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SUSTAINABLE MOBILITY FOR SUSTAINABLE CITIES: LESSONS FROM CYCLING SCHEMES IN MEXICO CITY AND GUADALAJARA, MEXICO

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Summary

Reliable, affordable, safe and clean urban mobility is essential for sustainable cities and communities (Sustainable Development Goal (SDG) 11). This issue, which is common to all cities – big and small, wealthy and developing, ancient and newly established – may be most pressing where economic and population growth are leading to the fastest increases in vehicle ownership, a key driver of urban congestion, air pollution, traffic accidents and municipal infrastructure spending. Overcoming the challenges to attain sustainable mobility systems requires coordination between citizens, private firms, and urban/local, regional and national governments, each of which plays a unique and essential role in facilitating the billions of trips that happen daily in urban areas across the globe.

This policy brief presents lessons from Mexico City and Guadalajara, where pioneering urban cycling schemes are redefining mobility and liveability in urban Mexico. Through an inclusive approach that recognises the diverse needs of its citizens, and the varied barriers to active transport that they face, policy-makers in Mexico City and Guadalajara are helping to maximise the benefits of urban cycling. Although public bicycle-sharing schemes (PBSSs) in both cities cover a relatively small part of the metropolitan areas (3% and 5% respectively), analysis here shows that they are a critical piece of urban transport infrastructure that complement the public transport network.

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ABOUT THIS POLICY BRIEF

This policy brief was prepared by the University of Leeds. It was developed in partnership with the Coalition for Urban Transitions, which is a major international initiative to support decision-makers to meet the objective of unlocking the power of cities for enhanced national economic, social and environmental performance, including reducing the risk of climate change. The research presented here was conducted in support of the Coalition's Economics workstream, and builds on previous University of Leeds and Coalition research on the economic and social benefits of low-carbon cities. The opinions expressed and arguments employed are those of the authors.

CITATION

Balderas Torres, A., Zafra Ortega, A., Sudmant, A. and Gouldson A., 2021. Sustainable mobility for sustainable cities: Lessons from cycling schemes in Mexico City and Guadalajara, Mexico. Coalition for Urban Transitions. London and Washington, DC. https://urbantransitions.global/publications

Funded by UK Government

This material has been funded by the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.

Shared bicycles in Mexico City.
Credit: Alfredo Hernandez Rios/Shutterstock

The public health benefits of such PBSSs, and cycling in general, are significant: by increasing levels of physical activity and reducing air pollution, premature deaths are prevented. While current impacts are modest relative to the thousands of lives lost to car accidents and air quality across Mexico each year, the scope for expanding PBSS within these cities – and in 18 other urban areas in Mexico with populations greater than 500,000 – suggests that thousands of lives could be saved from expanded and integrated PBSSs.

Of greater significance may be the contribution these cycling policies and programmes are having on the way policy-makers approach urban mobility. Transport policy in Mexico has often prioritised large-scale projects focused on private vehicles that are disconnected from ideas of compact urban development. The emergence of cycling schemes, however, reminds us that urban planning decisions, last-mile connections and neighbourhood-level design are essential considerations for reliable, affordable and safe urban mobility.

This policy brief is one of a series on frontrunning climate actions in cities around the world. The objective of this series is to strengthen the evidence on the economic and social implications of low-carbon, climate-resilient urban development. The series focuses on providing robust data on actual or ex post outcomes of climate action, ranging from better public health to job creation to greater equity. Each case study explores some of the preconditions for the successful design and delivery of urban climate action and provides national policy recommendations that could enhance their effectiveness and benefits.

Highlights

- Reliable, affordable, safe and clean urban mobility is essential for sustainable cities and communities (Sustainable Development Goal (SDG) 11). Conversely, private car ownership can be costly, and lead to dysfunctional, inequitable, deadly and polluting transport networks. Congestion is a symptom of mobility options failing to meet residents' needs, and is costing cities 1–5% of urban GDP each year.[1] Poor outdoor air quality, caused in large part by the transport sector, is responsible for more than 3 million deaths each year and millions of hospital visits, and traffic accidents cost more than 1 million additional lives.[2]
- With technological breakthroughs, such as mobile phone applications and battery-powered scooters, "new mobility" has emerged as a buzzword in urban policy-making. A well-established technology, however, is having a dramatically more substantial impact on urban mobility: the public bicycle-sharing scheme (PBSS).
- More than 1,200 PBSSs have been developed globally in just the last decade,[3] including highly successful systems in the urban cores of Mexico City, and Guadalajara, Mexico.

- While PBSSs currently account for a relatively small proportion of trips within a relatively small part of Mexican cities, the scope for scaling up cycling and achieving substantial social, economic and environmental benefits is massive. If Mexico's 20 urban areas with populations greater than 500,000 implemented schemes with comparable ambition as those in Mexico City and Guadalajara, thousands of lives could be saved from improved public health.
- More significantly, the PBSSs in Mexico City and Guadalajara – EcoBici and MiBici – are playing a leading role in helping to establish an alternative to motorised transport in their respective cities. Programmes to encourage wider participation in cycling, including bike lessons for children and closing streets to all transport except bikes on Sundays, are increasing cycling usage. Historical data indicates that the systems are establishing themselves as key elements of the transport network.
- In 2019, there was an unexpected fuel shortage in the country which provided the opportunity to demonstrate an additional benefit of these public systems: increased resilience for transport networks in the face of disruption. During this period, usage of EcoBici in Mexico City remained high, while in metropolitan Guadalajara, MiBici saw a dramatic increase in usage and new memberships. Conversely, the lockdown following the COVID-19 pandemic represents a challenge for these systems, as usage rates have plummeted to levels unseen since 2010 and 2016 respectively for EcoBici and MiBici. Public cycling schemes have proven more resilient thus far than their privately owned counterparts, some of which have gone bankrupt, and PBSSs are well positioned to play a larger role in urban mobility as we emerge from the crisis.
- To accelerate the shift to non-motorised transport in Mexican cities, policy-makers need to support the continued expansion of urban cycling infrastructure while addressing challenges related to road safety and the physical and digital integration between public and non-motorised transport networks. By working towards this goal, a myriad of social, economic and environmental benefits will be unlocked. This requires the cycling network to be physically, operationally and politically integrated into transport policy-making, and for transport policy-making to be connected more formally into urban planning policy. National policy-makers can also take specific actions to support decentralised technical bodies and civil society organisations that are critical actors promoting sustainable mobility.

1. The challenge: Sustainable mobility and urban growth

THE GLOBAL CHALLENGE

Cities thrive by bringing people together, but private car-based transport pushes people apart: in many cities globally, more than 20% – and in some cases as much as 50% – of urban space is devoted to private vehicles, crowding out space for homes, offices, parks, schools, hospitals, and the wider things that bring people to cities in the first place.[4]

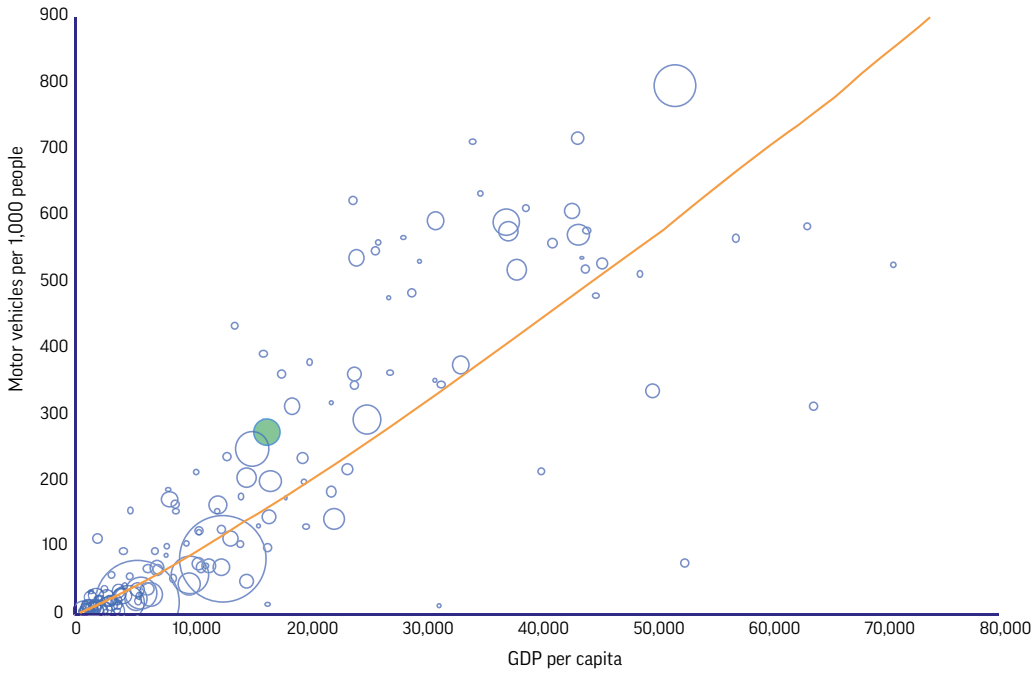
Beyond the opportunity cost of devoting prime real estate to cars, a dependence on private transport comes with other costs as well. Globally, 1–5% of urban GDP is lost each year due to congestion.[5] Poor outdoor air quality, often largely attributable to urban transport, is responsible for almost 3 million deaths globally.[6] And traffic accidents take the lives of more than 1.25 million people across the globe every year.[7]

In this context, alongside ever-increasing private car ownership (see Figure 1), alternatives to a future where urban infrastructure is built mainly around the needs of cars have become a focus of urban policy-makers. Scooters, shared taxis, a growing number of mapping and route planning technologies, and even personal jetpacks[8] are among the technologies that have amassed billions of investment, and (in some cases) millions of users, in recent years.

Amid the hype and general enthusiasm, however, one technology stands out as having realised a significant positive impact on access to reliable, affordable and safe mobility in urban areas: the public bicycle-sharing scheme (PBSS). Bicycles offer an efficient mode of transportation for short distances and are widely available for all levels of income.

The first bicycle share scheme appeared in Amsterdam in the 1960s, and since then many experiments and models have been implemented in small communities and cities all over the world (e.g. in Denmark, the UK and the US), which more recently evolved into the docked and dock-less PBSSs. These have spread rapidly – globally more than 1,200 PBSSs have been developed in just the last decade. Accessible and familiar to large portions of the population, low-cost, quiet, zero-emission, compatible with existing infrastructure and taking up relatively little space, public bicycles are uniquely suited to the challenge of urban transport adapted to the needs of the 21st century.[9] The varied degrees of success different schemes have seen, however, points to the need for careful review of best practice, including around infrastructure provision, and coordination and integration with the wider transport network. However the challenge remains to adapt existing infrastructure for the wider and safe use of PBSSs.

Figure 1. Motor vehicles per 1,000 people versus GDP per capita



Notes: The size of each circle represents the population of a country; only countries with a population greater than 10 million are included. Mexico is in green.
Source: Nation Master, 2014.[80]

THE CHALLENGE IN MEXICO

In 2015, the total population in Mexico was approximately 119 million,[10] of which 74% live in cities.[11] The UN estimates from 2018 predict that, in 2019, the population will have reached 128.9 million.[12] In 2018, the country had 401 cities according to the National Urban System, and 13 of them had populations of more than a million.[13] Population growth in the 10 major metropolitan areas (excluding Mexico City) was 2.9% per year from 1990 to 2010, well above the national average of 1.8%.[14] According to the most recent estimates, approximately 65% of the population live in metropolitan areas.[15] Metropolitan areas face many challenges with intermunicipal coordination, which directly affects the provision of services and the quality of life of their population. In some cases, coordination between different state-level governments is necessary as some of their municipalities share a metropolitan area.

In recent decades, Mexican cities grew horizontally, integrating once isolated settlements and municipalities into bigger urban regions. This territorial expansion occurred at a higher rate than population growth: over the last three decades the population of Mexican cities has doubled while their area has increased tenfold.[16] As a result, the demand for and use of private transport has also grown rapidly: the number of private cars in Mexico increased eight times between 1980 and 2018 while the distance travelled per vehicle increased 1.5 times.[17]

This growth pattern produced fragmented and disconnected urban spaces, increasing transport times and rising expenditure on mobility. The provision of public services, including roads, water supply, sanitation and public transport, has not been able to cope with this growth rate, generating a myriad of private and public costs collectively estimated at more than 4% of national GDP,[18] and expenditure on mobility is the highest among countries in the Organisation for Economic Co-operation and Development (OECD).[19] In addition, it is estimated that 14,000 lives are lost annually in Mexico as a result of poor air quality and 24,000 lives are lost in road accidents.[20] Without leadership from the national government, these trends from the past will dictate the future of Mexico's cities: the vehicle fleet is expected to more than double to 70 million cars and trucks by 2030.[21]

2. Methodology

Analysis for this policy brief includes information from different sources to understand how PBSSs have evolved over time in both cities. Methods include a set of semi-structured interviews with key actors in urban transport in Mexico, original analysis of open data from PBSSs in Mexico City and Guadalajara, and the results of a survey answered by citizens in both cities, including users of the cycling schemes. The interview guide and survey applied are included in the Appendix. In addition, this paper also relies on extensive document analysis supplemented with consultation from a range of actors, including cycle users and members of the public, academic experts and firms involved in the industry.

INTERVIEWS AND SURVEYS

Semi-structured interviews were conducted with 12 key informants from different stakeholder organisations involved in various aspects of the design, implementation and running of third- and fourth-generation PBSSs in Mexico. These organisations included local and national government departments, a university, two transport consultancies, a transport policy think tank, a public PBSS operator, and four dock-less BSS/scooter companies. World Resources Institute Mexico provided support by pointing out other relevant stakeholders to interview. The purpose of the interviews was to gather perspectives from the full range of actors involved in the evolution and governance of BSSs, with a particular interest in understanding how the schemes have evolved and what the enabling factors, challenges and areas of opportunities are for these schemes to deliver co-benefits and expand to other cities.

A survey was delivered using an online marketing company to a sample of 275 citizens in each of the two cities in January 2020. The sample was selected from adults living in the local jurisdictions covered by the PBSS and quotas were established by gender, age and income. The objective of the survey was not to draw a representative view of the urban population nor the population of BSS users.

Table 1. General characteristics of the survey samples applied in Mexico City and Guadalajara

	CDMX		GDL		ALL CDMX	ALL GDL
	Users	Non-users	Users	Non-users		
Age						
18 to 24	33.0%	22.3%	32.1%	24.1%	29.3%	29.6%
25 to 34	41.2%	39.4%	44.4%	34.5%	40.6%	41.2%
35 to 45	19.2%	23.4%	18.2%	27.6%	20.7%	21.2%
46+	6.6%	14.9%	5.3%	13.8%	9.4%	8.0%
Gender						
Women	45.6%	59.6%	50.3%	48.3%	50.4%	49.6%
Men	53.8%	39.4%	49.7%	49.4%	48.9%	49.6%
Rather not say	0.5%	1.1%	0.0%	2.3%	0.7%	0.7%
Socio-economic group						
High (A/B)	13.2%	17.0%	13.4%	17.2%	14.5%	14.6%
Medium-high (C+)	28.6%	24.5%	27.8%	27.6%	27.2%	27.7%
Medium (C)	20.3%	29.8%	18.7%	34.5%	23.6%	23.7%
Medium-low (D+)	21.4%	17.0%	23.5%	11.5%	19.9%	19.7%
Low (D)	16.5%	11.7%	16.6%	9.2%	14.9%	14.2%

Notes: CDMX = Mexico City; GDL = Guadalajara; n = 275 in both cases.

The objective was to use an unbiased sampling strategy to assess the effect of different factors – such as gender, age and income – on PBSS usage patterns. Other sampling strategies were tested, such as a snowball technique on social media and through the direct invitation of PBSS users; however, the results of these pilots indicated a strong bias towards individuals with higher than average usage of BSSs. The use of marketing companies to explore specific aspects of the schemes, such as environmental valuation, has been made before.[22] The objective of the survey was to understand the drivers of usage of PBSS, as well as its strengths, opportunities and weaknesses. In particular, questions were included to explore the usage of PBSS and mobility patterns in the cities during the fuel shortage that took place in the country at the beginning of 2019. The quotas requested from the marketing company were: 50% by gender; all adults by quotas (30% 18–24 years, 40% 25–34 years, 20% 35–45 years and 10% older than 46 years); by income (15% high, 25% medium-high, 25% medium, 20% medium-low and 15% low). However, small variations were accepted. See Table 1 for the values of the samples for the two cities. Previous or current usage and membership of the PBSS was not required; one of the questions explored whether the respondent was a user or had been a user of bike-sharing schemes. Results showed similar patterns, with 65.9% of the respondents in Mexico City and 68.2% in Guadalajara stating that they were users.

DATA AND HEALTH MODELLING

Analysis of open data includes EcoBici and MiBici monthly registrations, estimation of total active users, number of trips and trips per bicycle. Information is presented on a monthly basis since the schemes began operating; the historical trends are used to assess qualitatively the effect of the fuel shortage in 2019 and of the COVID-19 pandemic in 2020.

Based on the information gathered, it was possible to study the number of trips, the type of users, and how users are interacting with the transport system. Health co-benefits are estimated using well-established approaches from academic literature[23] to generate indicative estimates.[24] Results obtained help to estimate the magnitude of the main co-benefits of cycling in the two cities, including:

- The number of vehicle kilometres travelled and corresponding fuel saved;
- Emissions avoided from vehicle use, which can be divided into exhaust emissions, such as carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter ($PM_{2.5}$ and PM_{10}) and evaporative emissions such as hydrocarbon (HC); and
- Health impacts: positive effects from physical activity and negative effects from air pollution and accidents. This is calculated according to: reduced mortality risks associated with additional levels of exercise in minutes per week; increased mortality risks due to accidents between vehicles and bicycles; and increased mortality for cyclists associated with increased exposure to $PM_{2.5}$, PM_{10} or NO_x.

3. The policy context

GOVERNANCE OF TRANSPORT IN MEXICO

Fragmented responsibilities and capacities around the governance of transport lead to gaps, overlaps and conflicts around transport policy in Mexican cities.[25] Different federal, state and local public entities regulate and manage specific aspects of transport services and also coordinate the participation of other relevant actors, such as private companies and other metropolitan councils.

Legal responsibilities

Local governments (i.e. municipalities) hold the constitutional power to intervene in the formulation and implementation of public transport programmes. However, in practice this power has usually been transferred to state-level governments, due to municipalities' lack of resources and capacity to manage and provide public transport services. One benefit of this approach is that state-level governments have a longer time horizon for action (i.e. six-year periods, although recently city mayors have had the option to go for re-election after their first three-year period). Local governments also have the mandate to regulate and guide urban growth, using instruments such as land-use and development plans, building regulations and codes of construction. The way in which these policies are poorly or effectively implemented shapes the demand for transportation.

Challenges for long-term action

In this regard, one pervasive problem in municipalities is that, with changes in local governments every three years, policies are often discontinued, including urban development and transport initiatives. An approach to address this challenge is the creation of Municipal Planning Institutes (IMPLANs). Municipalities have the possibility of creating IMPLANs, as decentralised public entities in charge of the coordination and integration of urban development programmes over the long term. In metropolitan areas, where there is more than one municipality, Metropolitan Planning Institutes serve the same function across multiple municipalities. Unfortunately, not many municipalities have created IMPLANs (65 out of 401 cities),[26] and, where they have, in practice many of them do not yet meet the institutional requirements for their appropriate operation[27] or have the necessary funds and staff. Out of the 74 metropolitan areas in the country, only one has seen the formation of an IMEPLAN – the Metropolitan Area of Guadalajara (MAG). In Guadalajara nine municipalities have agreed to create the Institute of Planning and Development Management of the Metropolitan Area of Guadalajara (IMEPLAN, Instituto de Planeación y Gestión del Desarrollo del Área Metropolitana de Guadalajara).

Limited public funding

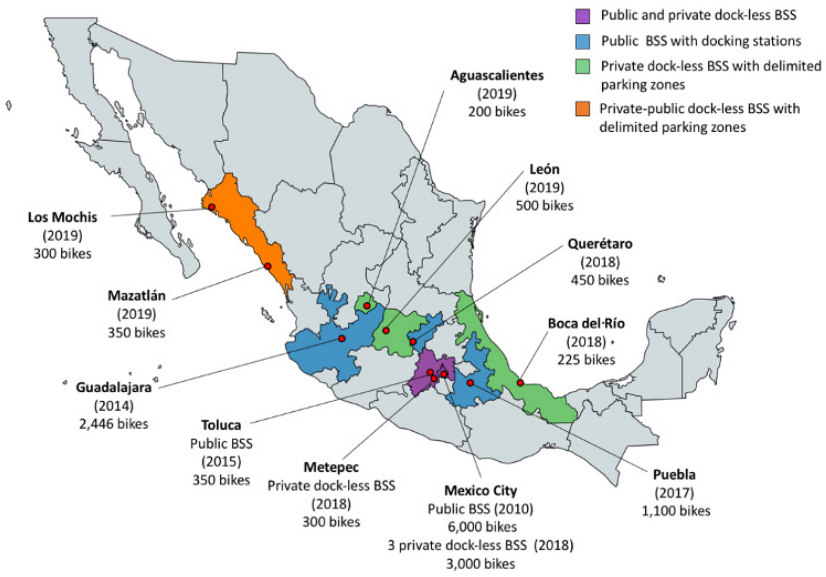
The majority of funding of public budgets in the country is allocated from the federal to the state and municipal governmental levels; local authorities collect their own resources through property tax and by charging for public services (e.g. water supply). However, typically collection efficiency is quite low, accounting for less than 25% of the public local budget. At the national level, the Ministry of Agrarian, Land and Urban Development (SEDATU) is the authority responsible for providing a national policy framework for urban planning and development and local sustainable mobility programmes. There have been efforts to coordinate the work of institutions and financial mechanisms to promote sustainable mobility programmes across different sectors and geographic jurisdictions; unfortunately, a divide remains between urban planning programmes and the design, adoption and use of sustainable mobility technologies. Examples of financial mechanisms set up by the federal government to promote sustainable mobility in Mexican cities are the National Infrastructure Fund (FONADIN) and the Mass Transit Federal Support Program (PROTRAM), but there is a gap around funding for active travel, as PROTRAM focuses on mass transit. Federal government requires local or state-level authorities, including IMPLANs, to prepare Integrated Sustainable Urban Mobility Plans (ISUMP) as a prerequisite to financing mass transit infrastructure. Nevertheless, ISUMPs have poor links to urban development policies and strictly these are not local or state-level formal planning documents.[28]

Metropolitan Funds (MF) are regional financing mechanisms that have, as one of their purposes, the operationalising, coordinating and financing of transport and urban accessibility programmes locally; they also finance other projects and types of infrastructure. Furthermore, given the technical difficulties of accessing finance for sustainable mobility and of coordinating efforts, MFs have failed to promote sustainable urban mobility, by allocating 75% of their financial resources to private vehicle infrastructure nationwide (e.g. tunnels, highways, bridges).[29]

Recent advances in mass-transit investments in the last two decades include bus rapid transit (BRT) systems introduced in Mexico City, Guadalajara, Monterrey and León, connected to other modes of transport.[30] The expansion of the subway and the commuter rail line that connects Mexico City and Mexico state offer other examples of attempts to reduce pollution and improve public transport.[31] Mexico City and the state government of Jalisco are working on integrating all local transport services with a single pre-payment card. This started in January 2020 in Mexico City; it has also begun in the MAG and been concluded in Puerto Vallarta, the second largest city in Jalisco.

Initiatives for sustainable transport can emerge through bottom-up processes or top-down policies. At the local level, municipalities can design and implement their projects in coordination with or being driven by IMPLANs or an IMEPLAN, and use their own resources or those from sources such as MFs. Resources from MFs are allocated through competitive bids, thus cities and IMPLANs/IMEPLANs with stronger technical capacities might have higher chances of accessing resources.

Figure 2. BSSs developed in Mexican cities



Lack of technical capacity serves as a major barrier to this approach, however, and only approximately 25% of municipalities have urban development plans.[32]

Top-down transport programmes – for example, initiatives such as FONADIN and PROTRAM, which aimed to coordinate policies between the ISUMPs and state and local planning – have been heavily biased towards private vehicle transport. More than 90% of national transport funding is spent on infrastructure for private transport (e.g. roads, tunnels, bridges), despite less than half of trips being completed by this mode.[33] State-level governments also have the possibility of allocating part of their budget to promoting urban sustainable mobility options. There has not been a national programme to promote bicycle-sharing schemes (public or privately led); as will be shown, these initiatives are taking place following the leadership of regional and local governments. However, there is high potential to facilitate the expansion of existing schemes and their replication in other cities, if the national government designs an active programme to push these innovations forward, including with financial resources.

The emergence of PBSSs in Mexico

Bicycle-sharing schemes (BSSs), both public and privately led, have emerged in a number of Mexican cities in recent years, with several starting operations in just the last year (see Figure 2). Relying on different technologies and business models, some of these schemes have run into conflict with local policy-makers, and the largest private operator in Mexico City, Mobike, lost its permit to operate in late 2019.

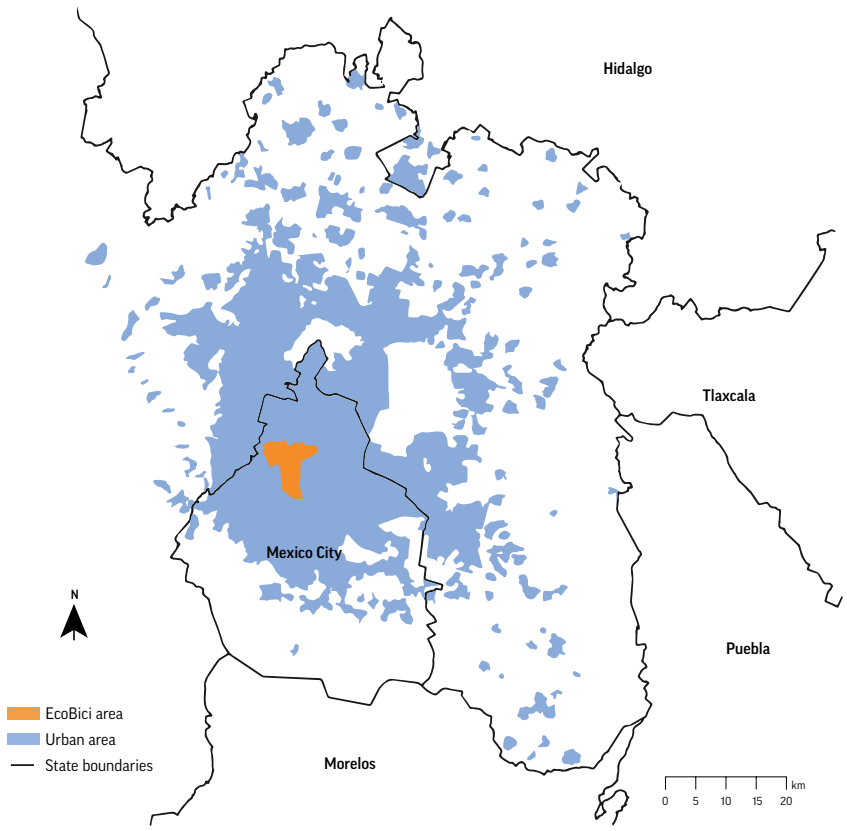
In the context of non-motorised mobility options, the largest PBSSs in the country, based on the absolute number of bikes and trips, operate in Mexico City and Guadalajara, since 2010 and 2014 respectively. The relative maturity of these schemes, compared with the number of upstarts in cities across Mexico, offers the opportunity to explore best practices and learning.

CITY POLICY CONTEXT

Mexico City

The metropolitan area of Mexico City (Figure 3) is the largest in the country and the fourth largest city in the world, with 22 million inhabitants.[34] The overall metropolitan area comprises 16 municipalities in Mexico City and 59 municipalities in Mexico state and one in Hidalgo state.[35] About one-quarter of the national GDP and employment is concentrated in the metropolitan area of Mexico City.[36] During the last two decades of the 20th century, a policy to decentralise industry in Mexico accelerated the transition to a service economy in Mexico City.[37]

Figure 3. Urban areas of the metropolitan area of Mexico City and the corresponding areas covered by EcoBici



Substantial investments in mass transport have had significant impacts on mobility in the city over the last two decades, with investments in PBSS (EcoBici), expanding the BRT (Metrobus), light rail, metropolitan train, cable bus and the subway (Metro). Wider actions include parking maximums for new developments and the replacement of microbuses in the city to reduce pollution. Across the city, only one in five trips are by private car, while nearly half of all trips are by one of the different forms of public transport.[38]

There is concern, however, around the extent to which investments have prioritised the urban core of the city, and that there are areas only accessible to medium- and high-income groups.[39] Mobility is expensive for many, costing residents of outlying areas more than one-fifth of their income.[40] Mobility is also costly in Mexico measured by the time it takes to travel around the city and particularly from the outskirts: on average, private car drivers in Mexico City spent nearly 160 hours in traffic per year, the fourth worst figure in major cities in Latin America.[41]

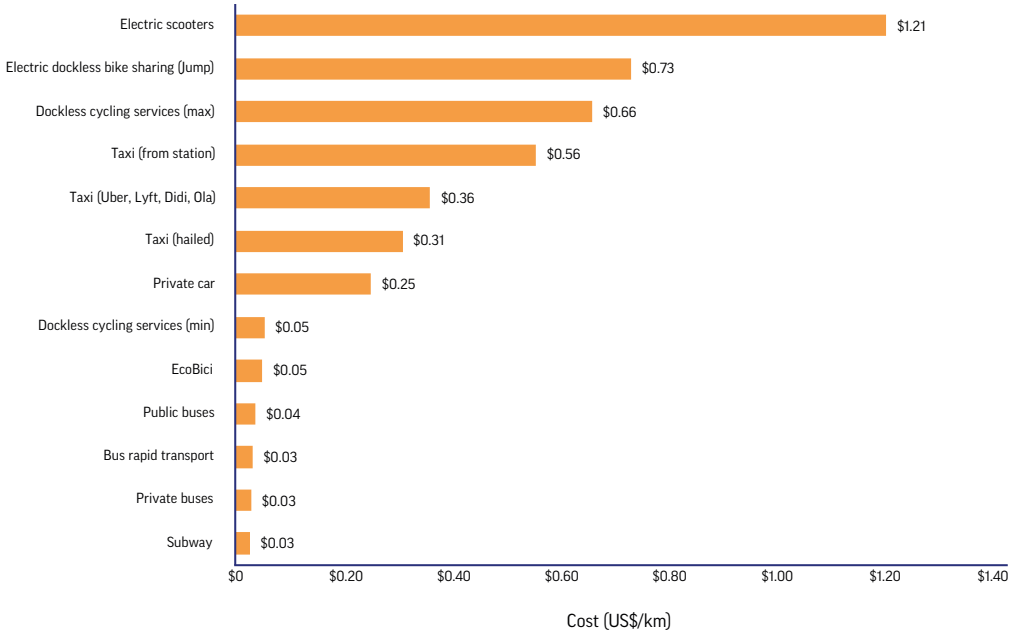
Looking to the future, Mexico City has announced an 80/20 approach that will dedicate 80% of spending to walking, cycling and mass transport options, and only 20% to private vehicles.[42] Specific areas of action include expansions of the Metrobus BRT system, expansion of the metro and light rail systems, investment in low-emission buses, expansion of protected cycle ways, and investment in a gondola cable car system called Cablebus.[43]

EcoBici in Mexico City

EcoBici was launched by the regional government of Mexico City in 2010 as an effort to reduce air pollution and carbon emissions, and provide an affordable transportation mode. Prior to the implementation of this programme, a feasibility assessment was conducted by the National Autonomous University of Mexico (UNAM) to consider physical, environmental, urban design and transportation characteristics of the city.[44] In 2009, this study made different recommendations to promote non-motorised mobility options, including public cycling schemes. Stations and bicycles are owned by the Mexico City government and an agreement for its operation was made with the company Clear Channel, which owns the software for operating the scheme. The scheme is partially financed by user payments (fees have gone from MXN300 to MXN480 (US$15–24)[45] per year from 2010 to 2020), with remaining costs subsidised by the state-level government of Mexico City. The general conditions suggest that the private company gets paid a subsidy of MXN200 million (US$10.1 million) per year.

The rapid uptake of the scheme was facilitated by a set of social programmes designed to change the public's perception of cycling, which was part of the strategy proposed in the feasibility study developed by UNAM. Muévete en Bici, the closure of major avenues in the city on Sundays to promote walking and cycling, began in 2007, and by 2015 was, at 55 kilometres, the third longest public cycling route in the world.[46] Paired with Muévete en Bici, bike training programmes started

Figure 4. Cost per kilometre for different travel modes in Mexico City



in 2009 to teach a new generation not only how to cycle safely, but also that cycling is an effective, safe and low-cost means of transport, as well as a recreational activity.[47] These programmes provided residents with a safe space in which to practise cycling, and also the opportunity to see what their city would be like without cars.

Local support for EcoBici has allowed the scheme to provide critical last-mile mobility to Mexico City's already substantial public transit network. As can be seen in Figure 4, EcoBici and some modalities of the private dock-less cycling schemes (ones with yearly memberships) are the only two options for mobility (apart from walking and one's own bicycle) that are cheaper than a private car and not fixed by specific starting and stopping points (as with the subway). However, some modalities of dock-less systems (pay-as-you-go options), electric bike-sharing schemes (Jump) and electric scooters have higher costs. Jump electric bikes initially had a proposed cost of MXN30 (US$1.50) per minute,[48] but when the service was launched, a fixed fee structure of MXN10 (US$0.50) per trip and MXN3 (US$0.15) per minute was implemented.[49] This led to one of the highest costs per kilometre for urban travel options (at US$0.73/km; see Figure 4). Jump ceased operation in Mexico City in May 2020 during the COVID pandemic.[50]

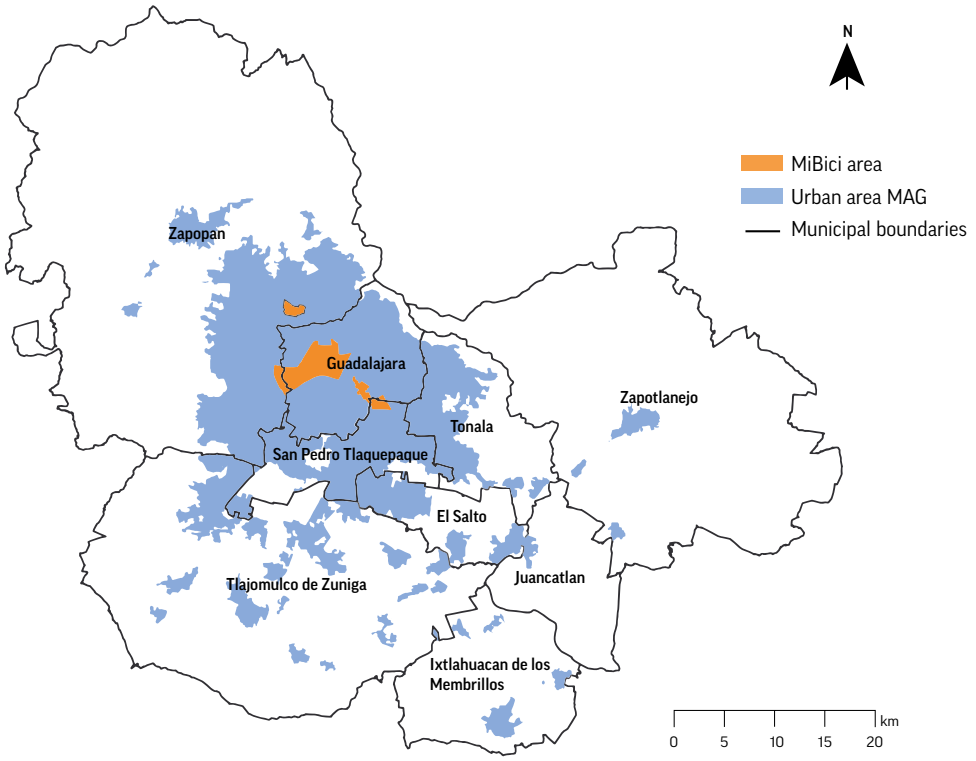
Since its creation, EcoBici has seen four expansion phases adding new areas and stations to the scheme. EcoBici's four expansion phases included an increase in the number of bicycles, cycling infrastructure improvements and installing more bike lanes. In February 2010, the scheme started with 1,114 bikes. By December 2012, there were 3,700 units, by 2016, 6,565, and in 2020 there are 6,800.[51] In 2016, it was expected that by 2018 there would be 8,600 bicycles;[52] however, this did not happen. Recent plans aim to expand the scheme to 10,000 bikes by 2024. Despite this, EcoBici is the largest public bicycle-sharing scheme in Latin America.[53]

THE METROPOLITAN AREA OF GUADALAJARA (MAG)

Guadalajara is the capital of the state of Jalisco, and its metropolitan area is the second largest city in the country (Figure 5). The state contributed 7.1% of national GDP in 2019,[54] and 62% of its population and 67% of its economic activity are concentrated in the capital and its surrounding metropolitan area,[55] which is a relatively wealthy area of Mexico. The metropolitan area integrates nine municipalities, which had a joint population of 5 million in 2017.[56]

The city has one of the highest motorisation levels in the country, with 62 private vehicles per 100 inhabitants in 2018.[57] This is well above the national average of 26.9 private vehicles per 100 inhabitants[58] and is comparable with values reported in countries such as Italy and Finland.[59] Investment in public transport for many years did not meet the investment made in private vehicles. The city has only two light rail and one BRT line. The second line of the light rail system was finished in 1994, and it was not until 2014 that construction started on Line 3, and it had not been completed by the first quarter of 2020. Following a surge of interest in BRTs following successful projects built in León and Mexico City, the first BRT line was completed in 2009 by the 2006–2012 state-level administration (political party PAN), as part of an ambitious plan to build eight routes, which were even registered as a project under the Clean Development Mechanism of the United Nations Framework Convention on Climate Change (UNFCCC).

Figure 5. Urban areas of the Metropolitan Area of Guadalajara (MAG) and the corresponding areas covered by MiBici



However, local mayors in Guadalajara, San Pedro Tlaquepaque and Zapopan at the time from a different party (PRI) opposed the project and only one line was built. The PRI later won control of the state-level government in 2012–2018 and the project to build the additional BRT lines was suspended. Now, as part of the 2018–2024 state-level government led by the MC party, a second BRT system is in construction in the main city ring (MiMacro Periférico), initial studies for Line 4 for the light rail system are being developed, and the integration and consolidation of the transportation system is progressing.

Nevertheless, the light rail lines and BRT in operation serve a limited part of the urban area and its population; in the rest of the city, collective transport is provided by different public and mostly private providers (concessions), but the service is often unreliable and not integrated yet into a consolidated system.

The accelerated growth of the population and economic activities in the region has been based on the horizontal expansion of the city to once rural and highly productive agricultural areas. In this context, some of the most prevalent problems in the city are related to traffic congestion and consequently to air pollution and health problems. Urbanisation processes have focused primarily on the building of housing to meet the population demand. However, this has usually centred around building houses and residences, but the necessary investments in the provision of the accompanying basic services and infrastructure have not been made (e.g. in road/street infrastructure, water and sanitation, electricity and public transport). There is a deficit of public infrastructure in the growing urban areas. As a response to this process, and acknowledging the need to coordinate metropolitan governance, in June 2014 the IMEPLAN was created as the decentralised public and technical body to guide urban development in the city.

Civil society in the MAG has been very active in the promotion of non-motorised mobility options. Cyclist groups and urban tours have been a tradition for many years, and these groups pushed for getting inclusive mobility on the public agenda. Bike-friendly culture in the city received a boost in 2004 when the local government of Guadalajara started the car-free Sundays from 0800 to 1400 in some of the main streets in the city, in a scheme called theViva Recreativa. Viva Recreativa has recieved support from successive governments representing different parties.[60] After many years of activism, key social mobility leaders have been included in local, metropolitan and state-level governmental offices in charge of transport and urban planning.

MiBici in the Metropolitan Area of Guadalajara

MiBici started operations in December 2014 financed by the state government of Jalisco. It was operated by the now-defunct Institute of Mobility and Transport of the State of Jalisco, and upon this body's demise, MiBici became the responsibility of the Metropolitan Development System through its Metropolitan Agency for Mobility Infrastructure and Services (AMIM), a decentralised public body.[61]

As is the case with EcoBici, MiBici's stations and bicycles are owned by the state government and an agreement for its operation was made with the company BKT Bici Pública. BKT Bici Pública is a local company, which set up and operated "Bikla" (slang for bike) – the earliest BSS in Mexico – from 2006 to 2012, with 40 stations, 150 bicycles and 5,000 users.[62] MiBici is partially financed by the fees paid by users (the yearly membership fee has gone from MXN365 to MXN416 (US$18 to US$21) per year from 2014 to 2020), although this contribution covers roughly 20% of the operative costs. Therefore, it is important that the system is subsidised by the state government of Jalisco, through the IMEPLAN and through the Metropolitan Agency for Mobility Infrastructure; overall, the operative costs in 2018 were MXN37 million (US$1.9 million). The concession for the operation of MiBici was reinstated in September 2020 through a competitive bid process. After an impasse in the tendering process, the contract was renewed with BKT Bici Pública, including a still undisclosed compromise to lower operating costs and subsidies.[63] During the impasse, from 4 to 11 September 2020, users of MiBici faced some operative problems.[64] Although the service was quickly resumed, this situation highlights a potential risk in the collaboration between public and private organisations. Administrative deadlocks can compromise the provision of the service, and quality could be affected if there is not a functional balance between cost, technical capacity and experience.

Since its creation, MiBici has had three major extensions, expanding from an initial 860 bikes in 86 stations to the current 2,446 bikes and 274 stations within three municipalities: Guadalajara, Zapopan and Tlaquepaque.[65] In March 2020, the government of Jalisco announced that 450 new bicycles have been purchased and are ready to be integrated into the scheme.[66] It is expected that MiBici will continue to expand to other areas of the city, although immediate plans for this have not yet been made public. MiBici is the only operating PBSS in the city.

At the beginning of 2020, local governments and IMEPLAN started a three-month pilot test to allow private companies to introduce different micro mobility dock-less technologies (e.g. scooters, bikes), but these have not been deployed for permanent operation. The Mobility Working Board, which IMEPLAN coordinates, has now approved a Technical Norm for the implementation of Networked Individual Transport Systems (STIR), such as scooters or dock-less bikes, which will be put up for approval in the Metropolitan Coordination Board in the next couple of months and then for consideration in all nine municipalities. IMEPLAN developed the rules and procedures for municipalities to develop dock-less bicycle-sharing and scooter operations. This was not the case for MiBici since it was a pre-existing initiative of the state-level government.

4. The case study: The impact of EcoBici and MiBici

MOBILITY BENEFITS

Increasing ridership and last-mile mobility

Since their creation, both the EcoBici and MiBici schemes have seen a steady increase in trips taken, which shows that the platforms are increasingly embedding themselves into the transport networks of parts of Mexico City and the MAG (primarily the urban centres). Since EcoBico's inauguration in Mexico City in 2010, up until May 2020, users have made 67.3 million trips.[67] In Guadalajara, MiBici started in December 2014, and by the end of May 2020 its users had accumulated 13.5 million trips (see Figure 6).[68] In 2019, total trips made by EcoBici and MiBici users numbered 8.4 and 4.6 million, respectively. Therefore, on average, daily trips made by EcoBici and MiBici users in Mexico City and the MAG in 2019 numbered 23,092 and 12,658, respectively.[69]

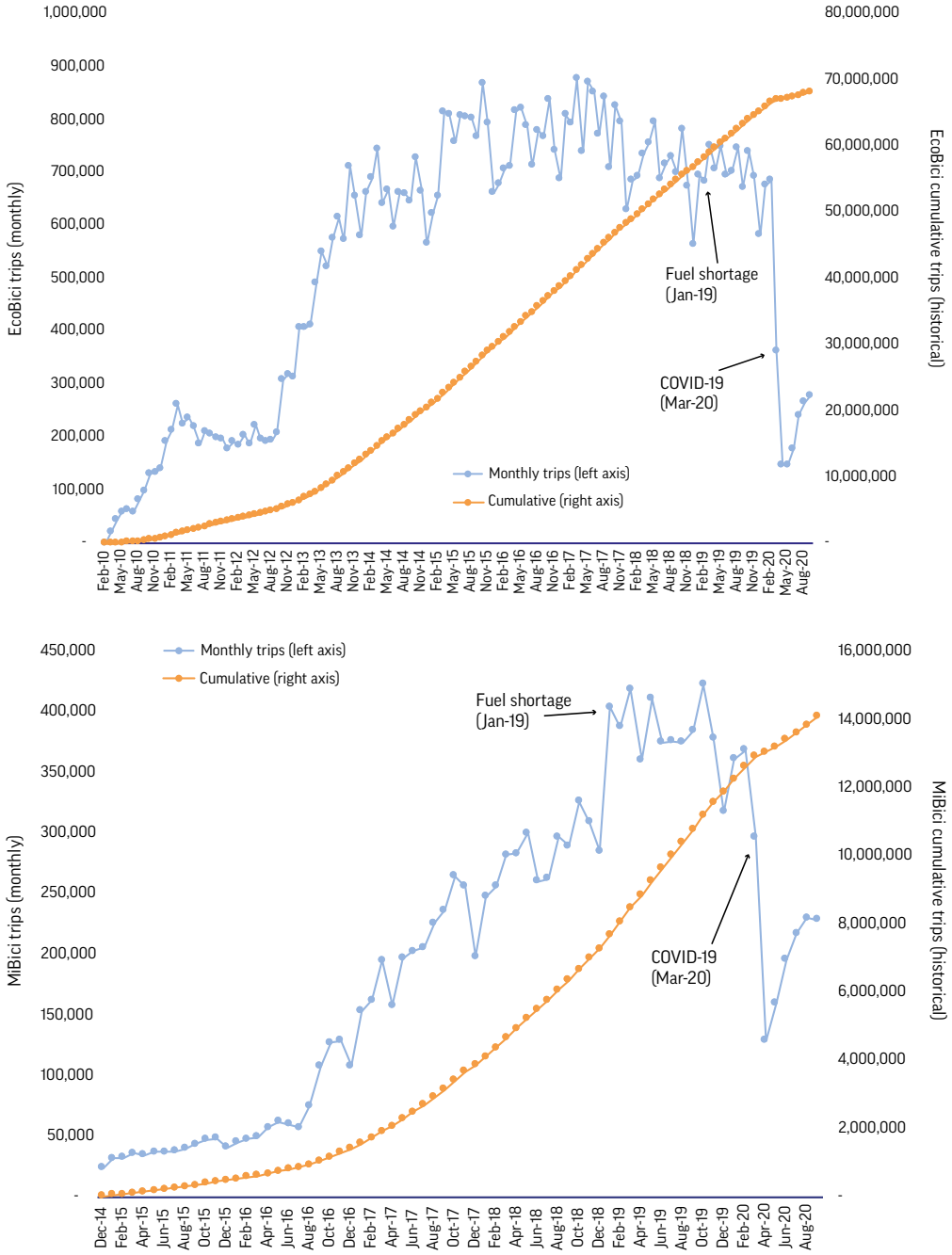
City-level mobility and PBSSs

In the metropolitan area of Mexico City in 2018, the daily number of trips across all modes of transport was 34.56 million,[70] whereas in the MAG in 2014 this figure was around 11.5 million daily trips.[71] Overall, the trips made using the PBSSs represent in absolute terms a very small proportion of total trips: about 0.07% and 0.11% across the respective metropolitan areas. This level is not unexpected, since the area of operation for EcoBici and MiBici is limited to 2.5% and 4.7% of their respective urban areas (see Figures 3 and 5).

The extent to which the limited area currently covered by the PBSS in each of these cities inhibits its contribution to mobility can be shown with illustrative statistics. If we assume the number of trips across the city is roughly homogenous, the total number of daily trips (including all modes of transport) in the specific areas served by the PBSS is 0.877 and 0.534 million for Mexico City and the MAG respectively. As a share of their area's total trips, the proportion of trips made using PBSSs increases to 2.6% for Mexico City and 2.4% for the MAG. An important lesson can be drawn from these figures: extending the area covered by the PBSS and its deployment to other municipalities in the metropolis, in combination with mass transit transport options, could entail a substantial increase in the contribution of these schemes to urban mobility. This requires coordinated action between the mayors of different municipalities and state-level governments and, in the case of the metropolitan area of Mexico City, the cooperation of different states. Governance challenges associated with the cooperation required should not be overlooked.

However, more detailed studies are required to uncover the role that PBSSs, as non-motorised transport options, play in urban mobility systems. In this it is important to note that PBSSs might be used as an initial, final or intermediate mode of transport.

Figure 6. Historical numbers of trips made by EcoBici and MiBici users, monthly and cumulative data



Source: Authors' elaboration, based on open data from EcoBici and MiBici.[81]

For instance, a one-way multi-modal trip (e.g. public transport, BSS and walking) might be accounted for in statistics as one trip divided across three trip-legs. This accounting approach obscures the role of cycling relative to an approach that

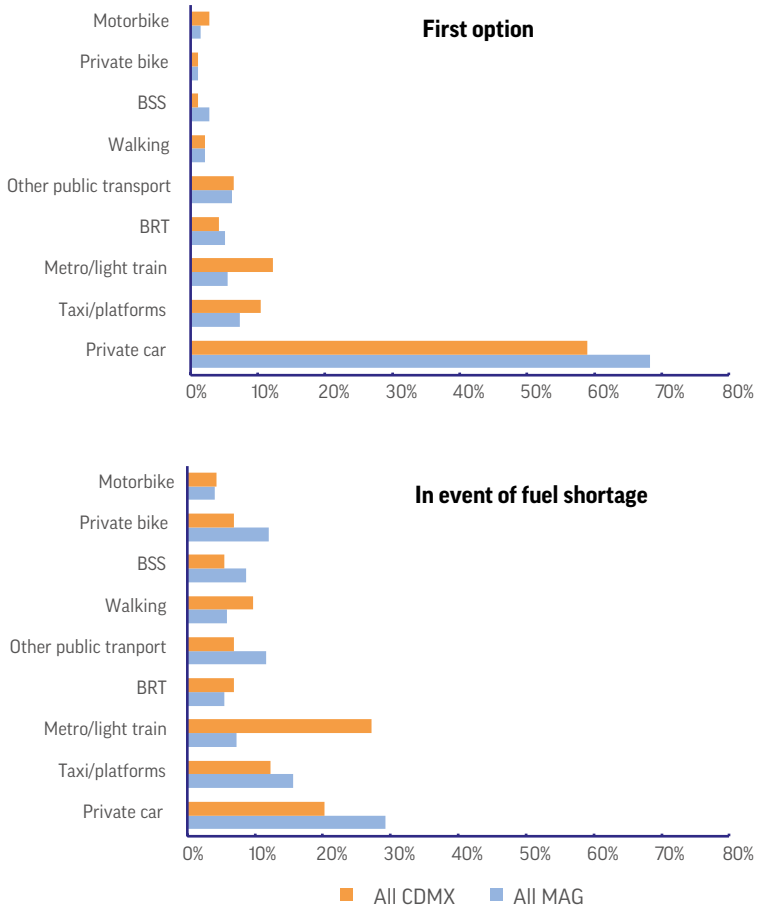
accounted each new transport mode and initiating a new trip. More detailed analysis of the contribution of PBSSs to overall mobility, including the monitoring of transport demand and number of trips within the areas in which they operate is needed.

Supporting the resilience of the transport network

Resilience during the fuel shortage

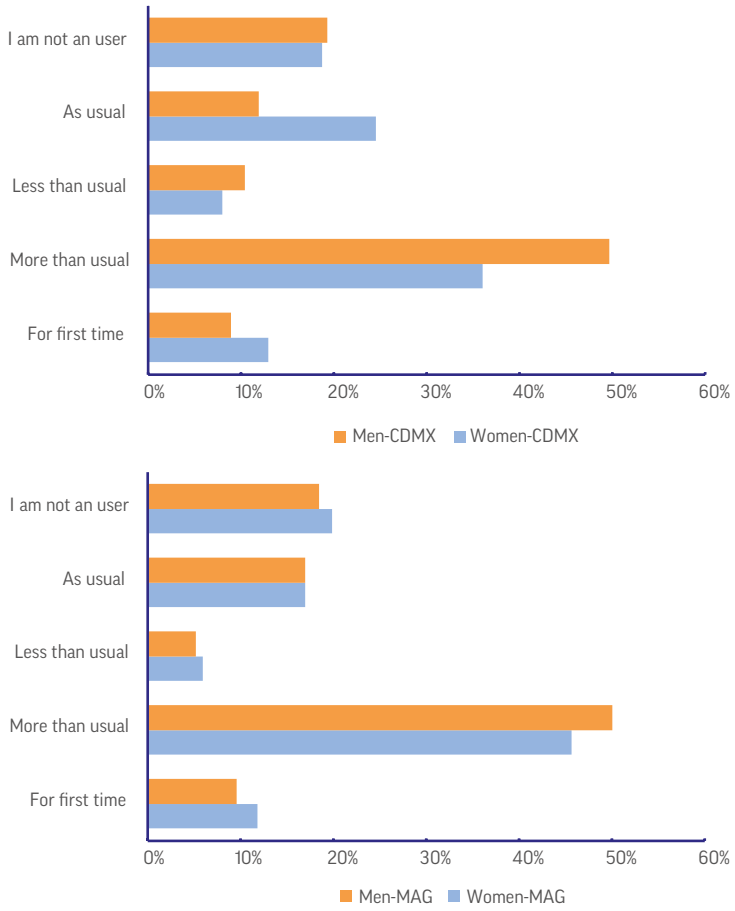
The concentration of people and infrastructure in cities makes them uniquely vulnerable to shocks. Indeed, in Mexico, nearly half the urban population live in areas that have been identified as being acutely at risk from natural disasters and a changing climate.[72] Resilient mobility networks in this context are important not just for maintaining the regular movement of people and goods and services around cities, but for enabling the response to crises. Still, a challenge remains to continue the expansion of PBSSs, integrated with stations of mass transit systems, to the urban peripheries where most vulnerable people tend to live.

Figure 7. Preference for different modes of transport under normal conditions and during a fuel shortage



Notes: Survey applied to 275 citizens in each city.

Figure 8. Use level of PBSS in Mexico City and Guadalajara during the fuel shortage in 2019 by gender



Notes: CDMX = Mexico City; MAG = Guadalajara; n = 275 (all respondents) in both cases.

As each scheme has become more established, its role in supporting urban mobility has become more defined. We explored in our survey the role that BSS play in the mobility patterns of the respondents, by asking their preference for different modes of transportation under normal conditions and in the event of continued shortage of fuel (see Figure 7). Although two-thirds of the participants indicated that they are active users of BSS, responses show that only a small fraction of respondents consider BSSs their first option for mode of transportation: 1.1% in Mexico City and 2.9% in the MAG. However, this percentage increases almost fivefold and threefold, to 5.4% and 8.8% respectively, in the event of a continued fuel shortage; in this scenario, the usage of public transport (metro/light train and other public transport) seemed one of the highest increases in preference. In the context of the COVID-19 pandemic, as lockdowns are gradually lifted, it could be expected that people will be more reluctant to use public transport and thus the use of PBSSs might become more attractive.

These results point to the importance of EcoBici and MiBici as first-mile and last-mile mobility options, which complement other modes of transportation, mostly public transport, and enable users to complete the entirety of trips without a private car. This comes as no surprise: given the large horizontal expansion of these cities, many people have to commute long distances on a daily basis, and the relatively small size of PBSS areas restricts the number of people who can use the scheme as their main mode of transport. There are two alternative ways of increasing the role of BSSs: first, promoting more compact cities thereby reducing the need for long trips, and second, extending the areas where BSS are available. The role of BSSs can be explored further, with a particular need for further research where a preference for BSS is assessed bundled in combination with other modes of transport.

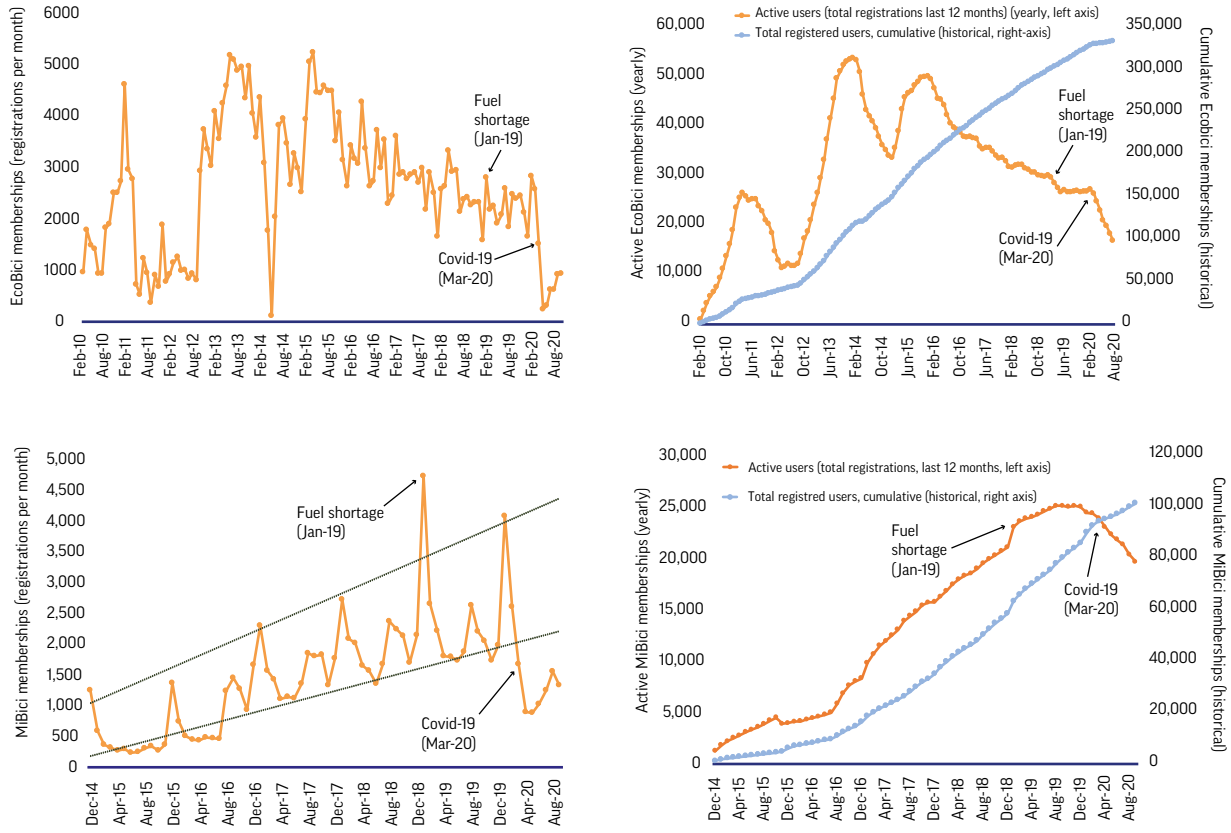
Increase in use and membership of PBSS during the fuel shortage

A broader shift taking place can be seen in the "natural experiment" created by the fuel shortage across Mexican cities in January 2019. During this period, 11% and 10% of the respondents to the survey in Mexico City and Guadalajara stated that they had used BSSs for the first time. The increase was larger for women, possibly out of a desire to avoid oversaturated public transport services (see Figure 8). Results also show that 42% and 48% of the respondents had used BSSs more than usual during this period. This shows that policies aimed at increasing the cost and opportunity to use of other transport options can help to promote the uptake and use of BSS and more sustainable mobility options.

An increase in active membership data for MiBici can be seen in the MAG during the fuel shortage in January 2019 (see Figure 9, right panel). Most users pay annual memberships, so it is important to note that the month when the PBSS started its operations defines the pattern of renewals. In the case of the MAG, many annual memberships are renewed each December/January and a cyclical pattern can be seen in the data, with clear rises and falls. However, in January 2019, the memberships sold presented a significant increase on what would have been expected by the trend. That month, more than 1,400 users were registered. Usage patterns in the following months suggest most of the users have continued to use MiBici. Nevertheless, the impact of the fuel shortage was temporary, and some of the citizens did not renew their membership in late 2019 and early 2020, thus the number of memberships sold and total active users decreased.

The pattern observed in Mexico City is quite distinct: there are large fluctuations in memberships sold and a decreasing trend can be seen consistently since late 2015 (Figure 9, lower left panel). We hypothesise that this may have been due to the fact that several competing mobility firms, including dock-less bikes and scooters, were introduced to EcoBici's area of operation. These schemes were introduced before the fuel shortage, which might have contributed to the gradual reduction in active users of EcoBici as many users might have switched to these options even following the fuel shortage. However, more detailed studies are needed to understand changes in these patterns in Mexico City.

Figure 9. Number of memberships sold, active users (cumulative registrations of last 12 months) and historical total number of users for EcoBici (top) and MiBici (bottom)



Source: Authors' elaboration, based on open data from EcoBici and MiBici.[82]

These results show the value of public cycling for urban resilience. These results also signal a broader shift taking place in the transport sector in Mexico City and Guadalajara. While private cars remain the preferred mode of transport for many residents, a significant portion of the population is willing to cycle given the right circumstances.

The impact of COVID-19

Due to COVID-19 and the associated lockdown, the number of trips by the PBSS and the membership numbers of the schemes, both in Mexico City and the MAG, plummeted from March to May 2020 (see Figure 6 and Figure 9). Figures started to recover in June but they have not reached the levels observed in February 2020. As a measure to help to curb COVID-19, local authorities in Mexico City designated additional bike lanes (54km).[73]

Table 2 shows the data on trips and membership of EcoBici and MiBici during the first months of the pandemic. The data shows that the lowest number of monthly trips was observed in May in Mexico City and in April in the MAG.

The usage of PBSSs has recovered over the summer; however, by the end of August, monthly trips using EcoBici were 38.9% of those observed before the pandemic (in February), while for MiBici this figure was 62.6%. The number of memberships purchased by month in August was even lower in Mexico City – 35.9% of the level before the pandemic in February, compared with 59.5% in the MAG. Reduced registration of EcoBici memberships means that, for the first time, the number of active users of MiBici is higher than the number of active users of EcoBici. A similar shift has taken place in the number of trips. In February, the number of trips made using EcoBici was 86% higher than for MiBici; by August, this was down to 15%, and in May and June there were actually more trips made by MiBici users for the first time.

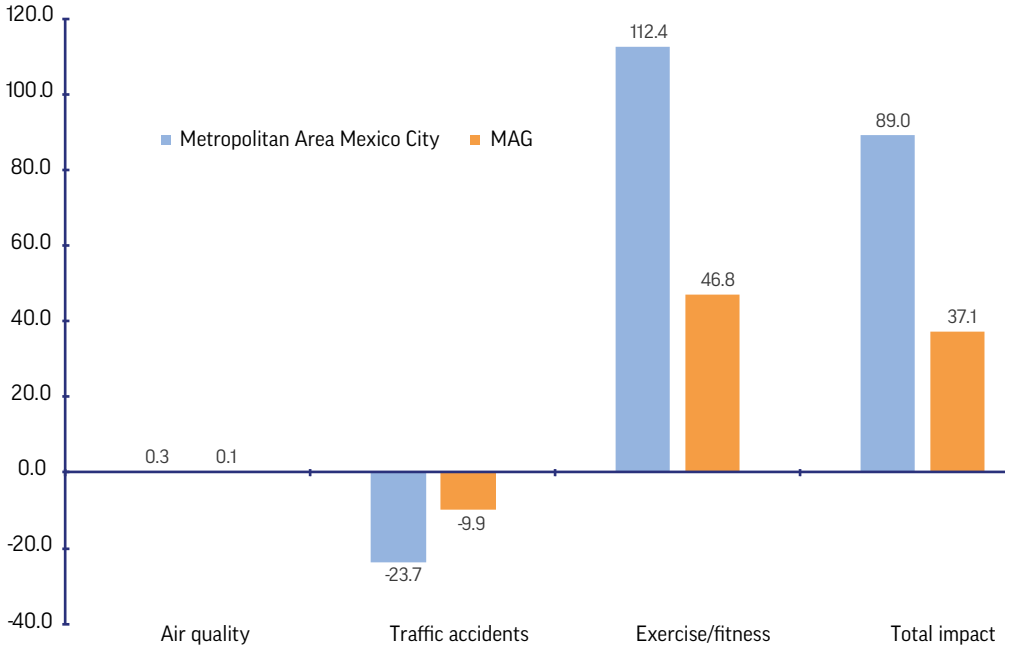
Table 2. Evolution of the number of trips, memberships purchased and active users of EcoBici and MiBici during the COVID-19 pandemic

	ECOBICI			MIBICI			ECOBICI-MIBICI RATIO		
	Monthly trips	Memberships purchased	Active users*	Monthly trips	Memberships purchased	Active users*	Monthly trips	Memberships purchased	Active users*
Feb-20	686,327	2,576	27,216	369,486	2,615	24,385	186%	98.5%	112%
Mar-20	364,343	1,512	26,472	297,975	1,682	23,923	122%	89.9%	111%
Apr-20	149,123	237	24,796	129,657	903	23,076	115%	26.2%	107%
May-20	148,513	315	23,026	160,400	882	22,326	93%	35.7%	103%
Jun-20	179,738	630	21,060	196,516	1,024	21,835	91%	61.5%	96%
Jul-20	242,838	626	19,847	218,382	1,249	21,330	111%	50.1%	93%
Aug-20	266,940	924	18,291	231,119	1,555	20,399	115%	59.4%	90%
Aug/Feb-20 ratio	38.9%	35.9%	67.2%	62.6%	59.5%	83.7%	–	–	–

* Total number of memberships purchased in the previous 12 months.
Source: Authors' elaboration, based on open data from EcoBici and MiBici.

It is expected that these figures will continue to be at lower than pre-pandemic levels, as long as social and economic activities are not fully resumed. This type of situation is particularly challenging for private BSS providers, as they will see pay-as-you-go revenue levels drastically reduced in the short term. It is, however, also expected that budget cuts could reduce the subsidy for the operational costs of PBSSs too.

Figure 10. Health benefits associated with cycling in Mexico City and Guadalajara



Options that could be explored to increase financial resources for the operation of public schemes include selling publicity that could be displayed in the bike stations. By acknowledging the value of the benefits and co-benefits of the PBSSs, the case can be built for maintaining current budget levels, particularly because in addition to public benefits they offer a low-cost mobility option to the population in a time where the economy is entering into a recession.

HEALTH IMPACTS

PBSSs have contributed to the promotion of local sustainable modes of transportation and cultural change. Increasing the overall numbers of cyclists on the streets of Mexican cities leads to several interconnected impacts on public health, as a result of reduced air pollution, increased physical activity and increased numbers of vehicle accidents involving bicycles. Converting these impacts into "lives saved" involves the use of dose response functions, which provide indicative figures for overall health impacts. Here, the results are presented for health benefits associated with current cycling levels in both metropolitan areas.

Using publicly available data on wider travel by bicycle in the city,[74] cycling in Mexico City and the MAG results in reductions of $PM_{2.5}$ and NOx air pollution, leading to a very small effect on lives saved, at 0.3 and 0.1 per year respectively.

At the same time, cycling leads to certain traffic fatalities (see Figure 10). More important than either of these impacts, however, is the wider impact on public health resulting from increased levels of exercise, which in Mexico City alone is estimated to save nearly 112 lives annually. Accounting for overlap between different causes of mortality, cycling in Mexico City reduces mortality by approximately 89 lives each year, while in the MAG mortality is reduced by approximately 37 lives. These estimates align closely with independent studies that have assessed the health impacts of PBSSs in Mexico, such as work by WRI in 2019[75] (which estimates 14 lives saved by reduced premature mortality among MiBici users in the first four years of operation, a time period during which usage was less than half of what it is today; see Figure 9).

These figures seem initially modest in the context of the number of lives lost to preventable causes – as previously mentioned, nearly 38,000 people die as a result of air pollution and road accidents every year in Mexico[76] – however, the geographic scale of these figures is not comparable. If we assume that these deaths are distributed proportionally by population, across the country, casualties translate to 7,025 and 1,597 for Mexico City and the MAG respectively. Thus, the total impact represented by "lives saved" by cycling in both cities is equivalent to 1.3% and 2.3% of the casualty numbers.

ENVIRONMENTAL IMPACTS

EcoBici and MiBici contribute to quantifiable reductions in greenhouse gas (GHG) emissions. Drawing on a survey of more than 550 users and members of the wider population, respondents were asked which mode of transport they would use in place of trips taken by EcoBici and MiBici (Table 3). By extrapolating these results to the total number of trips in 2019, results indicate the direct emission reductions would be around 1,767 and 712 tonnes of CO_2e per year; indirect emissions could be accounted for by reduced congestion but are not estimated here.

Results suggest that EcoBici's contribution to GHG emission reductions is equivalent to removing approximately 500 cars from the streets of Mexico City, while in the case of MiBici this figure equals 200 cars in the MAG. While these figures are modest in the context of each city's overall emissions, they reveal that policies supporting non-motorised transport have a complementary impact on air quality and GHG emissions reduction. It must also be remembered that, at present, PBSSs only serve a small fraction of the urban areas in the metropolis.

Table 3. Estimated carbon emission reductions in Mexico City and Metropolitan Area of Guadalajara from the use of PBSSs

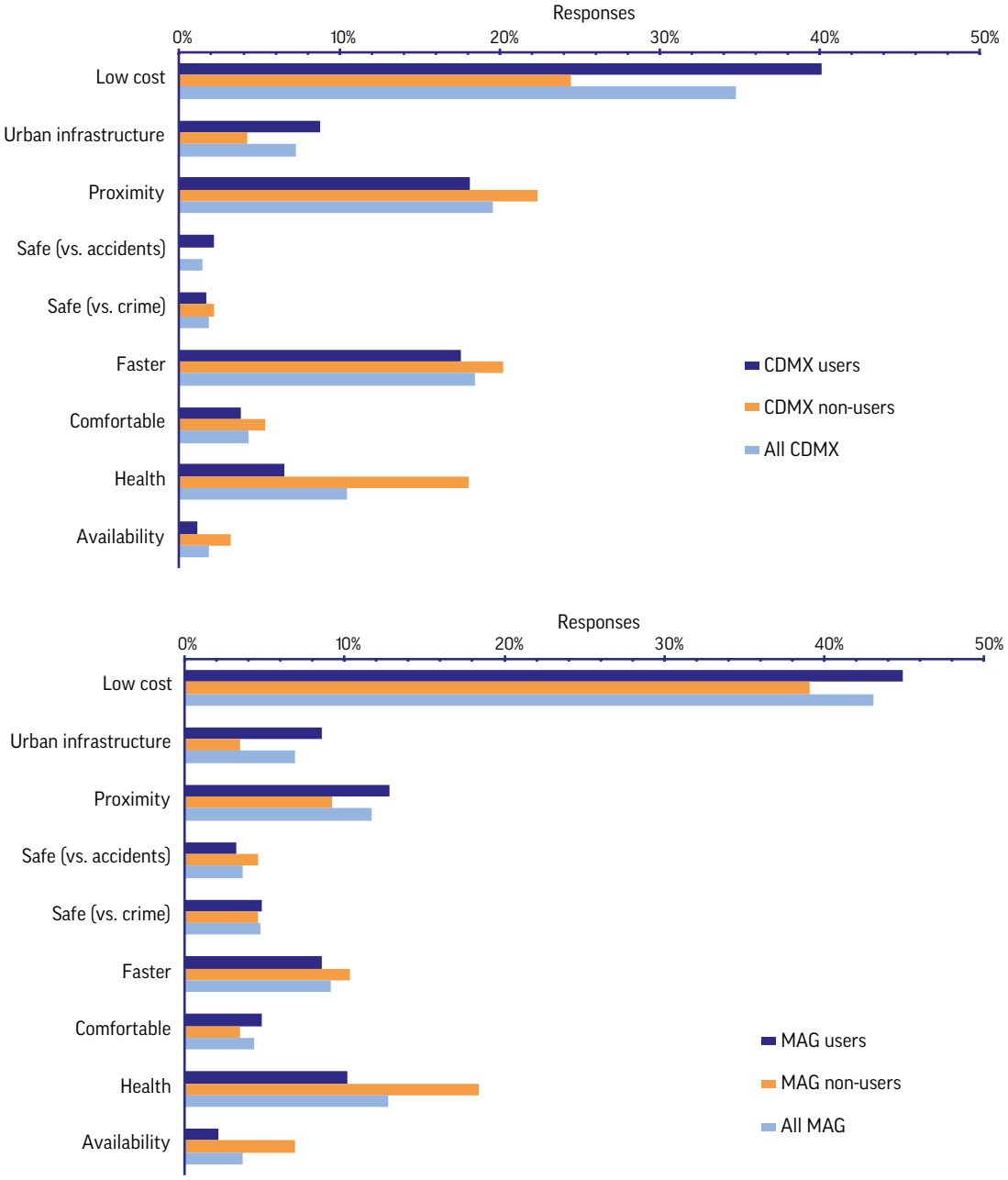
Alternatives mode of transport	Responses CDMX	Responses MAG	Emission factor*	Emissions reduced CDMX (tCO2e/yr)	Emissions reduced MAG (tCO2e/yr)
Private car	26.8%	25%	206	978.9	428.6
Taxi/Uber	17.1%	13%	206	622.9	214.3
Light train/ metro	11.0%	5%	5	9.7	1.9
BRT	4.3%	7%	5	3.7	2.7
Other public transport	10.4%	18%	27	49.5	41.4
Own bike	9.1%	13%	0	-	-
Walking	18.9%	18%	0	-	-
Other; motorcycle	2.4%	1%	237	102.3	23.4
				1,767.3	712.5

* gr-CO2e/km-passenger.[77]
Notes: CDMX = Mexico City; MAG = Guadalajara.
Source: Sedema 2019[79]

SUPPORTING A NON-MOTORISED FUTURE FOR ALL

Beyond their impact on public health and GHG emissions, bike-sharing schemes in Mexico City and the MAG are contributing to a wider shift in the transport network, towards walking, cycling and public transport, and away from private vehicles. Higher usage of PBSSs and cycling in general facilitates the transition to more compact cities, as space currently dedicated to roads and parking, can be freed up for other more valued uses. By positioning PBSSs strongly within the urban culture, even as a valuable city brand,[78] its usage might be seen as more prestigious and appealing to middle-class people and groups that might otherwise use their cars.

Figure 11. Main advantages/reasons for usage of BSSs in Mexico City and the MAG, first choice



Of critical importance, however, is that these benefits are distributed across the urban population, and especially to segments of the population whose mobility is otherwise limited because they do not have access to a private vehicle. Evidence from a representative survey of the general public in each city shows that BSSs may have particularly large benefits for low-income populations. According to the results of our survey, in both Mexico City and the MAG, the low cost of trips received the highest proportion of responses under the primary reason for being used (see Figure 11);

this holds even for those respondents that indicated they were not active users of BSSs. In the MAG, health benefits seem to be a more influential factor, whereas in Mexico City proximity and a higher velocity for moving around in the city (i.e. faster) are two of the main reasons for usage after low cost.

BSSs offer a transportation option with a lower cost. The results of the survey seem to confirm this claim, as on average the groups with the lower income levels in both cities have the higher percentage of BSS users in our sample (see Figure 12).

LOOKING TO THE FUTURE

Expanding PBSSs along transit corridors within urban areas, and in new urban areas, would substantially increase the scale of public health benefits. Across Mexico, there are 20 urban areas with more than 500,000 inhabitants but only five of these have PBSSs (see Figure 13). These figures emphasise the important role cycling and PBSSs can play in improving public health in Mexican cities. At the same time, they reveal opportunities for greater impact.

PBSSs can be central to promoting sustainable modes of transport. They can alleviate crowding on public transport, provide critical first-mile and last-mile mobility, improve public health, reduce GHG emissions and encourage a longer-term shift away from the cost, noise and pollution of private cars. However, to flourish, their expansion and integration into the wider public transport network depend on urban and national government action.

Long-term urban transport and land-use planning need to include provision for cycling in general and PBSSs in particular in a standardised fashion. Since commuters often need to cover long distances, a PBSS is a feasible option for enabling low-emission multi-modal trips, if it is integrated coherently with mass transport infrastructure. PBSS stations need to be built at every metro, light rail or BRT station, and throughout the surrounding area, but also plans to expand these systems need to make provision for stations and cycling in advance of their completion.

Figure 12. Usage of BSS in Mexico City and Guadalajara, by socio-economic/ income groups

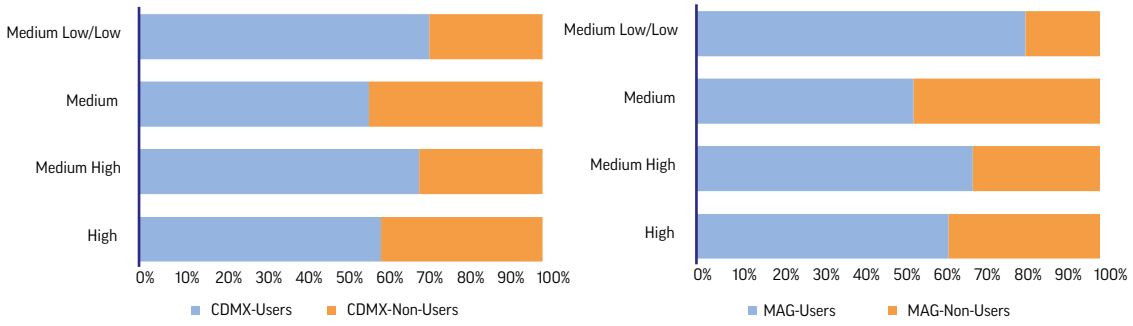


Figure 13. Cities with populations larger than 500,000 inhabitants, showing which have developed PBSSs

This includes bicycle racks and docking stations, and designated areas for new mobility operators. Stations built on the edges of the existing networks may have relatively low user activity, but their ability to provide a larger section of the population with a first-mile and last-mile mobility alternative to private car travel make these some of the most critical stations in the network. The option to introduce dock-less BSSs, whether public or private, can reduce the need for building up infrastructure such as extra stations; however, close coordination is needed if these are privately owned and ad hoc regulations would be required to prevent theft and ensure the appropriate use of public space. Potential conflicts or competition can also emerge between public and private services that also need to be properly regulated.

New urban developments need to incorporate design elements that encourage or even require non-motorised transport. This includes encouraging mixed land-use developments, appropriate levels of density, access to public transit options, pedestrian infrastructure and protected bike lanes. At a more granular level, a range of interventions can be made in both existing and new urban spaces to support sustainable mobility. Widening sidewalks and crosswalks, segregated bike lanes, traffic calming measures on neighbourhood streets, turning parking spaces into bike stands, pocket parks or cafe spaces, street trees and a wide range of other specific measures can contribute towards encouraging cycling and walking. A set of neighbourhood planning guidelines incorporating these elements, and developed in consultation with NGOs, community organisations, developers and local people

could be a means of both creating a set of standards that carry support from a wide range of actors, and of encouraging conversation around this topic.

These guidelines need to be included in urban development plans and receive appropriate budgets. Technical bodies, such as IMPLANs/IMEPLAN, could be critical actors in coordinating the interests of different municipalities within a metropolitan area. There are still challenges in coordinating urban planning when municipalities of different sub-national governments are brought together, and in coordinating planning instruments from the local to the national level. One key aspect is that PBSSs should not remain isolated within one or two local jurisdictions. The potential of PBSSs for sustainable urban mobility will be fostered if schemes extend widely across cities and are integrated into the public transport system.

Importantly, the benefits from these measures extend far beyond mobility. Compact, connected and coordinated urban spaces support reliable, affordable and safe urban mobility, but they also support public health, economic productivity and job creation.[79]

COORDINATING THE NON-MOTORISED ECOSYSTEM

Beyond the physical landscape of urban areas, a "digital landscape" increasingly determines the nature of urban mobility. Mobile phone applications – sometimes connected with specific transport modes like bicycles, scooters and taxis, other times acting as a connection between a range of transport modes, as with Google Maps, Apple Maps and Citymapper – determine the way we move in urban environments. Whether these platforms encourage or discourage non-motorised transport – both explicitly in the form of recommendations for travel, and implicitly through default settings, the ordering of results and the way in which devices portray urban landscapes – is key. With a relatively small, although fast-growing, number of platforms, the national government is uniquely placed to work with new mobility providers to ensure that non-motorised options are prioritised. Governments can also work with these operators to develop guidelines and codes of practice around labour standards, data use and information sharing. Novel technologies, business models and approaches brought forward by these firms may revolutionise urban mobility, but until they can prove they provide a reliable and accountable partner to urban governments they should be approached with caution.

Finally, beyond physical and digital integration, Mexico can continue to lead a cultural shift towards increased non-motorised transport. Car-free days, streets closed to cars, and campaigns to teach road safety and cycling skills are all ways of legitimising cycling as an alternative mode of transport to private cars. Critically, land-use and urban development planning are important complements to support the transition to non-motorised transport. National leaders shouldn't under-appreciate the role of "soft" measures for continuing this progress. Public employees and government officials cycling, where possible, provides a statement of commitment to an alternative future for transport in Mexican cities. A great

deal of work can be done to educate the public around the health, financial and environmental benefits of active transport over private cars and to discourage the next generation from seeing a private car as their preferred means of mobility.

5. Policy recommendations

Unwinding decades of counterproductive urban development and mobility policy requires action today. In the following recommendations, we outline some of the key steps that need to be taken.

1. **Ensure transport funding reflects travel modes and prioritises sustainable mobility to foster sustainable urban transitions**

   Relative to their share of kilometres travelled or the number of trips taken, investment in infrastructure for private cars – including investments in roads, bridges, tunnels and car parks – far exceeds investment in mass or non-motorised transport. Furthermore, these investments only benefit a minority of the population, and will not support future socio-economic development or improved health outcomes for city residents. It is critical to embed the requirement, as part of investments, to consider existing mode shares, and their role in encouraging sustainable mobility. These approaches can be included periodically in the preparation of yearly budgets and in the preparation or revision of urban, transport and other strategic plans, and will foster long-term social transformations. Specific measures could include:

   - The creation of a dedicated sustainable mobility fund to be administered by national ministries (such as SEDATU);
   - The development of a national fund to cover the required maintenance and operational cost of PBSS; and
   - Requiring funding that encourages private vehicle mode sharing to be matched with funding for policies and measures that encourage sustainable transport.

2. **Prioritise the integration of cycling into the wider transport network**

   Travelling by car is frequently costlier and more time-consuming and stress-inducing than other modes of travel. Yet despite this, private travel continues to be preferred due to the certainty it provides, particularly in horizontally developed cities with long commutes and unreliable public transport services. Cycling can be made more appealing through the creation of dedicated cycling infrastructure and bicycle “highways”. Establishing national targets for kilometres of bike lanes developed and targets for levels of ridership, backed by funding, could rapidly accelerate the shift to cycling. Additionally, standards for the number of bicycle parking spaces outside metro stops, public institutions, new developments and public areas such as parks will also encourage commuters to travel by bicycle.

Furthermore, recognition of mobility as a human right – as in the law passed by the Mexican senate in December 2019 – needs to be adopted in practice by the government and formalised in SEDATU's policies. All these measures to increase the uptake of non-motorised transport will increase the resilience of the transport system while also providing a wide range of social, economic and environmental benefits.

3. Prioritise non-motorised mobility in urban plans and developments

Low-density developments located far from centres of employment, education and amenities incentivise residents' use of private cars – and in some cases cut residents off from services and opportunities. Additionally, poorly integrated developments often lead to under-investments in mobility.

Non-motorised mobility – with public bicycle sharing as a core element – supports compact, connected and coordinated development, with far-reaching social, economic and environmental benefits. National policy-makers should encourage dialogue between various actors, including urban stakeholders and developers, to establish guidelines for access to sustainable transport in new developments and plans, building capacities on road design and green infrastructure. When included in urban plans and developments, these approaches can reduce the need for corrective projects designed to insert non-motorised mobility needs into urban infrastructure in areas that initially neglected it. Taking such an integrated approach to planning can yield multiple benefits and release resources for alternative investments. Elements to be considered for neighbourhood design could include: reduced vehicle speeds on neighbourhood streets and more one-way streets, parking maximums (as implemented in parts of Mexico City), parking pricing strategies, cycling parking requirements, increased sidewalk and crossing widths, and requirements for bike lanes.

Specific actions the national government can take to prioritise non-mobility in urban plans include:

- Supporting city-level plans that establish development and non-development areas;
- Regulating ONAVIS (national housing bodies) so that they cannot provide financing where long-term transport plans have not been developed and approved by urban policy-makers;
- Requiring a minimum level of proximity to sustainable transit options (metro, BRT or bus) in order to be able to access National Housing Commission (CONAVI) subsidies; and
- Creating and funding technical metropolitan bodies with capacity to lead the implementation of non-motorised mobility plans through SEDATU.

4. **Save lives by emphasising road safety with policies and programmes and, where necessary, legislation**

   Dozens of cyclists are killed by motorised vehicles in Mexico and other developing countries every year. Road safety remains a key concern of urban cyclists, and a barrier to the wider uptake of cycling. Improved infrastructure is important for addressing this challenge, but educational efforts can also be an important tool. Teaching cycling skills and safety to children can be extended to other vulnerable users, including the elderly. Educational campaigns can also be extended to drivers. A campaign in the Netherlands, for example, teaches drivers to open their doors with their right hand, forcing them to shoulder check for cyclists.

   National governments can also implement legislation to support the safety of cyclists: reduced traffic speeds and mandated traffic calming measures, for example, can dramatically reduce the number of accidents. Mexico's recent reforms to the General Law on Human Settlements provide a basis for establishing a new national legal framework, and thereby preventing the development of a patchwork of state-level mobility laws that would prove challenging to coordinate and implement.

5. **Encourage successful PBSSs and sustainable transport policies by supporting coordination and learning between urban areas**

   Policy entrepreneurship at the state and city level led to the success of EcoBici and MiBici. Social awareness and engagement campaigns were critical to enabling citizens to feel ownership of the programmes and support the installation of stations, bike lanes and signs (although not without conflict). These successes could be enhanced by facilitating learning between urban areas. Dozens of departments, organisations and wider stakeholders played a role in each city, each with experiences and information that could be important for actors in other urban areas looking to support a shift to non-motorised transport. National governments can foster capacity-building of different stakeholders and create receptive frameworks where they can interact and monitor the implementation of sustainable mobility solutions over the longer terms. Specific actions could include:

   - Supporting the development of a network for Mexican and Latin American cities to showcase best practices in urban policy-making (e.g. in Mexico, SEDATU has just started to promote the National Metropolitan Network);
   - Showcasing success stories in urban policy-making at international events, including the UNFCCC; and
   - Defining best practices to engage citizens and other local actors in the planning, installation and operation of PBSSs. Taking an inclusive approach will help to create programmes that reflect users' needs and avoid conflicts.

It is important that city governments remain in control of the mobility ecosystem. It is important to regulate new private operators so that they provide a service that complements that of the PBSS while reducing direct competition. Specific actions could include:

- Integrating private sector mass operators with existing systems;
- Geo-fencing the areas where they could be used to prevent this competition;
- Licensing fees can also help to finance new cycling infrastructure; and
- Private companies should be encouraged to publish the data of their trips in order to assess performance of the overall non-motorised mobility ecosystem in a given city.

6. Conclusions

Familiar to the population, compatible with existing infrastructure and low cost – the features of public cycling schemes that make them less exciting than the new wave of urban mobility technologies and applications are the same features that have allowed public cycling schemes to achieve a major impact on urban transport. Renewing urban development policies to fully integrate sustainable modes of transport is the next step needed in Mexican cities.

The opportunity to leverage the success of public cycling schemes in Mexican cities and replicate it, lies in the hands of national policy-makers. Investments in cycling infrastructure, coordination between and within cities around transport and urban development planning, and continued support for cycling through educational programmes, can make Mexican cities leaders in the shift to non-motorised mobility. To achieve this, national policy-makers should act to support the expansion of BSS networks and their integration into urban development planning and mass transit transport services, creating sustainable mobility in cities for all.

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ABOUT THE COALITION FOR URBAN TRANSITIONS

The Coalition for Urban Transitions is the foremost initiative supporting national governments to secure economic prosperity and reduce the risk of climate change by transforming cities. The Coalition equips national governments with the evidence and policy options they need to foster more compact, connected and clean urban development. The Coalition's country programmes in China, Ghana, Mexico and Tanzania provide models for other countries on how to effectively develop national urban policies and infrastructure investment strategies.

A special initiative of the New Climate Economy (NCE), the Coalition for Urban Transitions is jointly managed by C40 Cities Climate Leadership Group and the World Resources Institute Ross Center. A partnership of 35+ diverse stakeholders across five continents drives the Coalition, including leading urban-focused institutions and their practice leaders from major think-tanks, research institutions, city networks, international organisations, major investors, infrastructure providers, and strategic advisory companies.

ACKNOWLEDGEMENTS

We would like to thank Fernanda Rivera and Ireri Brumón from SEMOVI in Mexico City, and Iván de la Lanza from WRI Mexico. We would also like to thank the Centro de Investigación y Proyectos en Ambiente y Desarrollo (CIPAD) for their support and contribution to the work. Arturo Balderas Torres would also like to acknowledge support from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 707539. Finally, we would like to thank Ramiro Alberto Ríos and Montserrat Miramontes for constructive feedback during the review process.

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