

TOWARDS SUSTAINABLE MOBILITY AND IMPROVED PUBLIC HEALTH: LESSONS FROM BIKE SHARING IN SHANGHAI, CHINA

Andrew Sudmant, Zhifu Mi, Lucy Oates, Xu Tian and Andy Gouldson

Summary

Sustainable cities and communities (Sustainable Development Goal 11) depend on reliable, affordable and safe urban mobility. Moreover, as urban areas continue to rapidly grow, the challenge of providing mobility options that meet the needs of rich and poor, of business and civil society and of young and old are deeply interwoven with the challenges of meeting a wide range of urban sustainability goals and addressing the threat of climate change.¹ Overcoming these challenges requires coordination between the millions of citizens commuting and making daily trips in cities, the thousands of private firms that facilitate urban travel, urban governments managing transport systems and planning transport interventions, and national governments whose policy support, technical expertise and access to finance are essential for effective action.

This policy brief presents lessons from Shanghai, where the world's largest bicycle-sharing scheme is being managed as part of China's first urban cycling strategy. Through a set of policies and regulations that are supporting the integration of cycling into the wider transport network and prioritise cycling safety, policy-makers are helping to maximise the benefits of urban cycling. An assessment of data on more than two million trips made by bicycle shows that bike sharing in Shanghai reduced fine particulate matter (PM_{2.5}) and nitrogen oxides (NO_x) emissions by 2.7% and 0.9%, preventing an estimated 23 premature deaths each year considering the impact of increased cycling on air quality, exercise levels, and numbers of traffic accidents.

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Coalition for Urban Transitions

c/o World Resources Institute
10 G St NE
Suite 800
Washington, DC 20002, USA

C40 Cities Climate Leadership Group

3 Queen Victoria Street
London EC4N 4TQ
United Kingdom

WRI Ross Center for Sustainable Cities

10 G St NE
Suite 800
Washington, DC 20002, USA

ABOUT THIS WORKING PAPER

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.

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Shared bicycles at Zhongshan Park Metro Station.
Credit: Joseph GTK / Shutterstock



These figures suggest that more than 1,000 premature deaths, tens of thousands of hospital visits and millions of respiratory events may be avoided every year by existing urban cycling initiatives across China. Added to this, greenhouse gas (GHG) emissions equivalent to removing approximately 9,000 vehicles off Shanghai streets are estimated to have been saved.

Equally significant may be the contribution that expanded cycling is having on mobility and the development of Shanghai. By making the city more affordable, accessible and safe to travel in, dockless cycling is a critical component of the city's shift to more compact, connected, and coordinated urban development.² As this revolution continues, the return of cycling gives Shanghai a claim to being the world's first megacity that provides a comprehensive set of non-motorised transport options to the majority of its residents.

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 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 the scale of their benefits.

Highlights

- Sustainable cities and communities (Sustainable Development Goal 11) need affordable, reliable, and safe urban mobility. But motorised urban mobility can be costly, prone to dysfunction and deadly. Congestion is a symptom of mobility options failing to meet residents' needs, and it costs many cities in Asia and Latin America 2–5% of gross domestic product (GDP) – and in Beijing as much as 15% of GDP.³ Furthermore, 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.⁴
- Technological breakthroughs have led to a proliferation of new mobility options and hope for the future of urban transport. Reliant on shared rather than privately owned vehicles, and dependant on digital as well as physical infrastructure, new mobility options such as ride hailing, electric scooters and dockless bikes are competing with existing transport options but they are also creating new demand for mobility.
- While improving the convenience of mobility for a segment of the population, many new mobility options have failed to improve transport systems⁵ or have exacerbated existing challenges.⁶ Shared bicycles may be an exception. As of 2018, there were more than 1,600 schemes in more than 1,200 cities with more than 18 million shared bicycles worldwide.⁷

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- Dockless bike-sharing schemes have become particularly popular, with more than 17 million dockless shared bikes now in use across the globe,⁸ of which three of every four worldwide were found in Chinese cities in 2019. Across 170 cities, more than 106 million users generate 50 million trips every day. In Shanghai, docked bike sharing arrived in 2009. By 2017 the city had more than 80,000 public bikes, making it one of the largest public bicycle systems in the world.⁹
 - In May 2017, China's national Ministry of Transportation drafted the first country-wide framework for regulating dockless bike sharing and issued formal regulations soon thereafter. Later in 2017, Shanghai enacted the country's first urban bike-sharing regulations. These include requirements that bicycles are registered with police and that companies provide insurance for users, as well as an electronic geofencing programme for bicycle parking.
 - Bike sharing in Shanghai reduced PM_{2.5} and NO_x emissions by 2.7% and 0.9%, preventing an estimated 23 premature deaths each year and avoiding hundreds of hospital visits and tens of thousands of respiratory events such as asthma attacks. Extrapolating these results across all Chinese cities with shared cycling networks suggests that as many as 1,000 premature deaths may have been prevented nationwide in 2016 alone, as well as millions of hospital visits and respiratory events being avoided.
 - The wider impact dockless cycling is having on mobility in Shanghai and the city's development path may be just as important as these other direct benefits. In conjunction with an expanded public mass transport system, restrictions on vehicle ownership and investments in pedestrian and cyclist safety, Shanghai can claim to be the world's first megacity that provides comprehensive non-motorised transport options for the majority of its residents. This shift in Shanghai's development path could have substantial benefits for public health, well-being and economic growth.¹⁰
 - To continue the success of bike-sharing models in Chinese cities, policy-makers need to address challenges related to road safety, physical and digital integration between public and non-motorised transport networks, sustainable business models and data sharing. This will require the cycling network to be physically, operationally and politically integrated into the wider urban fabric, and underlines the need for compact, connected and coordinated planning and development approaches. The opportunity this presents cannot be understated. Support for the continued growth of non-motorised transport in Shanghai can contribute substantially to fundamentally changing the experience of living and working in the city, with benefits for the economy but more importantly, the well-being of residents.

1. Congestion, air pollution and car dependency in urban areas

THE GLOBAL CHALLENGE

The nature of transport in urban areas may have changed more in the past five years than over the previous 50. Ever-increasing reliance on private vehicles and the addition of tens of thousands of kilometres of asphalt roads over decades have left many cities with congestion, inadequate connectivity, wasted public space and poor air quality. And investment in large-scale public infrastructure such as subways and rapid bus networks has thus far failed to adequately address these issues. The cost of congestion in cities, which is a symptom of mobility options failing to meet residents' needs, is greater than 1% of GDP in most European and North American cities, 2–5% of GDP in many cities in Asia and Latin America, and as high as 15% of GDP in Beijing.¹¹ Poor outdoor air quality, which is attributable to the transport sector by as much as 70% in some regions of the world, is responsible for almost 3 million deaths each year, as well as millions of visits to hospitals and respiratory events such as asthma attacks.¹²

Drawing on technological breakthroughs, the recent proliferation of new mobility options has raised hopes that there is an alternative to a future of more roads and private vehicles, more congestion and poor air quality. Relying on shared rather than privately owned vehicles, and depending on digital as well as physical infrastructure, new mobility options such as Uber and Didi Chuxing (ride hailing), Lime and Bird (electric scooters) and Mobike¹³ (dockless bikes) are competing with existing transport options but also creating new demand for mobility. This emphasises the extent to which conventional transport systems are under-serving urban residents.

Many of these new mobility options have so far failed to deliver improvements in the performance of transport systems.¹⁴ Indeed, some of the technologies that have drawn the most attention may have only exacerbated existing mobility challenges.¹⁵ It is therefore ironic that the technology that may have the most potential to radically improve urban mobility is one that has existed for centuries: the bicycle.

The first bike-sharing scheme appeared in Amsterdam in the 1960s¹⁶ and in 2018 there were more than 1,600 schemes in more than 1,200 cities, with more than 18 million shared bicycles worldwide.¹⁷ Dockless bike-sharing schemes – also referred to as “free-floating” or “fourth generation” bike sharing – have become particularly popular in the past few years, with more than 17 million dockless shared bikes now in use across the globe.¹⁸

The nature of transport in urban areas may have changed more in the past five years than over the previous 50.

Low cost, compatible with existing infrastructure and familiar to large portions of the population, shared cycling schemes may also be popular because of the way that cycling complements – rather than competes, as private vehicles do – with public transport options. Bicycles can be an effective way to reach a transit station, or get from a station to a destination, providing critical ‘last-mile’ infrastructure. Bicycles also require relatively little space and infrastructure (particularly when compared with other modes of transport), are quiet and zero emission, can reduce energy consumption and air pollution, and can increase the resilience of transport networks to weather or unexpected failures.

Cycling can therefore play an important role in the shift towards sustainable transport systems, with substantial benefits for public health and well-being. Research from the World Cycling Alliance finds that cycling directly contributes to the delivery of 11 of the 17 Sustainable Development Goals (see Box 1).¹⁹ Beyond the benefits to urban mobility, this shift also enables compact, coordinated and connected urban development, leading to economic benefits in terms of job creation, productivity and economic growth.²⁰

BOX 1 Cycling and the Sustainable Development Goals

In 2015, all United Nations Member States adopted 17 Sustainable Development Goals as part of the 2030 Agenda for Sustainable Development. These interconnected goals seek to address critical global challenges “including those related to poverty, inequality, climate change, environmental degradation, peace and justice”.²¹ Cycling can contribute to the achievement of these goals in the following ways:

- **Goal 1 (No poverty):** Cycling is often the only affordable means of transport for people who live in poverty in both urban and rural areas, providing access to education, jobs, markets and community activities.
- **Goal 2 (Zero hunger):** Cycling provides access to food markets for both consumers and small-scale producers.
- **Goal 3 (Good health and well-being):** The physical activity of cycling contributes to a healthy lifestyle.
- **Goal 5 (Gender equality):** Cycling increases access for women and girls to water, schools, markets and jobs.
- **Goal 7 (Affordable and clean energy):** Cycling is one of the most energy efficient forms of transport.
- **Goal 8 (Decent work and economic growth):** According to the European Cycling Foundation, the cycling sector creates more jobs for the same turnover than any other transport sector.

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- **Goal 9 (Industry, innovation and infrastructure):** The more people cycle, the easier it becomes for governments to build resilient infrastructure and sustainable transport systems that provide affordable and equitable access.
 - **Goal 11 (Sustainable cities and communities):** Cycling is affordable, safe, healthy and non-polluting, thus making cities more inclusive, safe and sustainable.
 - **Goal 12 (Responsible consumption and production):** Transporting goods and people by bicycle makes production, consumption and delivery of goods more sustainable.
 - **Goal 13 (Climate action):** The bicycle is a symbol for decarbonising transport and societies.
 - **Goal 17 (Partnerships for the goals):** Many organisations, including civil society, government and the private sector, are working in partnership to promote cycling and cycling technology in both developed and developing countries.
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Bike-sharing schemes are receiving attention on the global stage and are increasingly seen as a key instrument in the sustainable urban mobility toolkit. Successful networks, however, depend on cycling networks being embedded into wider transport networks and being supported with appropriate infrastructure. Indeed, in the absence of appropriate implementation, increases in traffic accidents and disruption to transport networks as a result of abandoned, damaged or poorly distributed bicycles can lead to net negative impacts for urban residents.

THE CHALLENGE IN CHINA

Rapid urbanisation and economic growth, both of which have occurred at an unprecedented scale over recent decades, have led to an exponential increase in demand for mobility in Chinese cities.²² To meet this demand policy-makers have undertaken massive investment in public and private transport networks; China has one of the world's longest highway networks, with almost 4.5 million kilometres built,²³ and the expansion of metro systems in Chinese cities is currently the single largest contributor to new kilometres of transit in the world.²⁴

Despite these efforts, congestion and constrained mobility pervade life in many Chinese cities. Although Beijing has seven ring roads and one of the world's most extensive subway networks, congestion has been estimated to cost the city as much as 15% of GDP annually, which is symbolic of the magnitude of China's urban transport problems.²⁵ According to recent data China is home to 22 of the world's 50 most-polluted cities, with as much as 50% of its urban air pollution in some cases attributable to transport.²⁶

The primacy of road-based transport in many parts of the country has contributed to the growing sprawl of Chinese cities, leading to feedback between transport and land-use decisions. In places where mass transport and non-motorised mobility are unavailable or inconvenient, private-vehicle ownership is inadvertently encouraged. And where there are many private vehicles, more roads are seen to be necessary. Lower-density development on the periphery of Chinese cities, which has led the density of urban China to decline,²⁷ will be costly and challenging to change, locking these areas out of the social, economic and environmental benefits of compact, coordinate and connected development.

A consequence of the rapid expansion of ‘conventional’ transport infrastructure has been a decline in cycling.²⁸ More crowded streets, longer commutes and a shift to cars have led to a decline in travel by bicycle, from more than 60% of all trips in Shanghai and Beijing in the 1980s to fewer than 20% of trips in the 2000s with the most dramatic declines among young people.²⁹ In some cities, the percentage of trips from cycling fell into the single digits. Across China the share of trips taken by bicycles declined on average by approximately 3% each year from the late 1980s through to the late 2000s.³⁰

The emergence of dockless cycling in Chinese cities over the past five years has dramatically upended this trend. In a matter of years urban centres have shifted from fewer and fewer bicycles to sidewalks made impassable by the number of discarded bicycles. The opportunity this shift presents is massive, but so too are the consequences of uncoordinated and ineffective local and national governance. This policy brief discusses Shanghai’s leadership in developing a comprehensive approach to governing urban cycling and integrating non-motorised options into its transport network, and outlines options for furthering its success.

2. Methodology

To assess the impact of dockless bicycles on public health, analysis of data from dockless bike users is used to quantitatively estimate the environmental and health benefits in Shanghai. Mobike, one of the largest firms offering dockless bicycles in the city, provided data on dockless bicycle trips – including information on the distance and time of the trip – and trip start and end locations.

As of March 2017, Mobike had more than 4 million red-framed bikes in nearly 80 cities worldwide and received approximately 20 million orders a day – or 56% of the global market – making it the largest dockless bike-sharing company in the world. In Shanghai, Mobike has 450,000 bicycles, almost half of the 1.1 million shared bicycles to which the city is home.³¹

The dataset used to calculate the findings presented in this section represents 57% of total trip orders in Shanghai during August 2016 based on Mobike data. In total there were 1,023,603 orders made by 306,936 users for 17,688 bikes during this period. Trips not included in our analysis are those made by rival firms.

The analysis in this policy brief is based on the findings from several technical calculations, namely:

- The number of vehicle kilometres travelled (VKT) and corresponding fuels saved by bike sharing. Trips of less than 1 km taken by Mobike are assumed to have otherwise been taken by foot or public transport. Trips longer than 1 km are assumed to have otherwise been taken by public transport or private vehicle based on the modal share of public transport and private vehicles in the city. Across all trips in 2018 in Shanghai, 20% were by car, 23% were by public transport, 28% were by foot and 28% were by bicycle.
- Emissions generated from vehicle fuels, which can be divided into exhaust emissions, such as carbon dioxide (CO₂), carbon monoxide (CO), NO_x, particulate matter (PM_{2.5} and PM₁₀) and evaporative emissions such as hydrocarbons (HC). In this study, we focus on CO₂, NO_x and PM_{2.5}. Emissions factors for vehicles in China and are drawn from recent literature.³²
- The positive and negative health impacts of bike sharing: positive effects from physical activity and negative effects from exposure to air pollution and possible accidents. This is calculated according to: reduced mortality risks associated with additional levels of exercise in minutes per week; increased mortality risks associated with increased exposure to PM_{2.5}, PM₁₀ or NO_x in Shanghai, as drawn from recent literature; and the increased risk of death from additional cycling based on national data on cycling fatalities and total cycling distance.³³

For further information on the equations used, please contact the authors. In addition to technical analysis, this paper also relies on extensive document analysis supplemented by interviews across a range of actors, including cycle users and members of the public, academic experts and firms involved in the industry.

Table 1: Stakeholders interviewed

STAKEHOLDER	INTERVIEWS
Users	14
Transport experts	3
Firms in the dockless bike industry	3

3. Bike sharing in China

NATIONAL CONTEXT

Public bike-sharing schemes were developed in Beijing, Hangzhou and Shanghai in the late 2000s. However, it was only with the development of dockless bicycles attached to mobile payment schemes that cycling rates increased significantly in Chinese cities. Regulatory frameworks had not been designed with this innovation in mind, so there was space for firms to expand aggressively. Combined with the low cost of bicycles in China and the convenience of users not having to find stations, this expansion meant that dockless cycling networks quickly outgrew their docked counterparts. Within their first year of implementation, 40 companies deployed more than 16 million bikes across more than half of all prefecture-level cities in China.³⁴ This growth has continued: in 2019, three out of every four dockless bikes around the globe are found in Chinese cities. Across 170 cities (and counting) more than 106 million users generate 50 million trips each day.

The impact of this return to cycling has been far reaching. Users report benefits including greater travel convenience, extended travel range, saved travel time and reduced travel costs.³⁵ Bike sharing has also generated sustainable green employment, including an estimated 100,000 new jobs nationwide.³⁶

At the same time, there have been questions about whether dockless cycles are leading to net positive impacts on mobility in Chinese cities. Limited dedicated bicycle infrastructure has meant that cyclists use the same street space as cars, leading to high rates of traffic accidents.³⁷ Abandoned bicycles – some broken, others permanently locked after firms went bankrupt – block streets and access to businesses. And an uneven distribution of bicycles between urban centres and wider parts of cities made cycling a dependable option for only a subset of users.

NATIONAL POLICY

In response to rising numbers of complaints, the national government issued guidelines for dockless bikes in 2017. According to these guidelines, dockless cycling firms had to follow a set of financial guidelines, including separating advance payments and deposits on cycles in their budgets to provide security to users and transparency for investors. Critically, these guidelines also devolved governance responsibilities to municipal governments, who were made responsible for the management of bike-sharing schemes, including registering companies and regulating bicycle numbers, where they are and are not allowed in the city, and where they can park. Shanghai was the first city in China to develop municipal regulations.

4. Case study: Cycling in Shanghai

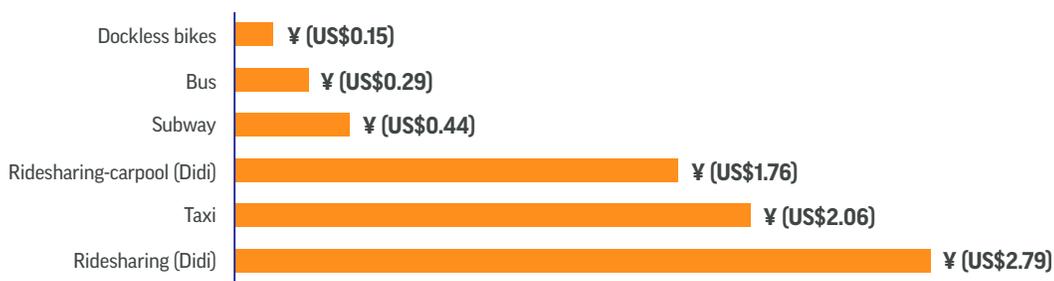
CONTEXT

Shanghai is the world's largest single-authority city^a by population³⁸ and has the world's largest port and the world's longest subway system. Located on the Yangtze River Delta, Shanghai is a world centre for global trade and finance and has seen rapid economic and population growth over recent decades.

Between 1950 and 2000 Shanghai grew from 4 million to 14 million inhabitants, and by 2019 the population had reached 26 million. If current trends continue, the city's population is projected to rise to nearly 31 million by 2030.³⁹ Although Shanghai's urban core features some of the world's tallest buildings and high density levels, the city as a whole has 5,800 inhabitants per km² – a similar level of density as London in the United Kingdom or Rio de Janeiro in Brazil – and its density has been declining.⁴⁰ Social and environmental challenges have developed in Shanghai as the city has grown. Deteriorating air quality and rising congestion, linked to the city's continued growth, are major challenges for urban policy-makers.⁴¹

Docked bike sharing in Shanghai arrived in 2009, with stations installed in five districts of the central business district. By 2017 the city had more than 80,000 public bikes, making it among the largest public bike systems in the world.⁴² A more significant shift towards cycling, however, came from the arrival of dockless bicycles in 2015. Dockless bicycles (and riders) have increased at near-exponential rates owing to their low cost (see Figure 1), the convenience they offer, the latent demand for last-mile transport options and a flood of investor capital, among other factors. The number of bikes on Shanghai streets rose to 260,000 at the end of 2016, to 630,000 by April 2017 and to more than 1.5 million by August 2017.⁴³

Figure 1: Cost of a 3 km trip in Shanghai by different modes of transport in 2019



Note: Figures obtained by researchers in Shanghai using local transport apps. Average figures are presented where applications gave different figures. Conversions are based on an exchange rate of approximately CNY 7 to US\$ 1 (5 Feb at xe.com).

^a City proper” refers to the continuous regional government by a single local government.

While their emergence was originally welcomed by most citizens and the city government, the growth in the number of companies and bicycles in Shanghai quickly led to issues similar to those seen in other Chinese cities. Oversupply of bikes in some areas of the city – with some districts reporting 16 bicycles per resident – led to blocked sidewalks and disrupted access to businesses. The regular bankruptcies of cycle companies (10 in 2017) led to bicycles being abandoned and vandalised. Insufficient infrastructure for bicycles discouraged cycling in some parts of the city and forced cyclists to compete with cars. And the sheer number of companies, more than 10 at any time between mid-2017 and early 2018, and the concentration of bicycles in the most built-up parts of the city made it challenging for users to depend on cycling for their commute.

POLICY APPROACH

Following national regulations in May 2017, Shanghai enacted the country's first urban bike-sharing regulations. Key aspects of the regulations include a requirement that bicycles are registered with police to prevent vandalism and to

keep track of the number of bicycles, a requirement that insurance is provided for users, regulations around bike parking and a programme to use electronic geofencing to let users know where they can and cannot park their bikes.

Aggressive action to support low carbon cities leads to substantial social, economic and environmental benefits.

The benefits of these regulations emerged rapidly. In 2018, a project between the Shanghai city government and Mobike to develop real-time mapping and 'geofencing' (whereby users are provided a map on their phones of where they can and cannot park), in conjunction with a ban on parking in seven locations in downtown Shanghai, led to a 30% decrease in illegal bicycle parking. By the end of 2018, the city government had worked with wider bike-share companies to create more than 70 prohibited parking areas and more than 890,000 dockless bikes (over 60% of the total shared bikes in the city) had been registered with the traffic police system. Regulations

surrounding e-payments and protections for deposits and insurance are reported by users to give them a greater feeling of security and are cited by firms as a contributor to greater financial stability for businesses.

Complementing the regulation of dockless bicycle firms and riders is a set of policies that promote a broader shift to non-motorised transport. Planning at the city level is guided by the Shanghai Master Plan (2017–2035),⁴⁴ which calls for a “one-networked, multimodal, fully covered and highly intensive” public transportation network. The plan aims for at least 85% of trips to be made using green modalities (public transport, walking or cycling) by 2035. The master plan also emphasises urban density and includes a cap on the population at 25 million people and the footprint of the city at 3,200 km². In addition, the document outlines a commitment

to integrated development by recommending increasing the growth of jobs outside of the commercial core of the city and nearer the places where workers live. While the plan makes no specific mention of cycling, it does emphasise key elements of the “compact, connected and coordinated” urban development programme needed to promote non-motorised transport. These elements include green mobility targets, bringing homes and workplaces closer together, and expanding public transport.⁴⁵ More generally, these policies are in line with a wider literature that shows aggressive action to support low carbon cities leads to substantial social, economic and environmental benefits.⁴⁶

At the neighbourhood level, planning is guided by Shanghai’s Street Design Guidelines. These guidelines (Box 2), emphasise the many interconnected uses of city streets that need to be prioritised before private vehicles. While urban development planning is led by city-level policy-makers, aspects of the Shanghai Street Design Guidelines require action from each of local, urban and national actors. Changes to speed limits, for example, require national and urban policy-making, as do building new bike lanes or widening sidewalks. Community-level actors can, however, influence aesthetic changes, such as whether streets have trees and greenery, how clean streets they are, what retail options they have and what signage businesses are allowed.

Box 2: Shanghai Street Design Guidelines⁴⁷

The Shanghai Street Design Guidelines, published in 2016, was the first planning document of its kind in China and was based on the principle that streets are public space rather than infrastructure.⁴⁸ The Shanghai Bureau of Planning and Land Resources, the Shanghai Transportation Commission and the Shanghai Urban Planning and Design Research Institute compiled the guidelines, which have inspired more than 20 other Chinese cities to design their own.⁴⁹

Architects who advised the agencies on the design of the document describe the streetscape “as both a concept (the way we think and approach the planning of streets) and a design (the way we choose and prioritise physical design elements against their functionality)”.⁵⁰

Around the world, similar people-oriented urban planning approaches include the Home Zones in the UK,⁵¹ Complete Streets in the US⁵² and the woonerf (“living yard”) concept in Belgium and the Netherlands.⁵³

Key concepts outlined in the Shanghai Street Design Guidelines have a particular emphasis on non-motorised transport. Limiting the size of blocks and avoiding the “super blocks” that have come to dominate development of some parts of Shanghai, make it easier for pedestrians to travel between streets.

Wider sidewalks and fewer car lanes encourage walking and cycling and slow traffic, improving safety. Standardised bike lanes, one-way streets, traffic calming, improved signage, wider crosswalks, more street trees, store and building frontage closer to the street and host of other specific measures help to make non-motorised mobility more convenience, safer and more enjoyable.

While the Shanghai Street Design Guidelines was published with the endorsement of the City in 2016, whether these guidelines have been thoroughly implemented across the City's development is not clear and evidence from interviews suggest that cars continue to be prioritised in some developments in the City.

By combining national and urban regulatory approaches, city-level urban planning, and neighbourhood design, Shanghai is employing an approach to encouraging cycling that recognises the range of different barriers the city faces as it envisages a shift to higher non-motorised transport. At the same time, Shanghai is also recognising the complementarity between different sets of policies.

Mixed-use development (city-level planning) is associated with higher rates of non-motorised transport. But rates can be increased further if there are also bicycle lanes (neighbourhood-level design) and when regulations give users confidence that they can deposit funds with bike firms (national policy). Improved public transport (urban policy) encourages walking and cycling to an even greater extent when trip planning platforms prioritise public and non-motorised options (national policy), and when neighbourhoods encourage non-motorised transport with wider sidewalks, trees and design features that slow cars, including speed bumps, regular crosswalks and residential zone speed limits.

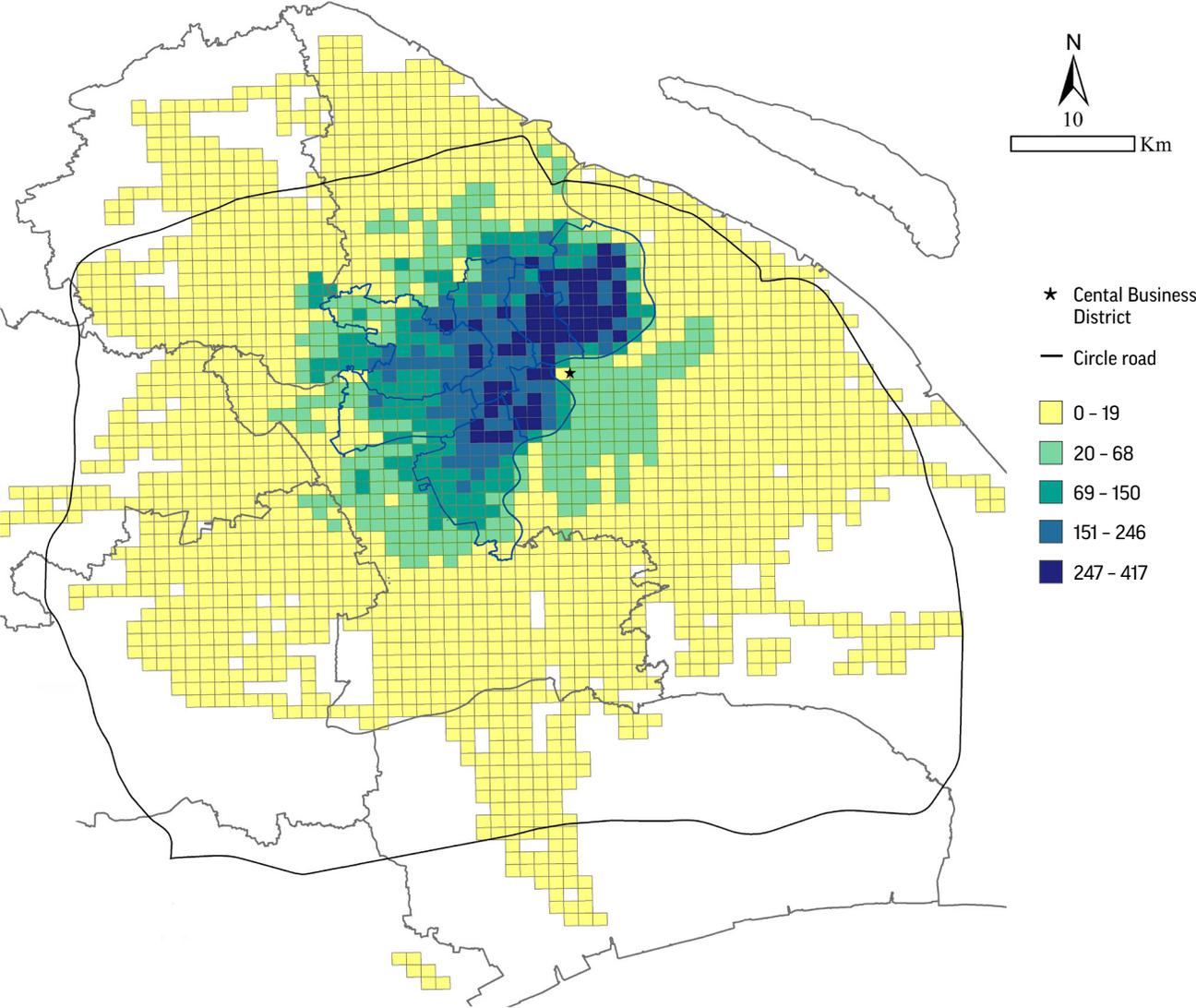
Collectively, urban regulations of cycling firms and riders (guided by national policy), city-level development and infrastructure plans, and the neighbourhood planning guidelines in Shanghai underline the commitment of policy-makers and the integrated, multilevel and long-term approach to urban climate action recommended by leading academic research.⁵⁴

ENVIRONMENT AND HEALTH IMPACTS

Drawing on the Mobike data, dockless bicycle transport in Shanghai reduced PM_{2.5} and NO_x emissions by 2.7% and 0.9% in 2016. Considering the combined impact across improved air quality, increased levels of exercise and increased numbers of traffic accidents, it is estimated this led to 23 premature deaths being prevented. In addition, hundreds of hospital visits and tens thousands of respiratory events (such as asthma attacks) were avoided. Further GHG emissions equivalent to removing approximately 9,000 vehicles off Shanghai streets are estimated to have been saved.

Figure 2 shows the spatial distribution of the environmental benefits of bike sharing. Notably, the environmental benefits are much higher in more developed districts where population density is higher. The density of environmental benefits is highest in Hongkou district, which has the highest population density in Shanghai of 35,000 people per km². This suggests that pollution was reduced most in the places where it has the greatest potential to improve health outcomes.

Figure 2: The spatial distribution of NO_x emission reductions in Shanghai



These benefits are likely to be concentrated amongst the most vulnerable members of society. Poor air quality is particularly dangerous for children, pregnant women and older people.⁵⁵ More generally, while this analysis uses best practices and scientifically supported figures for the impact of air quality on health, there is growing recognition that even low levels of poor air quality can negatively impact well-being, by affecting a person's mood and willingness to spend time outside, increasing cold and flu rates, and in a myriad other subtle ways.⁵⁶ This means that existing estimates of the health impacts of poor air quality are likely to be conservative. Moreover, a changing climate that brings more heatwaves and temperature inversions, both of which aggravate poor air quality, will lead to even more pronounced negative health impacts, emphasising the need for action.⁵⁷

5. Looking to the future: Rebuilding the Bicycle Kingdom

As late as the 1980s China was referred to as the “Bicycle Kingdom”.⁵⁸ In recent decades, however, rapid economic growth, massive investment in roads and changing trip patterns have resulted in a steep decline in non-motorised transport. Revitalising cycling can contribute to solving major congestion, deadly air pollution and unequal access to mobility, and can support economic growth and the well-being of urban citizens. The actions of national and city government have provided a strong basis for cycling to re-emerge, but it is now time to capitalise on this progress.

EMBEDDING CYCLING IN THE WIDER URBAN SYSTEM

It will be critical to continue embedding cycling in urban infrastructure to ensure that residents view non-motorised transport as a reliable component of the transport system. This requires coordination between the building of cycling infrastructure and other elements of the mobility network. Bicycle racks and designated bicycle parking need to be paired with metro stations and bus stops, not just in the city centre where demand is consistently high, but also at the stops outside the city centre. Doing so will provide residents with end-to-end non-motorised mobility. As electric dockless bikes become more popular and more widely available, charging stations need to be built, ideally in the locations where they will be in demand. The importance of this coordination can be codified in the next update to the Shanghai Master plan and written into documents like the Shanghai Neighbourhood Guide.

Planners also need to consider how the wider fabric of the urban environment encourages or discourages cycling and non-motorised transport more generally. People who live in higher-density, mixed-use neighbourhoods with access to transit are far likelier to cycle, particularly for reasons other than recreation.⁵⁹ For example, neighbourhood-level research conducted in communities that are within two km of a subway station shows that bike-sharing schemes increase cycling more than one-third.⁶⁰

This need not imply that to support cycling existing neighbourhoods need to be completely rebuilt: small changes, where possible, can support a longer-term change process. Slowing traffic in residential areas and making streets one-way where possible improves safety for cyclists, as does increasing the size and visibility of crossings, building protected bike lanes, standardising lane width and making sure they are continuous between destinations.⁶¹ Walking, cycling and more vibrant neighbourhoods can be supported more generally by prioritising people over cars by widening sidewalks, bringing commercial and residential frontage closer to the sidewalk, planting street trees, limiting development sizes (by area) to prevent “trapping” pedestrians (or providing clearly marked pathways), and a host of other specific interventions.⁶² The benefits of these measures, and of a movement towards more compact, connected and coordinated neighbourhoods, include cleaner air, job creation and, the improved well-being of residents.⁶³

These measures can also have direct impacts on the economy. Research has found that bike-sharing schemes have a positive impact on house prices in zones of medium and high density, demonstrating peoples’ preference for shared streets and access to cycling infrastructure.⁶⁴ Neighbourhoods that are densely populated but highly liveable are strongly related to economic productivity – the fundamental driver of rising incomes.⁶⁵ To the extent that cycling is critical for dense but liveable neighbourhoods, it may also be critical for future economic prosperity.

EMBEDDING CYCLING IN THE DIGITAL MOBILITY LANDSCAPE

Policy-makers also need to consider how cycling is embedded in the digital mobility landscape. Commuters are increasingly turning to digital platforms on their phones for recommended travel options. Given that there are only a small number of such digital platforms, controlled by a small number of powerful technology firms, there is tremendous opportunity to align platforms’ recommended travel options with a public interest in increased non-motorised and public transport use. Policy-makers and platform operators need to consider the “frictions” and “barriers” that make it challenging for platform users to commute using multiple modes of public and non-motorised transport – such as having to switch applications to pay for different transport modes.⁶⁶ Policy-makers and operators also need to think about the influence of default options of mobility platforms, which can steer users towards or away from non-motorised mobility, the process platforms use to compare private and public transport options, and the way data is collected, stored and shared between platforms and between mobility providers and transport planners.

MAXIMISING CO-BENEFITS

National leadership is imperative to continuing China’s shift to non-motorised transport, liveable density and increased urban productivity. Support for cycling, is not only complementary to these goals but is also an area of potential future

competitive advantage for the Chinese economy. In response to the number of global shared-bike users growing from 227 million in 2017 to 306 million in 2019, Mobike, Ofo and other major players in China's bike-sharing sector have been expanding outside China.⁶⁷ This has meant that these companies have been under pressure to be seen as good corporate citizens that contribute to, rather than compete with, local and national government efforts to govern local transport. At the same time, so-called "new mobility" firms, including those operating dockless bikes, have increasingly been considered important components in major technology companies' plans to provide a single, integrated experience for their users. Mobike has received substantial investment from internet giant Tencent while its main competitor Ofo has support from Alibaba. As this "maturing" of the dockless cycling industry continues, national regulations around mobility data and mobility platforms will be critical for Mobike and Ofo, and by extension Tencent and Alibaba, gaining public and private support to continue expanding outside China.

More than half of all global road traffic deaths are of vulnerable road users including pedestrians, cyclists and motorcyclists.

Continued focus on urban safety will also yield an increase in urban cycling. More than half of all global road traffic deaths are of vulnerable road users including pedestrians, cyclists and motorcyclists, with a disproportionate number of happening in Chinese cities.⁶⁸ This risk to cyclists and pedestrians, and the likelihood that residents may choose other modes of transit over cycling, are to a significant extent determined by road design and planning approaches that prioritise private cars and other motorised transport. Neighbourhoods built according to the principles of compactness, connectivity and coordination are not only safer, but are also more energy efficient, generate higher rates of economic and employment growth, and fewer GHG emissions and air pollutants.⁶⁹ Specific actions that can support increased cycling and non-motorised transport, many already outlined in this brief, can support a process of feedback whereby safer cycling reduces traffic, encouraging further cycling and co-benefits including cleaner air, more vibrant neighbourhoods, and increased economic productivity.

THINKING BEYOND INFRASTRUCTURE

Beyond infrastructure, technologies and the development of business models, cultural attitudes and norms also affect levels of cycling. While a long history of high rates of cycling make Chinese cities globally unique, a more contemporary idea that a private vehicle is a sign of wealth and prosperity is affecting China much as it has many other regions of the world. Changing this association requires leadership. In Bogotá, weekly car-free days led by the city’s mayor and known as “Ciclovía” are credited with dramatic shift in public attitudes around cycling. Ciclovía now take place in 496 cities and 27 countries.⁷⁰ In Mexico City, the expansion of bike lanes and physical infrastructure has been supported by bicycle training programmes, which have been particularly important for increasing the rate of cycling among young women and girls.⁷¹ In Denmark, a comprehensive approach to encouraging cycling that featured investment in infrastructure, but also a commitment from members of government to commute by bicycle, has contributed to a pro-cycling public mentality in Copenhagen.⁷² These examples show the importance of comprehensive programmes of action around mobility that think beyond the physical and technical characteristics of the city and its transport networks.

6. Policy recommendations

This analysis suggests a number of policy recommendations for the Chinese government, and other national governments, wishing to improve sustainable mobility and public health through bicycle-sharing programmes.

1. Prioritise the physical integration of bike-sharing into the wider transport network

More than 90% of transport infrastructure in Shanghai and in most global cities is designed to primarily serve private vehicles. Continuing this approach will only lead to more traffic and more congestion. A commitment to building dedicated cycling infrastructure – at the level of ambition applied to the construction of subway lines in the 2000s, in line with the Shanghai Street Design Guidelines and in coordination with the Shanghai Master Plan – could make Shanghai a world leader in urban cycling. National targets can be set around the kilometres or use rates of bike lanes and bike “highways” (where cyclists are not stopped by traffic lights). Standards can also be developed for the number of bicycle parking spaces outside public institutions, metro stops, new developments and public areas such as parks. National governments can also consider shifting national transport budgets from roads to public and active transport options.

2. Work with bike-sharing firms to enable the digital integration of urban transport

Residents of Chinese cities increasingly rely on digital platforms to guide their travel and mobility. For mobility to improve in urban areas, these platforms must integrate fast and efficient public transport options and prioritise low-cost, non-motorised options – including cycling and walking – over taxis and private vehicles for mobility. As bicycle-sharing firms consolidate and are increasingly controlled by China’s largest technology firms, and as mobility services are integrated into wider digital platforms, there is a critical need for an open dialogue about how mobility recommendations are made, what services and options are presented, and how a common need for public and

non-motorised mobility is being weighed against the interests of private mobility actors. National policy-making leadership is vital to preventing a fragmented landscape of mobility platforms covering different geographies, travel modes and demography. National actors can employ legislation, such as requiring mobility providers to make public transport options the default choice for users. Or they can also consider incentives, for example providing subsidies to firms that show better-than-average use of public and non-motorised transport options. The most appropriate and effective measures will be developed by convening key stakeholders and working collaboratively with them to ensure the integration of the rapidly changing digital and physical landscapes of transport in Chinese cities.

National policy-making leadership is vital to preventing a fragmented landscape of mobility platforms covering different geographies, travel modes and demography.

Require the (consensual) sharing of anonymised data related to travel patterns and user behaviour

Information generated by a growing number of third-party transport options, including dockless bikes, scooters and shared taxis, provides unparalleled insight into travel patterns in the city. Anonymised sharing of this data – with the consent and knowledge of users – is critical for effective planning by both public and private actors. For public actors, for example, new subway and bus routes can be designed to more closely match travellers’ needs based on information about the trips they are already making. With more firms operating each week, and new innovation in mobility progressing rapidly, national actors are perfectly positioned to establish standards around data collection, management, dissemination and sharing. In relation to bike sharing specifically, Chinese policy-makers can look to Mexico City, where basic anonymised data from the city’s bike-sharing scheme is made available online.⁷³ In terms of data regulations, the General Data Protection Regulation in the

European Union provides a set of standards common to different sectors and both public and private entities to provide the public with confidence in how their data is gathered, stored and used.⁷⁴

3. Establish requirements for minimum levels of dockless bicycle access across urban areas

The financial case for dockless bikes will be strongest for areas close to busy metro stations, but last-mile mobility is no less important at the furthest reaches of the public transport system. Ensuring that bikes are available at these places, and in satellite towns and suburbs connected to the city by bus or rail, could both increase participation and support bicycle–rail integration. Private bus companies and taxis are often regulated to provide certain levels of service, across different times and routes; similarly, dockless bike-sharing needs to be made consistently available if it is to be used widely. Policy-makers can achieve this in different ways, including subsidising trips in different parts of the city or regulating for a minimum number of bikes to be available at certain places at certain times of day.

4. Account for cycling in building codes and spatial plans

“Super blocks” – very large developments surrounded by multiple lane roads – have made up a significant portion of new development in Chinese cities. Best-practice guidelines for new developments, created through a dialogue between national actors, urban stakeholders and developers, and built into existing building codes, can help to establish the foundations for non-motorised mobility. Limiting block length (e.g. to 150 metres or less) can prevent pedestrians from being “trapped” behind large buildings. Capping street widths (e.g. at 45 metres for two-way streets) can reduce vehicle speeds and make for safer street crossing. Standard distances between street-level retail, commercial and residential buildings and sidewalks (e.g. of 1–3 metres) can make streets more vibrant. Maximum numbers of parking spaces per building occupant (e.g. 10 per 100 in residential buildings) can encourage non-motorised and public transport options. And secure bicycle storage and changing facilities, as required in a number of European countries, can encourage cycle commuting.

5. Prioritise road safety with policies and programmes and, where necessary, legislation

Concerns around safety remain the largest barrier to higher rates of urban cycling, especially for vulnerable populations. Improved infrastructure can help to address this issue, but policy-makers also need to pay special attention

to vulnerable populations who may be excluded from the transport network if bicycles are prioritised. Efforts to teach cycling skills and safety to children and other vulnerable users have been successfully implemented in Mexico City⁷⁵ and could inform a national programme in China. Beyond behavioural change, national governments can implement legislation to encourage road users to pay greater attention to cycling. In Dutch law, car drivers are by default liable in any collision with a vulnerable road user. Reducing traffic speeds in dense urban areas has also been shown to significantly improve safety for bicycles, pedestrians and drivers, as have design features that could be standardised for residential areas, including traffic calming measures, car free streets, and alternating one-way streets.⁷⁶

6. Make cycling a source of national pride

Long before Copenhagen and Amsterdam were known as havens for cycling, China was the “bicycle kingdom”.⁷⁷ Regaining this identity requires more than infrastructure. Car-free days and bicycle parades, teaching children (and especially girls) cycling skills, and encouraging where possible government officials to cycle instead of drive are statements of a commitment to prioritising people over cars. National leadership in this area is critical. In addition to encouraging government employees to cycle to work, the national government can create a platform for their successful bike-sharing firms by featuring them at global events like the annual Conference of the Parties to the United Nations Framework Convention on Climate Change and by setting national targets for levels of cycling.

7. Conclusions

“New mobility” – a range of physical and application-based options for travel around cities, including hail-and-ride taxis, dockless bicycles, electric scooters and routing applications that layer different transport modes, are redefining urban transport. But while the focus on public attention is often captured by the latest and flashiest technological advance, the humble bicycle is the core technology driving substantial change in mobility – and urban development – in Shanghai.

After only a year and a half of operation, an estimated 23 premature deaths were prevented by dockless cycling in Shanghai. This takes into account the impact that increased cycling has had on air quality, levels of exercise and numbers of traffic accidents. In addition, hundreds of hospital visits and tens thousands of respiratory events, such as asthma attacks, were avoided and a reduction in GHG emissions achieved equivalent to removing approximately 9,000 vehicles from

Shanghai's roads. These benefits are likely to be largest for vulnerable members of society and may underestimate the broad-based positive impact of improved air quality. More widely, the shift towards non-motorised transport dockless bicycles is helping to shift Shanghai to more compact, coordinated and connected development, with wider social, economic and environmental benefits.

As this brief has demonstrated, the opportunity to expand these benefits is now. To achieve this, there needs to be coordinated action from national and subnational governments, including investing in dedicated cycling infrastructure, greater transparency and dissemination of data related to travel patterns and user behaviour, furthering the physical and operational integration of the cycling network into the wider urban fabric, and supporting a shift towards greater acceptable of cycling. Both government actors and members of the public can also lead by example: increasing the number of cyclists may be more important more than any other factor may support Shanghai's continued shift to becoming a sustainable city.

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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 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.

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