 2017).

SEMOVI launched a pilot program to regulate privately operated DBS schemesin March 2018. The city officially decreed that according to the legal framework relating to bike sharing in Mexico, companies interested in providing this service must apply for a permit from SEMOVI (in conjunction with the Department of the Environment and Natural Resources (Secretaría de Medio Ambiente y Recursos Naturales, or SEMARNAT)). To receive the permit, the operator must comply with various requirements, as follows (GoM 2018b):

- Certification as a Mexican company
- Technical proposal detailing implementation and operation processes
- Feasibility study, including demand analysis
- Letter of commitment for data sharing in real time
- Bicycle inventory
- Insurance for users with the same condition provided by ECOBICI
- Free registration for users and specific geofenced areas to park bicycles
- Prohibition of advertisements on bikes or other technical components of the scheme

According to press releases and news articles, there are currently three main companies operating in different districts of the city: Mobike in Miguel Hidalgo, Vbike in Benito Juárez, and Dezba in Cuauhtémoc. They are permitted to operate 500 bikes each; however, according to reports, certain of these companies might be exceeding these limits (Hernández 2018).

Q3: What institutional and regulatory framework is needed for a scheme?

Q3.1 Regulatory Framework for a Dock-Based Bike Share Scheme

From an analysis of various types of BSS, there is evidence that, within the institutional framework, interdepartmental collaboration, gathering of information, plan establishment, and various other activities can be facilitated by the nominated public, private, or hybrid entity operating as the bike mobility agency. This agency should be responsible for coordinating the relevant governmental departments, with support from local government leaders, such as the city mayor—essential for BSS projects gaining relevance and momentum (Quintanar Solares et al. 2011). While the government is responsible for oversight and performance, it is the responsibility of the implementing agency to remain neutral throughout the process in the best interest of residents and the financial interest of the operator/provider. Table 2 shows the activities of the implementing agency based on the study.

Table 2 | **General Functions of the Implementing or Coordinating Agency**

PLANNING	Develop Bicycle Mobility Plan, regulatory and institutional framework proposal/review, feasibility studies.
DETAILED SYSTEM DESIGN	Technical, institutional, and financial planning; and infrastructure and safety aspects.
ASSET OWNERSHIP	The implementing agency must carry out an analysis of the stations, terminals, docks, bicycles, and ownership of the information communications technology system.
SOCIAL OUTREACH	Promotion of cycling education and culture programs.
TENDERING AND CONTRACTING	The contracting structure of shared bicycle schemes will be framed by the decisions made regarding asset ownership. The list of service levels within the contract outlines the government expectations of the operator, as well as the penalties for lack of compliance and benefits to those who have complied. Service levels should be appropriately set to ensure that expectations are easily met so as to prevent the frequent fining of the operator.
DEVELOPING THE FINANCIAL MODEL	Depending on the legal identities involved (public, private, or mixed), detailed planning or oversight should be made on fees and the business models.
IMPLEMENTATION AND OPERATION	Depending on the legal entities involved (public, private, or mixed), an analysis must be carried out of the components, such as hardware, software, operation, publicity, and marketing.
INFRASTRUCTURE IMPLEMENTATION	Develop project proposal, including cycling lanes and equipment maintenance/supervision.
OVERSIGHT AND EVALUATION	Following the launch of the scheme, the implementing agency should be responsible for system management, and assess—in accordance with the service level—the operator's performance.
EXPANSION PLANNING	Post-implementation, it is necessary that this agency continue to supervise its planning as well as its promotional efforts for potential future expansion. It is recommended that assessments are carried out during the planning stage and on the current status.

Sources: Authors, based on case study research and consultations held in 2016–17 with experts from Institute for Transportation and Development; Metropolitan Area of Valle de Aburrá, Colombia; Motivate; and District Department of Transportation.

Q3.2 Regulatory Framework for a Dockless Bike-Sharing Scheme

Collaboration between DBS providers and local authorities is key for any city to gain the full benefits from a BSS, as well as to ensure the scheme offers safety and reliability. At the time that dockless bikes emerged, many DBS providers began operations without formal permission from local authorities, given that there was no need for them to secure public space for bike stations. Furthermore, various cities lacked appropriate regulatory standards for DBS, as was the case when other sharing-economy services first came on the market, such as Airbnb and Uber, prompting a backlash in some cities from government and citizens alike (De Clercq 2017). In San Francisco, United States, for instance, the Chinese DBS provider, Bluegogo deployed its bicycles without a permit and city authorities promptly took the bikes from the streets (Tchebotarev 2017). Amsterdam in the Netherlands has announced a temporary ban of DBS after removing dockless bikes that were brought into city streets without local authority approval (Reid 2018).

To manage the deployment of a DBS scheme, mitigate the negative impacts, and gain benefits to complement mobility goals, some cities have established a new regulatory framework, specifically tailored for DBS operations, and have introduced a permit application process and regulations. Some cities have established pilot programs to introduce the DBS model to residents and receive community feedback prior to informing the longer-term institutionalization and regulation of the scheme (GoUS 2018b). This presents several advantages to city and DBS provider(s) alike. A permit processing mechanism or a simplified tender procedure for multiple operators will enable cities to implement schemes at a much faster pace when compared with the slower, traditional competitive tender process generally applied to the station-based BSS (Lloyd 2017). Moreover, cities will be able to control a series of parameters vital to user safety, public space management, and urban planning, while residents will benefit from a new shared mobility service. The experience of Beijing with regard to its DBS scheme regulation is shown in Box 3.

The characteristics of city DBS regulations to date include standards that relate to fleet size; safety; maintenance; operations and accessibility parameters; defined parking areas; agreements regarding the use of public space and zoning; insurance; customer service and training; data sharing; and pedelec (low-power, pedal-assisted bikes) specifications (SFMTA n.d.; GoIt 2017a; GoIt 2017b; SUMC n.d.; GoB 2017; GoUS 2017a). The main parameters used in these regulations are summarized in Table 3.

Box 3 | Case Study: Beijing, People's Republic of China

Dockless bike sharing was first introduced in Beijing in August 2016 as one of the earliest adopters. ofo and Mobike are the two largest players, although a range of emerging companies, such as Bluegogo, Hello, Youon, and Xiaoming, among others, have also emerged in recent months. With the city experiencing clogged public spaces and blocked sidewalks due to the number of dockless bikes, the Ministry of Transportation at the national level published, in August 2017, the first country-wide regulatory framework as a means to resolve some of its issues. Beijing's municipal government also has issued regulations that relate to the parking challenge as the number of bikes continues to rise.

To limit the oversupply of bikes, which is leading to parking and public space disturbances, Beijing has requested that companies agree to a cap on the number of bikes, and has established parking regulations by way of geo-fence technology. Furthermore, operators now must provide user insurance for each trip, as well as ensure that no child under the age of 12 uses the service. Other regulations in place include the protection of user safety deposits made through independent financial institutions that oversee operator accounts. Additional standards at the city level include the following:

- GPS and bicycle safety standards
- Fleet-size control/restriction
- Security deposit surveillance and refund
- Proper operation parameters
- Information and data sharing
- Insurance provision
- Defined parking areas and public space requirements
- Bike maintenance and repair

Table 3 | **Examples of Requirements for Tendering Process of Dock-Based Bike-Sharing Schemes and Permit Provisions for Dockless Bike-Sharing Schemes**

ASPECT OF REGULATION	PARAMETERS/REQUIREMENTS
1. Permit issuance for a dockless bike-sharing (DBS) scheme	1.1 DBS provider to pay an annual fee for an operation permit/authorization within city boundaries.
	1.2 DBS provider to pay the public agency for the revision of permits and necessary inspections.
	1.3 DBS provider to pay an administrative fee for each city bicycle.
	1.4 Monetary fee by user to DBS provider if city staff needs to relocate or remove bicycles from any location that prohibits the discarding of bicycles.
	1.5 Fixed fees for potential maintenance and repair of public property.
	1.6 Reimbursement of costs incurred by public authorities for any violation of the law (including the repair or maintenance of public property).
	1.7 Rules for suspension of operation permit/authorization under specified circumstances.
	1.8 DBS provider to sign an agreement indemnifying and holding the city harmless.
2. Competitive bidding/ tendering process or request for proposal for a dock-based bike-sharing scheme	2.1 Details on the scope of work, with clearly defined roles and responsibilities of key stakeholders.
	2.2 Details on the capital and operational cost of repayments, reimbursements, and subsidies (if any), provided by the public agency to the private operator and vice versa.
	2.3 Details on the allowable revenue streams and revenue sharing mechanisms.
	2.4 Operational and maintenance requirements: Clearly defined service level agreements with details of penalties and incentives in abiding or deviating from them.
	2.5 Minimum technical requirements: bikes, stations, technology, payment mechanism, etc.
	2.6 Rules for suspension of tender/authorization under specified circumstances.
	2.7 Details on technical and financial evaluation process/scoring.
	2.8 Details on expected fare structure.

Source: Pfoser and Pajones 2017.

Q4: What is the planning process for implementing a bike-sharing scheme?

For any city considering implementing a BSS, it is essential to understand that bike sharing requires a win-win approach for the key stakeholders (i.e., user, city, and operator) (AP+D n.d.). A BSS with a clearly defined and accurate plan that provides oversight, adequate capacities, and sufficient time for each stage in its development will be more effective in the long term. Some cities tend to allocate less time to the planning process, focusing on implementing in the shortest time possible and thus leading to later issues.

The research carried out for this project found that it is possible to adapt bike sharing based on the characteristics of a city in terms of its size, population, density, weather, topography, and infrastructure. This applies regardless of the type of technology used and largely notwithstanding the level of wealth of a city, although this might affect how the BSS will be structured. There are various technical BSS guides available, which outline the common elements of the planning process, such as the feasibility analysis, definition of key parameters—specifically the coverage area and size of the BSS—according to city characteristics and business model. Notable examples of these include ITDP's 2013 and 2018 bike-sharing planning guides (ITDP 2013; ITDP 2018b) and CAF's practical guide in Latin America (Montezuma 2015). In addition, ITDP's publication *Optimizing Dockless Bikeshare for Cities* (ITDP 2018a) is key for any city faced with or looking to incorporate a DBS scheme (ITDP 2018a).

Planning a BSS at a scale that responds to city size and is easily accessible is crucial to achieve ridership outcomes. A BSS that is accessible will not only have balanced and equitable spread of station placements or designated parking areas for dockless bikes, but it will be integrated within the public transit system. Figure 5 lists some important steps in the planning process.

Figure 5 | **Planning Process for a Bike-Sharing Scheme**

- Overview of scheme design and implementation process.
- Basis for selection of framework for scheme (e.g., design, implementation).
- Insight into the challenges likely to be encountered.
- Inputs for the decision-making process.
- Analysis of city's demographic, geographic, and topographic conditions.
- Preliminary understanding on project financials, including potential and available funding sources, revenue streams, etc.
- Defining city's overarching goals for implementing a bike-sharing scheme.

- Comprehensive analysis of project components examined at prefeasibility stage.
- Detailed investigation establishing project's scope and expected outcomes.
- Detailed evaluation on:
  - **technical design:** demand, coverage, infrastructure, bicycles, operation, and technology;
  - **cost effectiveness:** business and financial model evaluation;
  - **social and environmental aspects:** fare structure, targted reduction in pollution/congestion;
  - **institutional framework:** implementation structure, roles and responsibilities of stakeholders, contracting arrangements, etc.; and
  - **financial elements:** feasibility of investments, revenue streams, funding sources, and mechanisms.

- Exact station location
- Size of system and each station
- Detailed technology of hardware and software requirements
- Detailed implementation plan

- Establish regulations either in terms of permit schemes or tender/request for proposal.
- Selected ownership and operations model is the key factor defining tendering and contracting process of the scheme.
- Well-defined tendering process and permit scheme is the key element in ensuring the success and sustainability of the bike-sharing scheme.

Source: Authors, based on Pfoser and Pajones 2017 and DeMaio 2016, as well as consultations held in 2016 with experts from Motivate; Metropolitan Area of Valle de Aburrá, Colombia; and Institute for Transportation and Development.

Q5: What are the operational and maintenance strategies of a bike-shareing scheme?

For traditional dock-based schemes, regardless of the technology, ownership, or operation model adopted by the city, the local government is involved in one way or another in its management due to the public space required for station infrastructure. The increasing commercialization and professionalization of bike sharing can alter the traditional role of local governments and create more complex revenue and financing structures that, in turn, may complicate operations and maintenance, as well as regulation.

Q5.1 Operational Strategies among Various Legal Entities

Publicly owned and operated: Bike-share assets are entirely owned and operated by the public sector (e.g., the city's departments of transportation, environment, or sustainability) or a public subsidiary agency. The agency is responsible for mobilizing funding, as well as managing all aspects of the BSS, including preconstruction, construction, operations, and maintenance.

Publicly owned and privately operated: The public sector outsources service operations to a private entity that will manage operations and maintenance (O&M). The entity is either paid directly by the public agency or recover costs through revenue streams, depending on the contractual agreement. Contracting may be structured singly, with one or more private entities charged with various aspects of service delivery and system maintenance.

Privately owned and operated (through contract, regulation, or other formal arrangement with the city): These are bike-sharing schemes that are entirely owned and operated by a private, for-profit, or non-profit entity. The entity is responsible for mobilizing funding and managing all aspects of the scheme, including preconstruction, construction, operations, and maintenance. Public sector involvement is limited to providing the land for station locations and establishing the permit/regulatory/operational conditions.

Table 4 includes further considerations that relate to ownership models and operational strategies in the case studies analyzed.

Table 4 | **Advantages and Disadvantages of Various Types of Ownership Model**[1]

OWNERSHIP MODEL	ADVANTAGES	DISADVANTAGES	EXAMPLE
Fully public	Greatest degree of control over station placement, service quality	Greatest amount of risk and responsibility for the city	Buenos Aires (EcoBici)
Publicly owned and privately implemented	Cost effective, with greatest flexibility on technology and other contracting options Lower coordination cost if single contract (as opposed to many) Operator has room to optimize different elements of delivery	More experience and effort on coordination of contracts/contractors, including timelines, terms, and performance Less flexibility and choice as one integrated contract Contractual structure, including revenue/cost sharing; can be complex to define	Medellín (EnCicla)
Private with formal relationship with city	Possible partnership approach with low stakes and risk for public authority	Little revenue sharing	New York City (Citi Bike)
Private; no formal relationship with city	Low responsibility Potential for regulating private activity through local frameworks Potential gateway to higher cycling rates	Limited control on public space, oversupply of bikes (no self-regulating force in private model) No revenue sharing Limited access to mobility data	Seattle (LimeBike)

Sources: GoUS 2018d; GoA n.d.; GoCo n.d.b; Fishman 2016; Wang 2016, and consultations held in 2016 with experts from Metropolitan Area of Valle de Aburrá, Colombia.
[1]Advantages and disadvantages referred to in the table above relate to the ownership model in general, not examples.

Q5.2 Monitoring and Control Strategies

Once the BSS is launched, the implementing agency can manage and evaluate the operator's performance against predetermined goals, objectives, and service levels. It is essential, at project inception, that strategies for monitoring and supervision are well defined and transparent in order to strengthen the relationship between government and operator(s). This can be achieved at contract phase when clear goals, objectives, and monitoring processes are set to ensure alignment.

It is also crucial at this stage to agree, through a contract clause between the operator and the implementing agency, how data will be shared. This will enable the latter to effectively evaluate operator performance.

While the setting of parameters may vary from city to city, it is essential in terms of managing and evaluating operator performance so as to ensure smooth and successful BSS implementation. This also should be clear in the binding contract. Some local governments are exploring the potential of charging private operators for the use of public space; in such cases there should be a contract clause that clearly defines, for example, the terms of payment and charges levied, among others.

A further factor to safeguard the efficient monitoring and control of BSS operations is to define the cycles of operational programming, control, and administration. There is evidence from this analysis that if this is clearly understood at contract phase, implementation will be more effective (FSCI 2018). The operator should be able to share real-time information with government, based on the contract.

Q6: What are the available options for financing a bike-sharing scheme?

A common challenge is the financial sustainability of the BSS business model. While there are multiple options available to investment in a BSS, various studies have shown that user and membership fees alone are insufficient to cover the necessary capital and the costs of O&M (GoUS 2012; Montezuma 2015). For example, Barcelona's BSS, Bicing, covers approximately 30 percent of its O&M costs through user and membership fees (Montezuma 2015). Other systems have higher levels of revenue collection that almost recover their entire operating costs, such as the Washington, DC's Capital Bikeshare and Boston's Hubway in the United States, both of which recover more than 80 percent of their O&M costs through such fees (DeMaio 2016). These revenues, however, are generally insufficient to entirely cover capital and O&M costs and, to close the gap, many cities are diversifying their revenue sources to increase the financial sustainability of their BSS.

Table 5 | **Overview of Available Funding Sources for Bike-Sharing Schemes in Cities under Study**

REVENUES	Payment to access the service	Some revenues are generated from payments to access the service, such as membership/subscription fees, user charges, fines for misuse of the system, and sale of merchandise or equipment.
	Sale of rights	The sale of rights, such as revenues generated from advertising on system equipment, naming rights, partnerships, and the leasing of public space to operators for stations also represent possible revenue for the city.
INCENTIVES	Grants	Some cities benefit from incentives in terms of monetary grants (public or private), land grants, or donations.
OTHER BUDGETS	Non-operating revenues	Several cities, together with bike-sharing scheme (BSS) operators, have used nonoperating revenues, obtained by leasing space on public furniture (e.g., bus shelters, billboards, kiosks, sidewalks, and street furniture) to advertising agencies.
	Taxation and fees	Special taxes and fees have been used in certain cases to contribute to BSS funding. Parking fees and fines are a way of funding a part of the capital or the operational and management costs. Boston's Hubway and Washington, DC's Capital Bikeshare in the United States and Barcelona's Bicing in Spain constitute such examples. In other cases, cities apply a tax on the greenhouse gas emissions of local industries, automobile manufacturers, and other polluting companies to cover capital and costs.
	Intergovernmental transfers	Some cities cover the capital cost of BSSs through their own budgets while providing operators fixed annual subsidies to cover operations and management costs. This type of intergovernmental transfer differs from that of a public grant, since to access these funds, the BSS must be considered by the city as an integral part of the public transport network. In this case, the city is able to allocate part of the public transport budget to the BSS. For example, Buenos Aires' EcoBici in Argentina is entirely funded through the city's public budget.

Sources: GoA n.d.; C40 Cities 2011.

Q6.1 Funding Sources

Funding sources are not reimbursable and are used to pay for the investment components of a BSS; that is, the basic capital cost for infrastructure. These are necessary also to attract and unlock third-party capital. An overview of funding categories is presented in Table 5.

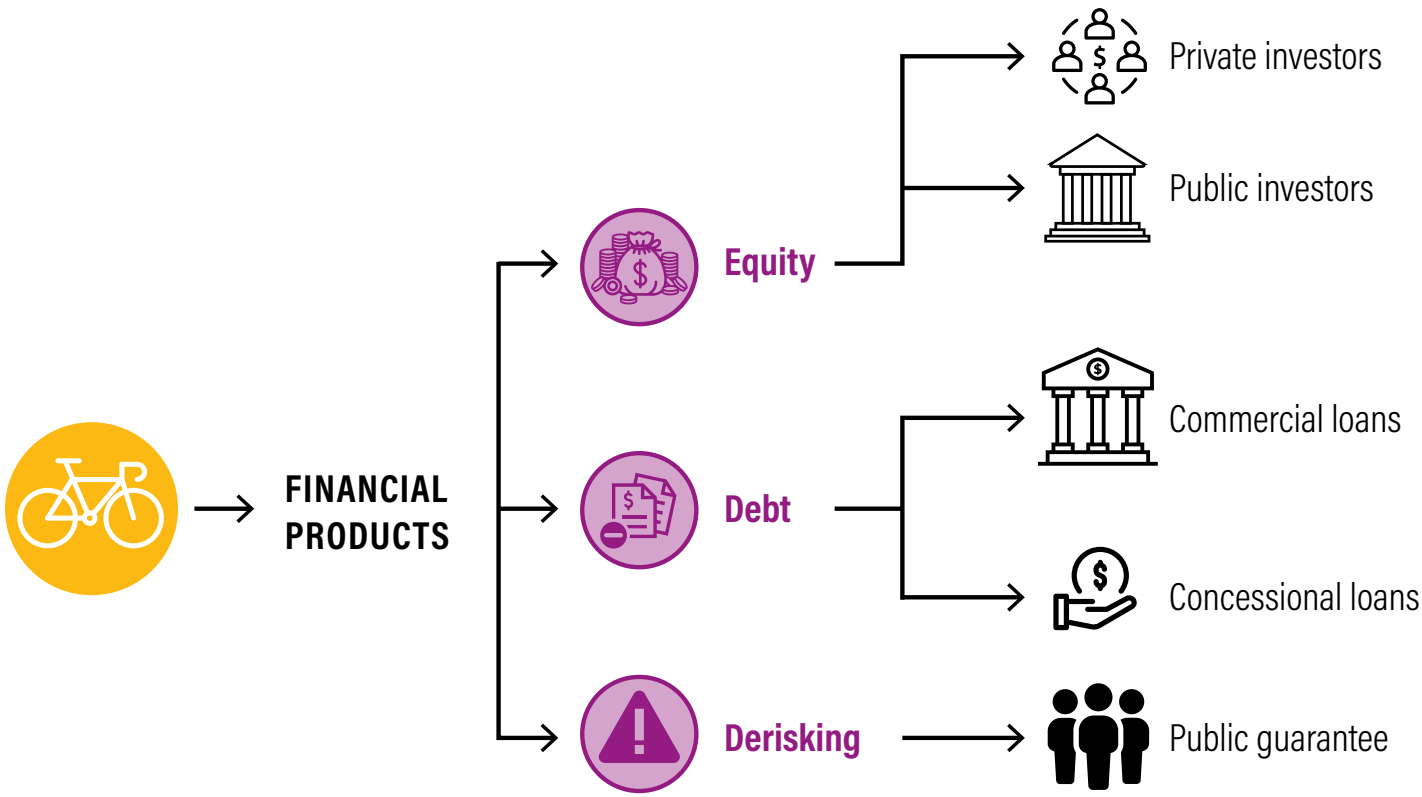
Q6.2 Financial Products

Financial products are reimbursable monetary resources that exclude future profit, allowing cities to mobilize investment capital from third parties in exchange for the payment of a fee, interest, or other costs associated with the financial service provided. BSS financial products consist of equity (private and public), debt (commercial and concessional loans), and derisking products such as public guarantees. An overview of various financial products available for BSSs are shown in Figure 6.

There is evidence from the case studies of little need by cities for financial products to develop a BSS (FSCI 2018). In fact, a BSS requires a relatively low initial capital investment compared with that required by other urban mobility solutions, such as a metro network or a bus rapid transit system. It is therefore unlikely that cities would need to incur such debt to pay for their BSS.

There are, however, cases whereby cities have used commercial loans and public guarantees to finance their BSS. For instance, New York City's Citi Bike is a wholly privately owned and operated scheme. The operator (Bike Share Holdings LLC) financed the scheme through debt and equity. Goldman Sachs provided a loan of US$42 million to cover initial capital costs and the purchase of equipment. The loan was guaranteed through a multiyear sponsorship contract with third parties. The operator later invested US$30 million in equity to expand the system.[4]

Figure 6 | **Overview of Available Financial Products for Bike-Sharing Schemes**



Source: Authors, based on case study research and expert information.

Q6.3 Dockless Bike Sharing: Financial Model

As indicated in Section Q1.4.2, the rapid expansion of DBS is creating a substantial impact on the bike-sharing scene. Since no new physical docking infrastructure is required, its implementation generally requires less capital investment (Pal and Zhang 2015). With the key players in the market backed by private venture capital, DBS implementation can be more rapid and would not require direct investment by the city. It also would facilitate pilot projects, given that private operators generally bear the cost of implementation. Chinese-based DBS companies Mobike and ofo are two major players taking advantage of this emerging financial model, having both received in excess of US$2 billion in funding to date. ofo further secured US$850 million in 2018 to cover its global expansion (CB Insights 2018).

Private DBS companies have claimed that their business model is profitable; this may depend heavily, however, on the number of bikes cities will allow companies to introduce in the pilot phase. In Washington, DC, for example, the limit was set at 400 bikes per company during the pilot period in 2018. Mobike and ofo exited this market in July 2018, citing this restriction as an impediment to their operational and financial feasibility; however, they left many other US cities that did not have such restrictions at approximately the same time (Lazo 2018). It is too early to draw informed conclusions either on the effects of DBS on urban mobility or on the certainty of the long-term financial sustainability of DBS providers. Such innovative schemes can potentially provide an excellent first- and last-kilometer connectivity solution for cities, linking transit hubs and extending their range to reach more residents. Local governments must closely coordinate with DBS companies to develop standards for safe operation and sustainably in order to ensure success. As more information about the feasibility of DBS operations emerges, cities may also consider implementing a publicly owned DBS, a model of which has yet to come to the fore.

Q7: What should be the structure for monitoring and evaluation?

The determinants of BSS success largely hinge on a well-defined and transparent monitoring and evaluation (M&E) framework (Fishman et al. 2013). As discussed in previous sections, the responsibility for M&E lies with the government, regardless of ownership model. The process is easier to undertake and more clearly defined in the case of hybrid and publicly owned and operated schemes. In the case of wholly private schemes, while parameters should be clearly defined in the permit document (Section Q3), the absence of the public sector makes the process more challenging.

In every case, it is crucial to ensure the M&E structure and the relevant processing mechanisms are clearly defined. The rapid expansion of this fourth generation BSS continues in the absence of comprehensive M&E frameworks which would adequately assess the effectiveness and impacts of this innovative technology, thus not only preventing reflective and consistent analyses but also constraining the ability to reliably quantify its potential broad-ranging impacts.

Q7.1 Service Level Benchmarks

A key element of M&E strategy is the service level benchmark (SLB) that measures system performance (hardware and software), service to the customer, maintenance, redistribution, marketing, and reporting. Usually defined in advance, SLBs should be included in government contracts to reflect the expectations of the operator in terms of compensation and fees for noncompliance, as well as rewards for meeting or exceeding expectations.

Each SLB should clearly define the fines in the event of falling short or the incentives if meeting or exceeding expectations. Ensuring that sanctions are in place will motivate operators to efficiently carry out their services. Examples of SLBs are listed in Table 6.

Table 6 | **Examples of Service Level Benchmarks**

PARAMETER	PERFORMANCE INDICATOR	DESCRIPTION	TIME	ACCEPTABLE SERVICE LEVEL
Bicycle distribution	High-priority stations/parking locations: empty, peak hours	Percent of the time that high-priority stations/ locations are empty during peak hours	Daily morning and evening peak hours	Should be less than 5% of total operating time
	High-priority stations/parking locations: empty, nonpeak hours	Percent of time that high-priority stations are empty during nonpeak hours	Operating hours, excluding peak hours	Should be less than 10% of total operating time
	Low-priority stations/parking locations: empty, peak hours	Percent of time that low-priority stations are empty during peak hours	Daily morning and evening peak hours	Should be less than 15% of total operating time
	Low-priority stations/parking: empty, nonpeak hours	Percent of time that low-priority stations are empty during nonpeak hours	Operating hours excluding peak hours	Should be less than 20% of total operating time
Availability	Bicycle availability	Average bicycle fleet available per diem	At 6 AM or at start of operations	Should always be 95% or more of total authorized fleet size
	Service availability	Number of hours scheme is operational	Operating hours of scheme	Should always be 100% of the agreed hours of operation (unless permission has been granted by relevant authority)
Registration	Member registration	Percent of valid applications and registrations that are processed, as well as memberships issued within a day	Throughout the month	90% of all valid applications should be processed within one day of receipt of application
	Registration of nonmembers or renewal of membership or top up of smart cards	Percent of valid applications for nonmembers; renewals and top up of smart cards within half an hour	Throughout the month	90% of all applications should be processed within half an hour
Maintenance	Access to website and availability of smartphone application	Percent of total time in a month when website not accessible or when smartphone application not available	Throughout the month	The website and smartphone applications are accessed and available, respectively, for at least 90% of time during entire month
	Maintenance schedule	Follows a predetermined maintenance schedule	Throughout the month	Maintenance schedule is followed more than 90% of time as predetermined
Parking (dockless bike-sharing schemes)	Parking of bicycles at designated places and in a prescribed manner	Number of bicycles parked at designated places and in a prescribed manner	Throughout the month	Should always be 100%; that is, bicycles always should be parked only at designated parking spaces and in the designated format as described in the section on parking.

Sources: Schroeder 2014; Lin and Yang 2011; Alvarez-Valdes et al. 2016.

The SLB reporting mechanism should be defined and the timelines identified (i.e., daily, weekly, monthly) for the submission of operator reports to relevant authorities. Public authorities should form a dedicated team to carry out the audits of performance through SLBs, using real-time data, the latter of which will facilitate operator authenticity. The General Bikeshare Feed Specification (GBFS), for instance, is a tool that has standardized this procedure by providing information on station location, bike and dock availability, pricing, and more without the use of an API (application programming interface) token or access token (NABSA 2017). The platform makes bike-sharing data feeds publicly available online in a standard format that is integrated into Google Maps and other transportation applications (Shared-Use Mobility Center 2016). In terms of monitoring SLBs, the GBFS is of significant relevance in terms of the standardization of supply-side indicators, such as station location, bike and dock availability, pricing information, and more.

BSS reports should be submitted on a regular basis to government authorities, providing them the necessary data parameters to inform them and the operator of ways in which they can improve not only system performance but also medium- and long-term strategies. Examples of data parameters are:

- average number of daily trips per resident;
- average number of daily trips per bicycle;
- point location: AA trips and AB trips (i.e., whether user returned bicycle to the docking station that the bicycle was first unlocked from, or whether it was returned to another docking station within the city);
- trip purpose;
- trip duration and distance;
- start and end times of trip;
- aggregated user data (e.g., gender, age group, city resident or not);
- record of fatal accidents and serious injuries;
- pollution reduction: reduction in carbon footprint, carbon dioxide emissions saved, among other criteria;
- number of motorized trips converted to nonmotorized trips; and
- BSS market penetration (i.e., registered users in terms of total city population).

Q7.2 Financial Reports

Another important M&E component is the financial reporting of the BSS. Financial reports are particularly helpful in assessing project sustainability and should include, but not be limited to, operating costs (i.e., labor; replacement parts; fuel for service vehicles; redistribution; marketing; website hosting and relevant maintenance; electricity and internet connectivity for stations; membership cards; warehouse and storage insurance; and administrative activities). Depending on the structure of the contract, operating costs also may include debt servicing. To facilitate the M&E process, the mechanism, criteria, and frequency of reporting should be predefined and agreed upon by operator and public entity alike.

The M&E structure should be complemented by other activities, such as field visits. This will not only secure transparency on how well the BSS meets its objectives but also inform the planning for future expansion or the transition to or integration with various other systems (Section Q10).

Q8: Why is safety an integral factor of BSS planning and what elements need to be considered?

As the trend in BSSs grows, it is essential in the planning and implementation processes to include bicycle design, infrastructure, standards, regulation, and enforcement, especially with regard to cities where cycling is nascent and motor vehicle drivers have yet to become accustomed to sharing road space with cyclists. This remains true from not only a public health perspective but also in terms of business viability, regardless of mode type—whether dock-based or dockless, or whether publicly or privately operated. The greatest barrier to a BSS is that biking is often not conceived to be a safe, normal, or convenient mode of transport. Furthermore, safety benefits will be shared by cyclists using their own bicycles. Section Q8 offers some recommendations for cities to promote safety as an integral part of their planning, implementation, and regulation for BSSs.

Q8.1 Review of Current Situation: Data and Survey

As part of the BSS scoping and planning process, the current status of parameters relating to urban cycling, directly and indirectly relating to road safety, should be assessed. This activity will not only help the city address its safety needs, but also facilitate the establishment of a baseline for cyclist safety.

Q8.1.1 Current cycling levels

Georeferenced biking injury and fatality incidences, combined with mode-share data, will enable the setting of a benchmark against which to measure the safety impacts of a BSS during its establishment and expansion. It also will contribute to the identification of key safety issues as has been the case, for example, in Bogotá, Colombia, where it was discovered that most cyclist accidents took place during the extensive network gaps of bike lanes (Verma et al. 2015). It is also evident that in London, United Kingdom, heavy vehicles are involved in a disproportionate number of cyclist fatalities, prompting the city to apply new safety standards and regulations for such vehicles (GoUK 2016). If available, city trip data can provide information on cyclists based on preferred cycling routes, their average trip time, number of trips, times and travel distances, connections to public transport networks, and areas of demand for cycling services.

Q8.1.2 Current provision of organized cycling activities

Another way to assess the need for new safety measures is by reviewing the current provision of organized cycling activities (e.g., advocacy and educational cycling groups and events) and their level of reach (e.g., member numbers, ride participants, new cyclists). These should be identified during the implementation phase. To strengthen the indicator, the gathering of such data as gender, age, socioeconomic group, and geography of cyclists, as well as the public perception of cyclists and cycling infrastructure, will provide insight into the status of the city in terms of its bicycle culture. Cities that are more hostile to cycling, for example, will have a disproportionate number of young and male cyclists compared with cities that are safer and facilitate cycling based on their BSS infrastructure and regulation, thus reflecting more of a balance between gender and age (Garrard et al. 2008).

Q8.1.3 Gathering metrics on current bicycle use

Metrics on current bicycle use in a city can help inform strategies to support bike sharing, such as bicycle training sessions for new riders and target locations for bike-sharing infrastructure and cycle lane networks. The manual or mechanical gathering of such information through labor-intensive surveys remains relevant to this day. For example, the extensive survey of "Ciclovia" users in Mexico City helped to define such strategies as to convince recreational cyclists to switch to commuter cycling (Southern and Perez 2012). New types of technology, furthermore, have emerged to facilitate the capture of cycling data, such as GPS tracking applications on smartphones (ECF n.d.). In New York City, Citi Bike has introduced a new data collection feature, Ride Insights, which enables riders to anonymously share BSS usage data on the routes they take. The data are aggregated and analyzed by the New York City Department of Transportation in terms of rider behavior along specific streets and avenues so as to inform bicycle infrastructure and safety, and share planning improvements (Citi Bike 2013). Cities also can use data from successful geolocation-based mobile applications to map cycling patterns, an analysis of which can then provide for appropriate changes, such as improved infrastructure planning, thus creating more integrated city cycling networks (Musakwa and Selala 2016).

Tracking the progress of bicycling trip and safety indicators over time is essential in BSS planning, as well as for successful implementation and operation. Nevertheless, a lack of sufficient data should neither prevent the establishment of a BSS nor hamper the improvement of cyclist safety. Instead, the gathering and analyses of data can later be a pertinent activity in the BSS implementation and monitoring process.

Q8.1.4 Reviewing current safety regulations and enforcement processes

The design and enforcement of laws are fundamental to all road safety, including urban cycling. BSS planning should take into account city laws and regulations already in place and assess whether or not they prioritize cyclist safety—and road safety, in general—and whether or not they are enforced. Such legal instruments to boost the safety and confidence of cyclists will contribute to the viability of a scheme. As such, cities should review their traffic and pedestrian safety laws and regulations as well as those relating to cyclists, and revise them if necessary (GoM 2016). If not already in place, specific laws can be implemented to improve cyclist safety, such as restricting automobiles from turning on red lights and permitting the "Idaho Stop" (a regulation that recognizes that bikes have lower speeds and wider fields of vision than do motor vehicles), so that cyclists are able to adhere to a stop sign as a yield sign and to a red light as a stop sign (McLeod 2013). Vehicular speeds also are a major factor in the safety and comfort of those using bicycles and should be taken into account during the planning stage, particularly in relation to BSS infrastructure. The World Health Organization, for instance, recommends speed limits of 50 kilometers/hour in urban settings, and a limit of 30 kilometers/hour or lower in areas where there is a high presence of pedestrians and biking, or in the absence of appropriately segregated infrastructure (WHO 2008).

Speed limits and street design alike should be reviewed and updated regularly over the long term to ensure conditions remain safe for biking.

Most BSS models do not require the use of a helmet and evidence of improved safety, as a result of city mandates to use one, are inconclusive. In fact, based on several studies, helmet enforcement is associated with a lower rate of bicycle use, weakening incentives to improve cycling safety and increasing individual risk (Clarke 2012; de Jong 2012). As a result, most cities have not included helmet use in their scheme and others, such as Mexico City, have repealed existing regulations so as to facilitate their scheme (Culver 2018; Teschke et al. 2015).

Q8.1.5 Evaluating the presence and adequacy of cycling infrastructure and equipment

A key physical component to BSS success in a city setting is the cycling infrastructure and equipment. Evidence shows that appropriate infrastructure is fundamental to cyclist safety and the motivation to use a bicycle (Hull and O'Holleran 2014). Cities should evaluate indicators such as the number of kilometers of connected bicycle infrastructure, number of kilometers of shared streets, number of bicycle parking stands, and number of mass bicycle parking facilities at public transport hubs (Reliance Foundry 2017; Goodman 2010). The quality of infrastructure should also be assessed, including whether or not existing cycle lanes provide adequate protection and segregation based on the speed and flow of adjacent vehicles, whether or not cycle lane designs provide sufficient space for cyclists, and whether or not they are sufficiently maintained (e.g., clarity of markings, quality of surface) to ensure the safety and comfort of cyclists. In the absence of a safe cycling infrastructure network, a city should plan and implement one in parallel with regulatory framework improvements and BSS implementation.

Q8.2 Safe Bicycle Design

Safety in a traditional, dock-based BSS has been significantly influenced by the design of the bicycles. The docked BSS, in general, shows a lower rate of collision compared

Figure 7 | **Common Safety Features on Docked Bike-sharing Bicycles**

Source: Adapted from Capital Bikeshare 2017b.

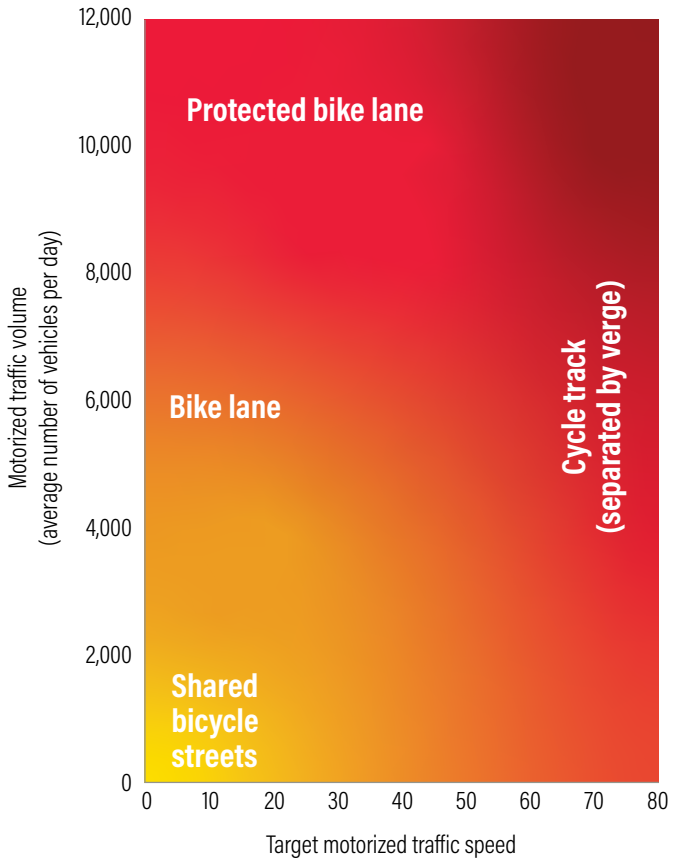
with personal bicycles, given that the former are designed for safe and comfortable use by inexperienced riders who have never or rarely used a bicycle for transport before (Martin 2016; Fishman and Schepers 2016). The bikes are heavy and have wide tires, which make it difficult to go fast. This design makes it less likely to jostle users when riding over bumps or potholes and more likely users will be able to avoid a collision. In addition, bike-sharing bicycles usually feature bright colors, built-in lights, and upright seating, which improve the visibility of riders (Figure 7) (Plumer 2016). In the case of DBS, bikes may be required to meet basic safety features such as lights or bells via pre-existing national standards for bicycles or local DBS regulations, depending on the regulatory context although, in general, the designs have tended to be smaller and lighter weight.[5]

Q8.3 Safe Cycling Infrastructure

The most effective way to increase cyclist numbers and reduce deaths and serious injuries is through a network of dedicated bicycle infrastructure (Dudata et al. 2012). This applies to private bicycles and the BSS and should be a chief consideration when undertaking any planning to increase bicycle use in cities. In theory, as improved infrastructure and access to bikes via BSS increase the number of cyclists on the road, a secondary effect of "safety in numbers" will be generated as well. Research has found that as bike ridership goes up in cities, crash rates tend to become static or drop (ECF 2012). There are several key components to consider when planning a network of safe bicycle infrastructure. The infrastructure must be appropriate to the type of street on which it is located, determined by measuring motor vehicle speeds and volumes on the street. At higher speeds and vehicular volumes, physical separation between bicyclists and motor vehicles becomes more important not only for safety (Figure 8) but also for comfort.

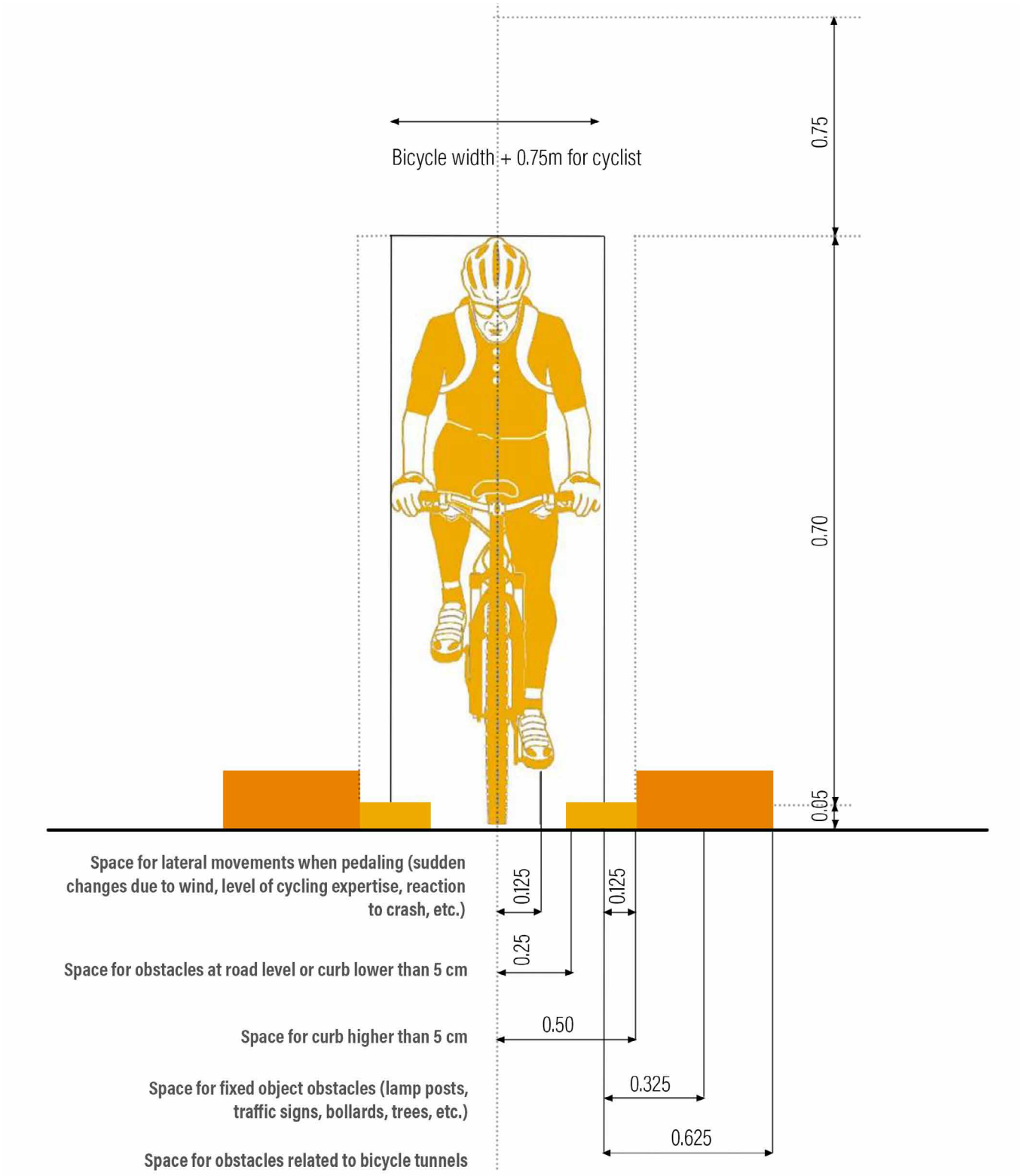
Cyclist preference for segregated bike lanes on busier streets has been evidenced multiple times and has a direct impact on cycling rates (Figure 9 and Figure 10). The impact is even more pronounced for women (Dill et al. 2014). It is also important that cycle lane designs provide sufficient space for cyclist movement (Figure 11). Inversely, in certain street contexts, an alternative to implementing segregated bike infrastructure due to high vehicle speeds is to lower the vehicle speed limit through changed regulations and street design. In this case, other traffic-calming measures, such as the presence of roundabouts instead of high-traffic signalized intersections, speed bumps, and coordinated traffic signal phasing, also could be implemented to ensure cyclist safety (Brookshire et al. 2016). In either regard, particular attention should be paid to intersections, which are the highest conflict areas in the street network and are often overlooked when planning bike lanes, leaving a crucial gap in the system (AASHTO 2012).

Figure 8 | **Cycling Infrastructure Should Be Determined according to Motor Vehicle Speed and Volume**



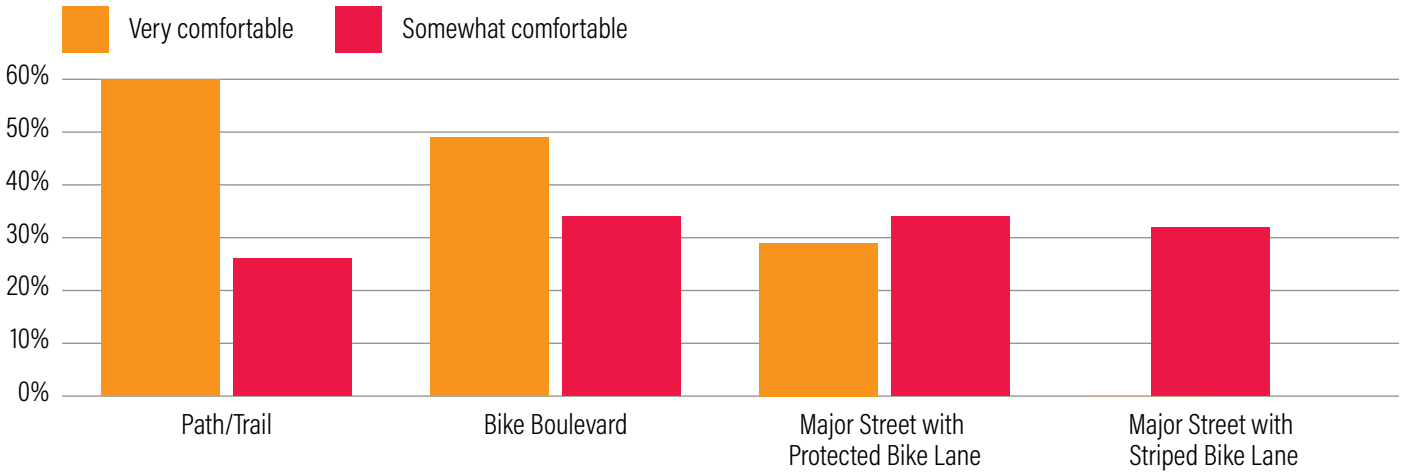
Note: For illustrative purposes.
Source: Adapted from CED 2012.

Figure 9 | **Necessary Space to Ensure Cyclist Safety**



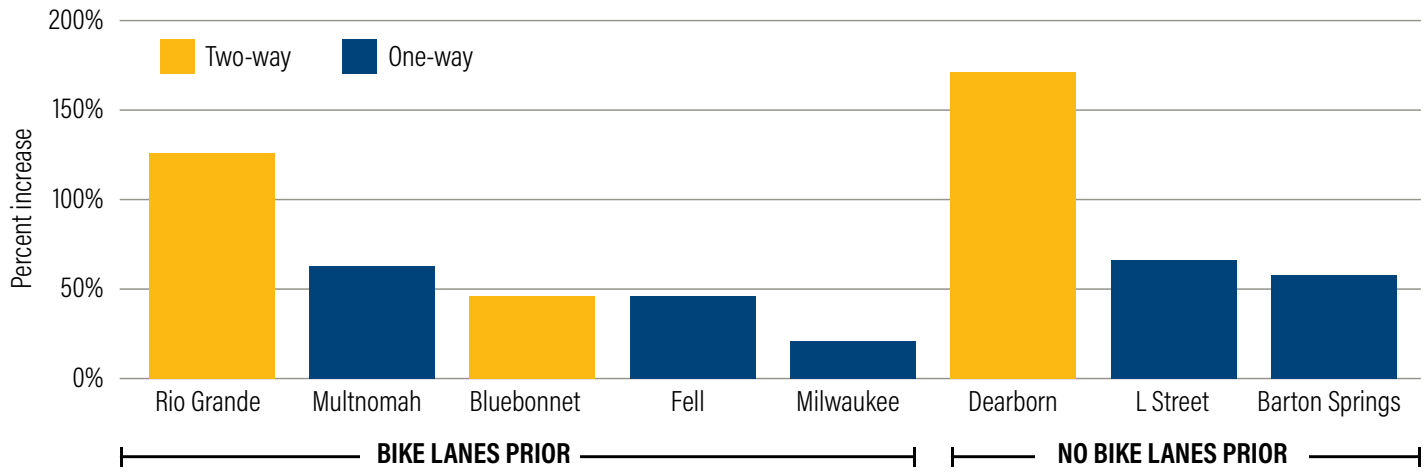
Source: Adapted from CROW 2017.

Figure 10 | **Cyclist Sense of Safety Varies with Infrastructure Provision**



Source: Adapted from Dill and McNeil 2016.

Figure 11 | **Cyclist Numbers Increase when New Cycle Lanes Are Implemented, or Painted Lanes Are Physically Segregated**



Source: Adapted from Monsere et al. 2014; Dechert 2014.

Q9: What are the branding and marketing elements of a bike-sharing scheme?

Branding and marketing give the BSS its own identity which, in turn, will generate a sense of pride and ownership by its users and the city. Some of the elements of a city's branding and marketing strategies in BSSs are described below.

Q9.1 Marketing and Outreach Campaigns

Marketing and consumer outreach efforts are required to generate interest in bike sharing among potential BSS users. Cities usually begin community outreach at least two months prior to the official BSS launch in an attempt not only to educate customers on how to operate the BSS but also to make drivers aware of these new road users. Many cities opt to organize workshops and training sessions, as well as set up stands at local events such as school fairs and city-wide festivals. This brings BSS awareness as well as facilitates the registration of new users. Some cities also partner with local businesses and institutions to offer promotions and incentives to potential users.

Harnessing and leveraging the reach of local universities and advocacy groups is important when organizing training sessions and classes for new cyclists and experienced bicycle users alike. Internally, cities also should educate local government staff and officials within certain

departments, such as those relating to parks/recreation, environment, and transport. This not only foments an internal understanding of the BSS and the costs and benefits it will provide, but also helps to integrate the BSS strategy into the overall city transport and urban development framework. Externally, cities can use traditional and social media campaigns to propagate the advantages of bike sharing to the public, as well as feature how it works. Large-scale communications strategies play an essential role before and after BSS implementation in order to ensure the safety of new cyclists and private car users. Once the system is launched, cities can also communicate directly with BSS users via the contact details collected during the registration process.

An important issue that still lingers around bike sharing and its marketing and operations processes, however, is the underrepresentation of people of color, lower-income groups, older adults, and less-educated groups. This is either partly due to a lack of bike-sharing stations in underserved communities or due to cost, lack of payment options and bank and credit card accounts, or lack of understanding or familiarity with the use of bike sharing (Hoe and Kaloustian 2014; McNeil et al. 2017). Cities establishing DBS regulations have sought to regulate operators to ensure equal distribution of bikes geographically, and to ensure low-income areas are not excluded. Certain cities and transport authorities aim to lower the barrier to access bike sharing by conducting community-specific marketing and outreach. For example, this could entail targeting underrepresented groups and reaching out to them by tapping into channels of minority communities (Buck 2013). Local bicycle advocacy groups also can play a major role in reducing barriers to bicycle use for new users from groups typically underrepresented in bicycling statistics. Cities and BSS providers can work with advocates and other groups, such as local universities and bicycle shops, to offer bicycle workshops and safety seminars as well as provide basic guidance on how to access and use the scheme.

Q9.2 Implementation of Education and Awareness Programs

Broader-scale education and motivational programs delivered by local government and law enforcement agencies also can communicate the benefits of cycling, as well as teach residents about safety and appropriate use. Events such as Open Streets or Ciclovias temporarily close long stretches of roadways to automotive traffic, allowing people to walk, cycle, or skate freely on the street (Hipp et al. 2014; Eyler et al. 2015). These types of events enable people to see and feel what a walkable and bikeable city is able to offer, encourage an active lifestyle, and provide an opportunity for people to become more confident in navigating their city by bike (SVBC n.d.).

Q9.3 System Identity and Bicycle Design

The BSS identity is a key aspect of branding, and cities often seek to associate their system with a sleek and modern image. A strong brand consists of a carefully thought out name, logo, and tagline. Planners give a lot of importance to defining the guidelines for the name and design of the bicycles, which will be the image by which the scheme will be recognized. Distinctive colors, frame style, molding, and graphics, together with the BSS brand name, help to differentiate bike-sharing bicycles from the rest of the bicycles in the city (UNDESA 2011). Integrating the bike-sharing brand with the rest of the city's transport network such as taxis, buses, and rail systems through color schemes and logos help to elevate service recognition and status.

Q9.4 Sponsorship and Advertising

A further element of BSS branding that should not be ignored is the potential of a city to receive funding for BSS operations through a collaborative sponsorship. As described in Section Q6, sponsorships refer to a cash or in-kind fee, with the expectation of a commercial return that will raise the viability of cities of all sizes to implement their schemes (Zagster Inc. 2016). In essence, they allow sponsors to create positive brand associations through advertising on the bikes, kiosks, docking stations, and online platforms, as agreed in the sponsorship contract. They sometimes also mean the company will receive naming rights to the scheme (Cornwell et al. 2005). This means that the sponsor the city opts for will have a significant impact on its overall image, so cities need to carefully select a company whose brand closely aligns with the city's aspirations and goals.

Some examples of sponsorship names are reported in Table 7. A more detailed example of New York City's Citi Bike scheme is highlighted in Box 4.

Table 7 | Examples of Bike-Sharing Scheme Sponsorships in Cities around the World

CITY	COUNTRY	BSS NAME	SPONSOR
Abu Dhabi	United Arab Emirates	ADCB Bike Share	ADCB Bank
Bangalore	India	Namma Cycle	TI Cycles India & Biodiversity Conservation India Pvt. Ltd. (BCIL)
Barcelona	Spain	Bicing	Vodafone
Boston	USA	Hubway	New Balance
Chicago	USA	Divvy Bikes	Blue Cross Blue Shield
Kansas City	USA	Kansas City B-Cycle	Blue Cross Blue Shield (among others)
London	UK	Santander Cycles	Santander UK
Minneapolis	USA	Nice Ride	Blue Cross Blue Shield
Montreal	Canada	Bixi Montreal	Manulife
Moscow	Russia	Velobike (Velobayk)	Bank of Moscow & Sberbank of Russia
New York City	USA	Citi Bike	CitiBank
Rio de Janeiro	Brazil	SAMBA Rio	Itau Bank
San Antonio	USA	SWell Cycles	Steward Health Care System
Santiago de Chile	Chile	Bike Santiago	Itau Bank
Toronto	Canada	Bike Share Toronto	TD Bank

Sources: ADCB n.d.; NammaCycle n.d.; Ajuntamento de Barcelona n.d.a; Hubway 2018; GoUK n.d.; BikeWalkKC n.d.; Nice Ride 2018; Bixi 2018; Velobike 2018; Citi Bike 2013; BCycle 2017; Bike Share Toronto n.d.

Box 4 | Case Study: Citi Bike, New York City, New York, United States

One of the most well-known success stories in the history of bike-sharing sponsorships is that of Citi Bike in New York City (NYC), launched in 2013 with 6,000 bikes in 300 stations, mostly across Manhattan and in some areas of Brooklyn. Owned and operated by Alta Bicycle Share, it was funded entirely through the private sponsorship of Citibank at the exclusion of public subsidies. It is now the largest bike share scheme in the United States, with 8,000 bikes and 500 stations across Manhattan, Brooklyn, Queens, and Jersey City (Citi Bike 2013; GoUS 2011; Schneider 2016).

NYC's BSS was approved by Mayor Michael Bloomberg in 2011, under the condition that the city would acquire a sponsor that could offer an eight-figure investment with a brand that matched NYC's image as one of the world's most powerful cities (Essex 2017). After pitching the idea to Apple and Nike, who eventually passed on the prospect, NYC's former secretary of the United States Department of Transportation approached Citibank. In making the pitch, NYC officials had recognized a successful precedent in London's Boris Bikes, which were sponsored by Barclays (now sponsored by Santander UK since April of 2015). To Citibank, Citi Bike represented a marketing breakthrough, viewed by Citibank as relating to everyday citizens (Essex 2017).

From the launch of the bike-sharing scheme in 2013 to fall 2015, Citibank's rating rose to 72 percent, while those who would consider purchasing a Citibank product increased by 43 percentage points. The model is one that many cities around the world aspire to replicate, and many city bike-sharing schemes are now seeking bank sponsorships (e.g., Toronto (Canada), Rio de Janeiro (Brazil), Abu Dhabi (United Arab Emirates), Moscow (Russia), and Santiago de Chile (Chile)). These types of sponsorships appear to generally work for corporate entities for two reasons:

- They provide many highly visible advertisement opportunities that move around the city each and every day, increasing brand recognition.
- The marketing investment showcases community engagement and local benefits that can generate a following and portray the sponsoring company in a positive way.

Q10: What aspects should be considered for the integration of dockless bike sharing?

The recent boom in DBS has added complexity to the bike-sharing scene and should be taken into account by city decision-makers when deciding whether, or how, to structure the expansion or transition of their service. The low barriers to entry presented by a DBS scheme might appeal to a city, since no investment or space allocation for permanent infrastructure is required. Furthermore, having private companies provide the service with no need for public funding also makes this a low-risk financial option.

Q10.1 Implementing a Fully Dockless Bike-Sharing Scheme

For cities that have yet to put a BSS in place, or those where dock-based bike sharing has not proved successful, implementing an entire system of dockless bikes may be an attractive option. In addition to the many benefits of a DBS scheme, presented in Section Q1, the technology is better suited to a city's climate and geographic or physical features than traditional schemes (Box 5). Furthermore, some dock-based schemes may struggle as the result of a flawed financial model and funding mechanism, especially if the scheme is not well integrated into wider public policymaking (Margolis 2017). With a DBS scheme, cities have an opportunity to integrate the private sector into the project, eliminating—or at least reducing—the need for public investment, thus facilitating project execution and enabling the sharing of risks in implementation and operation.

Box 5 | **Case Study: City of Seattle, Washington, United States**

Pronto Cycle Share, branded as Pronto!, was Seattle's bike-sharing scheme (BSS) that operated only from 2014 to 2017. Initially owned by a nonprofit organization, it was later purchased by Seattle's Department of Transportation. It included 54 stations and 500 bicycles, operated by Motivate (Fucoloro 2014).

The BSS, however, never met its full potential for a range of reasons. The scheme never reached the level of ridership it had hoped for, despite Seattle's ranking as one of the friendliest cities for bike riding in the country. The one trip a day per bike did not compare with New York City's 3.6 trips a day on its Citi Bike scheme (2016 data) (Grabar 2017; Small 2017; Spin 2017). A key factor for this BSS failure could have been the need for greater density and coverage of stations. Pronto!'s service mainly covered the downtown and University of Washington areas, a relatively narrow segment of the city. Other contributing factors could have been the city's hilly topography and rainy climate, making the heavy Pronto! bikes less than optimal for everyday travel, and the city's mandatory helmet law, potentially discouraging casual riders. Finally, the absence of dedicated funds, low ridership and membership, and substantial overhead led first to its borrowing against future sponsorships and ultimately to its demise (Small 2017).

Following the loss of the dock-based scheme, Seattle piloted a private sector program for a dockless bike share (DBS) scheme, becoming the first major city in North America to do so. The pilot began in July of 2017, enabling three companies to operate across the city (i.e., ofo, LimeBike, and Spin) (GoUS 2017a). Spin and LimeBike operates with 3,000 bikes (including electric bicycles) and ofo, with 4,000. The city requires operators to obtain a permit that covers safety issues, parking, insurance, operation, and data sharing with city authorities (Bordenkircher and O'Neil 2017). Standards for regulation were set only after a six-month trial period (July to December 2017), which provided the city sufficient time to study the DBS potential and resolve any challenges. The criteria for evaluation included ridership data, safety and collision statistics, vendor compliance, bike parking, and public space issues. After only four months, the three companies, together, had served nearly 347,300 rides compared with the experience of Pronto!, which amassed only 278,143 rides over a two-and-a-half-year period of operation (Cohen 2017; GoUS 2017a). The table below shows the entry and exits of DBS companies in Seattle.

DOCKLESS BIKE-SHARING COMPANIES OPERATING IN SEATTLE, WASHINGTON, AS OF AUGUST 2018

OPERATORS	DATE OF OPERATION	NUMBER OF BIKES PER COMPANY	AREAS OF OPERATION
Spin (exited in August 2018)	July 2017	3,000	Citywide
Limebike			
ofo (exited in July 2018)		4,000	

Sources: Cohen 2017; GoUS 2017a; 2018d; Lloyd 2017.

Effective planning and design are essential for a DBS scheme to further stoke demand for cycling and satisfy the needs of a city in the absence of a traditional dock-based BSS. The steps outlined in Section Q4 should apply, albeit with some adjustment, to ensure the success of a DBS scheme by creating a regulatory policy framework and ensuring that operators obtain a permit that covers a wide range of parameters, such as safety, parking, and data sharing, among others. Establishing scheme boundaries is essential, and many cities opt to work with operators in pilot schemes so as to collect and share data relating to usage, routes, and potential issues that might arise. Finally, the responsibility of oversight, improvement, innovative bike rebalances, data gathering, and bicycle parking should fall under a government agency (AP+D n.d.). Box 6 illustrates Singapore's experience in implementing a DBS.

Box 6 | **Case Study: Singapore**

Singapore recently cancelled its plan for a dock-based bike-sharing scheme (BSS) in favor of a dockless bike-sharing (DBS) scheme. Supported by a research grant and a partnership with private sector firms, the program provides low-maintenance bike parking spaces. Companies include Mobike, ofo, oBike, SG Bike, ShareBikeSG, GBikes, and Anywheel offering, together, 100,000 dockless bikes on a city-wide basis. The table below lists the entry and exit dates of these companies.

Three of these companies (Gbike, oBike, and ShareBikeSG) closed shop in July 2018 due to what they felt were regulations that were too strict, imposed by Singapore's Land Transport Authority, such as having to apply for a license, pay a registration fee for each bicycle, ensure bikes are parked in assigned areas, and operate a specific fleet size (Russell 2018).

Singapore's experience, similar to that of Washington, DC, in the United States, demonstrates the importance of the public and private sectors working together to develop infrastructure and regulations that will satisfy both parties. To ensure public safety and order in the city, and to track how data are put to use, standards for oversight need to be put in place; however, companies will walk away if they consider the regulations as too strict to provide an enabling environment for them to achieve success. As a result, cities will lose opportunities to reap the benefits of an effective DBS scheme, such as a higher level of cycling and potential reduced congestion.

DOCKLESS BIKE-SHARING COMPANIES OPERATING IN SINGAPORE, AS OF AUGUST 2018

OPERATOR	DATE OF OPERATION	NUMBER OF BIKES (TOTAL)	AREA OF OPERATION
Mobike	March 2017	100,000	Citywide
ofo	February 2017		
Gbike (exited in June 2018)	May 2017		
oBike (exited in June 2018)	January 2018		
SG Bike	August 2017		
ShareBike SG (exited in July 2018)	January 2018		
Anywheel	August 2017		

Sources: Hong 2017; Cheong 2017; Abdullah 2017; Lim 2018; Russell 2018.

Q10.2 Combining Docked and Dockless Bike-Sharing Schemes

In cities where the traditional dock-based BSS has been a success, introducing a DBS scheme comes with various challenges. Prevalent in many traditional bike-sharing schemes is limited user access, given that such schemes may not be always totally accessible to the wider population due to the lack of docking stations in certain parts of the city and the focus on city centers. Demand can rapidly outstrip supply as well, leaving some stations frequently empty and others full and unable to accept more bicycles, thus reducing user access. This also can come about as a result of a faulty operating model, where the scheme is not balanced quickly enough. System expansion to address these challenges requires significant planning, investment, and infrastructure (station) construction, which takes time and resources. Another issue that has emerged with traditional systems is financial sustainability, since the operational cost of a dock-based BSS tends to exceed revenue from user charges, implying that other types of funding sources must be sought.

In response to these issues, the DBS model of bike sharing presents an attractive complement to a dock-based BSS if the demand for greater access to bike sharing exists. It can be rapidly implemented and allows the rider to leave the bike wherever they decide to complete the trip, which in turn widens the catchment area of the bike-sharing service. This is especially beneficial for systems that have struggled to reach lower-income areas and communities that have not typically had good access to bike sharing. The flexibility and low-cost entry barrier that a DBS scheme presents as a mobility option allows for far more accessibility to younger and less bike-savvy communities.

In the case of coexistence of dock-based and DBS schemes, there is even greater need for a careful permit and regulation process, as well as the monitoring of impacts. Many cities have identified a pilot project model to manage this transition process. As highlighted previously, proper planning with designation of a responsible agency, a policy framework for regulation, and permits and safety requirements are still necessary and, as such, cities should have these stages prepared prior to plunging into implementation. Box 7 illustrates the experience of Washington, DC, in its combination of a publicly operated dock-based BSS and multiple privately operated DBS.

Box 7 | Case Study: Washington, District of Columbia and Metropolitan Area, United States

The District Department of Transportation of Washington, DC, in 2010, reviewed various bike-sharing scheme (BSS) proposals, together with Arlington County in the U.S. state of Virginia, with the view of implementing a BSS. Motivate, a private company, was selected through tender process based on local and tristate (District of Columbia, Maryland, and Virginia) needs. Washington, DC, launched Capital Bikeshare in September 2010, a BSS that covered Washington, DC, and Arlington County, with 1,100 bikes across 114 stations—100 of which are in the eight wards of the District and 14 of which are in Virginia. The City of Alexandria, Virginia, joined the program with eight stations in 2012, followed by Montgomery County in Maryland in 2013, with 51 stations across its six neighborhoods (Capital Bikeshare 2017b). Since then, the scheme has undergone expansion to become one of the largest in North America, including more than 4,300 bikes and more than 500 stations across the Washington, DC, metropolitan area.

In addition to the traditional dock-based BSS expansion, Washington, DC, recently experimented with a dockless bike-sharing (DBS) scheme. As part of a pilot program, managed by the city, various companies started business in the District in August 2017. The program included private sector DBS entities, such as LimeBike, Spin, JUMP, Mobike, and ofo. The initial permit process through the District Department of Transportation (Dockless Demonstration Project) for up to 400 active bikes per company took place until April 2018 (Smith 2018). The pilot project was then extended until August 2018 to continue evaluating program effectiveness and to design more tailored management policies (GoUS 2018a). Since then, two other companies joined the pilot period. Skip (formerly Waybots) and Bird provide e-scooters; and LimeBike and Spin added scooters to their fleets of dockless vehicles (Clabaugh 2018; Meyer 2018; Fowler and Tsukayama 2018; Spin 2018). Each of these companies has their own phone application whereby users are able to rent and unlock the bikes. With the exception of federally administered land, users are permitted to leave the bikes in any location they choose, as long as it is "on a public sidewalk, in the public right-of-way between the sidewalk and the curb or at a bike rack located in the public right-of-way" (BTS 2017). DBS companies have experienced some management challenges in Washington, DC, as in other regions, with many reports of vandalism, theft, and inappropriate parking (Lazo 2017). JUMP, with bikes that have battery powered electric motors to assist with pedaling and requiring a bike-rack lock up (Alim 2017), charges US$2 for up to 30 minutes. Spin, LimeBike, and Mobike charge US$1 for up to 30 minutes, while ofo charges US$1 an hour.

The strict regulations and the 400-bike-per-operator limit on each company put in place by the District, however, have impacted the performance of the DBS scheme. In fact, in July 2018, ofo and Mobike exited the area before the completion of the city-run pilot program, citing that restrictive regulations hindered growth and made operations in the market unsustainable (Glambrone 2018). In November 2018, The District's Department of Transportation released a new permit application for a dockless vehicle program, which includes an expansion of the vehicle fleet cap to 600 bicycles and scooters per company, taking effect in January 2019. Some of the new requirements also include applying for separate permits for bikes and scooters and ensuring bicycles are equipped with lock-to technology (GoUS 2018e).

The table below summarizes the entry and exit of DBS companies in the Washington, DC, metropolitan area as of November 2018, before new permits were introduced.

DOCKLESS COMPANIES OPERATING IN THE WASHINGTON, DC, METROPOLITAN AREA AS OF NOVEMBER 2018

OPERATOR	DATE OF OPERATION	NUMBER OF VEHICLES PER COMPANY	AREA OF OPERATION
Mobike (exited in July 2018)	September 2017	400	Citywide (except federally administered land)
LimeBike			
Spin (transitioned to electric scooters in August 2018)			
JUMP			
ofo (exited in July 2018)	October 2017		
Skip (electric scooters)	May 2018		
Bird (electric scooters)	March 2018		

Source: GoUS 2018c.

CONCLUSION

Providing the opportunity for safe and convenient bicycling should be considered a key element of mobility and transport strategies and plans in cities across the world. A BSS is a powerful way in which to consolidate bicycle access in cities and integrate cycling into the wider mobility network. This publication brings to light the pertinent questions and considerations that decision-makers need to assess before, during, and after BSS implementation, as well as during its operation. An awareness of these aspects will contribute to a successful BSS through informed decisions that relate to planning, regulation, operation, maintenance, funding, safety, and branding.

The benefits of the third-generation, dock-based BSS for cities are well established. Bike technology, however, is rapidly changing, and cities must be proactive in order to understand the risks and opportunities that each generation of bike offers, particularly the emerging fourth generation. This knowledge will equip them to identify and facilitate the establishment of one or more schemes that is/are most appropriate for the local context. The most significant technological advancements, DBS and the e-bicycle, have the ability to bring a range of benefits; however, for this to materialize, cities must be prepared to develop and negotiate the type of mixed regulatory strategies required to manage challenges such as the use of public space, data sharing, and road safety. Even if a BSS is entirely run by an independent, private operator or operators, it is essential that the same planning process be conducted as for any other transport intervention, taking into account the broader mobility and road safety strategy for the city.

Due to the rapid changes, the evolution of BSSs since the introduction of the DBS scheme calls for continual scrutiny and analyses. The more information available, the better informed cities will be to find the balance between governance, regulation, and innovation. There are many opportunities for further research to understand the implications for all 10 thematic areas covered in this document: technology, policy, institutions and regulations, planning, operations and maintenance, financing, monitoring and evaluation, safety, branding and marketing, and transition or expansion.

As the landscape of bike sharing continues to rapidly evolve, there are a range of topics and themes that should be explored in subsequent research. Some of these include monitoring mode-share changes as DBS becomes more and more popular in cities globally, and how this might affect urban transport travel patterns and trends more generally. It would also be useful to carry out more in-depth reviews of the financial and business models used by DBS companies, some of the challenges they have faced, and whether or not these relate to regulation and limits on the number of bikes or to excessively high operational and capital costs. If these new types of innovations are to remain in the long term, a better understanding of the issues they are confronted with is crucial in tailoring the regulation and legal requirements that will benefit cities and private sector companies alike.

ABBREVIATIONS

BRT	bus rapid transit
BSS	bike-sharing scheme
DBS	dockless bike sharing
FSCI	Financing Sustainable Cities Initiative
GBFS	General Bikeshare Feed Specification
M&E	monitoring and evaluation
O&M	operations and maintenance
SLB	service level benchmark
WRI	World Resources Institute

APPENDIX A: CASE STUDIES

Below is a list of the 32 case studies relating to the bike-sharing schemes that were selected from 500 catalogued examples around the globe. The selection was based on geographic distribution, availability of system performance data, and consultation with experts.

NO.	CITY	SYSTEM	YEAR	SCALE
1	Paris	Vélib'	2007	Metropolitan
2	Barcelona	Bicing	2007	Citywide
3	Hangzhou	Hangzhou Public Bicycle	2008	Metropolitan
4	Brussels	Villo	2009	Metropolitan
5	Montreal	Bixi Montreal	2009	Metropolitan
6	London	Santander Cycles (Previously Barclays Cycle Hire)	2010	Citywide
7	Minneapolis-St. Paul	Nice Ride	2010	Metropolitan
8	Guangzhou	Guangzhou Public Bicycle	2010	Citywide
9	Buenos Aires	EcoBici Buenos Aires	2010	Citywide
10	Mexico City	ECOBICI	2010	Citywide
11	Washington, DC	Capital Bikeshare	2010	Metropolitan
12	Rio de Janeiro	Bike Rio	2011	Citywide
13	San Antonio	SWell Cycles (Previously B-Cycle)	2011	District
14	Tel Aviv	Tel-o-Fun	2011	Metropolitan
15	Taipei	You Bike	2011	Metropolitan
16	Boston	Hubway	2011	Metropolitan
17	Medellín	EnCicla	2011	Citywide
18	Berlin	Call-a-Bike	2011	Citywide
19	Kansas City	Kansas City B-Cycle	2012	District
20	Bengaluru	Namma Cycle	2012	Campus
21	São Paulo	Ciclo Sampa	2013	Citywide
22	New York City	Citi Bike	2013	Metropolitan
23	Chicago	Divvy Bikes	2013	Citywide
24	Santiago de Chile	Bike Santiago	2013	Citywide
25	Moscow	Velobike	2013	Citywide
26	Abu Dhabi	ADCB Bikeshare	2014	District
27	Las Condes	Bici Las Condes	2015	Neighborhood
28	New Delhi	Delhi Metro Public Bicycle Sharing Scheme	2015	Neighborhood
29	Philadelphia	Indego	2015	District
30	Seoul	Seoul Bike (Ddareungi)	2015	Citywide
31	Bhopal	Chartered Bike	2017	Citywide
32	Mysore	Trin Trin	2017	Citywide

ENDNOTES

1. A small number of BSSs offer bicycles for free, such as EnCicla in Medellín, Colombia.

2. Consultation held in 2016 with a representative from the Institute for Transportation and Development in China.

3. Consultation held in 2016 with a representative from the Metropolitan Area of Valle de Aburrá, Colombia.

4. Consultation held in 2016 with a representative from Motivate.

5. Consultations held in 2018 with Jonathan M. Rogers, Policy Analyst, District Department of Transportation, District of Columbia, United States; and Kim Lucas, Supervisory Transportation Management Planner, District Department of Transportation, District of Columbia, United States.

REFERENCES

AASHTO (American Association of State Highway and Transportation Officials). 2012. *Guide for the Development of Bicycle Facilities*. Fourth edition. Washington, DC: AASHTO. http://imentaraddod.com/wp-content/uploads/2017/07/AASHTO-GBF-4-2012-bicycle.pdf.

Abagnale, C., M. Cardone, P. Iodice, S. Strano, M. Terzo, and G. Vorraro. 2015. "Model-Based Control for an Innovative Power-Assisted Bicycle." *Energy Procedia* 81: 606–17. https://doi.org/10.1016/j.egypro.2015.12.045.

Abdullah, Z. 2017. "Mobike Enters Singapore's Bike-Sharing Market." *The Straits Times*. March 21. www.straitstimes.com/singapore/transport/mobike-enters-singapores-bike-sharing-market.

ADCB. n.d. "ADCB Bikeshare." www.adcb.com/about/sstanrprt/community/ADCB-Bikeshare.aspx. Accessed August 15 2018.

Ajuntament de Barcelona. 2017. "L'Ajuntament de Barcelona aprova l'adjudicació del nou contracte del bicing pels propers deu anys." Servei de Premsa. December 5. http://ajuntament.barcelona.cat/premsa/2017/12/05/lajuntament-de-barcelona-aprova-ladjudicacio-del-nou-contracte-del-bicing-pels-propers-deu-anys.

_____. n.d.(a). "Bicing." Ajuntamento de Barcelona, Barcelona de Serveis Municipals S.A. www.bicing.cat. Accessed May 12 2018.

_____. n.d.(b). "Cómo funciona, bicicleta eléctrica | bicing." Ajuntamento de Barcelona, Barcelona de Serveis Municipals S.A. www.bicing.cat/es/informacion/como-funciona/bicicleta-electrica. Accessed May 12 2018.

Alim, T. 2017. "Electric Ride: New Powered-Up Bike Share System Coming to DC." *WTOP*. September 21. https://wtop.com/dc/2017/09/electric-ride-new-powered-up-bike-sharing-system-coming-to-dc.

Alvarez-Valdes, R., J. M. Belenguer, E. Benavent, J. D. Bermudez, F. Muñoz, E. Vercher, and F. Verdejo. 2016. "Optimizing the Level of Service Quality of a Bike-Sharing System." *Omega* 62: 163–75. https://doi.org/10.1016/j.omega.2015.09.007.

Anaya, E., A. Castro, and X. Corominas. Anaya, E., A. Castro, X. Corominas. 2012. *Balance General de la Bicicleta Pública en España.* Girona: Fundación ECA-Bureau Veritas, and Jornadas de la Bicicleta Pública.https://bicicletapublica.files. https://bicicletapublica.files.wordpress.com/2013/03/balance-general-de-la-bp-en-espac3b1a.pdf.

AP+D (Alta Planning + Design). 2017. "The Dockless Bike Share Revolution." New Mobility Group. Alta Planning + Design. August 18. https://blog.altaplanning.com/the-dockless-bike-sharing-revolution-eb62698d81f8.

_____. n.d "How to Plan for Dockless Bike Share: Is Dockless Bike Share Right for Your Community?" Alta's New Mobility Group. https://altaplanning.com/how-to-plan-for-dockless-bike-sharing.

BCycle. 2017. "SWell Cycle: The Best Way to Get around San Antonio." https://sanantonio.bcycle.com. Accessed March 5 2018.

Bici Las Condes. n.d. "Bici Las Condes: Mejor Para Todos." www.bicilascondes.cl. Accessed May 13 2018.

BiciMAD. 2014. "La Bicicleta." www.bicimad.com/index.php?s=bicicleta. Accessed February 8 2018.

Bike Itau. n.d. "Aproveite o Rio de Janeiro, pedale com o novo Bike Rio!" https://bikeitau.com.br/bikerio. Accessed March 5 2018.

BikeMi. 2017. "BikeMi: The Electric Bicycle." www.bikemi.com/en/service-info/info/the-electric-bicycle.aspx. Accessed February 15 2018.

Bike Seoul. 2015. "Bike Seoul." www.bikeseoul.com:447/main.do?lang=en. Accessed May 13 2018.

Bike Share Toronto. n.d. "Bike Share Toronto." https://bikesharetoronto.com. Accessed May 13 2018.

BikeWalkKC. n.d. "Kansas City BCyle." https://kansascity.bcycle.com. Accessed May 10 2018.

Bixi. 2018. "Take. Ride. Return: From Station to Station." www.bixi.com/en/how-it-works. Accessed May 18 2018.

Bordenkircher, B., and R. O'Neil. 2017. "Dockless Bikes: Regulation Breakdown." Twelve Tone Consulting. https://nabsa.net/wp-content/uploads/2017/09/Dockless-Bike-Regulation-Breakdown-12-Tone-Consulting-1.pdf.

Brookshire, K., C. Sundstrom, L. Thomas, and R. Bloomberg. 2016. "Advancing Pedestrian and Bicyclist Safety: A Primer for Highway Safety Professionals." National Highway Traffic Safety Administration, United States Department of Transportation. www.nhtsa.gov/sites/nhtsa.dot.gov/files/812258-peds_bike_primer.pdf.

BTS (Bicycle Transit Systems). 2017. "Summary of Field Review of Dockless Bike Share." BTS. December 4. http://usa.streetsblog.org/wp-content/uploads/sites/5/2018/02/Bike-Transit-Dockless-bike-sharing-research-memo-120417.pdf.

Buck, D. 2013. "Bike Sharing Systems Push to Reach Underrepresented Groups." *Greater Greater Washington*. January 11. https://ggwash.org/view/29904/bike-sharing-systems-push-to-reach-underrepresented-groups.

C40 Cities. 2011. "Buenos Aires Is 'Better on Bike.'" (Blog.) September 22. www.c40.org/blog_posts/httpstagingc40orgrefineryblogpostsbuenos-aires-is-better-on-bike.

Call a Bike. 2018. "Call a Bike." www.callabike-interaktiv.de/en. Accessed February 13 2018.

Capital Bikeshare. 2017a. "Capital Bikeshare." www.capitalbikeshare.com. Accessed February 10 2018.

_____. 2017b. "Press Kit." Capital Bikeshare. www.capitalbikeshare.com/Press-Kit. Accessed February 10 2018.

CB Insights. 2018. "The Global Bike-sharing Boom: Dockless Models Look to Solve Urban Commutes & Transit Access." March 22. www.cbinsights.com/research/bike-sharing-boom.

CED (Cycling Embassy of Denmark). 2012. "Collection of Cycle Concepts 2012." www.cycling-embassy.dk/2013/08/01/cycle-concepts2012. Accessed June 14 2018.

Chase, R. 2015. *Peers Inc: How People and Platforms Are Inventing the Collaborative Economy and Reinventing Capitalism*. First edition. New York: PublicAffairs.

Chen, L. Y. 2017. "Mobike, Ofo Investors in Talks to Merge China's Biggest Bike-Sharing Startups." *Bloomberg*. October 3. www.bloomberg.com/news/articles/2017-10-03/mobike-ofo-investors-are-said-in-talks-to-merge-china-startups.

Cheong, D. 2017. "New Bike-sharing Scheme Hits the Road." *Straits Times*. February 18. www.straitstimes.com/singapore/new-bike-sharing-scheme-hits-the-road.

Ciclo Sampa. 2018. "Ciclo Sampa." www.ciclosampa.com.br. Accessed June 12 2018.

Citi Bike. 2013. Homepage. www.citibikenyc.com. Accessed April 13 2018.

Clabaugh, J. 2018. "LimeBike Adds Dockless Electric Scooters in DC." *WTOP*. March 12. https://wtop.com/business-finance/2018/03/limebike-adds-scooters/slide/1.

Clarke, C. F. 2012. "Evaluation of New Zealand's Bicycle Helmet Law." *The New Zealand Medical Journal* 125(1349). www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2012/vol-125-no-1349/article-clarke.

Cohen, A., J. Botha, and S. Shaheen. MTI. 2016. *Bikesharing and Bicycle Safety: MTI Report 12–54*. San Jose, California: Mineta Transportation Institute, College of Business, San Jose State University. http://transweb.sjsu.edu/PDFs/research/1204-bikesharing-and-bicycle-safety.pdf.

Cohen, J. 2017. "Seattle Test Will Lead to Regulating Dockless Bike-sharing." *Next City*. December 21. https://nextcity.org/daily/entry/seattle-dockless-bikeshare-pilot-regulation.

Cornwell, T. B., M. S. Humphreys, A. M. Maguire, C. S. Weeks, and C. L. Tellegen. 2006. "Sponsorship-Linked Marketing: The Role of Articulation in Memory." *Journal of Consumer Research, Inc.* 33: 312–321. http://eprints.qut.edu.au/44952/1/Sponsorship-LinkedMarketing.pdf.

CROW. 2017. *Design Manual for Bicycle Traffic*. Drukwerk, Publicatie. www.crow.nl/publicaties/design-manual-for-bicycle-traffic-(1).

Culver, G. 2018. "Bike Helmets: A Dangerous Fixation? On the Bike Helmet's Place in the Cycling Safety Discourse in the United States." *Applied Mobilities*. February 1–17. https://doi.org/10.1080/23800127.2018.1432088.

Dechert. S. 2014. "US Bike Ridership Surges with Protected Bike Lanes, Study Finds." *Clean Technica*. June 9. https://cleantechnica.com/2014/06/09/us-bike-ridership-surges-protected-bike-lanes-study.

De Clercq, G. 2017. "Paris Wants to Regulate Asian Bike-sharing Operators." *Reuters*. October 21. www.reuters.com/article/us-france-paris-bicycles/paris-wants-to-regulate-asian-bike-sharing-operators-idUSKBN1CP1UZ.

de Jong, P. 2012. "The Health Impact of Mandatory Bicycle Helmet Laws." *Risk Analysis* 32(5): 782–90. https://doi.org/10.1111/j.1539-6924.2011.01785.x.

Delgado Peralta, M. 2017. *Lessons from Ecobici for the Implementation of Public Bicycle Systems in Mexico*. Mexico City: Friedrich-Ebert-Stiftung. http://library.fes.de/pdf-files/bueros/mexiko/13309.pdf.

DeMaio, P. 2009. "Bike-Sharing: History, Impacts, Models of Provision, and Future." *Journal of Public Transportation* 12(4): 3. https://scholarcommons.usf.edu/jpt/vol12/iss4/3.

Dill, J., T. Goddard, C. Monsere, and N. McNeil. 2014. "Can Protected Bike Lanes Help Close the Gender Gap in Cycling? Lessons from Five Cities." Paper 15-3481. November. Nohad A. Toulan School of Urban Studies and Planning, Portland State University. https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1122&context=usp_fac.

Dill, J., and N. McNeil. 2016. "Revisiting the Four Types of Cyclists." Transportation Research Record: *Journal of the Transportation Research Board* 2587(1): 90–99. https://doi.org/10.3141/2587-11.

Divvy Bike Share Program. 2018. "Divvy Bikes." www.divvybikes.com. Accessed April 12 2018.

Dudata, N., C. Adriazola-Steil, and D. Hidalgo. 2012. "Saving Lives with Sustainable Transport: Traffic Safety Impacts of Sustainable Transport Policies." Issue Brief. Washington, DC: World Resources Institute. www.wri.org/sites/default/files/saving_lives_with_sustainable_transport.pdf.

ECF (European Cyclists' Federation). 2012. *Safety in Numbers*. Factsheet. Brussels: European Cyclists' Federation. https://ecf.com/sites/ecf.com/files/ECF_FACTSHEET4_V3_cterree_SafetyNumb.pdf.

_____. 2017. "Policy Framework for Smart Public-Use Bike Sharing." Platform for European Bicycle Sharing & Systems. June 20. European Cyclists' Federation. https://ecf.com/system/files/Policy%20Framework%20SMART%20PBS%20v01Jul17.pdf.

_____. n.d. "Cycling Data Collection." European Cyclists' Federation. https://ecf.com/what-we-do/urban-mobility/cycling-data-collection. Accessed July 16, 2018.

Essex, A. 2017. *The End of Advertising: Why It Had to Die, and the Creative Resurrection to Come*. Random House Publishing Group. https://books.google.com/books?id=rj4YDQAAQBAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false.

Eyler, A. A., J. A. Hipp, and J. Lokuta. 2015. "Moving the Barricades to Physical Activity: A Qualitative Analysis of Open Streets Initiatives across the United States." *American Journal of Health Promotion* 30(1): e50–58. https://doi.org/10.4278/ajhp.131212-QUAL-633.

Fishman, E. 2016. "Bikeshare: A Review of Recent Literature." *Transport Reviews* 36(1): 92–113. https://doi.org/10.1080/01441647.2015.1033036.

Fishman, E., and P. Schepers. 2016. "Global Bike Share: What the Data Tells Us about Road Safety." *Journal of Safety Research* 56: 41–45. https://doi.org/10.1016/j.jsr.2015.11.007.

Fishman, E., S. Washington, and N. Haworth. 2013. "Bike Share: A Synthesis of the Literature." *Transport Reviews* 33(2): 148–65. https://doi.org/10.1080/01441647.2013.775612.

Fowler, G., and H. Tsukayama. 2018. "Review: Scooters Might Revolutionize Urban Transport." *Washington Post*. April 21. www.washingtonpost.com/news/the-switch/wp/2018/04/19/electric-scooters-might-revolutionize-urban-transport-if-it-wasnt-for-stupid-humans/?utm_term=.ab3fa45b2787.

FSCI (Financing Sustainable Cities Initiative). 2018. "Financing Sustainable Cities Initiative: Helping Cities Accelerate and Scale-Up Investments in Sustainable Urban Solutions." (Database.) http://financingsustainablecities.org. Accessed 05/15/2018.

Fucoloro, T. 2014. "Say Hello to Pronto! Emerald City Cycle Share." *Seattle Bike Blog*. May 5. www.seattlebikeblog.com/2014/05/05/say-hello-to-pronto-emerald-city-cycle-share.

Garrard, J., G. Rose, and S. Kai Lo. 2008. "Promoting Transportation Cycling for Women: The Role of Bicycle Infrastructure." *Preventive Medicine* 46(1): 55–59. http://health-equity.lib.umd.edu/916/1/12pm.pdf.

Glambrone, A. 2018. "A Second Dockless Bike-sharing Company Is Exiting DC" *Curbed*. July 26. https://dc.curbed.com/2018/7/26/17616606/dockless-bike-sharing-mobike-washington-availability.

GoA (Government of Argentina). 2018. "Mi Bici Tu Bici." Municipalidad de Rosario, GoA. www.rosario.gov.ar/web/servicios/movilidad/bicicletas/mi-bici-tu-bici.

_____. n.d. "Ecobici." Buenos Aires Ciudad: Autonomous Government of Buenos Aires, Government of Argentina. www.buenosaires.gob.ar/ecobici.

GoB (Government of Brazil). 2017. "Comitê municipal de de uso do do viário resolução no 17, de 12 de de Dezembro de 2017." December 12. Prefecture of São Paulo, GoB. www.prefeitura.sp.gov.br/cidade/secretarias/upload/transportes/cmuv/resolucao_bike_sharing_12_12_17.pdf.

GoCo (Government of Colombia). n.d.(a) Encicla. area metropolitana del valle de aburrá, goco. Metropolitan Area of Valle de Aburrá: Government of Colombia. www.encicla.gov.co.

_____. n.d.(b). "EnCicla - Sistema de bicicletas publicas." www.encicla.gov.co.

GoF (Government of France). 2017. "Saint-Lô. La ville teste les dix premiers vélos à hydrogène." December 12. Commune of Ouest-France, Government of France. www.ouest-france.fr/normandie/manche/saint-lo-la-ville-teste-les-dix-premiers-velos-hydrogene-5441373.

GoIn (Government of India). 2017. "Pedal with Pride." State Government of Karnataka, GoIn. www.mytrintrin.com. Accessed February 12 2018.

_____. 2018. "Guidance Documents for Public Bike Sharing Schemes PBS." Ministry of Urban Development: Government of India. http://moud.gov.in/cms/sustain-sutp-PBS.php.

GoIt (Government of Italy). 2017a. "Avviso pubblico per manifestazione di interesse per l'individuazione dei soggetti interessati a svolgere il servizio di bike sharing a flusso libero nel territorio del comune di Firenze." Commune of Florence, GoIt. May 31. www.ancitoscana.it/images/187496540_-_avviso_Bike_Sharing.pdf.

_____. 2017b. "Avviso pubblico per manifestazione di interesse per l'individuazione dei soggetti interessati a svolgere l'attività di bike-sharing a flusso libero nel territorio del comune di Milano in via sperimentale per la durata di tre anni." July 10. Commune of Milano, GoIt. www.comune.milano.it/dseserver/webcity/garecontratti.nsf/51607b595b240841c1256c4500569c90/a637d352280fa930c12581470056e333/$FILE/Bando.pdf.

GoM (Government of Mexico). 2011. "Cuatro anos de avances: Plan verde de la Ciudad de Mexico." Federal District Government, GoM. http://centro.paot.org.mx/documentos/sma/Informe_PV_a_4anos.pdf.

_____. 2016. *Más ciclistas, más seguros. Guía de intervenciones para la prevención de lesiones en ciclistas urbanos*. Department of Health/STCONAPRA/ITDP. Federal District, Government of Mexico. http://mexico.itdp.org/wp-content/uploads/MasCiclistas_MasSeguros.pdf.

_____. 2017. "CDMX: Hacia una ciudad ciclista." Federal District Government, Government of Mexico. www.cms.sedema.cdmx.gob.mx/storage/app/media/libro_ciclista.pdf.

_____. 2018a. "ECOBICI Ciudad de Mexico." Mexico City: Government of Mexico. www.ecobici.cdmx.gob.mx.

_____. 2018b. "Gaceta oficial de la Ciudad de Mexico." Vigésima Epoca, No. 281. March 14. Mexico City: Government of Mexico. http://data.consejeria.cdmx.gob.mx/portal_old/uploads/gacetas/224e2853c4cc1cc5fd7681405f73766c.pdf.

Goodman, J. D. 2010. "What Is Bike Culture?" *City Room* (Blog.) *New York Times*. March 30. https://cityroom.blogs.nytimes.com/2010/03/30/what-is-bike-culture.

Goodyear, S. 2017. "The Real Story behind the Global Bike-sharing Boom." CityLab. www.citylab.com/city-makers-connections/bike-sharing.

GoUK (Government of the United Kingdom). 2016. "Assessing the Direct Vision Performance of Heavy Goods Vehicles (HGVs)." Transport for London, GoUK. http://content.tfl.gov.uk/assessing-direct-vision-in-hgvs-summary.pdf.

_____. (n.d.). "Santander Cycles." Transport for London: Government of the United Kingdom. https://tfl.gov.uk/modes/cycling/santander-cycles. Accessed April 12 2018.

GoUS (Government of the United States). 2011. "PlaNYC: A Greener, Greater New York." Update. City of New York (State of New York). Government of the United States. www.nyc.gov/html/planyc/downloads/pdf/publications/planyc_2011_planyc_full_report.pdf.

_____. 2012. *Bike Sharing in the United States: State of the Practice and Guide to Implementation*." September. Federal Highway Administration, Government of the United States. www.bikesharing.ch/fileadmin/redaktion/bikesharing/Dokumente/Documents_et_autres/Bikesharing_in_the_United_States.pdf.

_____. 2017a. "2017 Bike Share Pilot: Regulatory Framework for Free-Floating Bike Share." Presentation by Evan Corey and Joel Miller, Seattle Pedestrian Advisory Board. December 13. Seattle Department of Transportation (State of Washington), Government of the United States. www.seattle.gov/Documents/Departments/SeattlePedestrianAdvisoryBoard/2017.12.13-SPAB_Dec2017-Bike_share_Dec11.pdf.

_____. 2017b. "Bike Share Permit Requirements." June 30. City of Seattle (State of Washington), Government of the United States.

_____. 2018a. "DDOT Extends Dockless Demonstration Project." Press Release. District Department of Transportation (District of Columbia), Government of the United States. https://ddot.dc.gov/release/ddot-extends-dockless-demonstration-project.

_____. 2018b. "Dockless Bike Share 2018 Pilot." Staten Island Community Board 1. June 12. http://nycdotbikeshare.info/sites/default/files/2018-06/Dockless_Pilot_Outreach_SICB1.pdf. City of New York (State of New York), Government of the United States.

_____. 2018c. "Dockless Vehicles in the District." District Department of Transportation (District of Columbia), Government of the United States. https://ddot.dc.gov/page/dockless-vehicles-district.

_____. 2018d. "Free-Floating Bike Share." Seattle Department of Transportation (State of Washington), Government of the United States. www.seattle.gov/transportation/projects-and-programs/programs/bike-program/bike-sharing.

_____. 2018e. "DDOT Releases New Permit Application for Dockless Vehicles." District Department of Transportation (District of Columbia), Government of the United States. https://ddot.dc.gov/release/ddot-releases-new-permit-application-dockless-vehicles%C2%A0.

_____. n.d. "Welcome to Adaptive Biketown." City of Portland (State of Oregon), Government of the United States. http://adaptivebiketown.com. Accessed May 12 2018.

Grabar, H. 2017. "Docks Off: U.S. Cities Are Being Invaded by Dock-Less Bike Share. It's Going to Be Messy—and Worth It." *Slate*. December 18. https://slate.com/business/2017/12/dock-less-bike-sharing-is-ready-to-take-over-u-s-cities.html.

Graeme, P. 2017. "Vandals and Thieves Take New Cycle-Share Scheme for a Ride." *The Times*. July 31. News Section. www.thetimes.co.uk/article/vandals-and-thieves-take-new-cycle-share-scheme-for-a-ride-hw3vvc3zg.

Gruber, J., V. Ehrler, and B. Lenz. 2013. "Technical Potential and User Requirements for the Implementation of Electric Cargo Bikes in Courier Logistics Services." In *13th World Conference on Transport Research (WCTR)*, held on July 15–18 in Rio de Janeiro.

Hernández, E. 2018. "Chilangos ven viable uso de bicicletas sin anclaje." October 11. *El Universal*. www.eluniversal.com.mx/metropoli/cdmx/chilangos-ven-viable-uso-de-bicicletas-sin-anclaje.

Hipp, J. A., A. A. Eyler, S. G. Zieff, and M. A. Samuelson. 2014. "Taking Physical Activity to the Streets: The Popularity of Ciclovía and Open Streets Initiatives in the United States." *American Journal of Health Promotion* 28(3s): S114. https://doi.org/10.4278/ajhp.28.3s.S114.

Ho, V. 2017. "People Are Dumping Shared Bikes in Horrible Piles." *MashableAustralia*. January 19. http://mashable.com/2017/01/18/bike-sharing-pile-up-china.

Hoe, N., and T. Kaloustian. 2014. *Bike Sharing in Low-Income Communities: An Analysis of Focus Groups Findings: Fall 2014*. Institute for Survey Research, Temple University. https://b.3cdn.net/bikes/fc16c31cbff25139a1_3cm6bfs04.pdf.

Hong, J. 2017. "Newly Launched Bike-Sharing Firm SG Bike Plans to Take Aim at Indiscriminate Parking." *Straits Times*. August 24. www.straitstimes.com/singapore/transport/newly-launched-bike-sharing-company-aims-to-target-indiscriminate-parking.

Huang, E., and J. Horwitz. 2017. "China's 'Uber for Bikes' Startups Are Being Taken for a Ride by Thieves, Vandals, and Cheapskates." *Quartz.* March 1. https://qz.com/919739/chinese-bike-sharing-startups-like-ofo-and-mobike-are-being-taken-for-a-ride-by-thieves-vandals-and-cheapskates.

Hubway. 2018. "Hubway Station Map." https://secure.thehubway.com/map. Accessed May 12 2018.

Hull, A., and C. O'Holleran. 2014. "Bicycle Infrastructure: Can Good Design Encourage Cycling?" *Urban, Planning and Transport Research* 2(1): 369–406. https://doi.org/10.1080/21650020.2014.955210.

Indego Philadelphia. 2017. "Ride Indego." www.rideindego.com. Accessed March 17 2018.

ITDP (Institute for Transportation & Development Policy). 2013. "The Bike-sharing Planning Guide." New York: ITDP. www.itdp.org/the-bike-sharing-planning-guide-2.

_____. 2018a. *Optimizing Dockless Bikeshare for Cities*. New York: Institute for Transportation & Development Policy. https://como.org.uk/wp-content/uploads/2018/06/ITDP-Optimizing-Dockless-Bikeshare-for-Cities-1.pdf.

_____. 2018b. "The Bikeshare Planning Guide: 2018 Edition." Institute for Transportation & Development Policy. https://3gozaa3xxbpb499ejp30lxc8-wpengine.netdna-ssl.com/wp-content/uploads/2013/12/BSPG_digital.pdf.

_____. 2018c. "The Online Bikeshare Planning Guide Is LIVE!" June 13. Institute for Transportation & Development Policy. www.itdp.org/publication/the-bike-sharing-planning-guide.

ITDP & GoIn (Institute for Transportation & Development Policy/Government of India). 2015. "Public Cycle Sharing System for Delhi." Draft. Government of the National Capital Territory of Delhi, Government of India. www.itdp.in/wp-content/uploads/2016/06/Delhi-cycle-sharing-report_Draft_150906.pdf.

Jennings, G. 2015. "Finding Our Balance: Considering the Opportunities for Public Bicycle Systems in Cape Town, South Africa." *Research in Transportation Business & Management* 15: 6–14. https://doi.org/10.1016/j.rtbm.2014.09.001.

Laamanen, M., M. Barros, and G. Islam. 2018. "Collective Representation on Collaborative Economy Platforms." In *Contemporary Collaborative Consumption*, edited by I. Cruz, R. Ganga, and S. Wahlen, 35–56. Wiesbaden: Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-21346-6_3.

Lazo, L. 2017. "Hey, You Can't Park There! Dockless Bike-sharing Bikes Ending up in Inappropriate Places." *Washington Post*. October 5. www.washingtonpost.com/news/dr-gridlock/wp/2017/10/05/abandoned-vandalized-and-illegally-parked-bike-sharing-bikes-now-a-d-c-problem/?utm_term=.730fd5087c02.

_____. 2018. "Mobike Becomes Second Dockless Bike Operator to Pull out of DC" *Washington Post*. July 25. www.washingtonpost.com/news/dr-gridlock/wp/2018/07/25/mobike-becomes-second-dockless-bike-operator-to-pull-out-of-d-c/?utm_term=.a8b13a0fd2aa.

Le Monde. 2017. "A Saint-Lô, les premiers vélos électriques à hydrogène en France." December 11. Section Économie (Smart Cities). www.lemonde.fr/smart-cities/article/2017/12/11/a-saint-lo-les-premiers-velos-electriques-a-hydrogene-en-france_5228161_4811534.html.

Le Parisien. 2017. "Paris: Encore Un Tour Pour 'P'tit Vélib'." July 3. www.leparisien.fr/info-paris-ile-de-france-oise/transports/paris-encore-un-tour-pour-p-tit-Vélib-03-07-2017-7107945.php.

Lim, A. 2018. "Anywheel, MoBike, ofo and SG Bike Apply for Bike-sharing Operating Licences." *Straits Times*. June 29. www.straitstimes.com/singapore/transport/anywheel-mobike-ofo-and-sg-bike-apply-for-bike-sharing-operating-licences.

Lin, J.-R., and T.-H. Yang. 2011. "Strategic Design of Public Bicycle Sharing Systems with Service Level Constraints." Transportation Research Part E: *Logistics and Transportation Review* 47(2): 284–294. www.sciencedirect.com/science/article/pii/S1366554510000839.

Lloyd, S. 2017. "City of Seattle Rolls out Rules for Private Bike Shares." *Curbed Seattle*. June 30. https://seattle.curbed.com/2017/6/30/15897458/private-bike-sharing-licensing-rules-seattle.

Luciano, F. 2015. "Cargo Bike Sharing." LinkedIn. December 14. www.linkedin.com/pulse/cargo-bike-sharing-francisco-luciano.

Margolis, J. 2017. "Seattle Becomes First US City to Try Dockless Bike Sharing, the System That's Transforming China." *PRI*. August 21. www.pri.org/stories/2017-08-21/seattle-becomes-first-us-city-try-dockless-bike-sharing-system-s-transforming.

McConville, M. 2010. "Mexico City Launches Ecobici Bike-Sharing Program." February 26. *The City Fix*. (Blog.) World Resources Institute. http://thecityfix.com/blog/mexico-city-launches-ecobici-bike-sharing-program.

McLeod, K. 2013. "Bike Law University Idaho Stop." *The League of American Bicyclists*. August 22. https://bikeleague.org/content/bike-law-university-idaho-stop.

McNeil, N., J. MacArthur, and J. Dill. 2017. "Evaluating Efforts to Improve the Equity of Bike Share Systems." *National Institute for Transportation and Communities*. https://nitc.trec.pdx.edu/research/project/884.

Mendez, G. 2014. "Beyond Move in Mexico City: Integrating Sustainable Mobility into the Everyday." June 30. *The City Fix*. (Blog.) World Resources Institute. http://thecityfix.com/blog/beyond-move-mexico-city-integrating-sustainable-mobility-ecobici-biking-gisela-mendez.

MetroBike. 2017. "The Bike-Sharing World at the End of 2016." (Blog.) January 25. http://bike-sharing.blogspot.com/2017/01/the-bike-sharing-world-at-end-of-2016.html. Accessed April 15 2018.

Metropolis. n.d. "Urban Public Bicycle Sharing Program: Hangzhou, China." https://policytransfer.metropolis.org/case-studies/hangzhou-china-urban-public-bicycle-sharing-program. Accessed March 13 2018.

Meyer, R. 2018. "Unfortunately, the Electric Scooters Are Fantastic." *The Atlantic*. May 31. www.theatlantic.com/technology/archive/2018/05/electric-scooters-are-the-cargo-shorts-of-transportation/561440.

Mi Bikesantiago. n.d. "Mi Bikesantiago." www.bikesantiago.cl. Accessed April 23 2018.

Mini-Bicicletar. 2014. "Projeto Mini-Bicicletar." www.bicicletar.com.br/mini-Bicicletar.aspx. Accessed May 15 2018.

Monsere, C., J. Dill, N. McNeil, K. Clifton, N. Foster, T. Goddard, M. Berkow, J. Gilpin, K. Voros, D. van Hengel, and J. Parks. 2014. *Lessons from the Green Lane: Evaluating Protected Bike Lanes in the U.S*. Publication NITC-RR-583. Portland: National Institute for Transportation and Communities.

Montezuma, R. 2015. Sistemas públicos de bicicletas para América Latina. Guía práctica para implementación. Bogotá: CAF, Fundación Ciudad Humana.

Musakwa, W., and K. M. Selala. 2016. "Mapping Cycling Patterns and Trends Using Strava Metro Data in the City of Johannesburg, South Africa." *Data in Brief* 9: 898–905. https://doi.org/10.1016/j.dib.2016.11.002.

NABSA (North American Bike Share Association). 2017. "General Bikeshare Feed Specification." GitHub. https://github.com/NABSA/gbfs.

NammaCycle. n.d. "NammaCycle: Public Bicycle Sharing for Communities." www.nammacycle.in. Accessed November 21 2017.

Navigo. 2016. "Vélos en Libre Service." (Blog). www.navigo.fr/j-organise-mon-deplacement/velos-en-libre-service. Accessed February 11 2018.

Nice Ride. 2018. "More bikes. More stations. More Minneapolis." www.niceridemn.org. Accessed March 9 2018.

Pal, A., and Y. Zhang. 2015. "Free-Floating Bike Sharing: Solving Real-Life Large-Scale Static Rebalancing Problems." Transportation Research Part C: *Emerging Technologies* 80: 92–116. www.sciencedirect.com/science/article/pii/S0968090X17300992.

Patterson, B. 2013. *Bicycle Account Guidelines: Measuring, Tracking and Reporting Progress to Inspire Better Biking in Your Community*. Vancouver: Urban Systems Ltd. https://bikeleague.org/sites/default/files/Bicycle_Account_Guidelines.pdf.

Pfoser, S., and M. Pajones. 2017. "Specification of Input, Output and Setting Options for a Bike Sharing Planning System." *International Journal of Transport Development and Integration* 1(1): 84–91. https://doi.org/10.2495/TDI-V1-N1-84-91.

Pidd, H. 2017. "Manchester's Bike-sharing Scheme Isn't Working—Because People Don't Know How to Share." *The Guardian*. Opinion/Cycling Section. July 17. www.theguardian.com/commentisfree/2017/jul/16/manchesters-bike-sharing-scheme-isnt-working-because-people-dont-know-how-to-share.

Plumer, B. 2016. "A New Study Looks at Why Bike Share Is So Much Safer than Regular Biking." *Vox*. Updated April 23. www.vox.com/2016/4/3/11349856/bike-sharing-safety.

Quintanar Solares, D. S., J. J. Sanchez Romero, and X. Trevino Theesz. 2011. *La movilidad en bicicleta como politica publica*. Cuauhtémoc, Mexico: Ciclciudades, Instituto para Politicas de Transporte y Desarrollo. www.acervoyucatan.com/contenidos/ciclociudadestomo1.pdf.

Reid, C. 2018. "Netherlands Knocks Heads Together to Make Dockless Bike Share Slightly More Seamless." January 31. *BikeBiz*. www.bikebiz.com/news/one-app-for-dockless-nl.

Reliance Foundry. 2017. "Bike Culture: Europe vs. America: How to Build Better Bicycle Communities." (Blog.) Updated June 22. www.reliance-foundry.com/blog/biking-usa-europe#gref. Accessed June 22 2018.

Rodriguez, D. 2018. "3 alternativas a Ecobici para pedalear en la Ciudad de Mexico." April 19. *El Pais*. https://verne.elpais.com/verne/2018/04/19/mexico/1524091790_166508.html.

Roland Berger. 2015. "Bike Sharing." Roland Berger. April 20. www.roland-berger.com/en/Publications/pub_bike_sharing.html.

Rushe, D. 2017. "Why We Can't Have Nice Things: Dockless Bikes and the Tragedy of the Commons." *The Guardian*, Politics Section. November 5. www.theguardian.com/politics/2017/nov/05/why-we-cant-have-nice-things-dockless-bikes-and-the-tragedy-of-the-commons.

Russell, J. 2018. "OBike Is Closing Its Dock-Less Bike-Sharing Service in Singapore." *Tech Network*. https://techcrunch.com/2018/06/24/obike-is-closing-its-dock-less-bike-sharing-service-in-singapore.

Schneider, T. W. 2016. "A Tale of Twenty-Two Million Citi Bike Rides: Analyzing the NYC Bike Share System." (Blog). http://toddwschneider.com/posts/a-tale-of-twenty-two-million-citi-bikes-analyzing-the-nyc-bike-sharing-system. Accessed March 20 2018.

Schroeder, B. 2014. "Bicycle Sharing 101: Getting the Wheels Turning: How to Take a Public Bike System from Concept to Reality." (Blog.) https://bicycle-sharing101.com/bike-sharing-101/contracting. .

SFMTA (San Francisco Municipal Transport Agency) n.d. "Stationless Bikeshare Program Permit Application." San Francisco: SFMTA. www.sfmta.com/sites/default/files/projects/2017/Bike%20Share%20Permit_v1.1_FINAL.pdf.

SGIAUI (Secretariat of Guangzhou International Award for Urban Innovation). 2014. "Public Bike Sharing." (Database.) www.urban-innovations.org/index.php/Public_Bike_Sharing.

Shaheen, S., S. Guzman, and H. Zhang. 2010. "Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future." Transportation Research Record: *Journal of the Transportation Research Board* 2143: 159–167.

Shared-Use Mobility Center. 2016. "Could Open Data Increase Bikeshare Use?" January 10. http://sharedusemobilitycenter.org/news/could-open-data-increase-bikeshare-use.

_____. 2018 "Dockless Bike Share Code of Practice for Operators in London." (Database.) http://policies.sharedusemobilitycenter.org/#/policies/985. Accessed May 13 2018.

Small, A. 2017. "The Four Horsemen of the Bike Share Apocalypse." *Citylab*. January 31. www.citylab.com/transportation/2017/01/seattle-bike-sharing-pronto-goes-under/513575.

Smart City Bhopal. 2018. "How to Rent, Park and Return a Chartered Bike." http://smartbhopal.city/how-to-rent-park-and-return-a-chartered-bike.html. Accessed August 1 2018.

Smith, M. 2018. "DDOT: DC Generally Favors Dockless Bike Share so Far; Dozens Stolen." *WTOP*. February 27. https://wtop.com/dc-transit/2018/02/ddot-dc-favors-dockless-bikeshare.

_____. 2018b. "Vélib." www.Vélib-metropole.fr/en/map#/. Accessed April 15 2018.

Spin. 2017. "The $5000-a-Bike City Bikeshare That's Hardly Used." (Blog). February 22. https://blog.spin.pm/the-5000-a-bike-city-bikeshare-thats-hardly-used-b004a2c31b45.

_____. 2018. "About." Spin. www.spin.pm/about. Accessed January 11 2018.

Sturdivant-Sani, C. 2018. "Can Dockless Bikeshare Pump up Cycling's Diversity?" *Citylab*. January 9. www.citylab.com/transportation/2018/01/can-dockless-bikeshare-pump-up-cyclings-diversity/549629.

Susan Shaheen, S., A. Cohen, and I. Zohdy. 2016. *Shared Mobility: Current Practices and Guiding Principles*. Washington, DC: Federal Highway Administration, Department of Transportation, Government of the United States. https://ops.fhwa.dot.gov/publications/fhwahop16022/index.htm.

Suzuki, H., R. Cervero, and K. Iuchi. 2013. *Transforming Cities with Transit: Transit and Land-Use Integration for Sustainable Urban Development*. Washington, DC: World Bank. https://doi.org/10.1596/978-0-8213-9745-9.

SVBC (Silicon Valley Bicycle Coalition). n.d. "Open Streets." https://bikesiliconvalley.org/open-streets. Accessed April 21 2018.

Tchebotarev, E. 2017. "With Hundreds of Millions of Dollars Burned, the Dockless Bike Sharing Market Is Imploding." *Forbes*. December 16. www.forbes.com/sites/evgenytchebotarev/2017/12/16/with-hundreds-of-millions-of-dollars-burned-the-dockless-bike-sharing-market-is-imploding.

Tel-O-Fun. n.d. "Tel-O-Fun." www.tel-o-fun.co.il/en. Accessed March 17 2018.

Teschke, K., M. Koehoorn, H. Shen, and J. Dennis. 2015. "Bicycling Injury Hospitalisation Rates in Canadian Jurisdictions: Analyses Examining Associations with Helmet Legislation and Mode Share." *BMJ Open* 5: e008052. https://bmjopen.bmj.com/content/bmjopen/5/11/e008052.full.pdf.

The Economist. 2017. "How Bike-Sharing Conquered the World." December 19. www.economist.com/news/christmas-specials/21732701-two-wheeled-journey-anarchist-provocation-high-stakes-capitalism-how.

UNDESA (United Nations Department of Economic and Social Affairs). 2011. "Bicycle-Sharing Schemes: Enhancing Sustainable Mobility in Urban Areas." Background Paper No. 8, CSD19/2011/BP8, Commission on Sustainable Development Nineteenth Session, prepared by Peter Midgley, Global Transport Knowledge Partnership International Road Federation. New York: UNDESA. http://fmt.isti.cnr.it/data/media/private/adaptbp/casestudy/background-paper8-p.midgley-bicycle.pdf.

VélibSmovengo & SAVM (Syndicat Autolib' Vélib' Métropole). 2018a. "Le Service Vélib'." Vélib'. https://www.Vélib-metropole.fr/discover/service. Accessed July 5 2018.

Velobike. 2018. "Velobike Moscow Bikesharing." https://velobike.ru/en. Accessed May 14 2018.

Verma, P., J. S. Lopez Valderrama, and C. Pardo. 2015. *Bicycle Account: Bogotá 2014*. www.despacio.org/wp-content/uploads/2015/01/Bicycle-Account-BOG-2014-20150109-LR.pdf.

Villo. 2018. "Villo!" http://en.villo.be. Accessed March 22 2018.

von Ritter Figueres, N. 2017. "What Can the Rest of the World Learn from Mexico City's EcoBici Bike-Sharing Scheme?" (Blog.) *LSE International Development*. The London School of Economics and Political Science. December 20. http://blogs.lse.ac.uk/latamcaribbean/2017/12/20/what-can-the-rest-of-the-world-learn-from-mexico-citys-ecobici-bike-sharing-scheme.

Wang, W. 2016. "Forecasting Bike Rental Demand Using New York Citi Bike Data." Dublin Institute of Technology. https://arrow.dit.ie/cgi/viewcontent.cgi?article=1083&context=scschcomdis.

WHO (World Health Organization). 2008. *Speed Management: A Road Safety Manual for Decision-Makers and Practitioners*. Geneva: Global Road Safety Partnership, WHO.

Yao, Y., and Y. Zhou. 2009. "Bike Sharing Planning System in Hangzhou." *Urban Transport of China* 7(4): 30–38.

YouBike. n.d "YouBike." https://taipei.youbike.com.tw/home. Accessed June 12 2018.

Zagster Inc. 2016. "How Collaborative Sponsorship Solves Bike Sharing's Funding Conundrum." (Blog.) https://www.zagster.com/blog/how-collaborative-sponsorship-solves-bike-sharings-funding-conundrum. Accessed March 12 2018.

_____. 2018. "Bike Share as a Service." www.zagster.com/platform. Accessed April 4 2018.

Zimmerman, M. 2016. "Bike Sharing Pedals toward a Fourth Global Generation." *Urban Land Magazine*. February 19. https://urbanland.uli.org/economy-markets-trends/bike-sharing-pedals-toward-fourth-global-generation.

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