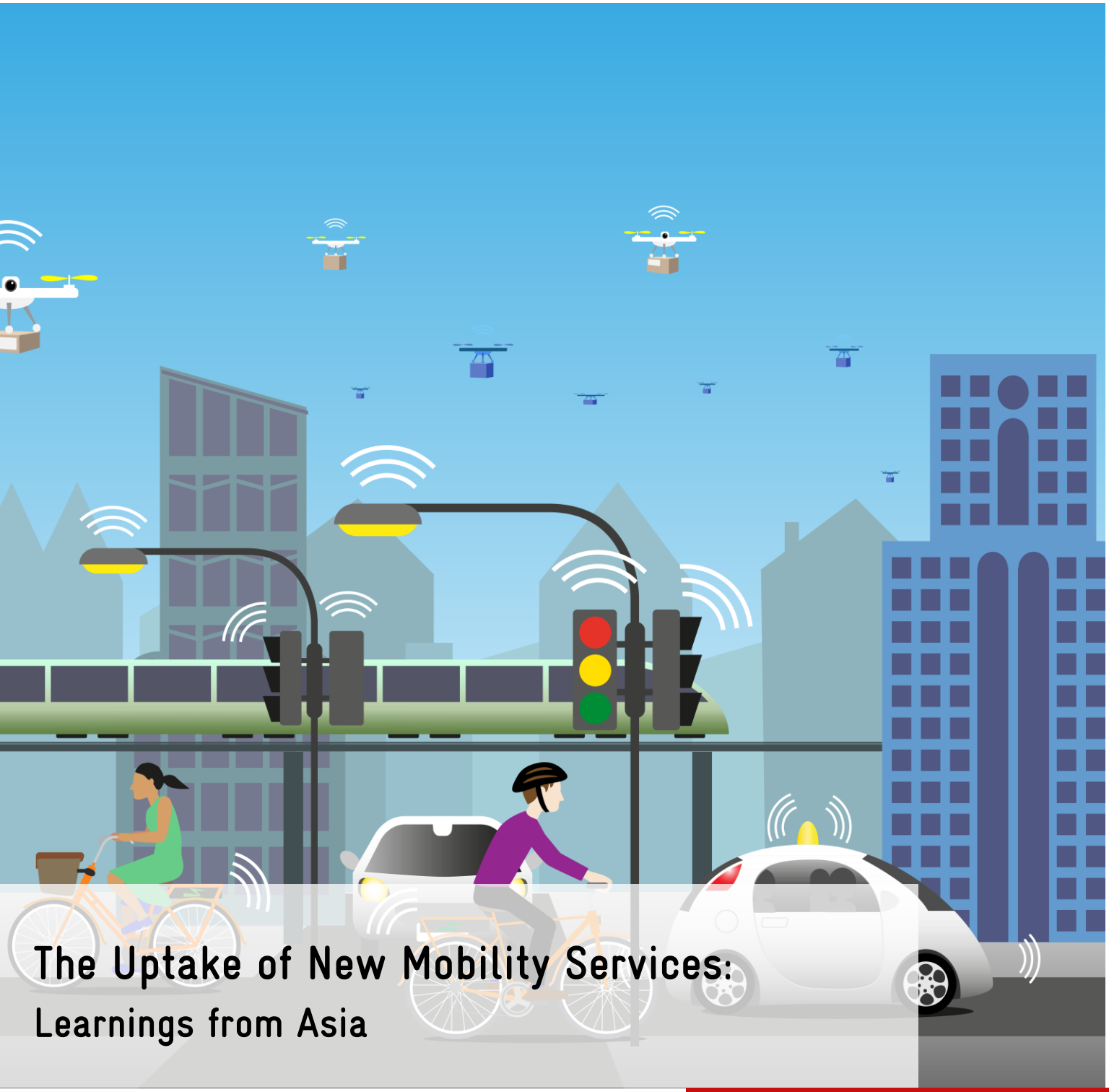


The Uptake of New Mobility Services:
Learnings from Asia

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of
Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit
of the Federal Republic of Germany

On behalf of
Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
of the Federal Republic of Germany

Sector Network TUEWAS

Imprint

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by:
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

Friedrich-Ebert-Allee 32 + 36
53113 Bonn
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn
T +49 6196 79-0
F +49 6196 79-11 15

E info@giz.de
I www.giz.de

Responsible
Sebastian Ibold (GIZ)

E transition-china@giz.de
I www.mobility.transition-china.org

Author
Dr. Tom Vöge

About the author:
Tom Vöge is a public policy and tech expert with a passion for sustainable urban mobility and educated to PhD level at the University of Southampton. In his 20-year career he has worked for the United Nations and the OECD, as well as in management consulting, membership associations, and academia, in addition to freelance roles for the European Commission, the Inter-American Development Bank, the World Maritime University, and GIZ.

Editors
Alvin Mejia, Sebastian Ibold, Kasinath Anbu

Acknowledgements
Dr. Marie Peters, Chenzi Yiyang, Michel Arnd, Avni Mehta, Tuan Anh Nguyen, Christian Mettke, Azarel Chamorro

Layout
Xin Hu, Lang Liu

Photo credits
Shutterstock / Solveig Been (Cover page)

This publication is a product of GIZ sector network TUEWAS.
The publication is co-financed by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), and the Federal Ministry for Economic Cooperation and Development (BMZ).

Beijing, 2021

Summary

Context and Rationale

New Mobility Services (NMS) – novel mobility services that are enabled by disruptive technology and innovative business models that facilitate effective sharing of mobility resources - such as ride-hailing or dock-less bike sharing systems, have been emerging with the promise of contributing to more sustainable and climate-friendly mobility - in Asia and beyond.

This report first discusses the developmental backdrop by which NMS are evolving in, as characterised by global and local trends and challenges that relate to the provision of urban mobility services, and opportunities for transformation as enabled by technological advancements. It then discusses the concept of NMS, and the relevant governance aspects based on global experiences and best practices. It then zooms into the dynamics in Asia and presents examples of regulatory responses for highly relevant NMS schemes (ride-hailing and bike sharing). Finally, it provides strategic insights and recommendations for utilising NMS to support sustainable urban transport in Asia. By this, this report aims to shed light on the contributions and the challenges that NMS bring for sustainable urban transport and cities.

Ten Key Principles to Make NMS Work

NMS remain a relatively new phenomenon. Many NMS started off operating outside a regulatory framework, either by choice, or through their innovative nature, then having positive and negative effects, before being reigned in. Many positive impacts of NMS are possible, including first and last-mile mobility complementing public transport, and making the multi-modal system more convenient. In parts of Asia that are deprived of high-quality, formal public transport, NMS have had significant impacts by providing safe and reliable transport for the first time. However, NMS schemes may also come with negative multi-dimensional (economic, social, environmental) impacts, as presented in detail in case studies in this document.

The NMS market and industry are highly dynamic in terms of both speed and scale, and the development of business models, service bundling, infrastructure, and new vehicle types as well as the integration of the transport, energy and information sectors is on-going. The analysis of NMS market dynamics and regulatory responses in this report results in 10 key principles for NMS governance which may maximise the benefits of NMS, while avoiding negative impacts:

1. **Legalise NMS through regulations**, i.e. issuing licences based on specific conditions rather than simply banning them;
2. **Use regulation to guide the sustainable development of NMS** to serve the social good and to avoid primarily investment-led implementation;
3. **Use regulation to ensure proper conditions of workers** in the NMS industry;
4. **Tailor regulations to the specific needs and conditions** at the local level, following national guidelines and development principles;
5. **Local regulations should focus on NMS levels** (except for licensing), and be technology and provider neutral;

6. **Ensure that NMS are integrated into the overall mobility system** by promoting Mobility-as-a-Service (MaaS) and complement the existing and future public transport system;
7. **Use and promote the principle of mobility data as a public good**, as data sharing between the public and the private sector in the context of transport will lead to an added value of these data sets;
8. **Use some elements of data-led regulation**, i.e. defining criteria and corresponding evaluation framework can provide sufficient flexibility to the NMS;
9. **Adapting governance structures, and upgrade capacities** are key considerations for authorities;
10. **Further targeted multi-stakeholder research and cooperation** both internationally and between the public and the private sector is key to sustainability.

1 Background

1.1 Global Developmental Challenges

The COVID-19 pandemic acts as a stark reminder of the Earth's and humanity's fragility. At the same time, it shows remarkable resilience in the face of disaster and a real determination to use this crisis to "build back better" for a "global reset" and towards a "green recovery" (UNEP, n.d.; WEF, n.d.; EC, 2020). But recent years have also shown a move in public perception from a need for environmental protection to urgent and decisive action being necessary to prevent a catastrophic decline, as urged by large youth movements (UNDESA, 2019).

Sustainable Development Goals

Mainstreaming of the environmental policy discourse on a multilateral level, prompted by the earlier emergence of related civil society movements, can be traced back to the United Nations Conference on the Human Environment in Stockholm, Sweden in 1972 (UN, 1972). Developments accelerated in the late 1980s, with the publication of the Brundtland Report (Our Common Future) in 1987, and the conduct of the UN Rio Earth Summit in the year 1992 (World Commission on Environment and Development, 1987; UNDESA, 1992; UNFCCC, n.d.).

And in this context, Our Common Future also offered the first universally accepted definition of sustainability as "...development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

These initiatives were followed by the UN Millennium Development Goals and subsequently, the Sustainable Development Goals (SDGs) as Illustrated in Fig. 1, which show interlinked global ambitions that represent a blueprint for achieving a sustainable future for all (UN, n.d.-a; UNDESA, n.d.).

Fig. 1: Overview of the UN Sustainable Development Goals (SDGs)

Mobility has been recognized as a key element that interlinks with many of the SDGs. The World Bank emphasizes the necessity for providing a critical enabling environment to support economic and social development to reach the SDGs, a critical component being sustainable mobility (Mohiedin & Vandycke, 2017).

"SDGs embody notions of universal access, road safety, energy efficiency, and deaths from air pollution. And from there, it is possible to define a vision for sustainable mobility, around 4 global goals, i.e.: (1) equitable access; (2) security and safety; (3) efficiency; and (4) pollution and climate-responsiveness".

Targets that directly relate to mobility have been adopted under the SDGs reflect the recognition of the critical importance of mobility towards achieving sustainable development (UN Habitat et al., 2015). Moreover, the SDGs also recognise the cross-cutting influence of transportation in achieving the other sustainable development goals as seen in the targets that can be deemed as indirectly related to transportation. These direct and indirect targets are shown in the table below (UN-Habitat et al., 2015).

Direct Transport Targets of the SDGs	
3. Ensure healthy lives and promote well-being for all at all ages (Road Safety)	3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents.
3.6 By 2020, halve the number of global deaths and injuries from road traffic accidents	7.3 By 2030, double the global rate of improvement in energy efficiency.
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation (Sustainable infrastructure)	9.1 Develop quality, reliable, sustainable, and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
11. Make cities and human settlements inclusive, safe, resilient, and sustainable (Sustainable (urban) transport for all)	12.c Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities.
Indirect Transport Target of the SDGs	
2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture (Agricultural productivity)	2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists, and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.
3. Ensure healthy lives and promote well-being for all at all ages (Air pollution)	3.9 By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination.
6. Ensure availability and sustainable management of water and sanitation for all (Access to safe drinking water)	6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all.

11. Make cities and human settlements inclusive, safe, resilient, and sustainable (Sustainable cities)	11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.
12. Ensure sustainable consumption and production patterns (Food loss and waste)	12.3 By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.
13. Take urgent action to combat climate change and its impacts	13.1 Strengthen resilience and adaptive capacity to climate-Analysis of the transport relevance of each of the 17 SDGs (Climate Change Adaptation & Mitigation) related hazards and natural disasters in all countries 13.2 integrate climate change measures into national policies, strategies, and planning.

Table 1. Transport-Relevant Targets of the SDGs
Source: UN-Habitat et al., (2015)

Global Climate Change

Another relevant global challenge in relation to NMS is climate change. The ratification of the UN Kyoto Protocol in 1992 set forth collective action towards combating climate change. In 2015, the 21st UNFCCC Conference of the Parties' (COP) landmark Paris Agreement introduced Nationally Determined Contributions (NDCs), testifying the translation of ambition into action (UNFCCC, 2015; UNFCCC, n.d.; NDC Partnership, n.d.). These agendas then culminated in the 2019 UN Climate Action Summit which reinforced the global understanding that keeping global temperature increase to 1.5℃ above pre-industrial levels is the appropriate global target, and thus highlights the urgent need to enhance short and mid-term mitigation actions across the globe (UN, n.d.-b; Rosane, 2019).

Mobility is key in the context of environmental protection and climate action - with around one fifth of carbon emissions globally being related to the movement of people and goods – and thus, innovation concepts that provide opportunities for systemic shifts towards more sustainable pathways are much needed. The International Energy Agency (IEA) estimates that road transport CO_2 emissions account for 74% of the total global transport CO_2 emissions. Relevant CO_2 statistics are presented in the image below (Slocat, 2018). Urban transport currently accounts for 40% of global CO_2 emissions and contributes up to 70% of air pollutants (WBCSD, n.d.), such as particulate matter, carbon monoxide, hydrocarbons, sulphur oxides, and secondary pollutants such as ground level ozone and nitrous oxide which has a Global Warming Potential 265–298 times that of CO_2 for a 100-year timescale (USEPA, 2020).

The IEA also estimates that 38% of the global road transport CO_2 is generated by countries in Asia (IEA, 2019). Fig. 3 shows the average annual growth rates of CO_2 emissions from transport globally (Slocat, 2018).

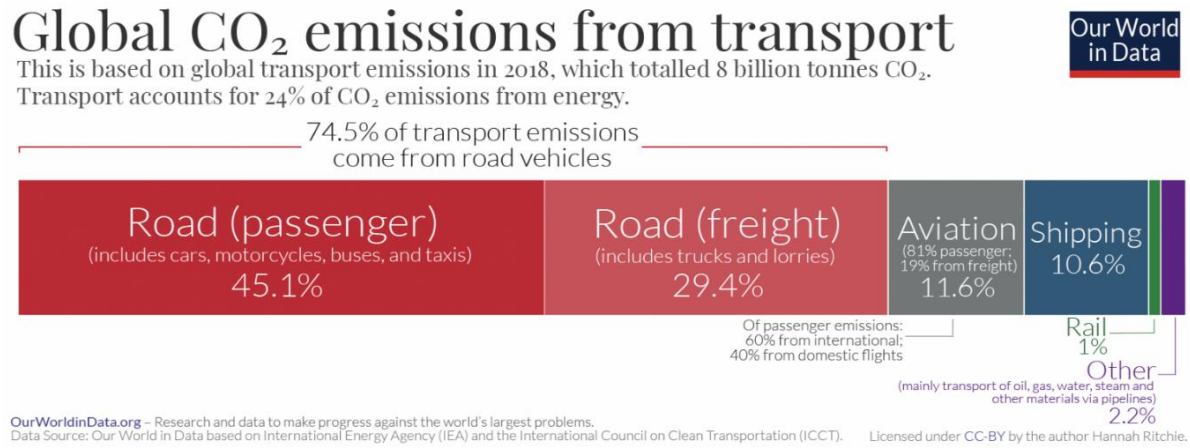


Fig. 2: Global transport-related carbon emission by mode
Source: Slocat (2018)

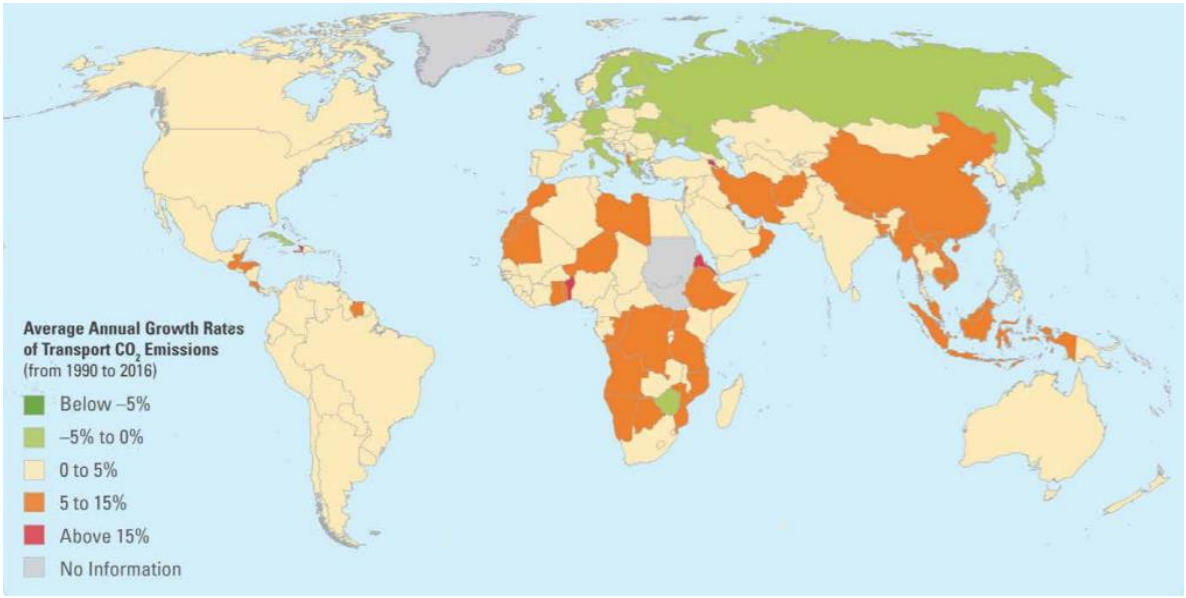


Fig. 3: Global transport-related carbon emission by country
Source: SLOCAT (2018)

1.2 Urban Mobility Challenges

Urban mobility, while contributing global environmental pressures, and developmental challenges, is an essential cornerstone of our urban systems, and the functioning of societies. Unprecedented trends in major drivers of urban mobility are now being observed globally, as well as in the Asian region.

Urbanisation

Urbanisation, i.e. the migration of rural populations to new or expanding urban areas for the prospect of jobs and a better life is another global mega-trend, happening at varying speeds and timescales in most parts of the world. According to the United Nations Department of Economic and Social Affairs (UN DESA) in their 2018 Revision of World Urbanization Prospects (UNDESA, 2018):

- Global urban population grew rapidly from 751 million in 1950 to 4.2 billion in 2018;
- A share of 55% of the world's population now lives in urban areas;

- This share is expected to increase even further to 68% by 2050; -
- Which could add another 2.5 billion people to urban areas by 2050.

According to a report by The Organisation for Economic Cooperation and Development (OECD), cities are not only home to around half of the global population, but also act as major centres of economic activity and innovation. The report, however, points to unequal outcomes, and differences in quality of life across and within cities. Furthermore, it sheds light on the impact of cities on sustainability (OECD, 2020). A point further developed by the United Nations Human Settlements Programme (UN Habitat) in The New Urban Agenda adopted in 2016 at Habitat III in Quito, Ecuador (UN Habitat, 2016):

> *"If well-planned and well-managed, urbanization can be a powerful tool for sustainable development for both developing and developed countries".*

Lage-scale urbanisation is in particular ongoing in emerging and developing countries in Africa and Asia. Seven out of ten of the world's most populous mega-cities are in Asia, with two each in Japan, China, India, and one in Bangladesh as seen in Fig. 4. In the last 20 years China's urban population alone grew by about 390 million people. It is expected that in the next 5 years (14th Five-Year Plan period 2021-2025), the urban population will grow by about 69 million people reaching a degree of urbanisation of 65 percent. By then, a total of about 916 million people will live in cities and about 493 million people will live in rural areas (in comparison, the United States and European Union have a combined population of about 841 million people).

This growth of urban population, in particular in the Asian mega-cities, comes along with significant environmental pressure, and complex challenges in relation to the provision of basic services, such as transport.

Economic Growth

Aside from exhibiting continued increase in urbanisation levels, the Asian region has also consistently been demonstrating strong economic growth (see Fig. 5). These major socio-economic trends have been deemed as key drivers of growth in transport demand.

Motorization

Such socio-economic trends, if situated within mobility systems that are not able to provide adequate, reliable, safe, and cost competitive public transportation services, can lead towards accelerated motorisation. As seen in Fig. 6, the overall growth in motorisation in the Asian countries is seen to outpace the trends in other world regions (ICCT, 2017).

1	Tokyo	37,435,191		Asia
2	Delhi	29,399,141		Asia
3	Shanghai	26,317,104		Asia
4	Sao Paulo	21,846,507		LAC
5	Mexico City	21,671,908		LAC
6	Cairo	20,484,965		MENA
7	Dhaka	20,283,552		Asia
8	Mumbai	20,185,064		Asia
9	Beijing	20,035,455		Asia
10	Osaka	19,222,665		Asia

Fig. 4: Overview of the world's most populous cities by country and region
Source: Wikipedia (2021)

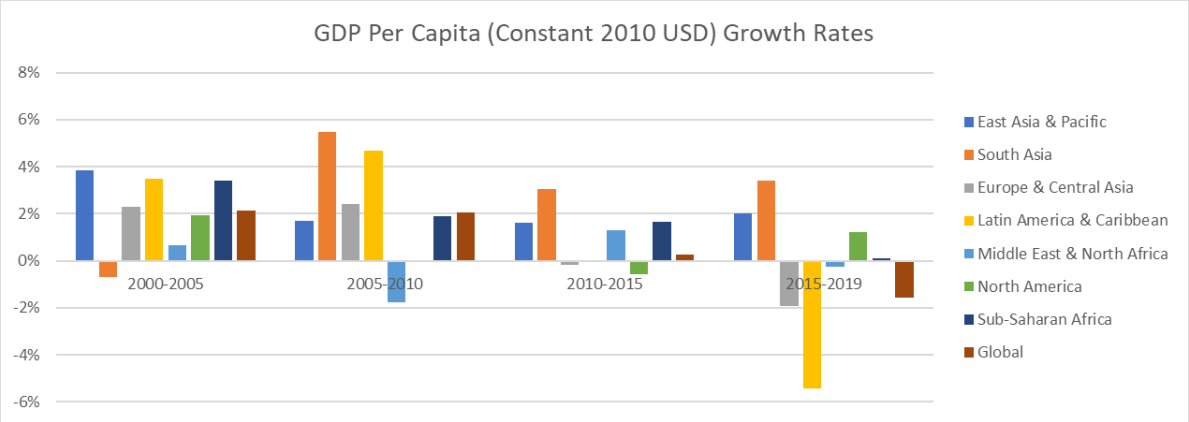


Fig. 5: GDP per capita growth rates by region
Source: World Bank (2021)

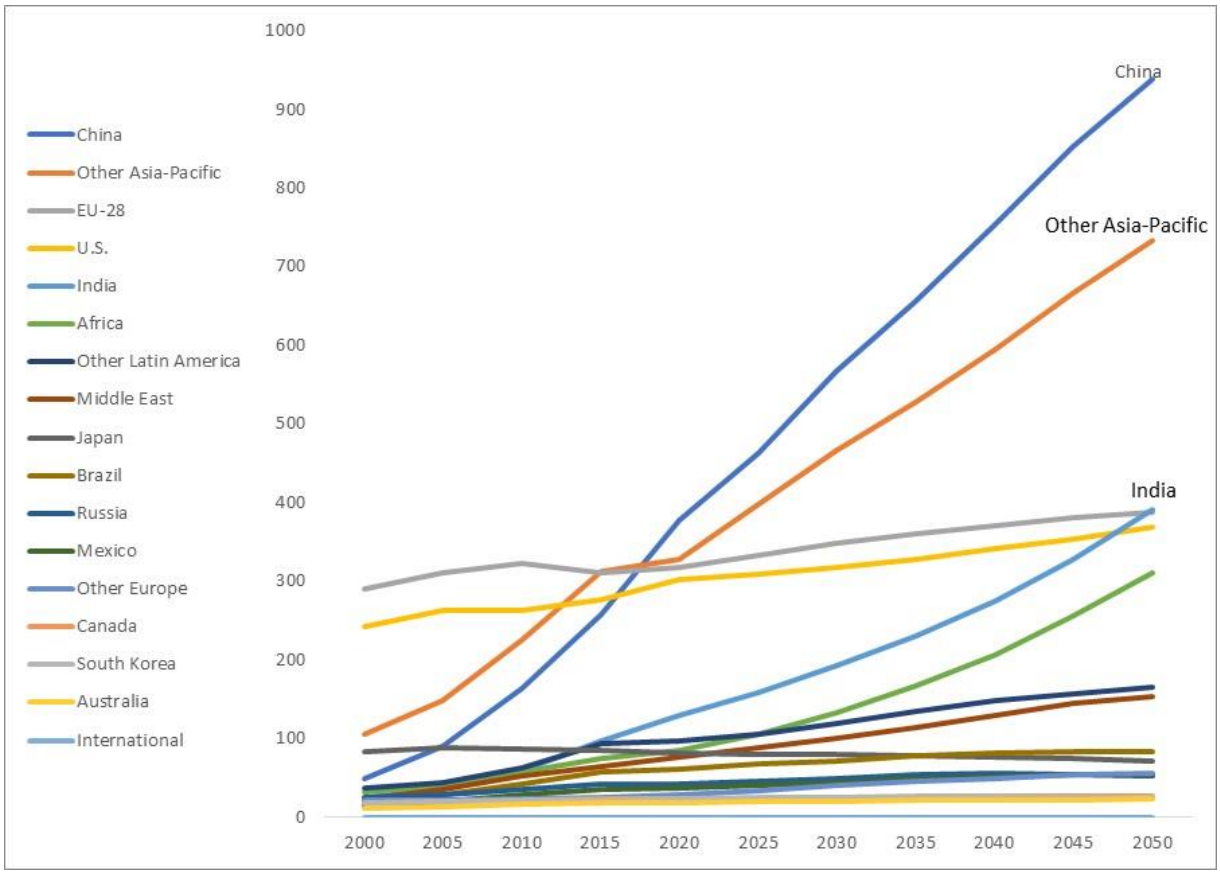


Fig. 6: Motorized Vehicles per 1,000 people
Source: ICCT (2017)
Note: Inclusive of Light duty vehicles; Buses (buses, minibuses); 2 and 3 wheelers; Light commercial trucks; Medium and heavy freight trucks.

Traditionally, sustainable mobility, as part of wider sustainable development, has aimed at reducing the environmental footprint of mobility. The World Bank (Lazer et al., 2020) considers sustainable mobility models economically viable, beyond addressing the imminent environmental challenges. They list:

- Low-carbon passenger transport;
- More efficient and electric vehicle fleet;
- Modal-shift to mass public transport;
- Reduce motorised travel demand.

Strategic and comprehensive decisions for integrated land use, urban development and transport planning are important for provisioning adequate services to the population. They also mitigate negative impacts of transport by avoiding motorised vehicle travel and shifting towards environmentally friendly and efficient modes (e.g. public transport). Thus, they improve the overall performance of the system. In emerging and developing countries the impact of these decisions often proliferates due to their limited resources and capacities, coupled with rapid growth trends and existing multi-dimensional, and multi-scalar pressures (UITP, 2020). Technological advancements are likely to contribute significantly towards potentially cost-effective solutions enabling sustainability in the mobility sector, with NMS potentially being a key tool in the sustainable mobility toolbox.

1.3 Digitalisation and the Impacts of Technology

The advancement of technology is providing opportunities towards enabling innovative solutions that can help address immediate and local urban mobility challenges, as well as contribute towards the attainment of wider, longer-term sustainability goals – as in the case of new mobility services (NMS), The key technologies enabling NMS can be categorized as those that are currently driving the fourth stage of industrial revolution, as described founder of the World Economic Forum, Klaus Schwab.

1st Industrial Revolution	2nd Industrial Revolution	3rd Industrial Revolution	4th Industrial Revolution
			
Mechanisation	**Connectivity**	**Digitalisation**	**Automation**
Transition from manual production to factories, using steam power and water power	Extensive railroad and telegraph networks for transfer of people, information, and electricity	Development of super-computers and the main-streaming of personal computers	Use of advanced digital technology, sensors, Internet of Things (IoT), big data, robotics, Artificial Intelligence (AI)

Fig. 7: Overview of the phases of the four industrial revolutions
Source: Schwab (2016)

In the case of the Asian region, there is potential for the wide diffusion of NMS as the region is exhibiting strong demand-side trends in terms of digitalisation, as well as in the utilisation of the internet. Based on data from the International Telecommunications Union, for example, the share of people using the internet in developing countries in East Asia and Pacific have already surpassed global rates around 2012 (ITU, 2021). Countries in South Asia, while still have significantly lower percentage shares of population that use the internet, are catching up as well. Such trends point towards the potential of NMS in the region.

The digitalisation of commerce is also playing a key role in transforming how goods are accessed and moved. The number of digital buyers globally is expected to double in 2021 as compared to 2014 figures (2.14 billion from 1.32 billion, respectively) (eMarketer, 2017). Emerging economies, including those in Asia, are exhibiting strong trends in e-commerce growth, and are projected to maintain such trends in the near future (Statista, 2020). The results of a global survey indicate how strong online e-commerce is in Asian countries as shown in Fig. 9 (Kemp, 2021). The growth in goods demand is now manifested through the wide emergence of platform-based delivery schemes that are more directed, and more responsive to the needs of the consumers, and provide bundled services.

Moreover, Asian countries are at the global forefront driving technology research and development - including in the field of innovative transport solutions, e.g. the concept of free-floating (rather than docked) bike sharing (transition-china.org/mobility, n.d.).

Considering the global developments, urban mobility challenges in the region, and opportunities arising from technological advancements, exploring the potential of NMS to be key tools towards sustainable mobility transformation is worthwhile. These tools can help in addressing some of the main mobility-related issues in cities including road safety, enabling a modal shift away from motorisation and privately owned cars to greener transport modes, and contributing to decarbonisation of the whole transport system and helping to reach the SDGs and country NDCs through innovation - in Asia.

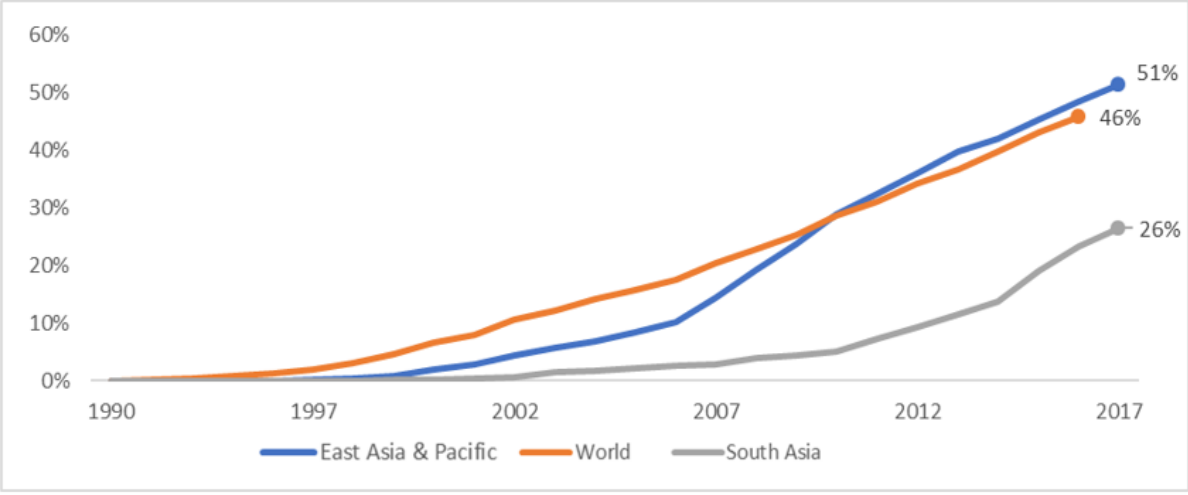


Fig. 8: Percentage of people that utilise the internet (excluding high-income countries)
Source: ITU (2021)

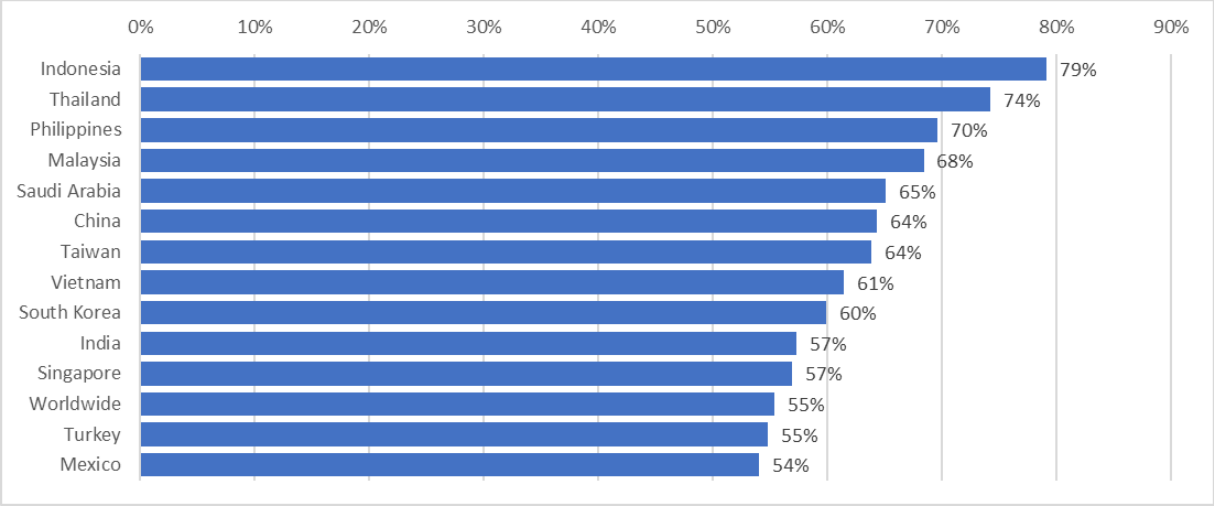


Fig. 9. Share of online population who bought online via mobile device (in the past month as of 3rd Q of 2020)
Source: Kemp (2021)

2 Introduction to New Mobility Services

2.1 Defining NMS

What are NMS? They can be described as novel mobility services that are enabled by disruptive technology [1] and innovative business models that facilitate effective sharing of mobility resources. This description encompasses mode-specific sharing services (e.g. ride hailing, bike sharing), as well as multimodal service models (TNE, 2018).

NMS can potentially alleviate the need for individual (vehicle) ownership through the provision of a variety of mobility choices, tailored to the needs of multiple users, or an entire (urban) community (Storme et al., 2021). NMS may deliver the same level or better mobility services which are more diverse and flexible and potentially costs competitive (Salon et al., 1999 as quoted in Palm et al., 2020; Shaheen and Cohen, 2018). NMS distinct themselves from previous mobility options due to their potential to replace the monoculture of private vehicle ownership with a polyculture of alternatives through the use of technology to enable effective sharing:

Smartphone uptake	Mobile internet access	Big data and data analytics	Booking apps	Mobile (online) payment
				
Portable platform for internet access and use of apps	Allows continuous communication between users and operators	Allows a real-time matching of supply and demand	User interface to request any type of transport service	Necessary back-office solution for service payment; NMS allows for integrated payments

Fig. 10: Overview of fourth industrial revolution enabling technologies for NMS

A generic description of how might NMS work is shown in Fig. 11 below.

Potential NMS Elements: Quick Example

> A booking made by a user through an **app-based access to a digital platform**
> An **innovative concept** which is **data-enabled** and has a **sharing element**

either for

> **Shared temporary access** to a vehicle as driver (car, scooter, bicycle, kick-scooter) or;
> **Matching driver + vehicle** (e.g. van, taxi, private car, tuk-tuk, motorbike) and passenger or;
> Shared-rides as passenger on **dynamic on-demand routes** (bus, taxi, van).

Fig. 11: An example of how NMS work

[1] A specific technology that can fundamentally change not only established technologies but also the rules and business models of a given market, and often business and society overall (Oxford University Press, n.d).

Given the centrality of "sharing" within NMS, it is useful to provide examples of services that facilitate the sharing of mobility resources:

- Shared **ownership** of vehicles (cars in traditional car-clubs)[2]
- **Access** to a shared fleet of various types of vehicles (e.g. car, scooter, bicycle, kick-scooter)
- Sharing of **underutilised asset** (car) and of **labour** (driver)
- Sharing **rides**, space inside vehicle (e.g. bus, van, taxi).

The main categories of common business models being employed within NMS schemes are depicted in Fig. 12 below.

"X-pooling"		**"X-hailing"**		**"X-sharing"**	
Bus-pooling	Vanpooling	Ride-hailing/ Ride-sourcing	e-hailing	Sharing of vehicles	Ride sharing
		  		   	 
On-demand operation of bus-like services but using dynamic routing in buses or vans owned by the platform with sharing of the space inside the vehicle by passengers.		On-demand operation of taxi-like personal transport directly from origin to destination. The service comes with a driver, either through privately-owned vehicles that connect to the platform (ride-hailing/ride-sourcing), or through official taxi services that are enabled by digital platforms (e-hailing).		Shared access to vehicles which can either be owned by the platform, or by individual owners that share such assets. In addition, "rides" can also be shared, wherein vehicle trips (activity-based) which would have happened anyway (i.e. from A to B) are shared with other users (thus making use of latent vehicle capacity).	

Fig. 12: Translating NMS into actual systems

[2] Outside the scope of this report.

Box 1. Shared Mobility

Exploring existing definitions of highly relevant shared mobility concepts is important within the context of understanding NMS schemes. For example, those definitions that have been shared by the Society of Automotive Engineers (SAE International) Shared and Digital Mobility Committee produced a "White Paper on Standardising Shared Mobility Terms and Definitions and the SAE Recommended Practice J3163™ - Taxonomy and Definitions for Terms Related to Shared Mobility and Enabling Technologies" as found below (SAE International, 2018a; SAE International, 2018b).

Bike sharing provides users with on-demand access to bicycles at a variety of pick-up and drop-off locations for one-way (point-to-point) or roundtrip travel. Bike sharing fleets are commonly deployed in a network within a metropolitan region, city, neighbourhood, employment centre, and/or university campus.

Car sharing offers members access to vehicles by joining an organization that provides and maintains a fleet of cars and/or light trucks. These vehicles may be located within neighbourhoods, public transit stations, employment centres, universities, etc. The carsharing organization typically provides insurance, gasoline, parking, and maintenance. Members who join a carsharing organization typically pay a fee each time they use a vehicle.

Micro transit is a privately or publicly operated, technology-enabled transit service that typically uses multi-passenger/pooled shuttles or vans to provide on-demand or fixed-schedule services with either dynamic or fixed routing.

Ride sharing (also known as carpooling and vanpooling) is defined as the formal or informal sharing of rides between drivers and passengers with similar origin-destination pairings. Ridesharing includes vanpooling, which consists of 7 to 15 passengers who share the cost of a van and operating expenses and may share driving responsibility.

Ride sourcing services are prearranged and on-demand transportation services for compensation in which drivers and passengers connect via digital applications. Digital applications are typically used for booking, electronic payment, and ratings.

Scooter sharing allows individuals access to scooters by joining an organization that maintains a fleet of scooters at various locations. Scooter sharing models can include a variety of motorized and non-motorized scooter types. The scooter service provider typically provides gasoline or charge (in the case of motorized scooters), maintenance, and may include parking as part of the service. Users typically pay a fee each time they use a scooter. Trips can be roundtrip or one way.

Fig. 13: Definition of shared mobility by SAE International

In the more recent past, the concept of NMS has also been reflected in the urban freight sector (see box 2). E-commerce has essentially brought forth business models that have stepped out of the traditional business-to-business (B2B) format. Online platforms have essentially solidified the importance of direct provision of products and services directly by businesses (particularly small and medium enterprises) to consumers (B2C), and vice versa (C2B). Moreover, consumer to consumer (C2C) trading has grown through the aid of digital technologies.

Due to the enhanced connectivity of entities due to e-commerce, access to a wider range of goods and services is being achieved, and transactions are being facilitated faster. Together with such, a general push towards the delivery of goods to end consumers (e.g. as opposed to intermediate nodes such as stores) is now being observed globally and is leading towards the increased complexity of urban goods distribution.

Box 2. Examples of NMS schemes in urban freight

Crowd shipping is an innovative delivery model that aims at maximizing unexploited transport capacity through the provision of shared mobility services by the public. It is also referred to as crowdsourced delivery. It can potentially lead to more efficient deliveries by maximizing trips which would have happened anyway, its ability to reduce congestion and pollution is questioned as it relies on dedicated trips performed using private motorized vehicles (Paoheimo et al., 2016). Crowd shipping schemes have been operating in many Asian countries (e.g. PiggyBee in India; Renren Kuaidi in China; Bistip in Indonesia; Jojo Delivery in the Philippines; Wilivery in Vietnam).

Digital freight platforms/online freight exchanges are digital platforms that allow shippers to request and book transport services. These requests are assigned to service providers within the network. These are mechanisms that are used for matching the demand and supply for freight transportation services and can turn "dead mileage" (e.g. by maximizing the fill rate of vehicles which would have travelled anyway) into revenue-generating ones and can contribute towards making the road freight sector more efficient by reducing empty vehicle-kilometres and reducing fuel wastage. These systems would also ideally reduce transaction times, and thus costs, in making transportation-related transactions. Online freight exchanges examples are: (freightbazaar in India; Hongkong freight exchange; Philippine Cargo Exchange; Transport4U in Malaysia).

Shared passenger-cargo systems can optimize the use of public passenger transport modes by utilizing their spare capacities for transporting goods/ materials, and thus utilizing these as joint resources for passengers and goods (Masson et al, 2015). Shared passenger-cargo systems are normal practice in many Asian countries, as even "passenger" vehicles (including public buses, microbuses, three-wheelers) are used for transporting goods.

Shared delivery schemes enable entities to share transportation resources and bundle deliveries in order to increase efficiency. By pooling delivery runs, they reduce empty runs and thus reduce cost and externalities. This can be achieved through better coordination between these entities which can also be facilitated through digital means.

Shared cargo bike is an interesting concept that is gaining traction, particularly in Europe (Germany, Hungary, Austria) such as the "commons cargo bikes" initiative. This system features cargo bikes which are free of charge, shared, easily accessible cargo bikes. This concept started out in Cologne, Germany, where in 2013, free cargo bikes were made available for 3 days (Cyclelogistics, n.d.).

Courier network services utilises online applications and platforms to facilitate the delivery of goods and are setup to facilitate the entry of dedicated for-hire delivery contractors to provide specific services for monetary compensation (Shaheen et al, 2015). Courier network services have also proliferated and have primarily been fuelled the boom in e-commerce industry, and the accompanying demand for express delivery services (e.g. Didi Delivery, GrabExpress, Ninja van, Ubereats, Foodpanda, Meituan Dianping 3690.HK, ele.me). Courier network services act quite similarly as the hailing services for passenger transport and are facilitated by specific entities that enable the participation (e.g. of individuals) as transport carriers.

2.2 Evolution of NMS: History and Horizon

Analogue Phase

The emergence of the ideas of shared mobility can be traced back to as early as a few years after the second World War, with the concept of "car clubs" or "car sharing" (Shaheen et al., 1998). These concepts differ from today's car sharing approaches, where sharing refers to a shared access rather than shared ownership of vehicles (Shaheen et al., 1999). Car-clubs were community-based systems, where underutilisation and parking needs of private cars were addressed through e.g. access to a jointly owned fleet of vehicles in a residential area (Rain Books, 1998). The concept eventually evolved from having a focus on shared vehicle ownership to access to shared fleets (Arthur D Little Future Lab, 2014).

During this "analogue" phase (before broadly available mobile internet and apps), docked bike sharing, schemes also appeared. The concept of bike sharing was

introduced in 1965 in Amsterdam by a group called "*Provo*" which provided fifty "white bikes" as a statement against the use of automobiles. Anyone who wanted to use the bikes had free access to the bikes. The "second-generation" bike sharing schemes featured heavy-duty bikes equipped with non-standard components, and distinguishable designs to mitigate theft (Midgely, 2011). These would be the forefathers of more advanced (including free-floating) bike sharing systems that would appear later.

Digitalisation Phase

The emergence and mass uptake of smartphones, and enabling technologies, mobile internet and payment and the development of innovative business models and the platform economy brought forth a digital era that set the stage for NMS. New companies enthusiastically championed new mobility options in different geographic markets.

Whilst ride-hailing can be traced back to much earlier times, it started in earnest in modern times with Uber. But very quickly both similar as well differing related business models and companies emerged globally and in specific geographic markets, most notably: Uber, Lyft, Didi Chuxing, Careem, Freenow, among others.

In the case of shared bikes, the third-generation bike sharing schemes featured smartcard technology that enabled user identification (e.g. Vélib system in Paris). These also feature stations with docks that featured user interfaces, and tracking technologies installed into the bikes that enabled location identification, and activity monitoring (Shaheen et al., 2010, Matrai & Toh, 2016). As primarily dock-enabled systems, these third-generation schemes face drawbacks brought about by the need to physically return the bikes into the docks, particularly bike redistribution. Fourth generation bike sharing schemes are characterised by more sophisticated bikes that feature technologies that enable the process of locating, accessing, securing the bikes under a dockless system (Shaheen & Guzman, 2011). The integration of mobile apps into the system also enables the provision of real-time information, and better integration with public transport systems and can eliminate the need for the physical docks.

In addition to the emergence and mass uptake of enabling technologies, another key component for the growth of this market is the influx of funding and rapidly increasing financial interest of venture capital firms (Frazer, 2019). However, the success of NMS would never have been possible without the development of innovative business models and companies enthusiastically (maybe at times also aggressively and disruptively) championing these new and exciting transport options. It then appears that the exponential growth of such NMS can be seen as a function of different factors:

$$Eq.1. \quad Exponential\ Growth\ of\ NMS = mass\ market\ uptake\ of\ enabling\ technologies + seemingly\ limitless\ venture\ capitalist\ funding + innovative\ business\ models + visionary\ leadership$$

The NMS revolution is influenced and accelerated by the evolution and uptake of technology and new business models as illustrated by Fig. 14 below (beesmart.city, n.d.).

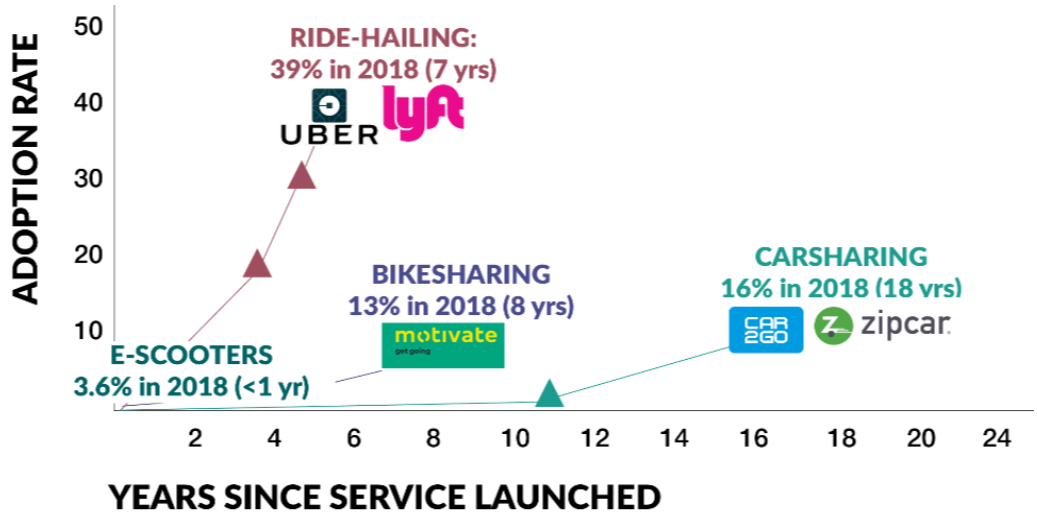


Fig. 14: Adoption rates vs. years since service launched for various NMS
Source: beesmart.city (n.d.)

What is on the Horizon for NMS?

After having discussed the current state-of-play of the global mobility revolution and the uptake of NMS, this section looks briefly at emergent and future trends.

Starting off with vehicle automation, mainly in the context of ride-hailing, this technology is currently undergoing testing, [3] with the hope of reduced operational costs and better road safety performance by removing human-related risks (Lazarus et al., 2017). Ultimately, automation will further decrease the human element in the sharing economy, as fleets will be owned by platforms and operation without the current approach of so-called "driver-partners", which allows for a flexible income source (Hawkins, 2019). Automation has been permeating into specific transport sub-systems (e.g. in port operations) and is also now being tested in controlled, as well as real-life contexts all over the globe (e.g. automated vehicles sandbox in Singapore). The move towards automation will bring significant changes, not only in terms of how goods and people are moved, but also in terms of the overall transport systems considering governance, management, operations, to name a few pillars.

Another concept in the transport sector, in addition to vehicle automation, is Mobility-as-a-Service (MaaS). Whilst varying definitions exist, it generally involves an app-based central information, booking, payment, and ticketing system for all transport options in a city (MaaS Alliance, n.d.). With the additional option of mobile phone style bundle contracts, which give access to "free" miles per mode, based on a monthly subscription (Neckermann Strategic Advisors, n.d.). Fig. 15 shows an overview of MaaS functionalities (Future Mobility Finland, n.d.).

In general, a further integration of NMS with other sectors (e.g. information, energy), services, platforms and business models can be expected.

[3] See getcruise.com; waymo.com.

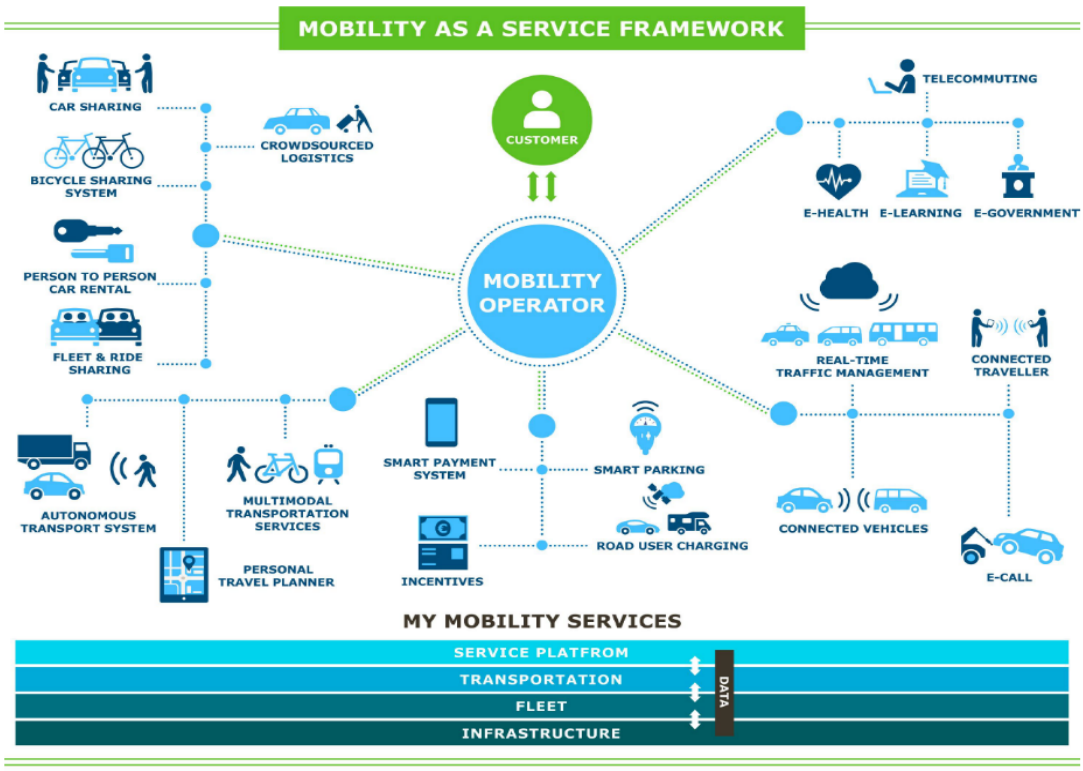


Fig. 15: General overview of the Mobility-as-a-Service (MaaS) concept
Source: Future Mobility Finland (n.d.)

2.3 Governance of NMS

Potential Impacts of NMS

As NMS can potentially bring forth transformation in a disruptive manner, potential wider impacts of the direct changes brought about by NMS need to be taken into consideration. As with any technological advancements, NMS may lead towards direct and systemic benefits, technologies – and the accompanying transition processes – can also result in challenges. The 2020-United Nations General Assembly (UNGA) suggests that rapid technological change may benefit development but could also endanger other virtues (UN, 2020).

"The spread of ICT & global interconnectedness has great potential to accelerate human progress... However, there are also unintended negative consequences [incl.] labour displacement, concerns about privacy & respect for human rights".

Situating emergent technologies within a socio-technical system that considers a holistic view in terms of the potential impacts (positive and negative) is key towards the appropriate assessment of, and optimal integration of such technologies.

The actual impacts of specific NMS applications would depend on a variety of factors such as the type of NMS being applied, the nature of the base scenario where the NMS is applied to, the level of uptake that will be realised, among others.

Economic	
Economic costs of transportation externalities	NMS can potentially reduce the economic costs of externalities as overall vehicle trips (e.g. health, safety, environmental costs) are reduced, or if substantial shifts towards public transport are realised (e.g. through better first and last-mile connectivity; integrated services). Streeting and Brown (2019), for example, estimates that lower vehicle accidents due to NMS can lead towards improving overall economic performance.
Costs of asset acquisition (e.g. vehicles)	The concept of sharing can, on the one hand, potentially lead towards enabling accelerated transformation of fleets towards becoming more environmentally sustainable. For example, the acquisition premiums for e-vehicles can be spread out to more agents if the buyer of the e-vehicle enrols it into a shared programme which enables revenue generation. On the other hand, NMS schemes, for the same reason, may potentially induce vehicle purchase. In the case of the Philippines, for example, there seems to be evidence that ride-hailing schemes may have contributed towards the increased vehicle sales in the country (Lorenciana & Dagooc, 2017).
Costs to users / compensation of workers	Achieving transparency as to how many NMS providers charge their users and compensate the associated workers (e.g. drivers) has proven to be quite a challenge due to the algorithm-based nature of such determination processes. Multiple instances across the globe in the recent past has featured strikes, and lawsuits that relate to these issues. Moreover, as many of the entities related to NMS present themselves as information technology companies rather than transportation companies, the applicability of regulations (e.g. related to transportation pricing, insurance responsibilities, responsibilities towards involved workers, among others) are blurred.
Economic opportunities	The proliferation of NMS can lead towards different industry opportunities (e.g. in related fields such as digital technologies; operations and maintenance; energy). On the one hand, in China, for example, bike sharing programmes have been seen as one of the most attractive investment options since 2016 (Storme et al., 2021). These NMS can also provide more direct labour opportunities, such as gig economies that arise from shared e-scooter sharing systems (e.g. related to redistribution and charging). On the other hand, NMS may potentially lead towards negatively impacting the profitability, and thus leading towards employment risks to those which are involved in the incumbent modes (e.g. taxi), as we had seen in global examples that involved Uber, Lyft, and other such companies. In addition, NMS may potentially open opportunities towards the creation of quasi-monopolies that dominate local urban mobility markets and prices and lead to socio-spatial conflicts and accessibility issues.

Environmental	
Urban environment pressure	NMS can potentially alleviate pressures to the urban environment if these are successful in curbing the need to own private vehicles thereby reducing the needed space for parking. Reduction in private vehicle ownership, coupled with shifts towards public transportation, and the utilisation of cleaner vehicles (if supported by the NMS schemes) can lead towards substantial reductions in urban air pollution as well. On the other hand, there is also evidence that show that some schemes may also have negative impacts towards public transport (and active mobility). Such undesired modal shift away from green and active modes leads to more car trips and total vehicle kilometres driven, in addition ride-hailing cruising for next ride generates even more traffic. Rayle et al. (2016) emphasises that while on-demand services can complement public transport by enabling easier access to public transport stations, these services can also take away trips from public transport, particularly if the transit system is overcrowded.
Utilisation of resources	On a theoretical level, the concept of shared economies would contribute towards the reduction of overall extraction/utilisation of natural resources (i.e. reduced need for ownership of assets). However, there can be significant leakages that work against the realisation of such a benefit in NMS systems, such as in the case of oversupply of bikes for bike sharing systems (Taylor, 2018). It must also be noted that there are ancillary operations and infrastructure that needed to realise such services and should somehow be part of discussions that relate to resource utilisation analyses (and other types of impact analyses as well). While some forms of NMS can potentially alleviate the consumption of valuable spatial resources in urban areas (e.g. reduced vehicle ownership resulting in less parking space requirements, there are also concerns to be considered (e.g. dockless electric bikes, electric scooters needing safe and segregated road and parking infrastructure).
Greenhouse Gas (GHG) intensity of urban transport systems	On the one hand, NMS can contribute towards the avoidance of vehicle trips (as well as vehicle-kilometres), shifting towards more efficient/environmentally friendly ways of travel, and the provision of more environmentally friendly vehicles in urban systems, thereby reducing the overall consumption of fossil energy, and thus reducing the GHG intensity of urban transport. Martin and Shaheen (2011), as well as Clewlow et al. (2016), state that a quarter of vehicle-kilometres that would have occurred through personal driving are avoided through car sharing, and ride sourcing apps. On the other hand, there is also evidence that shows that the reverse might be happening in certain cases. “Dead-heading,” which refers to the portions of the trips where there are no passengers, has been identified as a significant issue for on-demand transport vehicles (Schaller, 2017). Henao (2017) observes that for every hundred passenger-miles performed by on-demand transport vehicles, sixty-nine extra miles were driven due to dead-heading. In the case of shared e-scooters, for example, which ideally would potentially result in lower emissions, particularly if they replace high polluting modes (e.g. private cars), and moreover, if they primarily support the shift towards public transport options. However, these can also result in “motorising” walking and biking trips, and shift trips away from public transport, as shown in a recent survey of users of such shared devices in France (ADEME, 2019).

Social	
Overall quality of service of transportation systems	As many of the NMS schemes can effectively address first and last-mile connectivity, and/or fill in public transportation gaps, these can potentially improve the overall quality of public transportation. However, the specific direction of the impact would depend on a case-to-case basis, depending heavily on the state of the transport systems (particularly the public transport network and services, in the case of passenger transport, for example).
Security, safety and privacy	As NMS schemes are heavily dependent on the use of data (including those of the users), significant concerns regarding data security and privacy may arise. Authorities globally are responding by adopting data standards that allow for the monitoring of activity data (e.g. vehicles and utilisation) but maintaining the anonymity of users. In terms of road safety, NMS can also potentially raise significant concerns, particularly in the case of micro mobility devices (e.g. shared e-kick scooters), as perhaps the current infrastructure configuration, and regulatory regimes may not be suited to accommodate these modes directly. Poor oversight of NMS (e.g. in the case of ride hailing) can also lead to the increased risks due to underqualified drivers and use of unsafe vehicles. In the case of urban freight schemes (e.g. courier network services), barriers towards participation as service providers are seemingly low (e.g. lax requirements in terms of vehicles and drivers), which may prove to be a concern, particularly in the case of road safety. Personal safety concerns are also significant certain NMS such as ride-hailing, as there had been numerous documented cases of abusive behaviour of drivers for shared modes, including even rape and murder. Similarly, the proliferation of small e-mobility devices that are featured in different NMS schemes is also proving to be a concern for many countries, as the adoption of device (as well as components) safety standards may not have caught up yet with the proliferation of such devices on the ground. Moreover, regulations and processes must ensure the maximum safety of users (as well as drivers, and delivery personnel) against abuse and harm by other agents in the system.
Access and equity	On one hand, it can be argued that NMS schemes may result in improving overall accessibility towards transportation services, and ultimately to activities and opportunities by opening a wider range of options for users. On the other hand, as these schemes are primarily dependent on the provision of user interfaces that require digital connectivity, issues of equitable provision of services arises. The increased dependence on such technologies may significantly deprive those who are not able to afford the devices that enable access to the services (i.e. smart phones), or the costs of digital connectivity, or those who are not digitally literate, and thus further increase transport inequity.

Table 2. Potential impacts of NMS

NMS Governance: Best Practices

Having explored the potential impacts of NMS, the section below now provides examples of governance practices relating to NMS from selected countries around the globe.

United States (USA)

- Recognising the need for consistent public and private sector standards and definitions across a suite of shared mobility service models that guide public policy and distinguish between types of services for users;
- Developing metrics, modelling, planning platforms, and methodologies to measure the economic and travel impact of shared mobility such as vehicle kilometres travelled, person miles travelled, commute travel time, etc., such that local, state, and federal public agencies can incorporate it as an integral component of land use and transportation planning;
- Recognising shared mobility as a key component of transportation policy and planning;
- Encouraging further multimodal integration;
- Addressing potential accessibility issues as the systems expand and evolve to be inclusive of all segments of society;
- Understanding insurance issues pertaining to regulation, availability, and affordability across a wide array of existing and emerging shared business and service models;
- Balancing data sharing (open data) and privacy for individual users and companies providing the services (USDOT FHA, 2016).

United Kingdom (UK)

In facilitating innovation in urban mobility for freight, passengers and services, the government's approach will be underpinned as far as possible by the following principles from the UK Department of Transport (UK DOT, 2019):

- New modes of transport and new mobility services must be safe and secure by design;
- The benefits of innovation in mobility must be available to all parts of the UK and all segments of society;
- Walking, cycling and active travel must remain the best options for short urban journeys;
- Mass transit must remain fundamental to an efficient transport system;
- New mobility services must lead the transition to zero emissions.
- Mobility innovation must help to reduce congestion through more efficient use of limited road space, for example, through sharing rides, increasing occupancy, or consolidating freight;
- The marketplace for mobility must be open to stimulate innovation and give the best deal to consumers;
- New mobility services must be designed to operate as part of an integrated transport;
- System combining public, private and multiple modes for transport users;
- Data from new mobility services must be shared where appropriate to improve choice and the operation of the transport system.

Finland

Finland strives to strike a balance in addressing the needs of users, incumbent transport providers (e.g. taxis), as well as NMS such as ridesharing while promoting fairness of competition, and competitiveness of service providers in both the passenger and goods transport sectors (TNE, 2018; futuremobilityfinland, n.d.). Finland issued the Act on Transport Services which essentially brought transport market regulations together towards increasing the freedom of choice in the market (GECKO, 2019; futuremobilityfinland, n.d.):

- Regardless of the mode of transport, mobility service providers need to ensure that essential, up-to-date data on its services is available and accessible through an open interface information system;
- The central element of first stage of implementation is open data. Data should be provided based on the standard, easily editable and computer readable and must include essential information such as routes, stops, timetables, availability, prices, accessibility, and access to the sales interface of the ticket and payment systems;
- The second stage focuses on the provisions on qualifications for transport personnel, as well as provisions on air, maritime, and rail transportation;
- The third stage laid down stipulations on professional qualifications, preparedness, opening up of information (e.g. postal), and provisions related to heavy road transport, as well as rail transport;
- At the regional (European level), the INSPIRE Directive (2007/2/EC) which establishes an infrastructure for spatial information in the European community (including metadata) has also played a key enabler of NMS (GECKO, 2019).

The following chapter will describe and analyse NMS markets development, and state of regulatory responses in Asia, before then developing specific policy recommendations.

3 Case Analyses: NMS in Asia

3.1 Introduction to the Analysis

After having given a general and global overview on NMS implementation, this section zooms in into the specific and more detailed situation in Asia - to start this section with a disclaimer, this study does not attempt to give an all-inclusive summary of all NMS in all of Asia.

Objectives of the Analysis

The objective being to cover some key market dynamics and country and population characteristics, allowing a balanced analysis for selected countries in the region, considering highly relevant NMS types.

Country Selection

This selection of countries (as well as the NMS types) covered in this report is based on a screening process based on literature review, complemented by additional information gathering processes.

Countries which are were deemed to be highly relevant in the wider context of this study, as well as being representative of different socio-economic backgrounds, levels of development, population, size, were selected for the analyses.

The large emerging economies India and China of course need to be included; in addition, Indonesia, Malaysia, Philippines, Thailand, and Vietnam had been included in the initial list to cover other aspects and because various types of NMS are widely implemented (see Fig. 16).

Fig. 16: Overview of countries in Asia selected for the study

NMS Selection

Having selected the countries to include in the analysis of NMS, a next step then is to narrow down the actual types of NMS to consider. Whilst countries were of course selected partly based on the availability of different types of NMS, to enable a comparable analysis of these systems a critical mass across the selected countries is necessary (see Fig. 17 below).

As seen in the illustration above, two specific types of NMS clearly emerge as being implemented the widest and thus being key for this analysis going forward:

1. Ride-hailing (using cars and partly motorbikes);
2. Bike sharing (including the free-floating and partly the docked variants).

For a further comparison, see Fig. 18 below. These systems will be looked at in the following section.

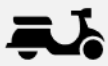
Selected countries in Asia	**Ride-hailing**		**Vehicle-sharing**			**Vanpooling**
	Car	**Tuk-tuk**	**Bike - floating**	**Car**	**Scooter**	
						
	+ (Motor-bike)		**+ (Bike - docked)**			
						
China	X		X	X	X	X
India	X	X	X	X	X	X
Indonesia	X	X	X	X	X	
Malaysia	X		X			
Philippines	X		X			X
Thailand	X	X	X			
Vietnam	X		X			

Fig. 17: Overview of NMS availability in countries in Asia (selection)

	Ride-hailing	Bike sharing
Additional relevance	It was Uber (and soon the many global competitors) and the ride-hailing concept that started the global NMS revolution.	Whilst bike sharing is not a new concept, the e-booking and free-floating concept put Asia on the NMS map (particularly in China).
Benefits	More efficient use of under-utilised assets (private car), flexible on-demand mobility solution, provision of convenient point-to-point transport services in underserved areas, gig-economy opportunities.	Modal shift to a green and healthy mode, solution for first-mile/last-mile dilemma in conventional/legacy public transport.
Visible conflicts		
	Labour market impacts (working conditions, pensions, salaries) & protests (competition with legacy systems and modes) etc.	Oversupply of bikes and abandoned bikes, blocked pavements, lack of integration into existing urban transport systems etc.
Conclusion	Clear need for regulatory oversight to lock in benefits and avoid negative impacts.	

Fig. 18: Comparison of selected issues surrounding ride-hailing and bike sharing

3.2 NMS Market Dynamics in Asia

Ride-hailing

App-based ride-hailing services are pioneers of digitalisation and platform economy trends in urban mobility. While it has provided huge benefits to users by offering more flexible, on-demand convenient and affordable services, it also resulted in significant challenges in regulation and legislation as the transport sector, particularly taxi services, was and still is heavily regulated in many countries and cities.

Ride-hailing services are a disruptive innovations vis-a-vis traditional taxis and concerns over road safety and passenger security remain. But despite the negative effects, ride-hailing can also be deemed as having brought about great benefits for society. Particularly in the case of many Asian cities where sufficient public transport systems are lacking, these systems have brought reliable, safe, and price competitive mobility options to the wider population, i.e. filling important urban mobility gaps across Asia (Leverenz et al., 2019).

The earliest ride-hailing operator in China is Didi Chuxing (formerly Didi Dache). Some of the other notable operators in Asia are Grab (Uber merged its ASEAN operations with Grab in March 2018), Ola, and GoJek. In 2017 alone, Grab had expanded its operations from 34 cities to 168 cities across 8 countries within the ASEAN region, with a valuation of EUR 5 billion at the time of the merger. GoJek has also been expanding its service to Singapore, Philippines, Thailand and Vietnam.

GoJek now operates in 207 cities across four countries in Southeast Asia, 203 of which are in Indonesia. Grab is present in 339 cities across eight countries, and the majority (224) are also in Indonesia. In India, Ola, the home-grown provider, is competing with the global player, Uber. In 2020, the number of users of ride-hailing in India exceeded 200 million. In China, Didi Chuxing dominates the NMS and ride-hailing market and carries out more than 30 million trips per day (Liao, 2019).

Ride-hailing operators initially bypassed the legal requirement for operating taxis in most markets they entered globally as they had established themselves as IT companies - or in US legal terms at one time as Transportation Network Companies (TNC) - rather than traditional transportation companies. This operating mode is the primary reason why it created friction world over and how existing laws became redundant to regulate them. In the case of Uber, for example, it had started its operation in the region without obtaining licenses or cooperation with local authorities. Since then many cities, regions and countries have banned the service, due to various reasons. In 2014, New Delhi temporarily banned Uber operation over a rape case where the Uber driver was charged with a prior sexual assault. Hong Kong police arrested Uber drivers as 'illegal taxi service providers' in 2015. In Bangladesh Uber was launched in November 2016 in the capital Dhaka, but within 36 hours of its launching, Bangladesh Road Transport Authority (BRTA) declared it illegal.

Appropriate regulatory frameworks would be able to guide such services to provide sustainable and flexible mobility solutions and to minimise negative impacts at the same time. In addition, there were many protests organised by taxi drivers and their unions against Uber in many cities worldwide as Uber's services were perceived as a threat to their livelihoods. The demonstrations, often involving taxis physically blocking roads, have forced public authorities to take actions to address the issue. Governments saw the need for regulations rather than simply banning the service, as enforcement was rather difficult and resource-consuming; e.g. in Bangladesh, although the Uber service was announced as illegal, the operation of the service was ongoing illegally until in December 2017 after the BRTA had formulated guidelines for ride-hailing companies. Most of the ride-hailing companies were given operating licenses by February 2018. Many countries in the region have formed similar guidelines or updated their laws related to the taxi service or plan to do so.

As the first ride-hailing service provider in China, Didi Chuxing, started operation in June 2012 before Uber started operations in the Chinese market in 2015. Similar to the situation in many countries, the service was being operated without regulations and had suffered from ban by local authorities and opposition by local taxi drivers in many cities. Shanghai was the first city in China to legalise the service in 2015. Soon after the national regulation was issued in 2016, Uber's unit in China was acquired by Didi Chuxing and all ride-hailing service providers in Chinese markets are Chinese home-grown companies.

India is one of the countries where the app-based ride-hailing service has grown very fast. India-based operator, Ola, has been widely available in India and expanding its business globally. The Indian government has responded to the market uptake by updating its existing laws and by issuing relevant national guidelines for service aggregators. The Indian government also sees the development of ride-hailing services as a part of its national transport strategy and national climate action plan.

Bike Sharing Schemes

With the fast digitalisation of the mobility sector, the decreasing costs of IoT sensors, and ubiquitous wireless internet access, a new type of bike sharing service came to market in 2015. The dockless bike sharing trend in the region was initiated in China where it immediately was embraced as an effective solution to meet the last-mile

demand in many metropolitan areas. It rapidly spread to other Asian countries, including countries where docked bike sharing service was not widely implemented and cycling had a very small share of the transport modes.

Compared to its predecessor - the docked bike sharing scheme – the dockless system on the one hand offers greater flexibility to fill the gaps in urban transport systems. Docked bike sharing services have often been supported by local authorities and planned as an integrated part of the local public transport services, e.g. many cities allow use of public transport monthly subscriptions to access the bike sharing. As mentioned before, in China, the docked services are operated by public transport service providers. On the other hand, while dockless systems can offer much more flexibility in terms of usage, integration can be more daunting due to this feature.

Dockless bike sharing schemes organically grew at a fast speed backed by venture capital. Because of the unique business model, the number of operators and the number of vehicles available in the market have been expanding rapidly in 2016 and 2017. All operators aimed to expand their business to be the leader of the market, thus driving others out of the market. By end of 2017, there were about 80 operators and more than 130 million bikes in the market.

Ibold (n.d.) has considered the development of the dockless bike sharing services in China having three distinct phases:

- Phase 1 (2016-2017): Investment-led growth;
- Phase 2 (2017-2018): Market consolidation;
- Phase 3 (2018 onwards): Cross-industry integration

After the rapid growth in Phase 1, significant oversupply of bikes, far exceeding the demand of the market, has caused problems such as intrusion through parking of dockless bikes, and waste from unwanted bikes. The services have also suffered from vandalism, contributing to the waste. Images showing the huge piles of abandoned and broken bikes in various cities, urged the governments to implement better policy and regulations to guide the development. Municipal and national governments responded to the issues and developed several guidelines, policies, and standards to navigate the development. Therefore, Phase 2 and Phase 3 were not only market-driven but also influenced by the government policies.

While the Chinese market had reached its limit, the big players such as Mobike and Ofo started their international expansions in India and ASEAN countries but also in Europe and Latin America. Singapore-based oBike has seen the ASEAN countries as a key market, competing with the main Chinese players in those countries. There was also a small number of local operators emerging in different countries.

Similar to docked bike sharing service, dockless bike sharing services have very limited success in India and ASEAN countries except in Singapore. Research has shown that in Malaysia, when the first dockless bike sharing service was launched by oBike in Kuala Lumpur, there were about 20,000 users (Pikri, 2017). However, the number of users decreased by 10% every quarter and a survey has shown that they used taxi services including Uber or Grab, to reach their destinations. Ofo launched its operation in Malaysia in 2017 but the operation did last only for a year (Rosnan & Abdullah, 2018). In addition, two bike sharing projects have been launched in Vietnam, at Hanoi University

of Science and Technology funded by Caritas, and in Hoi An City funded by the Transformative Urban Mobility Initiative (TUMI), a partnership implemented by GIZ.

Evolution towards Integration: NMS in Asia

Most, if not all, innovations in NMS have started with a singular idea (such as a business model, service, etc.), but over time many of these operators have expanded, both in their own domain through mergers and acquisitions with competitors, as well as developing way beyond the original service – aiming at establishing comprehensive service eco-systems as part of the wider platform economy. These platforms offer an array of other services, both related to mobility, as well as service beyond the mobility realm – including integration with consumer products purchasing (e.g. integrated discounts), lifestyle services or financial services. The display of visuals for the Gojek platform in Fig. 19 illustrates how such services are evolving (Gojek Tech, n.d.).

Fig. 19: The development of the Gojek logo and conclusions for the platform economy
Source: Gojek Tech (n.d.)

Gojek started with the singular service of ride-hailing with motorbikes, where an app matches bike owner/driver with passengers; the same idea as Uber, just using motorbikes - more prevalent in Indonesia, its original market - rather than cars. But they also eventually morphed into a diversified platform, as is evident when comparing the new with original logo. The original logo brought together the two ingredients of the business model, i.e. the motorbike and the internet, and now features a new icon that stands for the additional services that had been made available through the platform, i.e. vehicle-sharing, food-delivery, payment; this also illustrated well the move beyond transport services.

While such integration can be expected as a natural process, it may pose some concerns for NMS in view of mobility policy objectives. In the case of a large and diverse platform, these services might be offered purely to attract subscribers to the platform and may not directly be driven by aims related to wider goals.

According to their individual needs, customers can already coordinate seamlessly and book different mobility solutions such as car-sharing, ride-hailing-, public transport- or bike sharing options via MaaS platforms such as Moovel, Beeline or Whim App. The trend towards next generation mobility platforms will develop from single-sector MaaS towards inter-sectoral based platforms. In China, mobile internet platforms such as Wechat or Meituan already offer such All-In-One-App solutions (see Fig. 20) and first attempts are being made to link these platforms to carbon trading systems to promote low carbon traveling as done in the case of a MaaS platform in Beijing established in cooperation with the map providers AMAP (Gaode Map) and Baidu Maps.

Customers can access a variety of apps within one platform with only one account and can pay services within the platform via integrated mobile payment systems such as Wechat Pay or Alipay. This includes flight- and train ticket booking, bike- and car-sharing, ride-hailing and other mobility services but also services such as online shopping, food-delivery, hotel booking or public services and a variety of other functions such as communication, data sharing or gaming.

The fact that all these services are accessible with only one user account offers an in-App based tailor-made combination of different service offers and advertisement. Consumer and mobility choices will become more influenced by coupon, bonus or discount-integrated systems and driven by alliances between mobility providers and other service and consumer focused industries. This trend will also have a significant impact on NMS operators and offers a new set of additional revenue streams and the exploitation of new multi-stakeholder profit models.

In particular, location-based services, such as shared-mobility and food delivery services are becoming more integrated with each other and are in the focus of investment battles for the largest customer basis. Ride-hailing or bike sharing as a part of this environment will be affected by newly emerging cross-industry alliances between the mobility sector players with those in other sectors (e.g. energy, e-commerce, retail, tourism and leisure, and even the real estate sectors).

Fig. 20: The Meituan Super App Service "Eco-System" including mobility booking services

3.3 Regulatory responses in Asia

Having looked at the wider development of selected NMS markets in Asia, it is evident that NMS schemes come along with potentials for more diversified and sustainable mobility options, but with both positive and negative implications to wider mobility, as well as socio-technical systems. Regulatory oversight is thus necessary to lock in the benefits, while avoiding any of the negative aspects. The following chapter will look at example regulatory regimes for NMS in Asia.

Ride-hailing

Overview of Regulatory Responses in Asia

The guidelines and laws developed in selected Asian countries in response to the introduction of app-based ride hailing schemes being implemented are addressing the following common general issues:

- **Passenger security and safety**, particularly for women, is a primary concern. Guidelines or laws can require driver background checks, in-vehicle panic buttons, real-time monitoring of driver behaviour, and cooperation with law enforcement, such as providing operation data.
- **Road safety concerns** are mainly due to tiredness of drivers. Guidelines or laws can define working hours and working conditions; e.g. the Indonesian government plans to regulate the minimum rate for ride-hailing services to protect drivers' income to avoid overworking.
- **Basic requirements** relating to the participating contractors, and the vehicles are often imposed. However, there seem to be much more opportunities for encouraging or imposing the use of more environmentally friendly, as well as safer vehicles in such systems.
- As the legal frameworks try to catch up with the emerging technologies, there are still significant opportunities for **improving regulatory mechanisms towards ensuring equity** (e.g. integration with plans, ensuring transparent user costs determination, just compensation to contractors).

Country	Legal framework	Key contents
India	Motor Vehicle Bill 2019 (Amendment)	> To define taxi aggregator as a transport provider; > To authorise each state to licence and regulate services of an aggregator.
	Central Guidelines for Aggregator, (Draft) 2019	> To provide technical requirements to operators to ensure safety and security.
China	National Temporary Management Method for Operation of Internet-booked Taxi Services	> High quality of taxi service is encouraged; > To define minimum requirements for application for licence to operating the service; > To define minimum requirements for eligible driver; > To allow and require cities to develop city-level regulation to monitor and manage such services.
Indonesia	Ministry of Transportation Regulation No. 12/2019 and Ministerial Decree No. 348/2019	> For implementation of specific ride-hailing apps and minimum service standards; > For safety protection for motorcycle users which is used for the benefit of the community.
Malaysia	Land Public Transport Act Amendment (LPTA) 2017	> To define vehicle as a public service vehicle.
	Commercial Vehicle Licensing Board Act Amendment (CVLB) 2017	> To define the procedure of application for the licence of operating e-hailing service; > To define responsibilities of a licence holder.
Philippines	Department of Transportation and Communication (DOTC) Department Order No. 2015-11	> Inclusion of the TNVS (transportation network vehicle service) as a classification of public transport.
	Department of Transportation Department Order No. 2018-013	> Empowers the Land Transport Franchise Regulatory Board to regulate transport network companies and transportation network vehicle services.
	The Land Transportation Franchising and Regulatory Board (LTFRB) Resolution No. 96 (2018)	> To define e-hailing as a type of public transport service and how to apply for licence; minimum 60% of ownership of Philippine entities in running the operation of Go-Jek, an Indonesia operator.
Vietnam	Decree 10/2020/ND-CP on taxi operation including ride-hailing, and Circular 58/2020/TT-BCA dated16 June 2020 on "regulating the procedure for the issuance and revocation of license plate and vehicle registration for road motor vehicles" which is set to take effect from 01 August 2020	> To define that all cars providing passenger transport services via ride-hailing applications will be treated like taxis from beginning of April 2020; > To require taxi sign on each ride-hailing vehicle; > To define that ride-hailing apps would only help connect passengers and drivers and could not directly operate cars and decide rates; > To require payment for ride-hailing to comply with prevailing regulation on e-transaction; > All vehicles providing cargo and passenger transport must change from white licence plates to yellow ones with black letters and numbers.

Table 3. Key regulatory instruments relating to ride-hailing schemes in selected Asian countries

Based on the above, two countries have been selected for a more in-depth analysis in the following section, China, and India, both major markets for ride-hailing but with very different regulatory responses, China with strong requirements and India with a light touch using the aggregator concept.

Analysis for China

The first ride-hailing service, Didi Dache, started operation in June 2012 before Uber China started its operations in 2015. Currently, Didi Chuxing (the merger of Didi Dache and Kuaidi Dache in 2015), has over 550 million users and 31 million drivers (CNBC, 2019) and offers app-based transportation services such as taxi hailing, ride sharing, private car hailing, bike sharing, minibus pooling, on-demand delivery services, and automobile services (Reuters, 2018; Reuters; 2018b).

Similar to the initial situation in many other countries, the introductory service was operated without regulations and had suffered from ban by local authorities as well as from oppositions by local taxi drivers in many cities, due to concerns over unfair competition.

Shanghai is the first city in China to legalise the service in 2015. The Chinese national regulation on internet-booked taxi was issued in July 2016 that requires licence for ride-hailing operator and permits for vehicles ("internet-booking vehicle") and drivers ("qualification for driving internet-booking vehicle"). It also specifies that all data collected from operation and passenger information should be stored within China and be archived for a minimum period of two years.

Soon after the national regulation was issued, Uber's unit in China was acquired by Didi Chuxing, which resulted towards all ride-hailing services in Chinese markets being provided by Chinese home-grown companies. After the national regulation was published, many cities have published their own regulations to include additional requirements. Fig. 21 shows legalised process of ride-hailing service in China.

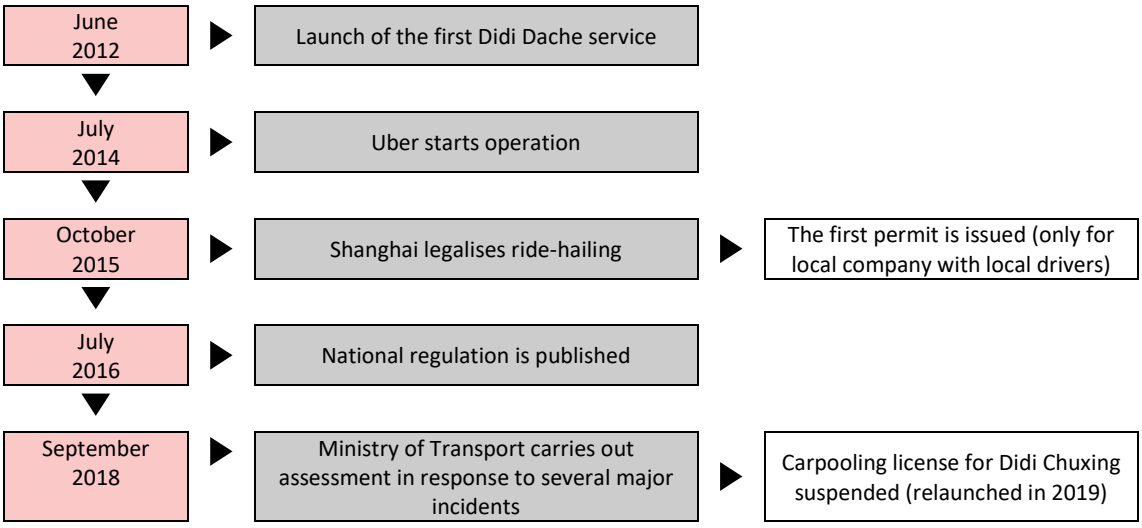


Fig. 21: Timeline of policy development for ride-hailing in China (Selection)

The box below shows the salient features of selected policies related to ride-hailing in China at the national and city (selected) levels.

Box 3. Ride-hailing policy development in China

National level

Issued by the Ministry of Transport of the People's Republic of China (MoT) in July 2016 as "Internet-booking Taxi Operation and Service Management Act", entering in force in November 2016, the act requires that:

- Operators need to apply for licences from local authority where the service is in operation;
- Vehicles used need to have 'internet-booking taxi' permit from local authority;
- Permits for vehicles and drivers are only valid in the city/province where the permit is issued;
- Drivers need to obtain 'internet-booking taxi driver' permit from local authority;
- Operators are to provide insurance for passengers;
- Operators are to store passenger and operational data in server in China for 2 years;
- Operators must not use any data collected for any other purpose except for ride-hailing;
- Operator must share data with authorities when required;
- Operator can set fare and charges.

Local level

Shanghai and Shenzhen are given as examples to analyse city-level regulations as the two cities employ different regulatory approaches, particularly those that relate to local labour markets.

Shanghai

Shanghai is the first city to legalise ride-hailing and issued the first "internet-booking taxi" permit in 2015. Currently the Shanghai government has two regulations on ride-hailing: the "Shanghai Internet Booking Taxi Operation Regulation," and the "Guidance on Advancing Healthy Development of Local Taxi Services."

As Shanghai deems that internet booking taxi services are an important part of the local taxi service, the two regulations need to be analysed together. The 'Shanghai Internet Booking Taxi Operation Regulation' was the foundation for the national regulation. It is important to note, though, that it includes a specific requirement for drivers to be permanent resident of the city. It is very unusual for a big city such as Shanghai, where the main labour force features many migrant workers.

In Shanghai, more than 40% of residents are not permanent residents of the city. Shanghai has approximately 410,000 drivers of internet booking taxis, but only 10,000 are Shanghai permanent residents. A recent assessment carried out by the Shanghai government shows that more than 80% of drivers of Didi Chuxing ride-hailing (the biggest operator) did not have appropriate permits, and corresponding fines were issued by the government, resulting in a sharp decrease in available ride-sharing services.

Although the requirement for permanent residents has been controversial, the Shanghai government insists to retain it. One possible reason is that it aims to protect local taxi services which are operated by state-own companies. Such a goal is contained in the contents of the 'Guidance Advancing Healthy Development of Local Taxi Services', published in 2016, shortly after the regulation on ride-hailing was published. The guidance indicates that the traditional taxi services (so called "cruising taxi") should be reformed to provide internet booking services, thus improving overall quality of service.

Shenzhen

Shenzhen's regulation on ride-hailing, published in November 2016, has similar contents on licenses for operators, vehicle and technical requirements and permits, to the one from Shanghai. However, the big difference is that Shenzhen does not require drivers' residency, making the permit application easier than in Shanghai.

In Shenzhen, there are about 60,000 drivers working in ride-hailing conducting about 10 journeys per day, which is about 2.75 times the journeys made by the normal local taxis in the city. The regulation, however, has resulted in the over-supply of ride-hailing services. Since 2018, the number of drivers for ride-hailing in Shenzhen has decreased again due to lack of demand.

Shenzhen has issued an amendment to its ride-hailing regulation in September 2019, following on the Shenzhen sustainable development strategy in 2018. The amendment defines that only electric vehicles can be used for ride-hailing services. From December 2019, only pure electric vehicles can apply for a ride-hailing service and existing vehicles. About 20,000 existing vehicles, which have a permit valid to end of 2020 will not be issued a new permit, thus being taken off from the market.

Below are some key insights based on the developments in the national and city (selected) responses to the emergence of ride-hailing services in China.

- Responsibilities

In China, the national regulation clearly defines that all operators of ride-hailing services need to apply for a licence from the local authorities. Permits for vehicles and drivers are also issued by local authorities. The national regulation only gives the basic requirements for operators, vehicles, and the drivers. Since the permits for vehicles and drivers are issued by the government, operators do not need to check the profiles of vehicles or drivers.

The national regulation also does not regulate fare and charging and allows system operators to design their fare system and determine the costs for passengers and drivers. That is very different from conventional taxi service in which fare is strictly regulated. The Chinese regulation sees a ride-hailing operator as a transport service provider, rather than an "aggregator" that only serves to connect the drivers and passengers, which is the case in other countries, such as in India. Therefore, the Chinese regulation requires operators to provide insurance for vehicles and passengers, liability for passenger safety and security thus lies with the operator.

The national regulation defines that local authorities are responsible for licences and permits and does not allow the use of licences and permits issued by other cities or provinces, even though most operators are national-wide. Such can encourage local protectionism, increase administrative costs on operators, and add obstacles to deployment of ride-hailing, and thus should be avoided.

- Protecting the local market

At the city level, Shanghai requires drivers to be permanent residents, resulting in operators using drivers without permit and then insufficient provision of services to meet local demand; Shenzhen has no such requirement, resulting in oversupply of drivers in ride-hailing. Therefore, how to balance protection of local labour market and provision of service should be carefully considered by local authorities and should be reviewed based on data collected from operation.

- Green vehicles

Shenzhen only allows electric vehicles to apply for ride-hailing service permit since end of 2019, to encourage use of electric vehicles, thus reducing pollution in the city. However, concern is raised that such regulation will reduce the effective provision of the service, resulting in difficulties in urban mobility. In 2020, it was reported that Didi Chuxing together with BYD is developing an own electric car, called D1, especially for its ride hailing service (The Verge, 2020).

- Regulation vs. supervision

The MoT carried out a comprehensive assessment on all operators of ride-hailing in 2018 after major incidents, and found out many issues, leading to suspending some services. In May 2021, 10 Chinese authorities including the MoT and the Ministry of Industry and Information Technology (MIIT) directed 10 online transport platforms (including Didi Chuxing, Meituan and Caocao) to rectify operational problems, such as lacking transparency in order distribution mechanisms and arbitrary adjustment of pricing policies, and suspected infringement of the lawful rights and interests of drivers). The move is seen as a general step on the path to strengthen anti-monopoly efforts, and to improve and

better develop the platform transport industry. Such regular assessments can help ensure the quality of ride-hailing and in general platform-based both passenger and delivery services and is key towards the enforcement of the requirements (South China Morning Post, 2021). Such assessments should also aim towards identifying needs for amendments to existing regulations.

- Other issues

The assessment also identified an area that was not regulated, i.e. advertising, that was a cause for a certain type of incidents (i.e. harassment to woman passengers). National and local authorities should take the supervising responsibilities by setting up assessment methods. Such action is missing currently in China, particularly in relation to dockless bike sharing services.

Analysis for India

India is one of the countries where the app-based ride-hailing service has grown at a rapid pace. The India-based operator, Ola, has widely available services in India, and in other parts of the globe. The Indian government has responded to the market uptake by updating its existing law, and by issuing accompanying national guidelines.

The Indian government also sees the development of ride-hailing services as a part of its national transport strategy, and national climate action plan by ordering the ride-hailing providers to reach 40% of their fleets as electric vehicles. Fig. 22 shows the state of the development of national regulations on the ride-hailing service in India.

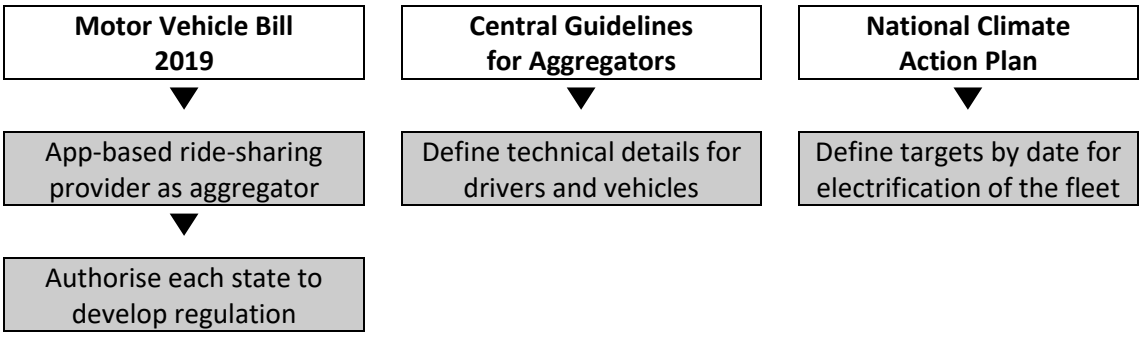


Fig. 22: Overview of policy development relevant to ride-hailing in India

Relevant national level regulations and policies affecting NMS in India are contained in the box below:

BOX 4. Ride-hailing policy development in India

National level

The Motor Vehicle (Amendment) Bill 2019

The Motor Vehicle (Amendment) Bill of 2019 which was approved by the House of Representatives in August 2019, recognizes app-based ride-sharing service providers as "aggregators," i.e. digital intermediaries or marketplace used by passengers to connect with a driver for transportation.

The law allows such companies to obtain licences from the state government, as such services are considered to be under the purview of the state-level authorities. It also authorises each state government to develop their own policies or regulations to guide or regulate development of such services.

Operators of the ride-sharing service must also be compliant with the Information Technology Act 2000 including its Amendment 2008 that addresses cyber security and safety, as well as measures for data and privacy protection, etc.

The Central Guidelines for Aggregators

In addition to the Motor Vehicle Bill 2019, the federal government proposed a policy entitled "Central Guidelines for Aggregators" in which the government lays out guidelines on pricing, safety, and other operation issues. This policy has been notified on 26 November 2020 (MORTH, 2020).

It defines the pricing and the maximum commission that can be charged by aggregators, which have been highly controversial. The guidelines allow either aggregators or state governments to decide the base fare. However, it puts a cap on the commission charged by aggregators to 10% of the fare of each ride (e.g. the maximum commission for Uber and Ola in India is approximately 20% of the total fare charged). The guidelines also states that surge prices must be capped at 1.5 times the base fare price.

For security and relevant data management, the guidelines require that aggregators have to store the data which their mobile apps collect on a server in India for a period of 2 years, from the date of collecting the data. If law enforcement agencies demand access to this data, aggregators will have to make it available to them. It also asks aggregators to set up a control centre based in the country. The control centre can immediately get in touch with the driver in case a driver veers off the assigned route. Aggregators will have to enforce facial recognition or biometric verification of drivers every 3 hours per day.

For road safety, the guidelines will have strict safety checks for drivers and maximum working hours of 12 hours per driver per day will be enforced. The guidelines requires aggregators to offer "utmost cooperation" to law enforcement agencies in case of any complaints from passenger; however, they will not be held liable for incidents that jeopardises the safety of a passenger due to the driver. The regulations also enable female passengers to have the option to share vehicles solely with other women. The guidelines also define minimum requirements for vehicle conditions. All vehicles are required to be labelled clearly as "chartered vehicle" or "taxi."

Paris Agreement and Green Vehicle policy related to ride-hailing services

The Indian Central Government is looking to push the new policy to boost the adoption of electric vehicles (EVs) as it tries to bring down its oil imports and curb pollution, so it can meet its commitment as part of the 2015 Paris Climate Change Treaty (Shanthi, 2019).

The government has reported to ask commercial vehicles to go electric and for taxi fleets including ride-sharing services, to increase the number of electric vehicles in their fleet and to aim to reach electric vehicles as 40% of the total fleet by 2026. It would mean that a ridesharing operator should convert their fleet as early as next year to achieve:

1) 2.5% electrification by 2021;
2) 5% by 2022;
3) 10% by 2023;
4) before hiking it to 40% in 2026.

Shifting towards cleaner vehicles have also been fuelled by efforts to reduce urban air quality, such as in New Delhi. In 2015, the Supreme Court of India ordered taxis (including aggregators) to move to the use of compressed natural gas (CNG) to boost air pollution reduction efforts. Due to protests, the Supreme Court eventually allowed diesel taxis that have national permits to operate in Delhi until the expiration of their permits. However, it had banned new registrations of such vehicles in providing passenger pick-up and drop services (Fortuna, 2020).

Selected City and state-Level regulations

For city and state-level regulations, notable points are discussed below (WRI, n.d.).

- Licence: In most sub-national (state or city) regulations, a ride-hailing provider should apply for the 'aggregator' licence. An aggregator cannot own any vehicles or hire any taxi drivers. However, in Delhi, the aggregator will have to apply for taxi service licence, which may be conflicting with the 'National Motor Act'.
- Vehicles: A vehicle used for ride-hailing can be private vehicle in some states and cities (e.g. in West Bengal) but in other states or cities, vehicles must be taxi or app-based taxi.
- Drivers: All regulations require minimum requirements for drivers' profiles. However, some regulations (e.g. in West Bengal) requires the ride-hailing providers to check drivers' profiles. Others require drivers to hold commercial vehicle driving licences, i.e. eligible to drive taxi. In that case, a driver's profile will be checked by public authorities.

Fig. 23: Relevant national regulations/policies in India

- Light and strict regulations

Current regulations in India may be categorised into two groups: light version or strict version. A strict version regulation is to consider a ride-hailing is a taxi service platform to connect taxis driven by taxi drivers with passengers.

A strict version regulation is to give ride-hailing providers more responsibilities to ensure appropriate vehicles and drivers used by the service, thus ensuring road safety and passenger security. The light version regulation has therefore additional requirements on data sharing to be able to supervise the service.

- Embedding into the local context

Since all the regulations have been in place for only short periods, it is not possible yet to conclude which approach delivers better results. The effectiveness of the regulations will also depend on local social and economic characteristics. Local authorities need to balance protection of local labour market, revenue, and provision of efficient urban mobility solutions.

- Recognizing the differences: Conventional vs. New Mobility Services

For local authorities, regulating ride-hailing as normal taxi service would be the easiest option. However, ride-hailing service is different from local taxi service, and such sharing-economy may be able to provide more flexible employment opportunities to the local workers.

Regulating ride-hailing as a local taxi service will not advance such unique benefits to local economy and urban mobility. Therefore, a lighter version of regulation and the local authorities to supervise ride-hailing service through data sharing can be recommended. This version has the advantage of being able to attach the adherence to specific policy objectives, e.g. pricing, number of vehicles, engine type, etc. to a license scheme

Bike Sharing

Overview of Regulatory Responses in Asia

The government response of defining policies and regulations here can be divided into two distinct groups:

- In countries with **small share of cycling** in urban mobility and no mass uptake of bike sharing, such as the Philippine, policies and regulations are focused on improving infrastructure for cycling and on promoting a cycling culture as part of sustainable development of the country;
- In countries with **mass uptake of bike sharing**, such as China, policies and regulations are focused on steering the development of bike sharing services towards positive impacts.

Country	Type of scheme		Relevant policies and regulations
	Docked	Free-floating	
China	> In most major cities.	> In most major cities (currently mainly Meituan, Hellobike, Qingju).	> No regulation on docked bike sharing since such service is operated as a part of public transport service; > National guidelines available since 2017; > Specific local policies and regulations in many cities.
India	> In 7 cities with various size of fleet.	> Mobike and Ofo initiated and operated services in India for a while and were then withdrawing from the market; > Limited number of local operators offering bike and e-bike sharing services.	> Electric scooters are promoted by the government under its 'National Electric Mobility Mission Plan' (NEMMP) aiming to reducing energy consumption and air pollution from the transport sector; > There is no specific policy related to bike sharing service.
Indonesia	> Small scale services launched by local communities or university students.	> oBike in January 2018; > Indonesian start-up GOWES in 2018.	> General regulation (Law 22/2009; Government Regulation 79/2013) on bike but still needs to develop more regulations on e.g. bike sharing, e-bike, etc.
Malaysia	> LinkBike in Penang in 2016.	> oBike in 2018 in Kuala Lumpur; > Ofo launched its operation in Meleka in 2017 but withdrawn in 2018;	> There is no specific regulation in place;
Philippines	> Pilot project from Asian Development Bank in 2012; > Small pilots (i.e. University-level).	> Ofo planned to open operations in Manila in 2018.	> Department of Public Works and Highways Order 2020-08: Guidelines on the Design of Bicycle Facilities; > National Transport Policy 2020.
Thailand	> Pun in Bangkok since 2012.	> Ofo initiated services in 2017 but withdrawn in 2018.	> Municipal policy on promoting cycling, e.g. Bangkok aimed to have 10,000 shared bikes, reduce speed limit of shared road space.

Table 4. Selected key regulatory instruments relating to bike sharing schemes in selected Asian countries

Based on

, two countries have been selected for a more in-depth analysis in the following section: China - as the first market for free-floating bike sharing and with stages of regulatory response, and; the Philippines - with less of a cycling culture and policies centring more on introducing bikes.

Analysis for China

The rapid uptake of dockless bike sharing services in China, particularly during the investment phase (observed in 2016-2017) had brought many environmental, transport and social issues to Chinese cities such as the following:

- Use of public space and overcrowding with oversupply;
- Environmental issues of removal of abandoned bikes;
- Economic struggle of platform operators due to extreme competition.

Market consolidation began in 2018 after the explosive growth phase, and government policies and regulations have played an important role in the transition. The reasons for the eventual market consolidation include the following:

- Slowing down of the market;
- (Inter-)national backlash;
- Increased (economic) pressure to merge;
- Tightening government regulation;
- Services expansion and cross-industry alliances.

Chinese cities have demonstrated that appropriate regulations and policies can mitigate its negative impacts and maximise benefits of the service. Chengdu was the first Chinese city that published its policy to regulate bike sharing services in March 2017. Shanghai and Tianjin took a different approach by jointly publishing three technical standards for dockless bikes and bike sharing services.

Soon after these local policy and technical standards were published, the national government published guidelines to regulate dockless bike and bike sharing in August 2017, which were based on the local experiences (China MoT, 2017). Since the national guidelines were published, more than 30 cities have published their own policy and regulations for bike sharing services. Fig. 24 below the timeline of the policies vs. commercial development.

The national guidelines only provide the principles and minimum requirements for operations. However, it requires municipal governments to draft their own policies and regulations, which many cities have done since. The policies from municipal governments define the principles of bike sharing services, and roles and responsibilities of various government departments. Such policies require local transport authorities to develop regulations on bike sharing services that give technical details pertaining to aspects such as quality of service, quality and maintenance of bikes, assessment of quality of services, parking space, responsibilities and rights of operators and users, enforcement of local transport, and law enforcement authorities for any misuse or damage.

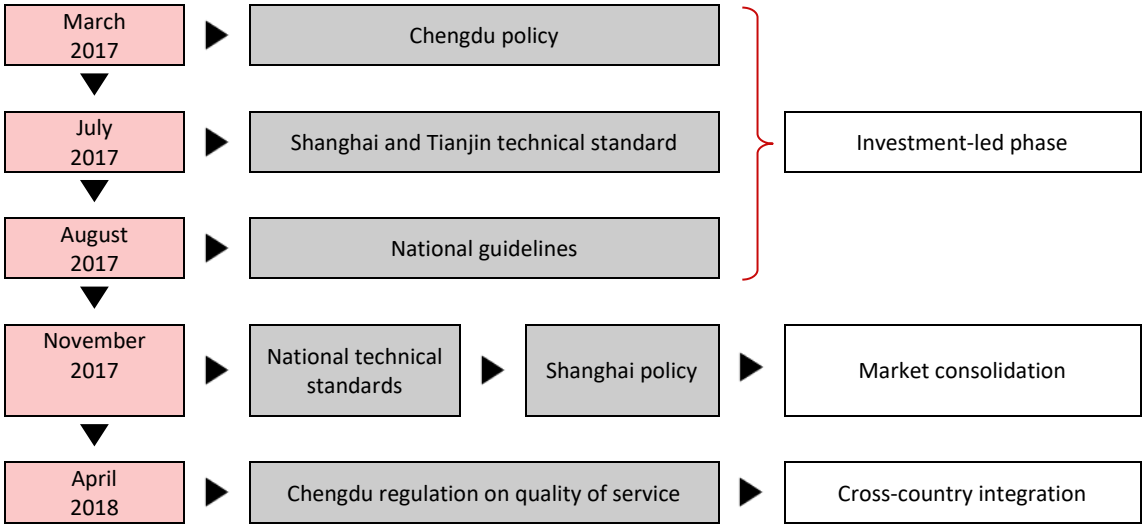


Fig. 24: Timeline for policy development for bike sharing services in China

Fig. 25 shows the different levels of policy making (national government, municipal government, and local transport authorities) and the associated policies and regulations.

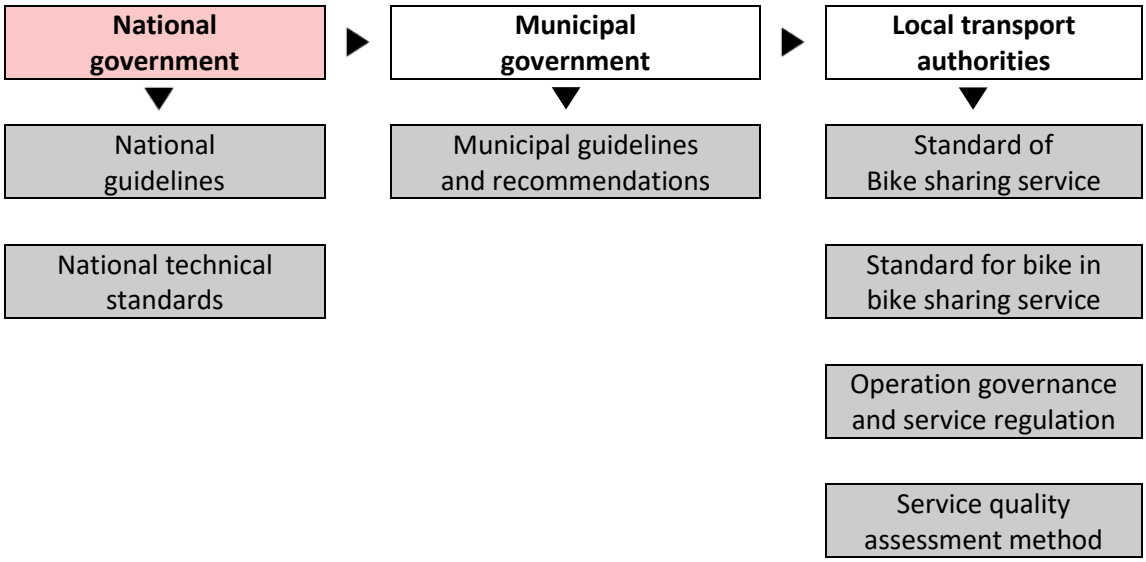


Fig. 25: Overview of different levels of regulation for bike sharing in China

Box 5 below shows the salient features of selected policies related to bike sharing systems in China at the national and local levels.

BOX 5. Bike sharing policy development in China

National level

China's MoT decided not to issue detailed regulations and standards, but to provide a high-level policy, i.e. national guidelines which were published in August 2017. The development of the national guidelines draws on published guidelines from Chengdu, and three technical standards published jointly by two major Chinese cities, Shanghai, and Tianjin.

The policy defines the roles and responsibilities of local authorities, who will be responsible for publishing policies, regulations, and legislations according to the local characteristics. Except defining roles and responsibilities of local authorities, the national guidelines also provides principles for development of the bike sharing service, and the minimum requirements:

- The principle is to ensure that bike sharing serves sustainable urban mobility, to ensure road safety and security, and to protect citizens' rights and interests;
- Each municipal government has the responsibility to publish regulations for services in its territory under the national guidelines to define bike sharing licensing, quality of services, quality of bikes, bikes' parking management, infrastructure, management of deposit, etc;
- Users must register using valid ID and real name; need to above 12 years age;
- It does not recommend the use electric bikes;
- It encourages to not require a deposit from users;
- User information and data must be protected and operators are not allowed to collect unnecessary data from users and to use users' data for any other purposes than the bike sharing service;
- It encourages cooperation among local governments, transport service providers, and citizens and fair competition;
- Social supervision and public opinion are considered to ensure services for citizens.

Local level

According to the national guidelines, each municipal government should define its own compliant policy and develop regulations accordingly based on local social and transport characteristics. More than 30 cities in China have published their own policies. Most cities follow the same model as that of the municipal government, in cooperation with the transport authorities and other departments. A municipal policy or recommendation can potentially have similar contents (albeit more detailed) as the national guidelines; e.g. Shanghai's 'Guidelines and Recommendations for Encouraging and Regulating the Development of the Bike Sharing Service', published in November 2017, includes the following (Government of Shanghai, 2017):

- The principle of development of bike sharing services is that the service should enable use of urban infrastructure and spaces, support use of public transport and ensure road safety;
- The government should guide the development through cooperation with the industry and other social groups, and continuously improve regulations;
- The government should welcome and encourage innovation, provide appropriate infrastructure for bike users and bike parking, promote safety of cycling and appropriate use of bikes;
- The operators must apply for a licence prior to operation and the number of vehicles available to users must be communicated to the transport authority;
- The operators must provide data required to the government for assessment of service quality;
- The operators must protect users' privacy and data collected from users must not be used for any other purposes except for operation of the service;
- The transport authority should cooperate with operators and use operation data to decide on parking spots and to recommend number of vehicles available on the market per year;
- The operators need to have a dedicated bank account for its users' deposit and prepayment; the financial authorities (e.g. the Central Bank's local branch) have the right to monitor the use of the capital;
- The transport authority should provide regulations to define standards of bike sharing and their vehicles, technical details of quality of service, and assessment methods;

- The users should not misuse bikes and respect rules of the bike sharing service. Law enforcement authorities should define punishment for any misuse, e.g. illegal parking, vandalism, theft, etc., and carry out the enforcement;
- The operator should provide appropriate insurance for users and bikes;
- The operator should evaluate user behaviours and build user credibility mechanism, and have responsibility to report severe misbehaviours to law enforcement and provide information on individual user's credibility to the national public service platform;
- The users and other social groups should provide feedbacks to the government to improve the service, and to serve the sustainable urban mobility purpose.

Private Sector-led Standards

In addition to the aforementioned policies and regulations, the China Communication Industry Association has also released their own technical standards pertaining to requirements for the bikes, apps, and operators:

The bike shall:

- Be enabled to "report" its position at least 4 times per hour while being locked;
- Be able to be locked and unlocked at least 8,000 times without any malfunction;
- Be able to be unlocked remotely;
- Stop calculating costs at a maximum of 30 second after being locked;
- Be functional under several weather condition.

The app shall:

- Be able to conduct automatic calculation of cost after each use;
- Provide functions that enable top-up of money and refund;
- Guide users where to park bicycles properly;
- Provide information to users on locations where cycling or parking is not permitted.

The operator shall:

- Have the capability to analyse operational data to understand distributions of bikes, usage of bikes, popular areas of pick-up and returning, and improve operation efficiency and quality of services to users;
- Build personal credibility mechanism to evaluate user behaviour, to identify whether users use and park shared bikes appropriately;
- Provide data security, ensure privacy, not use personal data for other purposes.

- Adapting to the evolution of NMS

In terms of technical regulations, different local authorities adopted different approaches. Shanghai and Tianjin published technical standards to regulate bikes that are used by the bike sharing service, and the quality of the service. Those standards provide technical details such as:

- The life cycle of each bike is 3 years, after that the bike should be taken off the market;
- Operators should have a minimum of one maintenance staff per 200 bikes;
- Bikes should be removed for repair within 48 hours after reporting malfunction.

Since technologies and policies are developing fast, those technical standards may not be valid soon (e.g. the 3-year life cycle is not compliant with the national policy on circular economy). Therefore, some cities are utilising a different approach in regulating bike sharing services, such as Chengdu. Instead of

descriptive regulations, Chengdu uses data-led regulations to define the method of assessment of service quality and build a platform to analyse data from operators to assess their operation.

- Managing through combining approaches

Based on the assessment results, the transport authorities will rate each operator, and provide recommendations on improvements going forward or to suspend its licence if an operator fails to meet the minimum requirements formulated in the policy. Beijing has taken, as many cities in China, the approach to limit the number of bikes. According to the Beijing Municipal Commission of Transport (BMCT), in order to further guide the bike sharing industry, the number of shared free-floating bikes in Beijing's central urban area (Districts of Dongcheng, Xicheng, Chaoyang, Haidian, Fengtai and Shijingshan) will be limited to a total of 800,000 units in 2021 (compared to 844,000 in 2020) and a bike registration cap will be put on companies in the same area (Meituan-400,000 units, Hellobike-210,000, Qingju-190,000) with numbers continuously being evaluated and adjusted based on transport demand and companies' service quality.

Analysis for the Philippines

Traditionally, cycling has not been a mainstream mobility mode in the Philippines. In the 1990s, bicycles were even banned on major roads in Manila due to safety and congestion concerns. Urban transportation in the major cities have primarily been dominated by "local" modes such as the tricycles, and the jeepneys. Due to severe traffic congestion in the cities, and the significantly low requirements towards acquiring motorcycles, the two-wheeler fleet in the country has been growing at a rapid pace. Data from the Land Transportation Office shows that the total registered motorcycles in the country have grown at an average annual growth rate of 14% from 2016 to 2020 (LTO,2020).

There had been some positive developments towards supporting cycling as an urban mobility mode in the country in the past, as reflected by the inclusion of cycling-supportive statements in past strategies, submitted legislation/bills, as well as initiatives at the local level – including pockets of initiatives on bike sharing schemes. The need to support cycling as an essential means of urban transportation has been emphasized during the COVID pandemic as well, as much of the main public transport modes were held to stagnation for a good portion of the year 2020. However, wider support, as well as social transformation towards embracing cycling as a viable and attractive mode are yet to be realized.

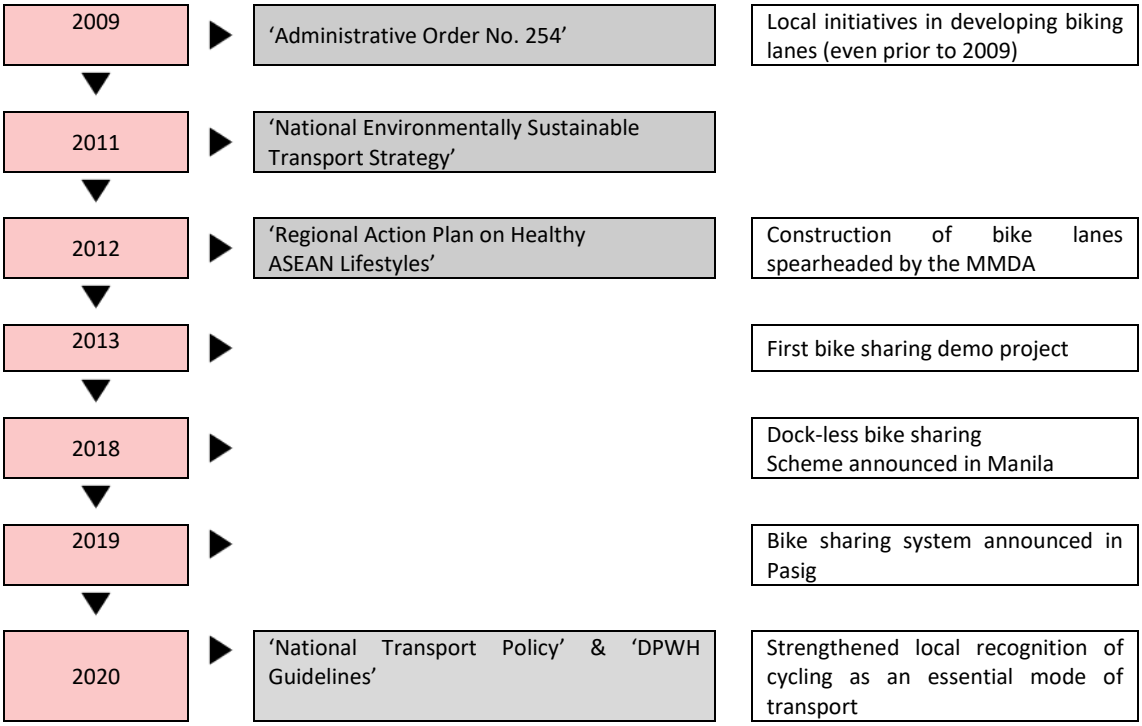


Fig. 26: Timeline of policy development for bicycle-sharing in the Philippines

BOX 6. Bike sharing in the Philippines

National level

In 2009, the 'Administrative Order 254' defined the new sustainable transport objectives including a declaration towards the formulation of a 'National Environmentally Sustainable Transport Strategy for the Philippines' (Office of the President PHL, 2009). This strategy was launched in 2011 and laid down a foundation for advancing sustainable transportation – including cycling – in the country. There had been other supporting pronouncements (e.g. ASEAN level strategies and action plans) that the Philippines has supported which recognise the importance of cycling (e.g. the ASEAN Regional Action Plan on Healthy Lifestyles, ASEAN, 2012). A number of government policies and regulations such as administrative orders, Senate and Congress bills, have been proposed, aiming at reducing congestion, air pollution, emissions from the transport sector and improving health by encouraging cycling, but many of these were not subsequently approved by the law makers (Bakker et al., 2017). The 'Bicycle Act' of 2016, for example, was approved by the Philippine Congress (lower house) in 2016 but had since remained as an approved bill in the lower house. A more recent bill has been filed which aims at supporting cycling, particularly in terms of enabling local governments to create local cycling offices, among other provisions (Bicycle Act of 2020). The existing guidelines for transport network vehicle services (TNVS), as well as the Omnibus Guidelines on the Planning and Identification of Public Road Transportation Services, both do not directly cover bike sharing schemes.

The Department of Public Works and Highways has issued national guidelines on the development of biking infrastructure along national road, and the National Economic Development Authority also issued the 'National Transport Policy' which stipulates that all units of government give "highest priority to the development of proper sidewalks and networks of bicycle lanes." There were cities (e.g. Pasig) that have issued executive orders that recognise the importance of biking as an essential mode of transport and have implemented supporting infrastructure changes (e.g. pop-up bike lanes) to support the use of bicycles. Under the *Bayanihan to Recover as One Act,* a Republic Act (RA 11494, effective September 2020) that was enacted to address the COVID-19 pandemic, 522.7 kilometres of bike lane networks in the country's national roads (338 kilometres in Metro Manila) are to be developed to help address mobility needs amidst reduced public transport operations (amounting to 1.3 billion Philippine pesos or 2.2 million Euros). As of March 2021, the Department of Transportation (DoTr) estimates that less than 19% of the network has been built (Cuyco, 2021).

Local level

Cities have initiated their own actions to promote cycling. For example, Marikina City (Metro Manila), was the first city to issue a bicycle ordinance in 1996. At the metropolitan-level, the Metro Manila Development Authority (MMDA) initiated the construction of dedicated cycling lanes since 2012 and by 2015 about 70 km cycling lanes have been built (MMDA, 2015).

A pilot bike sharing programme (*Tutubi* bike sharing system) supported by the Asian Development Bank (ADB) was launched in Pasig City in 2013. It featured a dock-based system with integrated payment features (e.g. smart card-based). The scheme was also piloted in other areas such as the Bonifacio Global City, and the University of Sto. Tomas (located in the cities of Taguig, and Manila, respectively). Various factors contributed towards the stagnation of the roll-out of such schemes. For example, Daudey(n.d.) points to the challenge of addressing the conflicts and cohabitation of users of the streets as prominent in the case of the Philippines. There were also significant barriers as to how the payment systems would be rolled out, as the scheme that was tested in Pasig utilized smart cards, which entailed additional barriers to accessing the system (i.e. including know-your-customer requirements, mechanisms for payments, etc…). A "chicken-and-egg" problem also occurred, as a viable proof-of-concept at realistic scales (i.e. multiple stations) was not possible unless further support was injected.

In 2019, the City of Pasig launched the 'Pasig City Bike Share System' which now features at least nine stations and 100 bikes. The City of Pasig has issued several supporting policies in the past that aims at promoting cycling in the city such as the 'Bicycle Promotion Ordinance' of 2011 which required the provision of bike parking for commercial establishments, and imposed penalties for violations related to the obstruction of bike lanes.

A student-led bike sharing system in the Diliman Campus (a 493-hectare campus located in Quezon City, Metro Manila) of the University of the Philippines was conceived in 2015. Support from the administration of the university was strengthened through the formation of a non-motorised mobility sub-committee after two years of piloting the system. The sub-committee is tasked to develop and implement supportive active travel directives within the university. The system started out with 30 bicycles in its inception which has now expanded to more than 100 units (Sharmeen et al., 2021). Users can have access (unlimited use) to the shared bikes through a monthly or subscription basis.

In 2018, Ofo announced that it would be operating dockless bike sharing schemes in the Philippines. However, this plan was not realised, as the company essentially has practically ceased. Significant developments in terms of recognizing the importance of cycling as an essential means of transport, as well as in providing cycling infrastructure have been witnessed during the onset of the COVID-19 pandemic in several major cities across the country.

- Evolving needs

The case of the Philippines points towards the realities of evolving needs. Several key factors are fuelling the evolution of the landscape of urban transportation in the country. Sustained urban population growth, coupled with increasing capacities to own vehicles- and the associated congestion impacts - , as well as the inability of urban public transport networks to provide adequate, high-quality services are all contributing towards encouraging the public to look for viable alternatives. Cycling has been gaining recent attention, and its importance has been highlighted during the COVID pandemic, which poses opportunities to potentially transform urban mobility systems towards being more sustainable in the long run.

- Hurdles towards transition

While cycling in general has been gaining more attention, bike sharing schemes have yet to take off in the country. There are significant challenges that relate to technology (e.g. identification and payments), markets (as the current

regulations do not directly cover bike sharing schemes), and society (wider awareness raising about cycling, and bike sharing systems are still significantly needed).

- Evoking change through proof-of-concepts

Isolated pilots such as the one that has been sustained in the University of the Philippines, while can be thought of as limited applications that might not reflect the real-world challenges of applying such schemes at scale, such can be microcosms of the wider socio-technical systems and can result in relevant insights that can feed into higher policymaking, and crafting of regulations. Moreover, replicating such small-scale experiments can also bring huge benefits in terms of awareness raising by exposing more people to such schemes (while minimizing risks and complexities), and creating positive experiences which can later fuel wider transformation.

4 Conclusions and Policy Recommendations

4.1 Key Opportunities and Challenges: NMS in Asia

This study started off with an examination of the backdrop for the development of NMS, including global challenges (sustainable development and combating climate change), urban mobility challenges, and opportunities for addressing such brought about by the advancements in technology. The report then looked into the concept and evolution of NMS and the governance of such, from a global, as well as Asia-specific lens. As products of the platform economy, and as key to more diversified, accessible, and sustainable urban mobility, NMS schemes have been introduced, and are currently thriving. This is a rapidly developing global phenomenon, often referred to the transport and mobility revolution. As a precise, internationally accepted definition is lacking, some theoretical frameworks were developed here in order to compare and to categorise the different types of NMS. At the heart of it lies the use of digital technology that opens up new urban mobility options with integrated sharing features. Sharing can refer to shared ownership, shared access, or sharing of vehicles or rides. Specific services here include ride-hailing, ride-pooling, car-sharing, bike sharing (free-floating or docked), or kick-scooter-sharing. A further sustainability improvement is move to electrification.

The analysis conducted has explored different types of NMS that are in operation in different countries to provide insights on what has worked and what has not worked. Clear positive impacts can be identified in terms of improving mobility, providing flexible employment options, and moving away from the private car to greener and healthier modes. At the same time, negative impacts have been observed, too. These includes impacts on legacy transport services and negative labour market impacts, potentially significant negative impacts on the mobility systems, and the environment.

These examples of positive and negative impacts point towards a clear need for regulatory oversight of the implementation and operation of NMS in Asia. The study thus looks at how NMS have been regulated so far, again, looking at some global experiences as background, but then looking specifically at regulatory responses to NMS in Asia, with a view to identify and categorise different governance approaches, and also identifies what has worked and what has not in terms of getting the best out of NMS. The ultimate goal, therefore, is to lock in all possible positive impacts NMS can have on urban mobility, whilst attempting to avoid any of the negative impacts observed and any other potential undesired and unintended consequences.

In terms of regulatory approaches for NMS, these can be characterized against the two extremes: implementation without rules vs. an outright ban, and the large grey area of varying levels of regulations in between. Whilst the two extremes are unlikely to produce positive impacts, somewhere in the grey area the best solution can be found. This will be a transparent licensing scheme for a specific type of NMS in a specific city, with a license being granted based on coherence to pre-defined rules. These rules may relate to the driver, the vehicle, the business model, pricing, data protection, etc. The possibility to withdraw a license due to non-compliance to the rules needs to be in place. In addition, there can also be varying levels of public-private cooperation.

Therefore, the key objective is to allow implementation of NMS under sufficient regulatory supervision in order for the positive impacts to materialise, and to minimise the negative outcomes. The same holds true for innovation, where a reasonably flexible way should be offered for safely testing out new modes, concepts, and business models to evaluate their usefulness.

- **Potential better utilisation of underutilised assets (i.e. private cars):** The rising vehicle ownership in Asia, coupled with rapid urbanisation rates and high concentration in major cities in the region, maximizing the utility of private cars through shared schemes, can potentially contribute towards providing feasible options towards alleviating increasing systems congestion due to the additional influx of such vehicles. NMS, particularly hailing and pooling solutions, can have a positive impact by improving the utilisation of private cars and by opening urban spaces due less need for parking, through vehicle owners working on a ride-hailing platform. The same goes for goods vehicles. In some cases, NMS schemes are making the line between passenger and goods vehicles more blurred, as they may enable (e.g. in the case of courier network services) the utilisation of different types of vehicles (e.g. passenger cars, vans, even motorcycles), for delivering goods/materials;
- **Potential generation of substantial employment opportunities:** As the sharing economy changes employment setups, sharing, hailing, and pooling, can be become new income streams in the transport and mobility field for those seeking a more flexible way of earning money, i.e. utilising their vehicle and their labour in a self-determined manner with other incomes. These can be seen in various forms of NMS in Asia (both passenger and freight). Ride-hailing schemes have provided employment opportunities for qualified vehicle operators in the region, while bike sharing schemes can spur local economies (e.g. in relation to hiring IT, bike maintenance and repair, operations personnel);
- **Provision of effective first-mile/last-mile solutions:** Many developing cities in Asia are constrained by capacity and financial resources challenges, and thus have less than optimal public transport systems, alongside poor network coverage. NMS, if properly integrated, have the potential to offer a safe, convenient, and affordable means to access major public transport networks, and can thus induce shifting trips towards such public modes. This phenomenon can also apply to the freight sector, as digital platforms (and the accompanying business models) are now enabling more entities and individuals to participate as providers of last-mile delivery services through shared light (or micro) vehicle fleets (and in some cases, vehicles, and services as provided by individual contractors).
- **Opportunity for improving mobility systems:** NMS can contribute towards “improving” urban mobility systems, in general. The introduction of NMS featuring

small, electric vehicles (dockless bikes, scooters) can result in significant benefits due to reduced energy intensity (i.e. energy used per unit of transport activity), and potentially the elimination of tailpipe GHG and air pollutant emissions (i.e. in the case of electric vehicles), or by directly providing more "active" mobility options. Moreover, wider systemic improvements can arise from the decrease space requirements compared to say, being dependent on private automobiles. NMS can contribute towards accelerating overall shift to clean vehicle technologies, as well building an open data ecosystem, if government support is there to trigger the right industry response. In the case of urban freight, the availability of a wider set of fleets as enabled by such NMS schemes can result in more optimal flow of goods;

- **Use and promote mobility data as a public good.** Major market trends (e.g. strengthened consolidation of mobility, as well as non-mobility-related-services) and the imminent diffusion of more advanced data-dependent technologies (e.g. automated vehicles) highlights the importance of anticipating future governance requirements related to data. The concept behind data-driven regulation is the move away from current and traditional descriptive regulation to a system where policy objectives are translated into quantifiable and measurable thresholds or performance indicators, and then being matched (if necessary, on a real-time basis) to the results of data analytics being performed on raw data collected. There are many hurdles to achieve this move, including data privacy and security issues, mistrust in the public sector to appropriately handle sensitive commercial and personal data, and data science capabilities to deal with the natural imperfection of data (e.g. noise, inconsistencies, lack of continuity, etc.). In terms of using data-led regulation for the governance of NMS, public private partnerships for the operation are likely key, as they will generate the necessary level of trust between both parties necessary for sharing data. Furthermore, capacity building in the area of data science might be needed within the public sector.

Higher utilisation of underutilised vehicles	Provide additional employment opportunities	Create solutions for the first mile/last-mile dilemma	Promote a modal shift to green and healthy modes	Use and promote mobility data as a public good
				

Fig. 27: Overview of key policy objectives for NMS implementation

Consideration towards addressing the negative effects is also important, too – as shown in the case studies presented in this report – which need to be avoided going forward in order to make NMS a viable solution for today's urban mobility problems:

	Avoid any **regulatory conflict** with legacy or other transport services by finding integrated regulatory approaches governing either system.
	Attempt to avoid **labour market issues**, otherwise address by considering effects on legacy services, and if necessary early retirement, retraining.
	Ensure **personal security** within NMS vehicles, through e.g. background checks of drivers, CCTV cameras, or feedback from users.
	Ensure **road safety** through e.g. mandated minimum conditions for: vehicles (standards for inclusion into the system and operational requirements); users and usage requirements (e.g. location-based, time-based regulations for using NMS vehicles, if necessary) and drivers (performance standards); and robust mechanisms for dynamic feedback.
	Invest in and provide safe and context-appropriate **infrastructure** for NMS vehicles, such as bicycles or scooters, to ensure safety for all road users.
	Counteract any **modal shift** against policy objectives, such as from green/active modes to single-occupancy ride-hailing through data analytics, optimal integration of these services, as well as sensitisation and awareness raising.
	Counteract the emergence of **additional trips** of single occupancy ICE vehicles through data analytics, quotas on roaming, or through pricing.
	Avoid **over-supply of vehicles**, which might occur in the investment-led phase, through quotas, data analytics, or bans on vehicle staging.
	Avoid any **data security** issues, including for privacy related data as well as commercial data, through implementing privacy by design principles.
	**Avoid the worsening of mobility inequity** through the: careful investigation of opportunities for directing services in priority areas; working towards proper oversight towards transparency (i.e. user fees; compensation); consideration for enabling access to such services by the vulnerable populations; prioritising investments in NMS within the wider investment prioritisation programmes.

Fig. 28: Issues to avoid through regulation when operating NMS

The key output of this study - in addition to providing a comprehensive guide to NMS in Asia and why this matters - is to formulate some guiding principles for relevant stakeholders - regulators, city officials, urban planners, among others – for properly integrating NMS, considering the complexity of the systems that they are to be introduced into. The following section will present key regulatory principles, followed by an outlook on possible NMS-related developments, and the key implications to look out for.

4.2 Ten Principles to Make NMS Work

Overall, the integration of NMS ideally should be planned within the frameworks of wider urban and urban-rural development, mobility- and other related/relevant plans to ensure that these complement long-term sustainability goals. Ensuring optimal integration can support existing active and public transport modes, instead of competing with them, and fill in service gaps in priority areas. The integration of NMS schemes must also consider the potential multi-dimensional negative impacts that such may have (e.g. equity challenges, negative impacts on labour in incumbent modes, potential negative impacts on the environment). Investments towards supporting NMS should also be reviewed within the wider investment priority programmes related to the provision of mobility (including basic infrastructure and services such as proper sidewalks, public transport waiting areas, etc.) to ensure that the provision of such new services do not impede the provision of basic mobility to the mobility-deprived, and thus contribute towards the equity of the mobility system.

Based on the analysis work carried out in this study, the following guidance can be formulated to help regulators, city officials, and transport planners but also the operators of NMS to provide the optimal level and type of regulatory oversight over the implementation and operation of NMS in Asia, in order to be able to lock in the positive impacts while at the same time avoiding negative impacts:

1. **Legalise NMS through regulations**, i.e. issuing licences based on specific conditions rather than simply banning them. The ideal solution lies somewhere between the two extremes of no regulatory oversight at all and an outright ban. Operation of NMS should be subject to license, and operational requirements. These conditions will likely include:
    - Levels of mobility provision;
    - Levels of personal security;
    - Infrastructure requirements;
    - Levels of road safety;
    - Costs and ticketing;
    - Insurance;
    - Condition of vehicles;
    - Requirements on drivers;
    - Parking regulations;
    - Zones for operations (priority and/or prohibited);
    - Data specifications and data sharing requirements;
    - Adherence to data privacy.
2. **Use regulation to guide the sustainable development of NMS** to serve the social good, and to avoid primarily investment-led implementation. The development and uptake of NMS often goes through cycles, which mean regulations need to be sufficiently agile to identify these and give the right regulatory guidance to steer development in such a way, that the needs of the societal good and of sustainable development can be met.
3. **Use regulation to ensure proper conditions of workers** in the NMS industry.
4. **Tailor regulations to the specific needs and conditions** at the local level, following national guidelines and development principles**.** Given the vast differences (e.g. culturally, climatic, economically, urban form, level of existing public transport services, etc.) there can be no one-size-fits-all approach. The best NMS implementation and regulatory

oversight needs to be determined locally, ideally through co-creation and stakeholder dialogue.

5. **Local regulations should focus on NMS levels** (except for licensing) and be technology and provider neutral. The starting point for regulations needs to be the transport policy objectives, not the technology. A city or region needs to define its policy principles for urban transport and development. NMS can then be part of the toolbox for sustainable urban mobility, but it needs to be about performance, not specific technologies. Careful attention should be given when considering standards relating to both physical, and digital components, to avoid unnecessary technology, or vendor lock-in.
6. **Ensure that NMS are integrated into the overall mobility system** by promoting Mobility-as-a-Service (MaaS) and complement the existing and future public transport system.
7. **Use and promote the principle of mobility data as a public good.** Data sharing between the public and the private sector in the context of transport will lead to an added value of these data sets, which should be available for the greater good to make transport more sustainable. In this context, data security including protection of private and commercial data is also key.
8. **Use some elements of data-led regulation**, i.e. defining a set of criteria and corresponding evaluation framework can provide sufficient flexibility to the NMS. Given the dynamic nature of the NMS market, regulators might already want to consider utilising a mix of traditional descriptive regulations and of data-led regulation, the latter wherever the existence and access to data lends itself to it. Quite important to this point is the need to set clear data-sharing requirements for NMS entities. The nature of NMS inherently enables the generation of a wealth of data, which are not only important in monitoring the performance of such services (and their adherence to operating standards) but can also be beneficial for informing wider planning and strategy development in cities. Stipulations requiring public application programme interfaces (APIs) that are based on authenticated, standardised formats (e.g. Mobility Data Specification, General Bike Share Feed Specifications), as well as data privacy practices and requirements should ideally be put in place (Transportation for America, 2021);
9. **Adapting governance structures, and upgrading capacities** are key considerations for authorities. Considering the pace of proliferation of NMS schemes, the way it is integrating ICT and transportation services, and the intricacies that are brought about by the disruptive nature of such schemes, authorities would need to rethink how their structures and capacities may be able to adapt to such changes towards ensuring that that system transition is achieved in a safe, equitable, and sustainable way.
10. **Further targeted multi-stakeholder research and cooperation** both internationally and between the public and the private sector is key to sustainability. The development of NMS systems, services, business models, and transport modes is highly dynamic and in flux, therefore exchange of information, experiences, and best practice is essential. There is also the need for more research into the effects

NMS on urban mobility. The utilisation of a “Living Lab” approach for conducting pilot projects and experiments related to NMS is highly recommended. Essentially, a living lab purposely conducts the analysis of issues, the design of solutions (e.g. in this case, NMS-related solutions), the conduct and monitoring of experiments in real-life settings, and the iteration of the solution with the cooperation of different stakeholders (e.g. citizens, authorities, academe, private sector). These real-life experiments would surface challenges and opportunities that emanate from the interaction of the technologies/services, with the local markets, regulations, and social acceptance and behaviours.

Whilst both the region and NMS concepts are likely to continuously develop at a rapid pace, learning more about NMS, and cooperating internationally should have the desired impact of this study to put NMS at the centre of sustainable urban mobility in Asia. There will be a need to consider a holistic approach that wrap arounds complex issues and interactions between mobility, technology, the platform economy, society, environment and infrastructure.

REFERENCES

ADEME (2019). *Usages Et Usagers des Trottinettes Électriques En Free-Floating En France*.

Arthur D Little Future Lab (2014). *The Future of Urban Mobility 2.0*. https://www.adlittle.com/sites/default/files/viewpoints/2014_ADL_UITP_Future_of_Urban_Mobility_2_0_Full_study.pdf

ASEAN (2012). *Regional Action Plan on Healthy ASEAN Lifestyles.* https://asean.org/?static_post=regional-action-plan-on-healthy-asean-lifestyles

Baer, J. (2019 Jun 4). "To dock or not to dock? The lowdown on dockless bike-share schemes." *JuliusBaer.com.* https://www.juliusbaer.com/en/insights/future-mobility/to-dock-or-not-to-dock-the-lowdown-on-dockless-bike-share-schemes/

Bakker, S., Guillen, M., Nanthachatchavankul, P., Zuidgeest, M., Pardo, C., Maarseveen, M. (2017). "Hot or not? The role of cycling in ASEAN megacities: Case studies of Bangkok and Manila." *International Journal of Sustainable Transportation*. 2017, Vol. 0, No. 0, 1–16. https://ris.utwente.nl/ws/portalfiles/portal/29087457/Bakker2017hot.pdf

Bee smart city (n.d.). *Kick e-scooters.* https://hub.beesmart.city/en/solutions/tag/e-scooter-sharing

China Ministry of Transport (China MoT). (2017). Guiding Opinions of 10 Departments including the Ministry of Transport on Encouraging and Regulating the Development of Internet Rental Bicycles. http://www.gov.cn/xinwen/2017-08/03/content_5215640.htm

Clewlow, R., Mishra, G. (2016). "Shared Mobility: Current Adoption, Use, and Potential Impacts on Travel Behavior." *Transportation Research Board 96th Annual Meeting*, Washington DC, United States. https://trid.trb.org/view.aspx?id=1439277

CNBC (2019 Aug 5). "Chinese rideshare giant Didi Chuxing makes big move in driverless car race" CNBC. https://www.cnbc.com/2019/08/05/chinese-rideshare-giant-didi-makes-big-move-in-driverless-car-race.html

Cox, W. (2017 Jun 13). "Dispersed Cities: Starting the 3rd Decade." *newgeography.* https://www.newgeography.com/content/005650-dispersed-cities-starting-3rd-decade

Cuyco, J. (2021 Mar 8). "PH needs more bike lanes, but gov't slow in building them." *Rappler.* https://www.rappler.com/business/philippines-needs-more-bike-lanes-government-slow-building-them

Daudey, L. (n.d.). "Challenges of a Future Bike-Sharing System: Manila." *Smart Cities Dive.* https://www.smartcitiesdive.com/ex/sustainablecitiescollective/manila-bike-sharing/119536/

Dudley, G., Banister, D., Schwanen, T. (2017). "The Rise of Uber and Regulating the Disruptive Innovator." *The Political Quarterly* Vol. 88, Issue 3 July–September 2017, pp. 492-499. https://onlinelibrary.wiley.com/doi/abs/10.1111/1467-923X.12373

European Commission (EC) (2020 July 3). *Boosting the EU's green recovery: Commission invests €1 billion in innovative clean technology projects.* https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1250

Fortuna, C. (2020 Dec 6). "India Imposes New Regs For Ride-Sharing Companies, Cuts Commissions." *Clean Technica.* https://cleantechnica.com/2020/12/06/india-imposes-new-regs-for-ride-sharing-companies-cuts-commissions/#:~:text=India%20Imposes%20New%20Regs%20For%20Ride%2DSharing%20Companies%2C%20Cuts%20Commissions,-

Carolyn%20Fortuna&text=Uber%2C%20Ola%2C%20and%20other%20app,to%20be%20Uber's%2026%25%20commission.
Frazer, J. (2019, Mar 11). "New Mobility Worth Billions? Venture Capital Thinks So." *Forbes.com.* https://www.forbes.com/sites/johnfrazer1/2019/03/11/new-mobility-worth-billions-venture-capital-thinks-so/#6599b42c47d8

Future Mobility Finland (n.d.). "Mobility as a Service." *Futuremobiltyfinland.fi website.* https://futuremobilityfinland.fi/vision/mobility-as-a-service/

GECKO (2019). *Analysis of regulatory responses and governance model*. http://h2020-gecko.eu/fileadmin/user_upload/GECKO_D2.5_Final_analysis_of_regulatory_responses_and_governance_models.pdf

Getcruise.com website. https://www.getcruise.com/technology/

Gojek Tech. (n.d.). "Gojek Rebrand Story." https://blog.gojekengineering.com/gojeks-rebrand-story-the-new-logo-fef8108ce6a

Government of Shanghai (2017). *Policy 2017* (93). http://www.shanghai.gov.cn/nw2/nw2314/nw2319/nw12344/u26aw54099.html

Guttentag, D., Smith, S. (2017) ."Assessing Airbnb as a disruptive innovation relative to hotels: Substitution and comparative performance expectations." *International Journal of Hospitality Management* Vol. 64, July 2017, pp. 1-10. https://www.sciencedirect.com/science/article/abs/pii/S0278431916302250

Hawkins, A. (2019 Sept 26). "Inside Uber's Plan to Take over City Life with CEO Dara Khosrowshahi." *Theverge.com.* https://www.theverge.com/2019/9/26/20885185/uber-ceo-dara-khosrowshahi-interview-exclusive

Hawkins, A., (2019, May 14). "Uber drivers are freelancers, not employees, federal labor lawyer says." *Theverge.com.* https://www.theverge.com/2019/5/14/18623467/uber-driver-freelancers-employees-federal-labor-lawyer-contractor

Henao, A. (2017). *Impacts of Ridesourcing – Lyft and Uber – on Transportation including VMT, Mode Replacement, Parking, and Travel Behavior*. [Doctoral Dissertation Defense PowerPoint slides]. https://media.wix.com/ugd/c7a0b1_68028ed55eff47a1bb18d41b5fba5af4.pdf

Ibold, S. (n.d.). *The Evolution of Free-Floating Bike Sharing in China*. http://sutp.transport-nama.org/en/news-reader/the-evolution-of-free-floating-bike sharing-in-china.html

The International Council on Clean Transportation (ICCT) (2017). *Roadmap model baseline results* (August 2017). https://theicct.org/file/3037/download?token=6sQzGz6k

International Telecommunication Union (ITU) (2021). Individuals using the Internet (% of population). World Telecommunication/ICT Indicators Database. https://data.worldbank.org/indicator/IT.NET.USER.ZS

Kamiya, G., Teter, J. (2019, Mar 28). "Shared, automated…and electric?" *IEA website.* https://www.iea.org/commentaries/shared-automated-and-electric

Kemp, S. (2021). Digital 2021: Global Overview Report. https://datareportal.com/reports/digital-2021-global-overview-report

Land Transportation Office of the Philippines (LTO). (2020). Registered Motor Vehicles. https://www.foi.gov.ph/requests/aglzfmVmb2ktcGhyHQsSB0NvbnRlbnQiEExUTy01MzQ1MDkyNjAwOTgM

Lazarus, J., Shaheen, S., Young, S., Fagnant, D., Voege, T., Baumgardner, W., Fishelson, J., Lott, J.S. (2017). Shared Automated Mobility and Public Transport. UC Berkeley: Transportation Sustainability Research Center. https://escholarship.org/uc/item/6589k2h1

Lazer, L., Khandelwal, N., Wellman, J. (2020, Jan 30). "Why is sustainable transport a great investment?" *World Bank Blogs.* https://blogs.worldbank.org/transport/why-sustainable-urban-transport-great-investment

Leverenz, J., Vajpayee B., Li, M. (2019, Dec 18). "Ride Hailing in Emerging Markets Is More Than Transport." *Invesco Ltd.* https://www.blog.invesco.us.com/ride-hailing-in-emerging-markets-is-more-than-transport/

Liao, R. (2019 May 6). "Can China's Ride-hailing Leader Didi Repair its Troubled Reputation?" *Techcrunch.* https://techcrunch.com/2019/05/06/didi-safety-pivot/

Lorenciana, C., Dagooc, E. (2017, May 31). "Uber and Grab continue to buoy Cebu auto sales." *The Philippine Star*. http://www.philstar.com/cebu-business/2017/05/31/1705178/uber-and-grab-continue-buoy-cebu-auto-sales

MaaS Alliance (n.d.). "What is Maas?" *maas-alliance website.* https://maas-alliance.eu/homepage/what-is-maas/

Martin E.W., Shaheen S.A. (2011). "Greenhouse gas emissions impacts of carsharing in North America." *IEEE Trans Intell Transp Syst*. 2011;12(4):1074–86. http://ieeexplore.ieee.org/document/5951778/

Masson, R., Trentini, A., Lehuede, F., Malhene, N. (2015). "A shared passengers & goods city logistics system." *European Journal of Transportation Logistics* 2015. https://www.researchgate.net/publication/280751672_A_shared_passengers_goods_city_logistics_system

Metro Manila Development Authority (MMDA) (2015 Aug 29). "Metro Manila bikelanes and bikesharing." *Official Gazette of the Philippines.* https://www.officialgazette.gov.ph/2015/08/29/metro-manila-bikelanes-and-bikesharing/

Midgely, P. (2011). Bicycle-Sharing Schemes: Enhancing Sustainable Mobility in Urban Areas. United Nations Department of Economic and Social Affairs Commission on Sustainable Development Nineteenth Session New York. https://sustainabledevelopment.un.org/content/dsd/resources/res_pdfs/csd-19/Background-Paper8-P.Midgley-Bicycle.pdf

Ministry of Road Transport and Highways – Government of India (MORTH) (2020). *The Motor Vehicle Aggregators Guidelines 2020.* https://morth.nic.in/sites/default/files/notifications_document/Motor Vehicle Aggregators27112020150046.pdf

Mohiedin, M., Vandycke, N. (2017 Jul 10). "Sustainable Mobility for the 21st Century." *World Bank* website. https://www.worldbank.org/en/news/feature/2017/07/10/sustainable-mobility-for-the-21st-century

Nair, C. (2020 Sept 25). "Why resilience - not technology - is the answer to our biggest challenges." *World Economic Forum website*. https://www.weforum.org/agenda/2020/09/insured-resilience-priority-heres-why/

NDC Partnership (n.d.) *Country Pages*. https://ndcpartnership.org/countries-map

Neckermann Strategic Advisors (n.d.). *Mobility as a Service (MaaS)*.
https://www.neckermann.net/2017/06/02/mobility-as-a-service/

Office of the President – Philippines (2009). *Administrative Order No. 254, s. 2009.*
https://www.officialgazette.gov.ph/2009/01/30/administrative-order-no-254-s-2009/

Organisation for Economic Cooperation and Development (OECD) (2020*). Cities in the World: A New Perspective on Urbanisation.*
https://www.oecd-ilibrary.org/urban-rural-and-regional-development/cities-in-the-world_d0efcbda-en

Oxford University Press (n.d.). *Oxford Reference webpage.*
https://www.oxfordreference.com/view/10.1093/oi/authority.20110810104753313

Palm, M., Farber, S., Shalabi, A. (2020). "Equity Analysis and New Mobility Technologies: Toward Meaningful Interventions." *Journal of Planning Literature* Vol. 36, Issue 1, 2021.

Pankratz, D., Eggers, W., Nuttall, K., Turley, M. (2018, Dec 20). "Regulating the future of mobility

Partnership for Sustainable Low Carbon Transport (SLOCAT) (2018). *Transport and Climate Change Global Status Report 2018*.
http://www.slocat.net/wp-content/uploads/legacy/slocat_transport-and-climate-change-2018-web.pdf

Pikri, E. (2017). "4 Months In & 20,000 Signups Later, oBike Proves Bicycle Vandalism Is Manageable in M'sia." *Vulcan Post.*
https://vulcanpost.com/617508/malaysia-obike-update-bike-sharing-startup/

Rain Books (1998). *Car Sharing Handbook.*
https://web.archive.org/web/20070720225314/http://www.rainmagazine.com/handbook.htm

Rayle, L., Dai, D., Chan, N., Cervero, R., Shaheen, S. (2016). "Just a better taxi? A survey- based comparison of taxis, transit and ridesourcing services in San Francisco." *Transport Policy*, 45(2016) 168-178. Doi:10.1016/j.tranpol.2015.10.004

Reuters (2018 Aug 6). "China's Didi to invest $1 billion in its auto services platform." *Reuters.*
https://www.reuters.com/article/technologyNews/idCAKBN1KR0IG-OCATC?edition-redirect=ca

Reuters (2018b). "China's Didi gets $500 million funding from Booking.com parent." *Reuters.*
https://www.reuters.com/article/us-didi-chuxing-booking-hldg-investment/chinas-didi-gets-500-million-funding-from-booking-com-parent-idUSKBN1K70TH

Rosane, O. (2019 Sept 24). "UN Climate Action Summit Falls 'Woefully Short' of Expectations." *EcoWatch.*
https://www.ecowatch.com/un-climate-action-summit-2640575796.html

Rosnan, H., & Abdullah, N. (2018). "An Exploratory Study of Bicycle Sharing in Malaysia." *Journal of ASIAN Behavioural Studies* 4(12).
https://www.researchgate.net/publication/329423241_An_Exploratory_Study_of_Bicycle_Sharing_in_Malaysia

SAE International (2018a). "Definitions for Terms Related to Shared Mobility and Enabling Technologies." *SAE Mobilus Website.*
https://www.sae.org/publications/technical-papers/content/wp-0010/

SAE International (2018b). "Taxonomy and Definitions for Terms Related to Shared Mobility and Enabling Technologies." *SAE Mobilus Website.*
https://www.sae.org/standards/content/j3163_201809/

Schaller, B. (2017). *Unsustainable? The Growth of App-Based Ride Services and Traffic, Travel, and the Future of New York City.*
http://schallerconsult.com/rideservices/unsustainable.htm

Schwab, K. (2016 Jan 1). "The Fourth Industrial Revolution: what it means, how to respond." *World Economic Forum website*.
https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

Shaheen, S.A., Guzman, S., Zhang, H. (2010). Bikesharing in Europe, the Americas, and Asia: Past, Present, and Future. 2010 Transportation Research Record: Journal of the Transportation Research Board, 2143. doi:
http://trrjournalonline.trb.org/doi/abs/10.3141/2143-20

Shaheen, S.A., Chan, N.D., Micheaux, H. (2015b). "One-way carsharing's evolution and operator perspectives from the Americas." *Transportation*. May 2015, Vol. 42, Issue 3, pp. 519-536. First online: 04 April 2015

Shaheen, S.A., Sperling, D., Wagner, C. (1998). "Carsharing in Europe and North America: Past, Present, and Future." *Transportation Quarterly.* Vol. 42, No. 3, pp. 35-52.
https://web.archive.org/web/20120320192219/http://www.uctc.net/papers/467.pdf

Shaheen, S.A., Wagner D., Wagner C. (1999). "A Short History of Carsharing in the 90's." UC Davis: Institute of Transportation Studies. https://escholarship.org/uc/item/6p3305b0

Shanthi, S. (2019 Dec 31). "Paving The Way for Emobility: State and Central Government EV Policies in India." *Inc42.com.*
https://inc42.com/features/paving-the-way-for-emobility-state-and-central-government-ev-policies-in-india/#:~:text=The%20government%2Dbacked%20Energy%20Efficiency,and%20three%2Dwheelers%20by%202030.

Sharmeen, F., Ghosh B., Mateo-Babiano, I. (2021). "Policy, users and discourses: Examples from bikeshare programs in (Kolkata) India and (Manila) Philippines." *Journal of Transport Geography,* Vol. 90 (2021) 102898

South China Morning Post (2021 May 15). "Beijing orders Meituan, Didi Chuxing and other ride-hailing providers to give drivers a fair share of revenue." *SCMP.*
https://www.scmp.com/tech/big-tech/article/3133614/beijing-orders-meituan-didi-chuxing-and-other-ride-hailing-providers

Storme, T., Casier, C., Azadi, H., Witlox, F. (2021). "Impact Assessments of New Mobility Services: A Critical Review." *Sustainability* 2021, 13, 3074.

Streeting, M., Brown, S. (2019). *The Economic Benefits of New Mobility for Australia.* https://www.lek.com/

Taylor, A. (2018 Mar 22). "The Bike-Share Oversupply in China: Huge Piles of Abandoned and Broken Bicycles." *The Atlantic.*
https://www.theatlantic.com/photo/2018/03/bike-share-oversupply-in-china-huge-piles-of-abandoned-and-broken-bicycles/556268/

The Verge (2020 Nov 17). "China built the first electric car designed exclusively for ride-hailing." The Verge.
https://www.theverge.com/2020/11/17/21570016/didi-chuxing-byd-electric-car-ride-hailing-china

TNE (2018). *Integrating new mobility services in urban transport.*
https://www.transportenvironment.org/sites/te/files/publications/2018_03_New_mobility_policy_paper_final.pdf

Transportation for America (n.d.). *Shared Active Transportation Playbook.*
https://playbook.t4america.org/data/

U.K. Department for Transport (2019). *Future of Mobility: Urban Strategy.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/846593/future-of-mobility-strategy.pdf

U.S. Department of Transportation Federal Highway Administration (USDOT FHA) (2016). *Shared Mobility Current Practices and Guiding Principles.* https://ops.fhwa.dot.gov/publications/fhwahop16022/fhwahop16022.pdf

UN-Habitat, United Nations Environment Programme (UNEP), Partnership for Sustainable Low Carbon Transport (SLOCAT) (2015). *Analysis of the transport relevance of each of the 17 SDGs.* https://sustainabledevelopment.un.org/content/documents/8656Analysis%20of%20transport%20relevance%20of%20SDGs.pdf

UN-Habitat (2016). *The New Urban Agenda*. http://habitat3.org/the-new-urban-agenda

United Nations (UN) (1972). *Report of the United Nations Conference on the Human Environment*. https://sustainabledevelopment.un.org/milestones/humanenvironment

United Nations (UN) (2020). *The Impact of Rapid Technological Change on the Sustainable Development Goals and Targets*. https://www.un.org/pga/74/event/the-impact-of-rapid-technological-change-on-the-sustainable-development-goals-and-targets/

United Nations (UN) (n.d.-a). *Millennium Development Goals and Beyond 2015.* https://www.un.org/millenniumgoals/bkgd.shtml

United Nations (UN) (n.d. -b). *Climate Action.* https://www.un.org/ClimateChange

United Nations Convention on Climate Change (UNFCCC) (n.d.). *The Paris Agreement*. https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement

United Nations Department of Economic and Social Affairs (UNDESA) (2019 September 24). *Greta Thunberg tells world leaders 'you are failing us', as nations announce fresh climate action.* https://www.un.org/development/desa/youth/news/2019/09/greta-thunberg/

United Nations Department of Economic and Social Affairs (UNDESA) (1992). *United Nations Conference on Environment and Development (UNCED), Earth Summit.* https://sustainabledevelopment.un.org/milestones/unced

United Nations Department of Economic and Social Affairs (UNDESA) (n.d.). *The 17 SDGs.* https://sdgs.un.org/goals

United Nations Department of Economic and Social Affairs (UNDESA) (2018). *2018 Revision of World Urbanisation Prospects*. https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html

United Nations Environment Programme (UNEP) (n.d.). *Building Back Better: Why we must think of the next generation*. https://www.unenvironment.org/news-and-stories/story/building-back-better-why-we-must-think-next-generation

United Nations Framework Convention on Climate Change (UNFCCC) (n.d.). *What is the Kyoto Protocol?* https://unfccc.int/kyoto_protocol

United Nations Framework Convention on Climate Change (UNFCCC) (2015). *COP 21 Sessions*. https://unfccc.int/process-and-meetings/conferences/past-conferences/paris-climate-change-conference-november-2015/cop-21

United Nations Framework Convention on Climate Change (UNFCCC) (2020 April 1). COP26 Postponed. https://unfccc.int/news/cop26-postponed

United States Environmental Protection Agency (USEPA). (2020). Understanding Global Warming Potentials. https://www.epa.gov/ghgemissions/understanding-global-warming-potentials#:~:text=Nitrous%20Oxide%20(N2O,than%20100%20years%2C%20on%20average.

Vanterpool, V. (2019, Mar 7). "United Nations Launches New Initiative to Reduce Road Crashes." *Vision Zero Network.* https://visionzeronetwork.org/united-nations-launches-new-initiative-to-reduce-road-crashes/

Waymo.com website. https://waymo.com/safety/

Wikipedia. (2021). *List of Largest Cities*. https://en.wikipedia.org/wiki/List_of_largest_cities

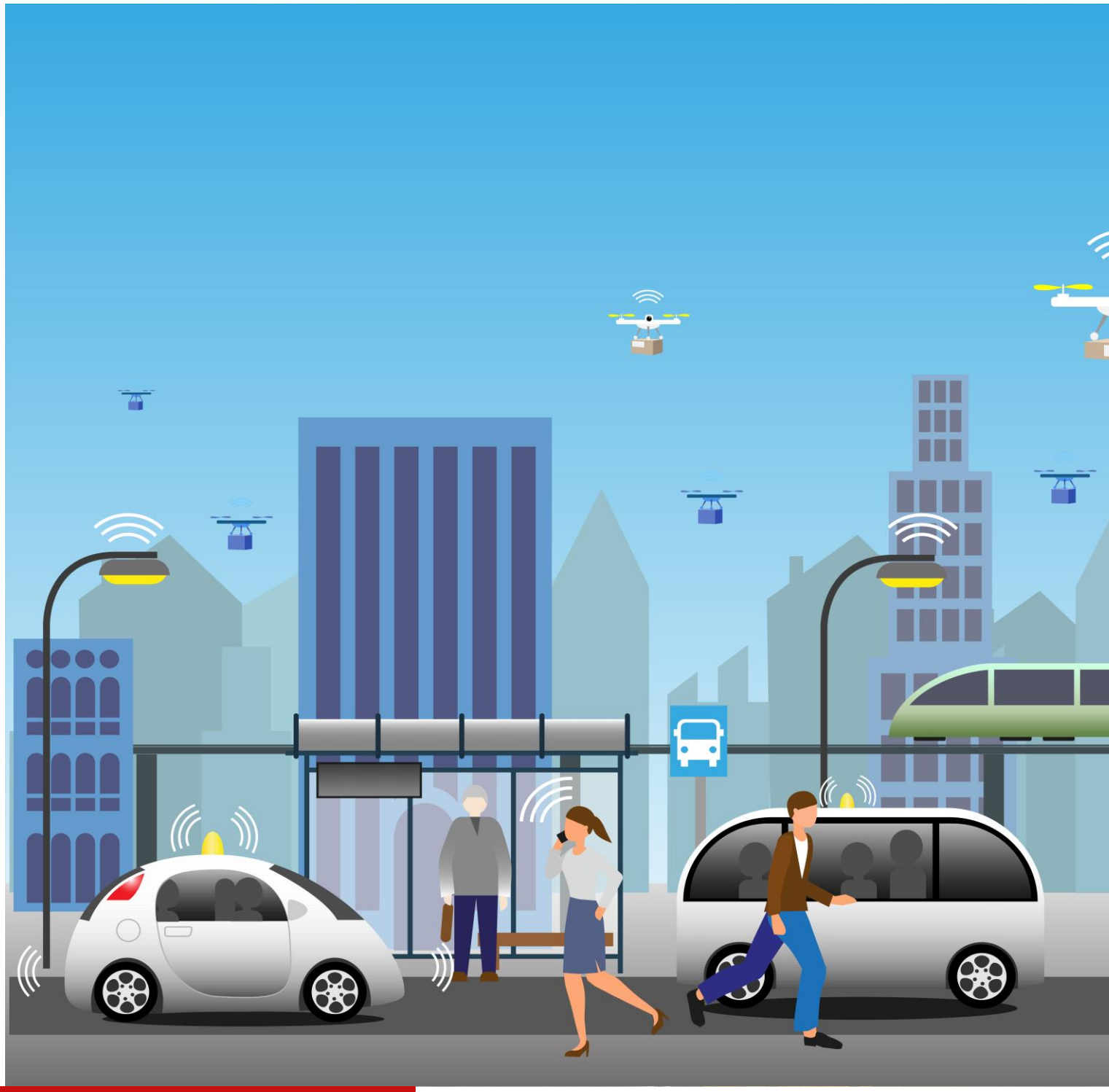
World Bank (2021). World Development Indicators. https://data.worldbank.org/indicator

World Business Council for Sustainable Development (WBCSD) (n.d.). SiMPlify. https://www.wbcsd.org/Programs/Cities-and-Mobility/Sustainable-Cities/Transforming-the-Built-Environment

World Commission on Environment and Development (1987). *Report of the World Commission on Environment and Development: Our Common Future*. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

World Economic Forum (WEF) (n.d.). *The Great Reset*. https://www.weforum.org/great-reset/

World Resources Institute (WRI) (n.d.). "New Sustainable Mobility." *WRI Ross Centre website.* https://wrirosscities.org/newmobility



Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Sitz der Gesellschaft
Bonn und Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Deutschland
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Deutschland
T +49 61 96 79-0
F +49 61 96 79-11 15

E info@giz.de
I www.giz.de