International Transport Forum | CPB Corporate Partnership Board

Transport Innovations from the Global South

Case Studies, Insights, Recommendations

Corporate Partnership Board Report

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Executive summary

What we did

This report seeks to open new perspectives for discussing and implementing transport innovation across the globe. It highlights solutions emanating from the Global South and encourages policy makers to look at them as sources of inspiration for innovation. It discusses benefits and challenges of implementing these solutions in the Global North and also suggests opportunities for South-to-South exchange. Moving beyond the concept of "reverse innovation", it puts aside the underlying assumption that innovation flows from North to South only. Overall, this report shows that the transport sector globally stands to benefit from Global South transportation and innovation practices.

To illustrate this, the report presents twelve case studies that show the tremendous potential of innovations developed and implemented in the Global South to inspire new solutions elsewhere. These case studies focus on public transport, shared mobility services and other ideas that increase the accessibility, connectivity and sustainability of transport systems. The report addresses both the transport of people and goods, featuring examples from urban mobility to long-haul logistics and air transport.

The chapters of this report have intentionally not been composed around specific transport modes, but around elements of answers to major questions that relate to innovation: who is involved in the process? In what ways and in which capacities? What are the drivers of innovation? Who benefits from innovation?

This study builds on a first report, published in May 2019, which served as an introduction to the topic. The present report includes additional examples to further illustrate each chapter's main idea. It presents findings and recommendations for policy makers and will serve as input for the International Transport Forum's Annual Summit on "Innovation for Sustainable Development" in May 2020.

What we found

The innovation process is geographically fragmented. From conception to implementation, a new solution is shaped by the exchanges of ideas, expertise and technologies between different regions of the world. This initial fluidity helps transport innovations to travel across contexts to a certain extent, although they will have to be adapted to local needs to successfully solve problems.

Governments actively shape innovation in transport. They are critical actors in today's knowledge-based innovation economies. They provide an enabling framework as well as sustained support for innovation. Beyond acting as facilitators, governments shape the vision and the mission of newly developed transport solutions. As proactive clients of innovative practices and products, they take on risk through major investments in Research and Development, in education and even in private initiatives.

Digitisation is transforming paratransit practices of the Global South in ways that are informing mobility practices in the Global North. Thinking of shared mobility as a novelty emanating from the Global North ignores how paratransit has been developed in emerging countries to cope with the lack of efficient transport options. Although they provide an essential service, paratransit systems are often very poor quality. Applying digital solutions can help overcome some of the shortcomings of paratransit. They can greatly improve commuters' journeys and enable them to plan their trips more efficiently. The app-based systems developed for paratransit help retain modal share for public transport. The data generated can help cities to design more accessible transport systems. In return, applying digital solutions developed for paratransit networks has helped develop more flexible mobility services in the Global North.

Successful innovations are rooted in existing embedded socio-cultural mobility practices. Innovations inspired by existing or sometimes forgotten practices often create the most promising developments for

transport systems. Long-standing socio-cultural mobility practices can be successfully revisited with the help of new technologies to produce more efficient transport solutions and promote driver well-being, passenger comfort and sustainable first and last-mile options.

Innovation is not a one-way street, and it is not a linear process. New solutions are not systematically based on a rationale where the focus is exclusively on a digital service that connects offer to demand. Some problems require different types of interventions than others; there is no one-size-fits-all innovation model.

The transport sector is increasingly shaped by unconventional actors and their new business models. The on-demand service industry, technological innovation in telecommunications, banking and finance are changing established models for accessing transport. Their impact on mobility is palpable and will certainly grow in the future – even if the context they traditionally operate in does not have strong links to transport.

What we recommend

Update transport policy and regulation to accommodate innovation that can contribute to economic growth and make transport more sustainable

A coherent policy stance towards technology and transport will foster adoption of innovative mobility solutions. In a variety of transport sub-sectors, restrictive regulation currently lags behind technological advances, thereby hampering new developments and deterring potential adopters of new services. Governments should stay informed of rapidly emerging and developing transport solutions and ensure that outdated and fragmented regulatory frameworks are updated. New technologies may need to be accorded the status of a recognised category of vehicle if they are to operate legally. National or regional governments may need to establish model guidelines for lower levels of government to use a basis for permitting and regulation.

Cooperate with research and industry, coordinate with all government levels

With the right policies and incentives in place, governments will be able to generate green growth and successfully answer pressing needs of the transport sector, such as providing sustainable, affordable and accessible mobility. Electrification of transport will benefit from coordinated policy measures between research, industry and transport sectors and policies that are aligned across local, regional and national levels. Introducing policy instruments such as non-monetary incentives and attractive contract conditions for fleet operators will also pave the way to further beneficial outcomes.

Leave room for bottom up innovation through a light regulatory touch

Technology-induced innovation can reshape transport systems as well as logistic industries in a way that serves the common good, but only if policy avoids stifling innovation through obsolete regulation. Policy makers thus should maintain a permissive regulatory environment and avoid being blinded by one-size-fits-all type of innovation. An open approach to innovation will allow transferring lessons from app-based mobility to public transport while also balancing nimble private transport options with better mass transport tailored to the mobility culture of each city.

Be ready to facilitate discussion between innovative actors and traditional operators

Since innovations can often be countered by incumbents who try to protect their own interests, public authorities should recognise the role played by all stakeholders and constructively engage with them. Authorities should be able to establish locally-appropriate incentives in their dialogue with transport operators to facilitate innovation; by the same token national government may need to intervene to overcome obstacles to innovative responses to poor transport services.

Foster innovation in the delivery of concessioned transport services

Incumbent operators of transport services subject to exclusive concessions, including those run by government-owned companies, may use existing regulations to exclude innovative services. Concessions are used where network economies mean that a single operator can supply the market more efficiently. Concessions are often associated with subsidies to provide otherwise unsustainable public services. Innovation can challenge the prevailing models of service delivery, offering higher quality services, or new services that partially overlap with existing services, or equivalent services at lower cost of subsidy.

Regulation should preserve and create opportunities for access to markets for superior services and governments should explore the potential for innovation to replace or complement current publicly subsidised delivery models (e.g. public transport versus dockless and docked shared two- and three-wheelers). Decision-making by transport authorities should be guided by the overall objectives of sustainable transport policy and transport sector regulation is not likely to be the best way to respond to economy-wide issues such as the conditions of employment in the gig economy.

Support change and build on existing cultural practices in order to improve quality of life for all

In any attempt to innovate or to transfer innovation from elsewhere, local needs should be considered and local assets mobilised. Socio-cultural embedded mobility practices should be at the forefront of innovation as the outcome solution is then more likely to be widely embraced by the population. Existing transport practices should not be considered as something of the past but rather as a basis that innovative practices can incrementally improve – or that can be re-introduced into mobility systems.

Create innovation sandboxes/living labs

A sandbox is intended to enable large groups to work without hierarchy towards the creation of innovative solutions and provide a safe space where innovative solutions can be tested without the full burden of regulation. Authorities should support such initiatives to foster the creation of new solutions while controlling for the impact of its application in real-life scenarios.

Look beyond transport towards non-traditional policy matters

Public authorities should stay informed of the variety of non-traditional actors who are increasingly shaping the future of transport. Acknowledging their role and understanding how they benefit from, or challenge, current regulations is imperative for finding adequate regulatory responses to their business models. Specific attention should be given to the wide range of new business models that rely on on-demand transport and to the new financial services ecosystems. Public authorities should engage with these unconventional actors in order to remain relevant as regulators in a fast-changing transport and economic landscape.

Expanding innovation horizons: An introduction

Innovation can be broadly understood as the process of translating an idea or invention into a good, service or policy that societies will adopt on a large scale. It differs from an invention in that innovation implies implementation, adoption and diffusion.

In the transport sector as elsewhere, this means creating greater value through the development of more effective products, processes, technologies or business models. Innovation is an essential part of the response to the challenges faced in the transport sector, including those related to climate change. In the current context marked by the 2008 economic crisis, innovation's contribution to driving growth and creating new employment opportunities is particularly important. This report focuses on how innovative solutions can effectively answer pressing issues related to transport accessibility, connectivity and sustainability around the world.

The Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, defines innovation as:

> …a new or improved product or process (or combination thereof) that differs significantly from […] previous products or processes and that has been made available to potential users or brought into use by the [innovator]. (OECD/Eurostat, 2018)

The OECD identifies two main types of innovation: product innovation or (business/institutional) process innovation. Product innovation concerns goods or services (either of which may not involve direct sales to consumers – as in the case of digital products offered at no cost to consumers but that facilitate other value-creating transactions). OECD (2018) breaks down process innovations into six sub-categories:

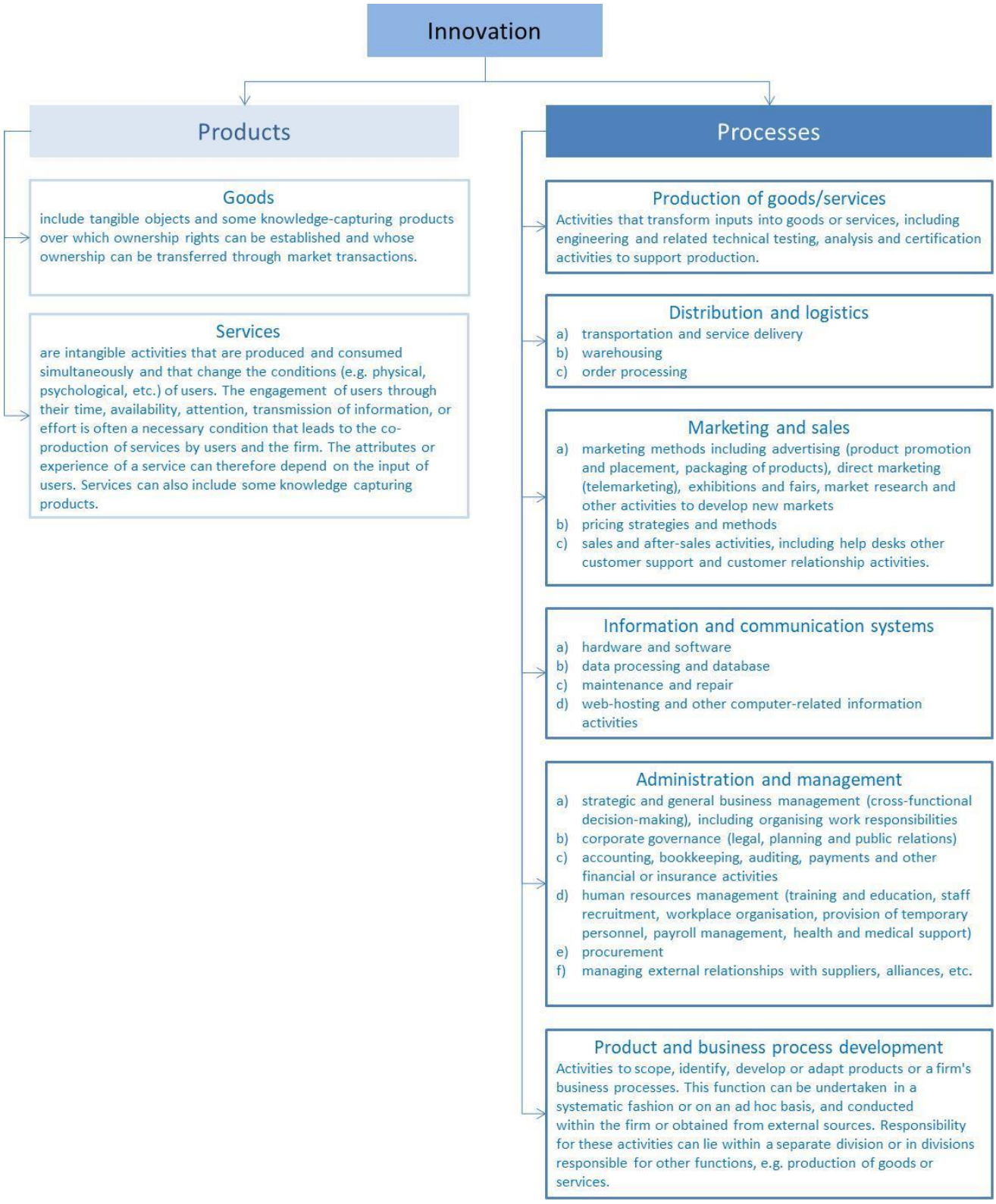
1. Production of goods or services
2. Distribution and logistics
3. Marketing and sales
4. Information and communication systems
5. Administration and management
6. Product and work process development

These then form the "innovation space" map (Figure 1) that can help situate what types of innovation are discussed in this report and determine if there are specificities in the types of innovations that emerge in the Global South versus in the Global North.

Innovation is diverse in its conception, development and deployment. For instance, incremental innovations sustain existing products, markets and value networks, whereas disruptive innovations create new ones.

Very early in the 20th century, Schumpeter (1934) emphasised the importance of social context for innovation. Evolutionary economics developed the idea that while innovation is driven by the need to solve problems and survive in a competitive world, it is determined by the local environment. This is often reflected by the numerous tech start-ups springing up in Africa, Asia and Latin America. While many parts of the Global South are grappling with poverty, corruption, political instability and health challenges, booming digital innovation hubs are also emerging. In Africa, for instance these hubs facilitate the emergence of innovative solutions by small entrepreneurs. They also help bridge the gap between innovators, the business sector and the government which is essential for innovations to be economically viable (Jimenez and Zheng, 2018).

Figure 1: "Innovation space" Map: Functional breakdown according to the Oslo Manual 2018



Source: OECD/Eurostat (2018).

This report introduces the argument that innovation is a fluid and sometimes fragmented process which results from the interplay of ideas, expertise and trials across different regions of the world. Technology is often incorporated in the developmental process when innovation arises out of conditions of scarcity. In such cases, innovation does not compete but is complementary to the traditional forms of technology transfer (Srinivas and Sutz, 2008). For instance, some could say the current expansion of free-floating electric two-wheelers in western cities is being stimulated by a diversity of practices: the ubiquity of nimble rickshaws in parts of the Global South, the progress of electrification and battery technology driven by the People's Republic of China, and the initial development of app-based mobility services in the United States.

This report, therefore, puts aside the assumption that innovation flows primarily from North to South. The term Global South in this report refers to low- and middle-income countries in Asia, Africa, Latin America and the Caribbean. It is used interchangeably with "developing and emerging economies". Thus, the Global South includes countries north of the equator, while the Global North extends beyond the high-income countries of North America and Europe to include, for instance, Australia and New Zealand. As putative boundaries between the two regions blur – not least by the near-instant availability of the latest digital technology – the potential for South-to-North and South-to-South transfer increases.

Even in the numerous cases where innovations do flow from the Global North to the Global South, their use and adaptation in the Global South may in many essential respects constitute an "innovation" (Zanello et al., 2016). For example, instant messaging technology developed in the Global North is used to underpin cash transfers and payments among the unbanked in the Global South (Duncombe, 2014).

What are the sources of innovation and are these the same in the Global North as in the Global South? Innovation exhibits strong path dependencies (Dosi, 1982). This path dependency is the result of interactions between various actors and the markets in which innovations are tested. These interactions and markets – e.g. the context of innovation – largely determine which products, services and processes are tested and which are successfully adopted and diffused. Insofar as local contexts differ between Global North and Global South markets – and also differ amongst the latter – the types of innovation that emerge may also be different in nature and scope. This does not preclude the transferability of elements of these innovations from one context to another – indeed, some transfers do occur, as discussed further – but only that certain innovations are more likely to occur in Global South contexts rather than Global North contexts, and vice-versa.

The process of innovating is heterogeneous and operates outside predetermined guidelines. The profusion of terms used to classify innovations illustrates this. However, certain types of innovation are often associated with certain regions of the world. Radical, technology-driven innovation is commonly associated with the developed economies of the Global North. Reviews of innovation in the Global South note that those markets share many common features, notably lower household revenues than in the Global North, poor public and private infrastructure, and poor or, at least, more constrained availability of services (Zeschky, Winterhalter, and Gassman, 2014). These conditions have led to the emergence of innovation characterised by high value and low costs. Such solutions, often interchangeably labelled as cost innovation (Williamson and Zeng, 2009), good-enough innovation (Gadiesh, Leung and Vestring, 2007; Hang, Cheng and Subramanian, 2010), resource-constraint innovation (Ray and Ray, 2010), frugal innovation (Radjou, 2014; Zeschky, Widenmayer and Gassmann, 2011; Economist, 2010), trickle-up innovation (Reena, 2009) or reverse innovation (Immelt, Govindarajan and Trimble, 2009; Trimble, 2012; Govindarajan, 2012), have garnered the interest of policy-makers seeking to address the challenges faced in the Global South.

This report challenges the emphasis put on the role of resource constraints or the need to overcome structural dysfunctions as the driving factor for innovation in the Global South (Radjou, 2014). Case in point, the inspiration for early platform-based ride-sourcing was partially motivated by dysfunctions in taxi and public transport markets in certain Global North, rather than Global South cities.

The notion of "reverse innovation" – often put forward by scholars and development practitioners – is ill-adapted to this report's findings. "Reverse innovation" refers to a solution introduced in a market of the Global South first, and adopted in the Global North afterwards (Immelt, Govindarajan and Trimble, 2009; Govindarajan and Ramamurti, 2011). This market-oriented definition ignores the complexity of the innovation process, whereby a solution ideation and development are inspired by or take place in different geographical locations (Zedtwitz et al., 2015).

Also, the term "reverse innovation" implies expectations that innovation originates by default in the Global North and flows to the developing world. Using language that accepts this as the principal mode of innovation transfer discounts the South's contributions to the global marketplace of ideas. It reinforces the idea that the South's pathway to social and economic development is dependent on support from the North.

By connoting frugality, or innovation arising from necessity as opposed to good leadership, the proposed innovation may be associated with poor quality, undermining potential translation into other contexts. Finally, the term "Reverse Innovation" is a paradox – it breaks down preconceptions of the directionality of knowledge and learning, whilst simultaneously reinforcing it. (Harris et al., 2016)

Three main objections are often formulated to discredit the potential of South-to-North transfer:

First, the idea of transferability itself is heavily criticised. Past attempts to replicate solutions from elsewhere have often failed to take into consideration local assets and needs. Here, innovation transfer is not understood as the duplication and introduction of a product as such in a new market. Rather, this report argues that the ability of transport innovations to travel across contexts can be enhanced by skilful promotion of the core functionality of the solution and by infusion of technology to counteract high labour costs. For instance, the Dabbawala system – whereby over 200 000 home-made lunches are accurately delivered every day to workers in Mumbai city centre – has inspired current food delivery systems across the globe. The Dabbawala system is modelled on a hub and spoke structure where kitchens of local residents in and around the periphery of the city are linked to the workforce in the city using various modes of transport, including foot, bicycle, motorbikes and cars; as well as the Mumbai local train system (Patel and Vedula, 2006).

A second objection argues that Western legal contexts are too rigid and formalised to accommodate innovations that originate in emerging economies. However, when recently facing a global economic crisis, countries of the Global North showed that they had the capacity to make rapid changes to their legal frameworks and regulations. Confronted by the rise of new services such as ride-sourcing or micromobility, regulation in countries of the Global North has already started to adapt and will likely continue to do so.

A third concern often put forward is that countries of the Global North have nothing to learn from transport in the Global South, stereotypically characterised by its clogged traffic and high road casualty rates. The aim of this report is certainly not to recommend South-to-North transfers that would set transport systems back in their progress towards transport safety and efficiency. However, examples of successful innovations in the Global South, ranging from the health care sector to the mobile phone industry, have already spread internationally and made a positive impact in developed countries (Govindarajan and Trimble, 2012). For instance, this report includes a case study on SafeBoda, an app-based motorcycle ride-sourcing and delivery service that prioritises the safety of its users above all else. SafeBoda's model demonstrates how innovative practices in the region have helped tackle the problem of road casualties in Uganda and Kenya and can inform moto-taxi services in the Global North. This report shows that certain mobility traditions and practices in the Global South can benefit global practice in the sector.

This report also seeks to encourage South-to-South learning by opening new perspectives for discussion. Innovations are often thought to be more naturally transferable from one country to another within the Global South. This belief relies on the incorrect assumption that environments in emerging economies are homogenous. However, policy makers in the Global South can still benefit from looking to their neighbours

as sources of inspiration. There are, for instance, some essential features that help shape the nature and scope of innovative products, services and processes differently in the Global South than in the Global North. They go beyond the importance of path dependency and the presence of specific barriers, such as resource and financial constraints, which innovation in the Global South often serves to overcome. In particular, the speed of uptake and potential for diffusion of innovations are strongly linked in the type of innovation considered *in a given context*.

Lower-technology innovations may not rely on sophisticated transmission channels (word-of-mouth may do) and do not require broad pre-conditional capacities (both in knowledge and capital) in order to rapidly diffuse amongst a set of potential adopters (Zanello et al., 2016). Thus some innovations may spread rapidly within certain contexts but may not scale beyond those contexts simply because people have not heard of them. This is less the case now with the advent of global ICT infrastructure and the accompanying access to globalised forms of knowledge, but it is still a factor that partially explains the lack of diffusion of many localised innovations within, and from, the Global South.

Further, a longstanding bias considers that the Global North alone sets the standard for progress. This bias, alongside limited communication channels between emerging economies, has historically led to less cross-pollination of innovations amongst the Global South. This report aims at fostering South-to-South transfer of knowledge.

A recent review of the creation and diffusion of innovation highlights a number of fundamental aspects to consider when contextualising innovation in the Global South (Zanello et al., 2016). These include the nature of the innovation (described above), the appropriateness or fitness for purpose of imported innovations, the effectiveness of communication channels that help diffuse innovations, the nature and cohesiveness of the fabric of firms within and across sectors, the presence and strength of trade bodies and other intermediaries, the importance of governance and institutional arrangements and the internal capacity (resources and skills) within firms and institutions to innovate. All of these are of a dual nature. That is, they can both help and hamper innovation.

Lack of communication and weak trade bodies can result in the emergence of different and uncoordinated innovations, thus resulting in either duplicative or multiplicative effects on innovation. Weak or inexistent governance structures can hamper innovation but they may also provide a degree of freedom to create new solutions. In less structured institutional or firm-level contexts (like those often found in the Global South), innovation is driven by people whose personal entrepreneurial skills and drive, alongside their ability to leverage networks, help in the implementation, adoption and diffusion of innovations – perhaps more so than in many more formal Global North contexts (Zanello et al., 2016).

Globally, transport policy makers strive to achieve the same goals: to provide efficient, sustainable, safe and equitable transport systems that are tailored to local socio-economic contexts. This report focuses on innovations in public transport, shared mobility services and other ideas that increase the accessibility, connectivity and sustainability of transport systems. It addresses the transportation of people and goods, across multiple modes, featuring case studies from urban mobility to long-haul logistics and air transport.

The case studies in this report showcase the use of technology in innovative solutions to transport challenges. In some of the presented cases these underlying technologies are "old", in the sense that they have been around for a while, but are applied innovatively to act as effective solutions to the problems of present day. For instance, BRT systems around the world have helped make transport networks efficient and environment-friendly. Well-planned implementation of this relatively old concept has transformed transport systems in the Global South as well as the Global North. Similarly, the electrification of three-wheeler rickshaws combined with innovative business models serves as another example of adapting an old-tech concept to work as a solution of the problems of the present. Other cases present the application of high-tech and cutting- edge technologies. For instance, the proliferation of drone use in the African

continent and other countries in the Global South to transport goods where no other efficient transport infrastructure is available.

In both instances, these innovations are looked upon as at the culmination point for the actors involved and circumstances under which these innovations take place. True to Schumpeter's original observation, this report looks upon innovation as a multilevel concept where the local environment in which technologies are applied matters just as much as the technologies themselves for the innovation to be a success.

The report aims at expanding innovation horizons and supporting transport policy makers in adopting new transport solutions. It champions the idea that by combining the innovation push of businesses and civic society with the right policies and incentives, governments can generate growth that will significantly reduce the burden from crashes, congestion, inequitable access, pollution and the contribution of transport to climate change, while also providing near-term economic, employment and health benefits (OECD, 2017b). The 12 case studies included in this report present different stories of how this is already happening in the Global South.

More specifically, the chapter "Leading the way" shows that public authorities play a major role in fostering innovation. It demonstrates that the creation of new solutions is not just the realm of garage tinkerers, start-ups and venture capitalists. The chapters "Embracing the informal" and "Revisiting global practices" focus on how embracing, revisiting and modernising existing and embedded practices carry potential for the future of mobility across the Global South and North. The chapter "Expanding transport policies" acts as a final reminder that policy makers should be eager to engage in partnerships with emerging – and often unconventional – actors who contribute to shaping the transport landscapes of today and tomorrow.

This is the second installment of a two-part report. *Expanding Innovation Horizons: Learning from Transport Solutions in the Global South* (ITF, 2019a), published in May 2019, introduced readers to the growing influence on the Global North of innovations generated in the Global South. It also described practical examples and asked questions for policy makers to consider. The present report integrates discussions and feedback in order to provide a more comprehensive analysis. It builds on previous examples and includes new ones to further illustrate each chapter's main idea. More importantly, it presents findings and recommendations for policy makers and serves as input for the International Transport Forum's 2020 Summit entitled "Transport Innovation for Sustainable Development".

Leading the way: How governments in the Global South foster innovation

The public often sees private entrepreneurs as the driving force behind innovation. Yet governments are frequently the hidden powerhouses that allow the ideas of these entrepreneurs to thrive. Governments at different local, regional and national levels provide the framework that enables competition, treats new entrants fairly and supports transitions that result from market disruption.

Governments' role is even more relevant when it comes to spurring innovation in "legacy" sectors such as transport (Weiss and Bonvillian, 2011). In these, powerful institutions and industry players protect the familiar ways of doing things. With large incumbents resisting change, it is harder to introduce innovations. Public intervention may be justified to avoid stagnation and lack of innovation. Lack of competition and market entry barriers are features of both the Global North and Global South, but there is evidence that these are often more widespread or acute in the latter (Zanello et al., 2016).

Policy makers mobilise a variety of instruments to effectively foster innovation. Some lay the most basic and essential foundation from which innovation might grow. Others are implemented later and encourage the innovation's broad adoption.

On the front end or supply side of innovation systems, governments introduce policy measures to reduce the risk associated with developing new solutions: such as basic research, technology prototyping, testing and demonstrations. Investments in the fields of education and research and development (R&D) are essential. Such expenditures result in collective goods: goods from which many can benefit without bearing the costs. In the Global South just like in the Global North, innovation systems are therefore critically impacted by public policy (OECD, 2017b). In the Global South, however, weak linkages between universities and the private sector generally hamper the potential for research-driven innovation with notable sector- and country-specific instances where this is much less the case (e.g. vaccine production in Viet Nam, chemical and mineral extraction in Pakistan, or cable and wire production in Nigeria) (Zanello et al., 2016). Further, where state intervention has expressly targeted university-private sector linkages and learning, pro-innovation outcomes are stronger for instance in South Africa or in the examples of University-run Enterprises in China (Zanello, et al.).

Public funding of R&D activity can be direct (through grants or subsidies) or indirect (through tax instruments) and target private or public research institutions. Public agencies and private partners often cooperate effectively through R&D agreements. High-tech developments and investments in R&D (especially those funding basic research) drive innovation in the transport sector. But they alone are not enough. Further conditions need to be met to ensure that spending on R&D will indeed spur innovation and growth. In China, for instance, the tremendous uptake of electric mobility was made possible by a virtuous feedback loop between research institutes, public authorities, and industry (UBA/GIZ, 2017).

Education is another key ingredient that boosts innovation. Universities are crucial to the development of spillover economies. They produce highly qualified workforces. Multi-disciplinary and research-intensive entities, they allow for different disciplines to interact. Innovative ideas are likely to flourish when engineering, design, management and humanities experts collaborate.

Start-up incubators have mushroomed around the world thanks to government support. The Global South is often at the forefront of these developments. Emerging tech clusters in many Asian cities, the rise of Kenya's "Silicon Savannah" in Nairobi, and the tech start-up ecosystem in Istanbul exemplify this development. Technical universities in Istanbul provide a strong push towards innovative technologies, but the government facilitates this thriving start-up hub, too, establishing technology parks and accelerators. In India, skilled, imaginative and knowledgeable workers trained in top-ranked universities helped the city of

Bengaluru become the country's first innovation hub. The city is referred to as the Silicon Valley of India and real estate services firm Jones Lang LaSalle (JLL) called it the world's most dynamic city in its 2017 City Momentum Index (WEF, 2017). The local government has also been deeply invested in this transformation, setting up various initiatives to support start-ups.

The role of public authorities is important for innovation-driven entrepreneurship in the Global South, where longer time horizons and wider tolerance for failure are required (Mazzucato, 2013; Basant, 2015). Financial markets are not as mature in the Global South as they are in the Global North. Opportunities for early and profitable start-up exits are limited. Short-termist and risk-adverse venture capitalists (VC) therefore, are less interested in providing support to these innovative actors.

On the back end or demand side of innovation systems, governments set incentives to encourage the adoption of new solutions. These include tax credits for new products, low-cost financing, price and loan guarantees and innovation-friendly procurement contracts (Weiss and Bonvillian, 2011). Public authorities, a large consumer of products and services, encourage innovation through their purchasing power. They buy innovation and can shape lead markets such as transport. For example, by introducing climate-related criteria to public procurement decisions, innovative industries and new business models may emerge that support sustainable economic growth (OECD, 2017b).

Public authorities at the city level tend to focus even more on the demand side of innovation systems. City governments have often been the first customer of charging infrastructure to encourage the shift to electric mobility (Tavasszy, 2018). Local governments have paved the way for new transport solutions by launching and supporting large, transformative projects. A case study on the Bus Rapid Transit system (BRT) systems later in the report demonstrates how BRT can be a transformative solution, if planned and implemented properly through integrating all stakeholders in the process. The BRT was developed incrementally in Brazil and then actively transferred to other Latin American cities by determined administrations.

Public transport is a major field for intervention since most city governments have the capacity to define the strategic and tactical objectives that operators have to fulfil. Public authorities can also leverage their substantial control over public space in order to push forward innovative practices such as the re-allocation of parking space, the management of access to priority lanes, or the reconfiguration of street space to facilitate the combination of diverse transport options (ITF, 2017a).

The above examples suggest that governments can foster innovation through their regulatory power. Public authorities set mandates or standards to push forward new solutions and accelerate their large-scale adoption. In legacy sectors such as transport, these instruments are particularly efficient when accompanied by attempts to level the playing field, lessening the advantages from which established actors more or less explicitly benefit. For example, setting mandates to reach a certain market share of electric vehicles is more impactful if subsidies on fuel are removed and a carbon-tax imposed at the same time.

Despite the waves of deregulation that occurred in the 1980s and 1990s, the state is still playing a more central role in innovation systems in the present period than it was in the 19th century (Crozet, 2010). In "The Entrepreneurial State: Debunking Public vs. Private Sector Myths", Mariana Mazzucato, professor for the economics of innovation at University College London, talks about "the visible hand of the State" and considers that "the State [is] neither a 'meddler' nor a simple 'facilitator' of economic growth. It is a key partner of the private sector – and often a more daring one, willing to take the risks that business won't" (Mazzucato, 2013).

Before her, Karl Polanyi (1944) had already exposed the crucial role of the state in shaping the current entrepreneurial system. Building on this literature, it is increasingly recognised that public authorities' role in fostering innovation is not limited to correcting market failures and crowding-in business investments thanks to attractive tax regimes. Governments do not magically de-risk but actively take on risk in targeted growth areas. In doing so, they create the vision, the mission and the plan for future innovations.

Governments have funded risky basic and applied research throughout history. Their large-scale and long-term investments have been the source of most radical innovations that have had an economy-wide impact. This holds true across a variety of industry sectors and from the United States to emerging economies. For instance, the algorithm behind Google's take up was funded by a public grant, and the molecular antibodies that opened the way to biotechnology were discovered in public laboratories in the United Kingdom. Debunking the myths of iconic companies and entire economic sectors often considered the pride of western private entrepreneurship reveals the crucial role governments have played and continue to play.

When looking at emerging economies, China and Brazil provide particularly telling examples of the state's role in shaping innovation. Their state development banks are "patient financiers" allowing for major innovation breakthroughs, notably in the field of green technology. In 2010, the China Development Bank set up a USD 47 billion fund that financed 15 solar photovoltaic manufacturers. The availability of these loans has largely helped to propel Chinese firms as major international players in solar power. The Brazilian Development Bank has massively invested in cleantech and biotech, approving a USD 4.23 billion financing in 2012 (Mazzucato, 2013). These investments specifically targeted young innovative companies to help them cross the "Valley of Death" stage. In that phase between having a proof of concept and full testing and approval, the lack of committed private finance makes it difficult for companies to survive without public support. The ability of emerging economies' development banks to invest confidently and take risks in fields hampered by the highest levels of uncertainty, which usually scare off private banks and venture capitalists, may come as a surprise to policy makers in the Global North.

Governments' actions across the Global South and the Global North are leading and shaping the information and communication technology and green revolutions. Progress in these two fields is also driving contemporary transformations in transport. Transport digitalisation and electrification are indeed two major trends around which a variety of innovative practices revolve, supported by governments who have chosen this path for the future of transport.

Finally, the state's role in shaping innovation does include the situations where governments have a limited understanding of certain evolutions of technology. Even where this is the case, often policy makers are eager to engage with and learn from competent stakeholders. The first case study of this chapter illustrates this point by showcasing Malawi's implementation of the first-of-its-kind drone testing corridor. The second case study discusses China's decisive turn towards electric mobility and the third focuses on interventions in the built environment led by local and national governments in the Global South. More specifically, Latin American cities were pioneers in implementing BRT systems to improve transport accessibility.

There are two important takeaways from this chapter for policy makers:

First, policies need to ensure that economic growth is aligned with creating a sustainable transport system for all. Sustainability of the transport systems has become as important as their economic viability. Many developing countries are trying to tackle urbanisation as well as motorisation through establishing an environment that fosters sustainable technological and mobility system innovations.

Second, it is important to determine the level at which government policies should be implemented to maximise their impact. In the Global South, the cities that emerged as tech and innovation hubs were usually supported by policies at the province/city level specifically aimed at providing a stimulating environment for innovations. That said, policy makers may wish to explore the potential impact of such policies on a larger level, i.e. the federal level or the state/regional level.

Box 1. Notes from the Field - Bambang Susantono

Bambang Susantono is Vice-President for Knowledge Management and Sustainable Development of the Asian Development Bank (ADB). Prior to this, he was the Acting Minister and Vice-Minister of Transportation of Indonesia.

Transport is changing. How people or goods move is different today than 40 years ago. It will be very different again 40 years hence. In this dynamic, governments of the Global South can be the leaders of change.

Developing countries can break the mould of traditional transport. Not locked into historical legacies, they enjoy the freedom to embrace innovation. The Global South pioneered transport advances such as Bus Rapid Transit (BRT). My home city of Jakarta was one of the first Asian cities to implement a full-service BRT system and leapfrogged public transport services that took decades to evolve in Europe and North America. ADB's focus on liveable cities will see around USD four billion invested in modern urban transport systems over the next four years.

The booming demand for personal mobility is partially met by burgeoning local manufacturers of 2-, 3- and 4-wheelers. The Asian car industry is less wedded to internal combustion engines, hence the region now has the largest share of e-vehicles worldwide. The ADB is supporting countries across the region in the transition to electric mobility.

Big data will profoundly impact transport systems. As Asia implements systems to manage urban transport and road and rail networks, the use of big data, mobile apps and user interfaces will allow information sharing and efficient operations well beyond conventional systems. We already see this with integrated travel apps that combine payment and information with many other services.

The future of transport is in the Global South's hands. The ADB will help it to realise that future.

Opening the skies: How Africa's first drone corridor enables innovation in aviation

A Zipline employee prepares a drone that will fly life-saving blood supplies to a remote clinic in East African Rwanda. *Source: Kristin Palitza/picture alliance/Getty Image*

In October 2016, Malawi's Department of Civil Aviation (DCA) signed an agreement with Unicef establishing a zone for testing drones. The "drone corridor" covers a 40-kilometre perimeter around Kasungu Aerodrome in central Malawi. Maximum altitude for drone flights is set at 500 metres (Unicef, 2016). Seven entities were vetted to operate drones in the corridor. They are companies, universities and non-profits that joined the trial programme for free under the condition that they share their findings with a stakeholder task force that includes the DCA, representatives of the various governmental sectors and the media. The drone corridor has been a great success and Malawi authorities are currently planning to extend its operation period (Hastings Jailosi, interview with authors, 19 March 2019).

What is the innovation aspect?

Tests in Malawi's drone corridor must include a humanitarian and development component while exploring the application of drone technology for transport uses, imagery, and data transmission. These drones have been used to identify mosquito breeding sites and collect soil for testing in order to combat malaria, a primary health risk in Malawi (Brown, 2018). The corridor has become a hub for developing partnerships that combine the various specialties of the different stakeholders. One collaborative effort, for instance, resulted in the first long-distance flight of a drone charged with two separate tasks: delivering medical supplies to remote areas and mapping road quality, flooding and housing density (Globhe, 2018). All findings on drone use that come from the trial programme are shared with the Malawi authorities, providing

policy makers with cutting-edge insights that allow them to keep pace with fast-changing drone technology (Jailosi, 2018).

Through collaboration with local authorities, Unicef has also established drone corridors in Vanuatu to deliver vaccines, and in Kazakhstan to identify and monitor disaster risks such as forest fires (Nene, 2019; Unicef, 2019). It recently announced a new partnership with the government of Sierra Leone to improve access to resources for children in isolated areas. Future plans include using drones in Namibia to transport blood samples from rural regions to medical labs in order to fight HIV. Drone delivery start-up Zipline transports urgent on-demand medical orders to doctors across rural areas in Rwanda and Ghana, bypassing traditional transport obstacles like rough terrain, flooding, and poor infrastructure. The drone fleet is on call around the clock, regardless of weather, and the average delivery time is 30 minutes. It currently delivers 65% of Rwanda's blood supply outside Kigali and serves roughly 12 million of Ghana's 30 million citizens (McNabb, 2019).

In addition to humanitarian aid, cargo airline Astral Aviation is pursuing commercial drone delivery in Kenya (Bekele, 2018a). Astral aims to use large cargo drones to deliver materials for the oil, gas, mining, and utility industries, as well as e-commerce parcels and mail to rural residents. Its FlyOx cargo drone has a 1 850 kg payload and 1 200 km range. The payload is comparable to most manned cargo planes, but its range is between two and five times the distance (Gadhia, 2018). The FlyOx requires less crew, making scheduling more flexible and stop-overs less frequent, thus reducing costs. It can also land on unpaved runways and water, providing greater access to remote areas and closer proximity to final destinations. Astral has worked with the Kenyan Civil Aviation Authority (CAA) to update its drone policy and establish pilot programmes. Besides the FlyOx, the cargo airline is developing a pilot with the Kenya Post Office for last-mile delivery using smaller drones with five and 10 kg payloads (Freight Week, 2018).

Indian Railways has experimented with drone cameras to monitor its railroads, supporting track and infrastructure maintenance, in hopes of increasing safety and reducing costs (Railway Technology, 2018). Beyond the transport sector drones have also ameliorated the safety and efficiency of mining, engineering, infrastructure maintenance, and agriculture in the Global South.

What are the benefits? What challenges exist?

The current approach to drone technology in the Global North is very different from that employed in Malawi. In most developed economies, separate entities define specific use cases and act as competitors in implementing it. The sharing culture at the core of Malawi's drone corridor set-up, on the other hand, allows all actors to learn from the tests and their findings, and share them with the general public, thus creating an innovation-friendly ecosystem.

Among the most important lessons from the Malawi drone testing is the authorities' success in raising awareness about the potential benefits of drones among affected communities and creating wide public acceptance. In the Kasungu area alone, about 34 000 people learned about drones. Of those, 46% were children (Unicef, 2018). The Malawi public outreach campaign can inform global policy makers on how to engage with civic society and overcome initial apprehensions about safety and privacy and convey the relevance of drone transport.

Health care logistics is a USD 70 billion industry, yet it only serves one billion people worldwide (Bright, 2019a). Access to health care products is often undermined by last-mile logistics challenges, but drone delivery has managed to circumvent many of these obstacles. Zipline claims to have made medical supply chains in Africa more efficient, suggesting that drones could improve service quality in remote areas of countries like the United States, where medical waste is high and rural citizens have poor access to healthcare (McNabb, 2019.) Indeed, due to its success in Rwanda, Zipline has been invited to join a drone

pilot with the United States Department of Transportation (DOT), and is working with the state of North Carolina to test medical deliveries.

As drones are deployed on an increasingly large scale, Malawi's drone corridor will need a fully functional Unmanned Traffic Management (UTM) system to prevent collisions with manned aircraft, something akin to the Global North's needs in congested airspaces. Insights from Malawi's UTM will be shared with global policy makers. But adding drones to air traffic in the Global North may pose a unique challenge. In 2010, the number of flight passengers in OECD countries surpassed the total population of Sub-Saharan Africa (Bakilana, 2015; OECD, 2012; World Bank, 2010). This suggests that while Global South airspace may be relatively empty, the Global North's is already congested. In late 2018, a Boeing 737 suffered severe damage after striking a drone over Mexico, and the United States Federal Aviation Authority (FAA) is now logging more than 100 reports per month of drone sightings by pilots (Beresnevicius, 2018; FAA, 2019).

Nonetheless, the United States DOT has paid close attention to Rwanda's progressive approach to drones, including its performance-based regulations that foster experimentation (Bright and Stein, 2018). Sharing drone flight data and writing machine-readable regulations will assist in enforcement of airspace laws, as well (Towers-Clark, 2019; ITF, 2019b).

What do policy makers need to know?

The Malawi drone corridor specifically addresses the issues policy makers face when engaging with the emerging private drone sector and the general public. Current regulation of drones is often restrictive. It hampers new developments and lags behind technological advances, causing reluctance among potential adopters. To smoothly integrate drones into the overall transport system and ensure the public's acceptance, governments must stay apprised of the rapidly developing concepts for drone designs, service and business models (ITF, 2018). The Rwandan government has made this possible by adopting performance-based drone regulations instead of mandating inflexible requirements prescribing specific materials or technologies.

The government of Ghana has leveraged its partnerships with the private sector to explore innovative drone use at zero cost to the government (Ghana Web, 2019). By using regulatory power to promote private pilot programmes, Ghana has enabled groups like Zipline to improve medical care delivery while freeing up public funds to address other pressing needs.

Transport's electric future: How China's coordinated policy approach creates green growth

An electric bus at a charging station. *Source: Mars Hartdegen/Flickr*

Technological progress is making electric vehicles (EVs) more affordable. In 2018, the number of new electric car sales almost doubled compared to the previous year (IEA, 2019). The People's Republic of China is the global leader in the deployment of all categories of electric vehicles, including nearly 50% of the world's electric cars and a larger electric bus fleet than the rest of the world combined (IEA, 2019; Eckhouse, 2019). According to the International Energy Agency, which reviews the number of battery electric (BEV) and plug-in hybrid (PHEV) vehicles sold in selected countries, China sold over one million new electric cars in 2018, by far the highest of any nation (IEA, 2019).

China is the biggest producer of EVs in the world. According to the China Association of Automobile Manufacturers, Chinese e-vehicles represented about 45% of the world's total EVs sales in 2016 (Charles, 2017). Electric vehicle production in China is growing rapidly. This is due not just to market choice, but also to state policies and subsidies (Institute for Energy Research, 2018).

There are three main reasons why the Chinese government takes strong actions to encourage e-vehicles. Firstly, rapid economic growth and motorisation have created serious air pollution problems, such as fine particle pollution and heavy traffic congestion, putting citizens' health at risk. Shifting to cleaner vehicles can create tremendous benefits. Secondly, China wants to decrease its dependency on oil imports and establish energy security. According to *World Energy Outlook 2017* (IEA, 2017), "China is a major force in oil markets, and the gap between rising demand of 11.5 million barrels per day (mb/d) in 2016 and falling production of four mb/d has made China the largest oil importer in the world." Thirdly, the Chinese government is pursuing innovative policies that focus on vehicles that have eco-friendly technologies, called new energy vehicles (NEV). NEVs in China refer to electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs). "Made in China (MIC) 2025", announced in 2015, aims to modernise China's industrial capacity by setting the target of NEV sales volume at three million in 2020, seven million in 2025, and 19 million in 2030 (ISDP, 2018).

What is the innovation aspect?

The major innovation that made China's move towards e-vehicles possible has been the regulatory push by the Chinese government. It strongly encourages the use of e-vehicles in order to make its transport sector less oil-dependent, reduce air pollution and greenhouse gas emissions, and develop its national electric vehicle industry into a world market leader (ITF, 2010; UBA/GIZ, 2017). Financial incentives, such as tax credits and tax exemptions, are a major tool for diminishing the upfront costs of EVs and encouraging the technology's adoption. China has launched a series of incentives that target all mobility actors across all modes of transport. As part of its "Public Transportation First" policy, in place since 2008, China is specifically pioneering the shift towards electric public transport. By focusing on research and development and tailoring subsidies to reduce risk for bus operators, Chinese authorities have encouraged a massive switch to electric buses (UBA/GIZ, 2017; Dickerson, 2018).

In addition, the Chinese authorities are moving towards quotas with the 2018 "New Energy Vehicle mandate" policy, non-monetary incentives such as high occupancy vehicle (HOV) lane exemptions, and simplified registration procedures for EVs. For instance, acquiring license plates in China can be time-consuming and expensive. But e-vehicle drivers can benefit from reduced prices and expedited services. In Shanghai, for example, the EV drivers' license plate fee, about RMB 100 thousand (USD 15 900), is not required (Lu, 2018). Such incentives are effective at attracting customers to e-vehicles.

The "dual-credit policy", a significant policy that took effect in China in April 2018, began imposing compulsory targets for vehicle manufacturers in 2019 (ICCT, 2018). It consists of New Energy Vehicle Credit Management Regulations promulgated in September 2017 and Corporate Average Fuel Efficiency (CAFE) Credit Management Regulations.

The New Energy Vehicle Credit Management Regulation is based on the Zero Emission Vehicle (ZEV) regulations in effect in California and nine other US states (NCB Research and Consulting, 2018). Companies that produce or import passenger cars become subject to the regulations. Vehicle manufacturers are evaluated by fuel consumption and EV production rates to obtain new energy credits. Manufacturers are required to produce a minimum number of EVs, and the amount of credits they receive is based on factors including e-vehicle driving range and weight. They are awarded "credits" when they produce or import new energy passenger cars based on the prescribed calculation method. If a company exceeds the credit achievement target value, it may sell its excess credit to other companies, thus earning profit. On the other hand, if the company's output falls below the target value, it will have to purchase NEV credits from other companies. In other words, automakers and imported car sales companies will have to increase production and imports of new energy passenger cars in proportion to the increase in passenger car production and imports each year (ICCT, 2018).

Providing research support is essential to lowering costs and improving EV technological performance. In 2001, the Chinese State Council approved the implementation of the National High-tech R&D Program aimed at developing new energy technologies, administered by the Ministry of Science and Technology (MOST, 2019). R&D efforts have focused largely on batteries, the most costly element of BEVs.

What are the benefits? What challenges exist?

Transport is responsible for around 23% of energy-related greenhouse gas emissions (OECD, 2018). The benefits of switching to electric mobility, then, are obvious, particularly when electricity is generated by sustainable means. Moreover, China's coordinated approach illustrates how, with the right policies and incentives in place, governments can generate industry growth while successfully tackling other policy priorities, such as providing sustainable, affordable and accessible transport. But China's local government has not been acting alone; local governments are also supportive of e-vehicles.

The local governments of Beijing and Shenzhen began a programme to provide the same amount of subsidies as the central government (Lu, 2018). Shenzhen has rapidly transformed from a modest fishing village of 30 000 in the 1980s to a megalopolis of some 12 million. The introduction of electric buses in 2009 was the turning point for the city in their efforts to control air pollution in the vast industrial region. Shenzhen became the first city to electrify 100 percent of its public buses (Poon, 2018).

Another challenge is the installation of the EV charging infrastructure. Limited battery capacity and travel range remains an obstacle for EVs, requiring additional charging stations and supporting infrastructure. China intends to provide 12 000 charging stations by 2020, able to accommodate up to five million EVs. If local governments submit the right procedures and meet certain conditions, they may be eligible to receive RMB 90 million (USD 14 million) for charging stations (Lu, 2018).

Subsidies provided to the NEV industry by central authorities since 2009 appear to have been effective. But financial incentives from both the central and local governments are scheduled to terminate by the end of 2020 (Fusheng, 2019). Instead, Dong Yang, president of the China Electric Vehicle Charging Infrastructure Promotion Alliance and executive vice-president of the China Association of Automobile Manufacturers, has stated, "Ministries concerned have exchanged their views, and asked regional governments not to offer financial incentives on cars but to spend the money on charging infrastructure instead" (Fusheng, 2019). Some Chinese provinces and cities have made announcements to support installing charging stations via subsidies, with the most generous subsidy reaching up to 30% of the total investment (Lu, 2018).

A final challenge is that increased vehicle use in China, irrespective of energy type (electric versus fossil fuel) exacerbates congestion and negatively impacts road safety performance and the use of public space. These issues are significant in densely populated urban areas. They underscore that inefficient or unsafe use of cars imposes burdens beyond their energy, greenhouse gas and pollution impacts, thus the establishment of new public transport systems is crucial.

What do policy makers need to know?

China's large-fleet pilot programmes for electrifying transport benefit from a virtuous circle between research, industry and policies that are aligned across local, regional and national levels. Today, China is also experimenting with creative tools in its shift away from subsidies and towards standards, non-monetary incentives and attractive contract conditions for fleet operators.

The projected worldwide move toward electric mobility raises questions that go beyond mitigating climate change and include aspects of industrial policy, such as who will be the leading manufacturer of e-vehicles in the future.

The Bus Rapid Transit system: How one Brazilian city impacted the rest of the world

BRT buses leave stations in Curitiba, Brazil. *Source: Marcio Jose Bastos Silva/Shutterstock*

A Bus Rapid Transit system (BRT) is a network of high-frequency and high-capacity buses running on designated lanes. BRT has two distinguishing characteristics: a specific intersection design that gives priority to BRT buses; and metro-style stations (ITDP, 2015). First implemented in Curitiba, Brazil in 1974 and now part of the transport landscape of more than 170 cities across the world, BRT demonstrates how the Global North can learn from emerging economies' innovative transport solutions (Reed, 2015; EMBARQ and BRT Center of Excellence, 2019).

What is innovative about BRT systems?

Born in the resource-limited environment of Brazil in the 1970s, BRT can be a competitive and resilient solution for urban transport. The unique system combines the efficiency and quality of metros with the flexibility and relative low cost of buses, while offering significant environmental benefits.

The duration and cost of its implementation are significantly lower than other mass-transit options. This is especially true when the service runs in dense urban areas. BRT routes can easily change or extend, since the network is not dependent on expensive and inflexible infrastructure like overhead electrical wires, rail tracks or underground tunnels. Its comparative flexibility favours an incremental approach to network implementation. After one year of operation, 16 kilometres and 22 stations were added to Rio de Janeiro's TransOeste, Brazil (C40, 2016).

The BRT dedicated right-of-way efficiently resolves conflicts related to unclear road and curbside property rights and ensures that buses avoid being caught in congestion. Platform-level boarding, off-board payment, and multiple doors also guarantee fast service. As a result, Los Angeles Orange Line buses run 30 to 50% faster than its regular non-BRT buses (Sisson, 2017). High-capacity, high-frequency BRT buses also allow for accommodating large amounts of passengers. Bogotá's bi-articulated buses can contain up to 270

passengers and Guangzhou exhibits peak-hour frequencies of 350 buses per hour, or nearly one bus every 10 seconds (C40, 2016). This feature makes BRT a viable option for large, densely populated cities.

In any transport system, a shift of users to public mass transport modes means greater environmental benefit (ITDP, 2017a). In the case of Mexico City, Metrobus transport corridors for BRT reduce greenhouse gas emissions and contaminants harmful to health and air quality. This is mainly due to modal shifts, where people who formerly used paratransit microbuses or private vehicles are now opting for the Metrobus, and the replacement of obsolete and heavily-polluting buses with high-capacity low-emission ones (Mexico City Ministry of Mobility, 2019). The Metrobus system has eliminated 80 000 tons of carbon monoxide between 2005 and 2010 (Anne-Marie, 2010). However, there are also limits to BRT systems. For example, demand on Mexico City's Metrobus line 1 rapidly exceeded capacity. Overcrowding has been further exacerbated by investments in high-rise office space along the corridor.

How and why has the BRT spread across the world?

The cost-effectiveness and resiliency of BRT has convinced over 170 cities to implement this transport solution. The incremental development and implementation of BRT in Curitiba from the mid-1970s to the mid-1990s was followed by an intense period of adoption in Latin America. Andres Fingeret, country director of Institute for Transportation and Development Policy (ITDP) in Argentina explained that "Due to the similar language and cultural context, it was easier for the success of BRT in Curitiba to be replicated elsewhere in Latin America" (Reed, 2015).

BRT success stories include many Latin American cities such as Bogota, Belo Horizonte, and, more recently, Mexico City. BRT systems carry 20.5 million passengers throughout the region every day. This rate is higher than for any other continent (EMBARQ & BRT Center of Excellence, 2019).

In the 2000s, African and Chinese cities started to implement BRT systems to either create or complement the backbone of their transport systems. Cities like Lagos and Johannesburg introduced BRT as an affordable alternative to trams with reliable services (Finn et al., 2011). As mentioned earlier, China made another significant contribution to BRT expansion by adding fully electric fleets that proved remarkably cost-effective.

In the Global North, the one of the most successful implementations can be found in Australia. Today, ridership on Brisbane's BRT has surpassed expectation, increased the share of public transport users, and reduced passengers' travel time (Bothwell, 2010; Mallqui and Pojani, 2016).

Elsewhere, however, transitions have often been incomplete. BRT projects have regularly been subject to budget cuts and conflicts of interest in the Global North, undermining their benefits to the point that the phenomenon has been dubbed the "BRT creep" (Malouff, 2011). For instance, BRT systems such as Paris Mobilien, East London Transit and Los Angeles BRT do not have exclusive access to dedicated lanes, resulting in dramatically reduced efficiency (Alvarez, 2006; Elledge, 2016). BRT tends to suffer from a poor reputation in those cities compared to other mass-transit options. Los Angeles BRT may soon be replaced by light rail, though it is considered the most successful example of BRT in the United States. TransMilenio has helped ease traffic congestion in Bogotá, Colombia since its inception in 2000. But Bogotá's population has grown rapidly in the same period. A lack of proactive city planning has resulted in increased density throughout the city, including in areas far from BRT corridors (Cervero and Dai, 2014). As a result, Bogotá is currently planning its first metro line.

What do policy makers need to know?

More than 170 cities are currently expanding, constructing, or planning a BRT system, despite the decline of BRT adoption across the globe since 2015 (EMBARQ and BRT Center of Excellence, 2019). BRT has potential for continued growth, and transport authorities can learn from other cities' experiences (Hidalgo, 2015).

The BRT example shows that a basic set of standards should be respected to successfully transfer innovations (ITDP, 2017a). Without that, there is a risk of losing some of the system's unique benefits. BRT offers not only opportunities to improve accessibility for citizens but to restructure urban and regional growth in more sustainable ways, such as incorporating high-quality infrastructure for pedestrians and cyclists. In Bogotá's case, transport-oriented development principles, such as specific building heights regulation, along BRT corridors were seldom applied. As a result, the Transmilenio had a limited impact on the broader urban fabric. If BRT planning is incorporated as part of a broader urban planning policy framework, it can improve mobility access in cities, spur equitable development and attract investment (Cervero and Dai, 2014).

BRT also shows that system-wide solutions require careful consideration of the existing transport landscapes and mobility practices. As exemplified by Mexico City (Dewey, 2018), Curitiba (Reed, 2015) and Tshwane, South Africa (C40, 2016), it is crucial to integrate all stakeholders into the planning, implementation, and operation of BRT networks. Integrating smart cards into fare payment should take into account existing practices to ensure coherent price setting, as well (Kash and Hidalgo, 2014).

The implementation of transformative solutions such as BRT must be followed by continual maintenance. When this has not been the case, decaying stations, overcrowded buses and platforms, and persistent use of highly polluting fuels have led the population to consider the BRT as an "inferior good" (Crôtte, Noland and Graham, 2009). This reinforces the idea that innovation is not only about trying something new, but about ensuring that best practices learned from other modes, such as vehicle maintenance and emissions standards, are also adopted.

Embracing the informal: How to modernise transport networks

Public transport in the Global South is often characterised by the co-existence of formal and informal systems. By definition, informal transport is neither regulated by public authorities, nor managed by licensed operators, nor planned as part of an integrated transport system. The term "paratransit" has been used to capture the diversity of practices that blur the line between the formal and informal sectors. Paratransit typically consists of a large number of private operators managing small fleets of buses, vans and lighter vehicles (Shimazaki and Rahman, 1996).

In the Global South, paratransit comprises various transport modes that fill the gap between public transport and private vehicles. Pedal-powered pedicabs in Manila, Philippines, robot minibuses in Kingston, Jamaica, and trotros in Accra, Ghana, all provide transport services at the fringe of legality. Far from being a marginal phenomenon, paratransit providers operate large networks. An estimated 145 000 boda-boda moto-taxis serve the two million inhabitants of Uganda's capital, Kampala (Evans, O'Brien and Ch Ng, 2018). Dozens of thousands of microbuses operate in the Greater Cairo region in Egypt, of which a considerable share does so without the appropriate license (Abdelaal et al., 2017).

The illegal status of paratransit is not always straightforward. In some cases, paratransit providers operate with a license, but on a different route, or disregard certain vehicle design and safety requirements. Even where paratransit operators lack the necessary license, they are often tolerated by public authorities, making their service permissible if not lawful.

Paratransit is actually often closely monitored and crucial aspects of the services it provides are regulated and coordinated through fairly formal arrangements, like cooperatives and route associations (Cervero, 2000). Paratransit thus follows socially embedded logics such as specific local power dynamics (Rekhviashvili and Sgibnev, 2019). As a result, paratransit is rarely a pure case of laissez-faire transport where supply and demand are the only factors affecting the market.

That said, paratransit does obey some of the rules of demand-responsive systems. Its on-demand stops, undefined schedules, flexible routes and variable fares ensure sustainability and profitability. Informal stops are known to local users and most buses follow regular routes – that is, unless a road becomes extremely congested and passengers agree to ad-hoc itinerary changes. Similarly, routes can be added or suppressed according to temporary needs. For instance, some paratransit routes serving Cairo University during the academic year stop functioning during summer vacation (Abdelaal et al., 2017).

Although paratransit may appear chaotic and backward to the outsider, it provides crucial access for millions of people. More specifically, paratransit connects poor neighbourhoods to job centres and provides transport to workers whose hours fall outside of normal operating times, for instance on night shifts (Cervero, 2000). Without paratransit, access to essential services and places in many cities of the Global South would indeed be severely undermined. For example, paratransit offers the main connection between Mexico City and its Metropolitan Valley (ZMVM), providing more than twice the number of daily passenger-trips than fully regulated public transport (Dewey, 2019).

According to estimates, paratransit doubles the number of jobs accessible within one hour of travel, compared to the number of jobs reachable by fully regulated transport modes (IDB and ITF, forthcoming). The most significant difference is in peripheral and low-income areas. This is also the case in Bogota, Colombia, where paratransit increases access to jobs by 40% in the mountainous informal settlements of Ciudad Bolivar and Usme (IDB and ITF, forthcoming).

Paratransit provides an essential service, but suffers from many shortcomings. A lack of information about schedules, stops and fares makes it difficult to use. Coverage is often patchy and reliability issues persist. In Manila, for instance, operators tend to concentrate their service on the main axes to maximise profits while the rest of the city is underserved (Schechtner and Hanson, 2017; Boquet, 2017). This can lead to a perverse outcome known as the "cream-skimming" effect: Paratransit only operates along the most lucrative routes, leaving unprofitable ones to the public sector - which then becomes unable to cross-subsidise its transport network (Cervero, 2000).

In Mexico, as in most other places where paratransit is ineffectually regulated, drivers do not earn regular salaries and on top of that must rent the vehicles they use. They earn income only on the fares they collect after paying their expenses. As a result, drivers compete in the streets for customers and make circuitous deviations along their licensed routes to maximise passenger numbers. This creates very long trip times on dangerously overloaded vehicles.

A lack of system-wide cooperation regarding coverage results in increased congestion on the principle axes and near the main pick-up and drop-off points. The accumulation of paratransit vehicles driving erratically to pick up the maximum number of customers leads to bottlenecks (Cervero, 2000). The large number of overlapping and circuitous routes also creates an inefficient network where residents in peripheral areas have to transfer many times to reach the city centre. Beyond time loss, this translates into more costly commutes since paratransit fares are not integrated across the service area. In the Metropolitan Area of Mexico City, this is exacerbated by the fact that paratransit operators are not allowed to cross the administrative border between the city and the states surrounding it. Even in this poorly-regulated transport network, regulatory obstacles accentuate income and socio-spatial inequalities (OECD, 2015; Dewey, 2018).

As a rule, paratransit offers lower-quality service than formal transport options. In many cities, contracts between transport authorities and paratransit providers are based on a fixed route cost where license fees do not depend on fare revenue. Paratransit providers rarely receive any government subsidies, yet their prices may be regulated. In Mexico City, for example, this is effectively enforced. Such a system incentivises operators to cut down on maintenance expenditures and to carry as many passengers as possible in their vehicles (OECD, 2015). Overcrowding reduces user comfort, spurs petty crimes and facilitates sexual harassment. Yet the system persists because standards are not systematically enforced. As a result, paratransit is often less safe and also more polluting than formal transport. Overall, paratransit can be viewed as an extreme case of a "legacy sector", where incumbents are strongly adverse to the introduction of innovative practices.

Undoubtedly there is significant room for improving current paratransit systems. Many of its flaws could be mitigated with the help of digital solutions that are changing mobility around the world. The rapid uptake of digital technology in the Global South, notably smartphones which are widely used even in low-income communities, could facilitate this development.

Transforming paratransit starts with acquiring adequate knowledge of existing networks. Encoding these into an established transport data syntax, such as General Transit Feed Specification (GTFS), makes it easier for commuters to catch the best ride. It also allows transport planners to better understand user needs and operators to offer new routes.

The first case study of this chapter presents "GTFS For the Rest of Us" initiative, which aims at improving the digital encoding of paratransit networks. It specifically draws on the Digital Matatu project in Nairobi, Kenya. This used mobile phones to collect and provide data on paratransit routes, stops and schedules in order to better map the informal transport system. A variety of app-based transport service providers therefore adapted their service to encompass paratransit.

The second case study of this chapter presents a case where digitalisation has been used to upgrade paratransit, not just capturing it. Jetty, a van-sharing service in Mexico City, aims to bridge the gap between paratransit and app-based mobility. It incentivises operators to provide a safe and comfortable service while helping them to optimise their routes and increase their profits (Dewey, 2019).

The third case study of this chapter provides examples from the Global South where ride-sourcing technology is employed to enhance the safety and security of travel in paratransit. One of the advantages oft app-based ride-sharing is that is provides an attractive mobility option for transport users concerned about the security of other transport modes. Notably in unsafe metropolitan areas, the robust identification of drivers and traceability of routes helps to makes trips more secure, particularly for vulnerable users who may otherwise not travel.

The solutions presented in these case studies could facilitate a future formalisation of paratransit by further blurring the line between formal and informal transport. Public authorities that are considering upgrading transport networks should recognise the role of paratransit, and be aware that ignoring semi-formal actors and their interests often results in failure.

Mexico City's implementation of a BRT system, for example, was successful in large part because of mutually advantageous agreements between the city and paratransit providers (Dewey, cited in Davis and Altshuler, 2018). In the event, the BRT operator companies were formed by former paratransit providers, who committed to purchase adapted buses with government support.

Because the service cannot operate across administrative borders, further expansion of the BRT into the Mexico City metropolitan area is limited, however. Here, paratransit services provided with two- and three-wheelers can provide effective solutions for the first and last mile. Embracing these options, rather than dismissing them as something chaotic, can increase connectivity to the BRT network and potentially enhance general accessibility.

The case studies presented below could – and should – provide a stimulus to create nimble, smaller-scale community- and demand-based transport options in the Global North. For policy makers, especially in the Global North, they offer three major takeaways:

First, policy frameworks must ensure that digitalisation serves specific local mobility needs. They must be established in ways that maximise the benefits from digitalisation.

Second, the regulators must ensure that existing mobility services and new entrants are treated equally.

Third, policy makers need to assess whether competitive pricing of app-based transport modes is enough to persuade commuters to use shared services. There might be other incentives that could encourage commuters to switch to shared services. Identifying these incentives and implementing them ensures that the potential of shared mobility services is fully realised.

Box 2. Notes from the Field – Fabio Duarte

Fabio Duarte is a Professor of Urban Planning at Pontifícia Universidade Católica do Paraná in Curitiba, Brazil, a research scientist at the Massachusetts Institute of Technology, and author of Unplugging the City (Routledge, 2017).

Shared mobility is everywhere when I travel cities as a global researcher. I take taxis in Brasília, hold on tight to Go-Jek motorcycles in Jakarta, or figure out how to reach my destinations with matatus in Nairobi and marshrutkas in Moscow.

These cities taught me that thinking of shared mobility as a novelty is a narrow view held in the Global North. It negates how countries with few cars and bad public transport are creatively coping with the lack of options.

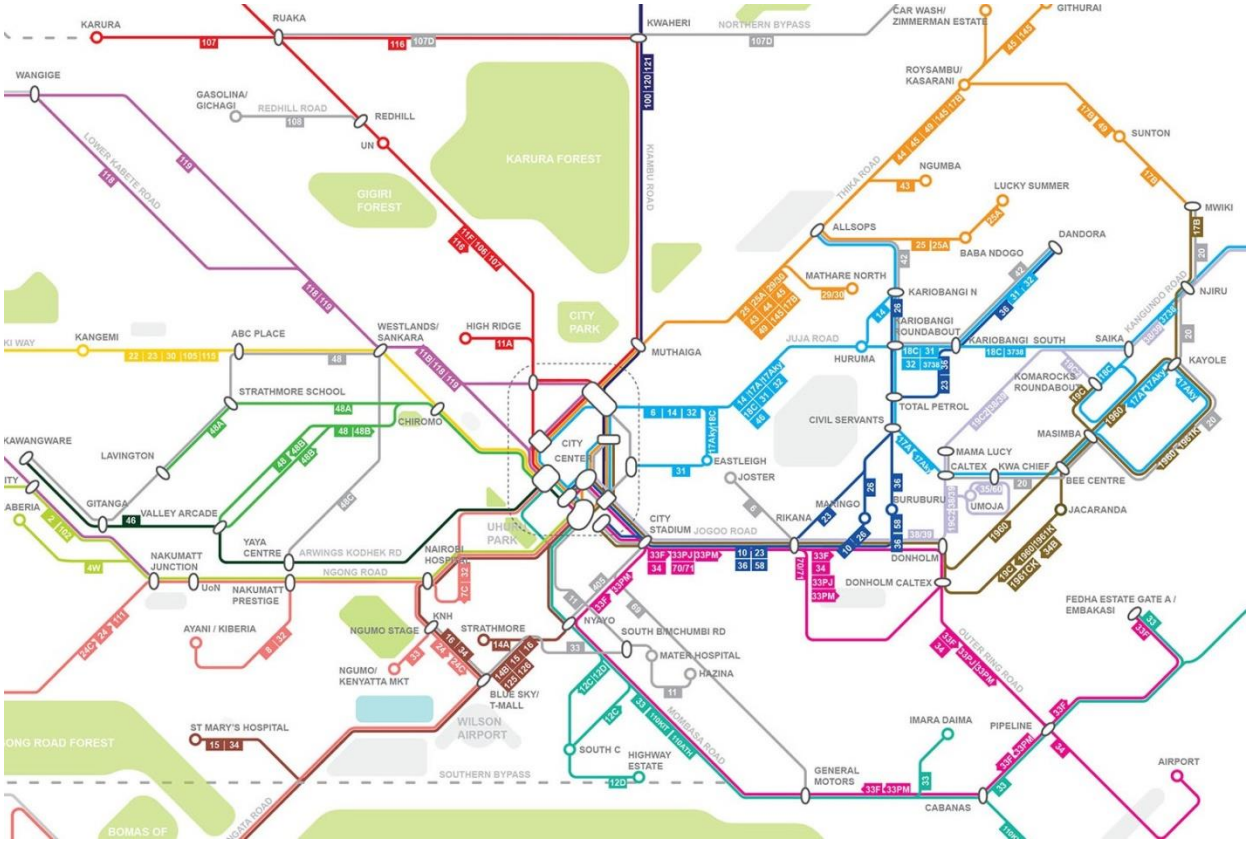
This informal mobility operates at the fringe of legality and remains almost invisible to the uninitiated. Digitalisation has changed this and disrupted mobility in both developed and developing countries.

Firstly, geo-localisation of vehicles in real time helps users to better plan trips and increases the sense of safety among passengers and drivers. Secondly, rating schemes that auto-regulate who is allowed into the system create a direct relationship between drivers and passengers and thus a mutual sense of trust.

Finally, demand-based routing and pricing structures create more flexible markets. They extend options for users by matching drivers and passengers in different areas and at different times.

As a researcher with practical experience in planning and transport in the Global South, I focus on how to transfer lessons from app-based mobility to public transport and find ways to balance nimble private transport options with better mass transport tailored to the mobility culture of each city.

"GTFS for the Rest of Us": How encoding Nairobi's informal transport helped transform global transport services



Detail of the Nairobi Matatu Routes map. *Source: Civic Design Data Lab Massachusetts Institute of Technology and C4D Lab Nairobi University*

The General Transit Feed Specification (GTFS) is a global standard for sharing public transport information. GTFS was originally developed to encode the fixed schedules and stops of Western formal transport networks. However, transport systems in most Global South economies are based on semi-formal solutions. "GTFS for the Rest of Us" is an initiative that brings together actors who seek to encode semi-formal transport within GTFS language and uses (Williams et al., 2015).

What is the innovation aspect?

One of the first attempts to address the lack of GTFS data on semi-formal transport was conducted in Nairobi in 2012-13 with matatus, the informal buses serving the Kenyan capital. The Digital Matatus initiative (DM), used mobile phones and GPS technology to collect data on 135 informal bus routes, including stop names and fares. This data was then converted into GTFS and visualised as a comprehensive map of Nairobi's non-official transport network. In 2015, the GTFS data was uploaded to Google and Open Street maps, making Nairobi's matatus network the first paratransit system to be included in mainstream routing tools (Williams et al., 2015). Riders immediately benefited by being able to better plan their commutes. Private operators and Nairobi's transport planners were also able to develop a more adequate matatu route network and gain insights for a future Bus Rapid Transit (BRT) system that can complement informal mobility.

Nairobi's high-profile case of mapping informal transport and incorporating the data into local transport planning has caught on throughout the Global South, highlighting the need to make data formats more

adaptable to demand-responsive transport. For instance, the data field "continuous stops" was added to GTFS's data syntax to indicate whether it is possible to board or exit at any point along the route. This inspired the development of the GTFS-flex extension, which gained relevance not only in cities of developing countries but also in rural areas of the Global North, where demand-responsive transport options are increasingly offered (Craig, 2017).

What are the benefits? What challenges exist?

DM's method has already been successfully replicated in other countries of the Global South. In Egypt, the start-up Transport for Cairo collected GTFS data and mapped parts of the semi-formal bus network in the capital, which was released in its entirety in 2018 and subsequently integrated into Google Maps (Abdelaal et al., 2017). Where Is My Transport's (WIMT) data services map developing cities' paratransit routes and schedules, corralling informal and formal mobility options into a single database (WIMT, 2019). The platform has already provided information on paratransit systems for several South African cities. By linking the paratransit data collected by WIMT with formal transport networks, users can identify multi-modal journeys – facilitating the role of paratransit as a feeder system for underserved areas.

WIMT's recent collaboration with the Inter-American Development Bank (IDB) and the International Transport Forum (ITF) to enhance data on Mexico City's pesero microbuses was another success. Within one month, WIMT captured data for over 1 000 informal routes and 30 000 vehicles and partnered with local authorities and civil society organisations to access data on the city's formal transport options (Lane, 2019). It then compiled all Mexico City public and paratransit data into a single organised data set, the city's first. The subsequent mapping revealed a previously unseen picture of commuting trends in and around the city, especially for the poorer clientele of the peseros.

In 2015, prior to WIMT's work, Mexico City's think tank Laboratorio para la Ciudad (LabCDMX) wanted to learn more about the pesero network of informal microbuses, which was thought to be providing about 70% of all daily public transport trips (Lane, 2019). They launched what they called a Mapatón, a gamified collective mapping "marathon" of paratransit routes throughout the city. Citizens used an app to track microbus routes, stops, and schedules, scoring points for participation. Four thousand participants tracked over 51 000 km along 2 765 routes, 1 763 of which were considered reliable (Téllez, 2016).

With data for these final routes, Mapatón then hosted a hackathon to analyse the data and identify trends. The game-style data competition excited residents and cost a fraction of the time and money of a government study. The findings have been used by Mexico City's Ministry of Mobility to inform research policy, and the open data has been incorporated into several local mobility apps (OPSI, n.d.). The Mapatón model is now being applied in four other Mexican cities, as well as Bogota (DATUM, n.d.).

In 2019, the Urban Transport Resource Center for Latin American and Caribbean Cities was founded by MIT's Civic Data Design Lab in collaboration with the World Resource Institute, the Columbia Earth Lab, and the Inter-American Development Bank. Based on learnings from DM in Africa it aims to provide guidance and information on how local actors can capture and utilise paratransit data in their cities (DATUM, n.d.). Its website DATUM details transport data projects in 11 cities and five countries across Latin America at various stages of development (DATUM, n.d.). DATUM serves as a complement to Digital Transport 4 Africa (DT4A), which lists eight African cities currently collecting data on paratransit activities (DT4A, n.d.). The twin digital resource centres.

Government in the Global North are also increasingly exposed to the need of understanding and regulating more "informal" means of transport e.g. the large number of free-floating micromobility vehicles. Cities have contracted a variety of data analysis companies to collect data about the new transport options, but the data they receive are inconsistent. The micromobility providers themselves are also having difficulty answering to data requests by cities, which arrive in countless different formats (Zipper, 2019).

Mobility Data Specification (MDS), a data standard released in 2018 by the Los Angeles Department of Transportation is trying to address this problem (Los Angeles Department of Transportation, 2018). MDS helps cities collect data in a singular format from any digitised player in urban transport. It empowers them to make informed policy adjustments regarding infrastructure, enforcement, equity, and access. MDS is already in use by 70 cities around the world (Reynolds, 2019).

What do policy makers need to know?

Mapping semi-formal routes provides a comprehensive picture of the whole transport network. It identifies geographical or social equity gaps in accessibility, allowing cities to plan a more efficient system. With this information, public authorities could promote intermodality and leverage paratransit as a feeder system for formal mass transport. Local leaders could use this more complete picture of movement through their cities to make more sustainable transport policy decisions and help guide public and private investment in transport.

With GTFS-flex data, transport is encoded as a flexible process and can become increasingly responsive to commuters' needs (MIT, 2013). Flexibility and responsiveness will be necessary in the Global North as its cities transition to a greater share of agile and unplanned mobility. Modern transport concepts such as Mobility as a Service (MaaS), where transport is increasingly on-demand, digitised, integrated, and shared, require a high-quality digitally encoded "mirror" of all mobility modes and user behaviours. GTFS-flex provides a means of encoding that.

First-class jitney service: How an app-based mobility company in Mexico City provides better quality for users of informal transport

Passengers wait in line at a pick-up point in Mexico City. *Source: ChameleonsEye/Shutterstock*

The Metropolitan Area of Valley of Mexico, an agglomeration that incorporates 18 municipalities, contains almost 30 million people. Many of these commute daily into central Mexico City (IDB and ITF, forthcoming). On average, 66% of total weekday trips in the Mexico City metropolitan area are made by public transport (INEGI, 2017). Formal public transport (metro rail, Bus Rapid Transit, light rail, and traditional buses) has been expanded in recent decades, but coverage remains limited. Only 11 of the area's 192 metro stations are located beyond Mexico City's borders, and its public transport network is insufficient for the lower income population on the outskirts (IDB and ITF, forthcoming). Roughly 30% of public transport in Mexico City was out of service during 2018 due to low investment in maintenance and infrastructure (Mexico City government, 2019).

As a result, the majority of citizens in the Mexico City metropolitan area rely on a large network of poorly regulated buses called peseros or jitneys. Every day, these jitneys provide 11.5 million passenger trips, while Mexico City's Bus Rapid Transit and subway systems carry 1.1 and 4.5 million passengers respectively (Dewey, 2019). Yet, travel by jitneys suffers from the typical downsides of non-regulated transport: lacking in safety, comfort and reliability.

Since 2017, Mexican start-up Jetty has been trying to upgrade the collective transport service offered by jitneys. Jetty does not own any vehicles but works in partnership with existing operators. Jetty incentivises the operators to provide a dedicated bus fleet tracked in real time, covered by more comprehensive insurance policies and driven by a trained and adequately rewarded workforce. In exchange, Jetty helps its partners to improve their performance by sharing with them the data gathered from its app users. It also

brings their partners business. Jetty's mobile app enables its users to look for rides and book a seat on upgraded jitney buses.

What is the innovation aspect?

Mexico City's loosely regulated, privately operated jitney industry employs roughly 100 000 people including drivers, mechanics, and supervisors. Informal transport moves most workers in this megacity affordably and efficiently, but often at the expense of drivers' and passengers' wellbeing, with tenuous financial margins. Jitney fares are kept dramatically low by regulations at USD 0.25-0.50 (Flores, 2019). Nevertheless, the government does not provide subsidies. Operators resort to weak insurance policies, highly pollutant vehicles with poor maintenance, exploitative labour practices, and crammed, uncomfortable and dangerous rides.

Jetty's offer reconciles better service with affordability and efficiency by bridging app-based mobility and collective transport. Thus Jetty has brought to bus services the same app-based ease that many ride-sourcing services already provide. Passengers enter their current location and desired destination on the Jetty app. Jetty matches the request to the nearest pick-up and drop-off point, and provides the schedule, vehicle type, and plates, the driver's name and photo, and the cost. Passengers who reserve a seat receive a digital ticket, as well as notifications alerting them of delays or updates. Jetty's in-app chat helps passengers solve any queries in real time. After the trip, passengers can also rate their experience and leave comments. Increased safety and reliability significantly improve the jitney user experience. Offering more direct routes and higher capacities, Jetty's app-based jitney booking ensures a higher degree of efficiency compared to ad-hoc ride-sourcing. Continuous monitoring of itineraries, schedules, and pick-up points further help to optimise the service, as does the collection of user data, which boosts Jitney partner-operators' revenue (Dewey, 2019).

Jetty's business model is a revenue-share with transport partners. Jetty takes over most planning, marketing, customer support, and driver training functions. The company hires drivers and maintains and operates vehicles. They develop their tech internally, leveraging feedback from passengers, drivers and transport partners to improve their apps. They identify revenue-generating, service-enhancing opportunities in existing jitney routes, and invite jitney co-op leadership to pilot their app. Most of their entry-level services can be used with the co-ops' existing vehicle fleet and some work in tandem with regular operations, reducing their revenue risk.

Jetty also analyses past passenger queries and schedule performance. They adjust the location of their stops (minimising average walking distance to destination), the frequency of their routes, and the type of vehicle used (matching demand to seat supply). Jetty leverages user trends (historical requests, user concentrations, etc.) to improve scheduling and services and periodically modifies the exact locations of boarding and drop-off points thus improving the efficiency of their operation.

Companies in other Global South countries have had similar inspiration. In Egypt, transport start-up SWVL has filled a market gap between poor public transport options and exceedingly expensive ride-hailing apps (Ahram Online, 2018). Clients use the SWVL app to reserve a ride on a small bus that follows a fixed route and timetable. SWVL currently has over 600 lines in Cairo and Alexandria, and is in various stages of expansion in Pakistan, Kenya, Saudi Arabia, Jordan, and Nigeria (SWVL website). The start-up aims to improve service by adding WiFi to its vehicles, an e-wallet to its app, and serving as a "feeder" to public transport options.

LULA of South Africa claims to fill the same market gap as SWVL, but focuses on providing a shuttle service for corporate employees through partnerships, as well as individual riders (Jackson, 2019). LULA crowdsources its private vehicles, providing door-to-door rides that are cheaper and less stressful for riders

than driving, and make driver schedules more dependable for corporate partners (Venture Burn, 2019). It leverages big data, mobile ticketing, and shared infrastructure to optimise routes, schedules and pricing.

What are the benefits? What challenges exist?

Jetty offers flexible commuting services through a digital platform in order to mitigate the lack of secure and reliable transportation in Mexico City. Its business model enables drivers and operators to be more responsive to passenger feedback, and incentivises the delivery of higher quality services. Jetty provides a low-cost solution to upgrading transport that requires limited investment and operational subsidies. This could be very appealing to countries and cities with tight transport budgets. Since Jetty's initiative helps slow the shift toward private cars, its experience is relevant in global cities struggling with severe congestion.

The challenge of offering reliable urban transport in the Global South is not exclusive to Mexico City. Jetty provides proper context-adapted incentives to improve transport quality. In cities where transport operation is privatised, it will be crucial that regulators establish locally-appropriate incentives in their dialogue with operators. Jetty's current expansion in Mexico City illustrates the programme's easy scalability, which could be adapted to cities where there is lack of safety, accountability, or comfortable mass transport networks.

What do policy makers need to know?

Mexico City's experience with improving the service quality of jitneys provides two main lessons for policy makers. Firstly, incremental service upgrades through technology-induced innovation can reshape the transport system in a way that serves the common good, but only if policy avoids stifling innovation through obsolete regulation. Secondly, sharing data among different mobility stakeholders can help address urban congestion and pollution by providing higher-quality transport services at prices that are above standard transport fares, but significantly below conventional ride-sourcing offers.

Safe and secure moto-taxis: How a motorcycle taxi service is altering door-to-door travel in sub-Saharan Africa

SafeBoda drivers participate in a demonstration for women's safety. *Source: UN Women/ Martin Ninsiima/ Flickr*

Informal transport is often the dominant form of public transport in sub-Saharan African cities. Informal microbuses and motorcycle taxis have been present for several decades. Their role is rising despite poor safety and security records (Diaz Olvera, Plat and Pochet, 2019; Ehebrecht, Heinrichs and Lenz, 2018).

SafeBoda is a motorcycle ride-sourcing and delivery service which connects customers with motorcycle drivers and facilitates cashless payments. The service was first launched in Kampala, Uganda, in 2014, where motorcycle taxis are called boda bodas (Olupot, 2019). In 2017, SafeBoda launched an app-based ride-sourcing solution that linked customers with the closest available driver. The smartphone app won the 2018 AppsAfrica Award (Nesbitt-Ahmed and Fraser, 2017; Allianz SE, 2019).

In 2011, and estimated 40 000 drivers were operating in Kampala (Olupot, 2019; Ehebrecht, Heinrichs and Lenz, 2018). Close to 10 000 of those were working with SafeBoda at the start of 2019. The company recently signed over 1 500 drivers in less than a year when it expanded to Nairobi, Kenya (Dada, 2019).

What is the innovation aspect?

SafeBoda innovates by placing safety first. It describes itself as a community of professional, trained boda boda drivers, offering a safer experience to passengers. Unlike the traditional informal motorcycle taxi sector, the company completes background checks on drivers, requires drivers to have several years of boda boda experience, provides first aid and road safety trainings and equips drivers with recognisable orange jackets and helmets.

Drivers have unique numbers on the back of their helmets to make it easier for customers to report misconduct. Customers have to rate their driver before they can request a new trip, further strengthening the safety management system (Otieno, 2019). The company offers financial rewards to drivers on the basis of positive customer ratings (Mwaura, 2017).

Innovation also lies in the cashless transaction system, which the company introduced in 2017 (Dispatch, 2019). Customers can choose to pay in cash or from the electronic wallet attached to their SafeBoda account. Customers can also use this e-wallet to pay for mobile phone airtime (PC Tech, 2019). Drivers can use the e-wallet to purchase services such as fuel and food (Dispatch, 2019).

Alastair Sussock, co-founder of SafeBoda, sees potential for adding a number of important FinTech services for both SafeBoda drivers and passengers. In 2019, the financial services company Allianz announced that their investment in SafeBoda was their digital-investment unit's first in an African-headquartered company. SafeBoda is seen as a promising start-up with substantial growth potential, including the development of relevant financial services and insurance products. (Allianz SE, 2019)

What are the benefits? What challenges exist?

Road injuries are the leading cause of death of young people between the ages of 15 and 29. The number of traffic deaths per unit population in Uganda is one of the highest in the world with 29 per 100 000 people (WHO, 2019). In Kampala, 75% of hospital admissions following road traffic injury are motorcycle taxi drivers and customers (Kigera, Nguku, and Naddumba, 2010). In this context, Ricky Thompson, co-founder of SafeBoda, reflects on his company's impact: "We have never witnessed any fatal accidents and we are very proud of that. What we really have seen is a big change in the minds of the people, and that is the beginning of road safety" (Rasmussen, 2019).

Riders are required to carry an additional helmet for their passenger, along with hygienic hair nets. But the passenger helmet wearing rate remains far too low: this is where market forces reach their limits and enforcement and education campaigns are required.

Women are particularly satisfied with SafeBoda due to the feeling of security provided by accredited and identifiable drivers, against a backdrop of sexual harassment and violence in Kampala. Safe mobility in the evenings is highly valued. In addition, ride prices are automatically calculated by the app, so women customers are no longer burdened by the stress and discomfort of bargaining with men or being overcharged. (Nesbitt-Ahmed and Fraser, 2017)

Yet women in sub-Saharan Africa are 41% less likely to use mobile internet than men. This creates a digital divide where women are excluded from app-based mobility services from which they would most benefit. The uptake of services such as SafeBoda is slowed by the cost of mobile ownership, which represents 10% of the average income in Africa. (Wintour, 2019)

In 2017, 43% of adults in sub-Saharan Africa had a bank account – the lowest proportion in the world (Gates Foundation, 2019). SafeBoda cashless transactions are delivering tangible benefits to both drivers and customers, who carry less cash and are less worried about being robbed. SafeBoda now gives loans to its drivers, thereby driving financial inclusion and boosting the economic activities through microcredit (Dada, 2019). Drivers, however, report that a number of their clients have not yet embraced the cashless wallet, due to low literacy levels and mobile Internet use.

What do policy makers need to know?

Many other motorcycle ride-sourcing companies operate in low- and middle-income countries. In Uganda, Uber and Bolt compete with SafeBoda and place an emphasis on the safety of the motorcycle rides. In Indonesia, Go-Jek has become a major mobility and financial technology brand. Those companies are

adding a technology layer to an already existing and highly popular mode, connecting drivers and riders more efficiently and making travel more affordable to the population. Some, such as Uber, also improve road safety by requiring drivers to be licensed, providing helmets for riders, and insuring all trips.

SafeBoda's and Go-Jek's experiences may inspire some app-based mobility companies to try to fill the gap in financial services in countries where traditional banking excludes a significant share of the population.

Access to mobile Internet can be a barrier to mobility services in lower-income areas. Digital inclusion has, therefore, become a central question in transport policy making, with a risk that women are left on the roadside of digital technology and mobile banking in Africa.

Inspired by Safeboda and other ride-sourcing companies, regulators could empower customers to rate the safe behaviour of drivers across the *entire* taxi industry. Driver behaviour may be negatively affected by fatigue as drivers can be affiliated to several platforms (Otieno, 2019). The phenomenon is called multi-homing, typical of the gig economy, and enables a driver to flout daily or weekly caps on working hours (Christie and Ward, 2018). As in the Philippines, policy makers in both the Global North and South could impose a unique identifier on drivers which is used across all ride-sourcing platforms (ITF, 2016). Policy makers should also ensure all ride-sourcing companies provide insurance to their drivers and customers.

Motorcycle taxis, similarly to other forms of motorised transport, impose a substantial public health burden on urban populations, with local air pollution causing premature deaths and chronic diseases. The smaller size of motorcycles in comparison to cars does not necessarily translate into a cleaner exhaust fume (Ehebrecht, Heinrichs, and Lenz, 2018). Emission controls, both roadside and periodic, applied on both private vehicles and taxis, should be implemented to protect the populations.

The development of alternative modes as part of sustainable urban mobility plans is, of course, essential. This includes the development of rapid transport systems and active modes. Aggregate mobility data should be shared with local government to facilitate the planning task. This could include curbside pick-up/drop-off counts and be facilitated by platforms such as SharedStreets, already used by Uber and Lyft (NACTO, 2018) or by the Mobility Data Specification, used in over 70 cities (Reynolds, 2019). For the formal public transport network to be attractive, one could learn from the SafeBoda experience: customers should have simple solutions to reward safe bus drivers and to ride cashless. There are always lessons to be learned from the informal sector where and when it sets the bar high.

Revisiting global practices: How to inspire a new mobility culture

Innovation is usually born out of need. Transport solutions are most often created in response to the specific needs of people in specific places. With careful adaptation, they can often be successfully transplanted. Sometimes however, innovation is best achieved by simply looking at an old, familiar practice in a new light. In other words, innovations inspired by existing or sometimes forgotten practices often carry promising developments for future transport systems.

Transport heritage is based on socio-cultural practices associated with the way people move in a given context. In the Global South, reliance on two- and three-wheelers is a distinctive trait of Southeast Asian transport heritage, for instance. Such practices are accepted and reproduced by travellers on a daily basis. Even when transformed by new technologies or business models, they retain a local flavour and continue to be used. In the Global North, traditional mobility practices have sometimes been forgotten, but can be readopted quickly and on a large scale.

Transport practices form a socially and culturally embedded heritage. This is due to the profound entanglement of transport system and urban forms, i.e. the spatial distribution of employment, housing and services. Transport impacts urban form, creating areas for growth and directing urban sprawl. But the reverse is also true, since urban form leads to the adoption of specific transport systems. Population size or density in a given area, for instance, shapes the type of transport it relies on (Yago, 1983).

Urban form itself is never externally determined; it is the product of social, economic and political forces. Jakarta's transport system, as Lo (2009) notes, for example, reflects the aspirations to be integrated into global networks, the desire of an urban elite for differentiation and the struggle for democratisation. The omnipresence of highways in the United States has been interpreted as a way for middle-class white commuters to geographically isolate themselves from minorities (Fotsch, 2007). And in Brazil's metropolis Sao Paulo, the stratification of its traffic between air travel and surface travel reflects the city's power dynamics (Cwerner, 2006).

An illustration of how transport heritage can be mobilised and transformed to meet current needs is China's recent push to revive its cycling culture. Until the mid-1990s, China was considered the "kingdom of bicycles". At the time, the country counted over 523 million bicycles or, 43 for every 100 inhabitants, with even higher ownership rates in urban areas (Huang, 2018). A dramatic fall in bicycle use followed policies introduced at the turn of the millennium to encourage the growth of China's automobile industry and the use of mass transport.

Today, the government is attempting to revitalise cycling culture in the light of rising of pollution and urban congestion. Private operators of dockless bike-sharing system and, to a lesser degree, municipal docked bike-share schemes are at the forefront of this push (Poon, 2017). "Bring bicycles back to the city", the slogan of Mobike, one of the main players in this field, directly echoes the heritage on which the success of shared bicycles in China builds. The availability of digital technology and mobile payment has also helped to reintroduce cycling as an easily available, efficient and affordable travel option.

Researchers, planners and policy makers studying mobility aim to understand the many ways in which the physical movements through transport are shaped by broader socio-cultural norms (Vannini, 2010). Commutes, for instance, do not equal "dead" time. Individuals do not travel passively, and their activities while commuting reflect meaningful social conduct. Many car drivers use their commutes to accomplish professional tasks, for instance, and for public transport users, transfer and waiting time are opportunities for consumption and entertainment, among other things.

In the words of Vanini (2010), "means of transportation and other ways of moving (such as walking or running) are not mere instrumental and neutral tools for getting from point 'a' to point 'b,' but are meaningful places and cultural environments in and of themselves. […] Means of mobility […] are agents in a complex ecology of roots and routes, of community and flow that cannot be understood by isolating variables from one another, or by examining forms of mobility outside of their geographical, social, cultural, and politico-economic contexts."

The case studies in this chapter illustrate how transport heritage can be transformed through the adoption and adaptation of technology to address local needs and improve both freight transport and the daily lives of commuters.

The first case study offers a showcase for cost-effective logistics: a pan-Indian relay truck service that is disrupting India's logistics industry. Modelled on the famous mid-19th century Pony Express in the United States, which linked Missouri and California via a system of relay riders on horseback, the Indian relay truck service turns a historic transport practice into a viable solution for the present with the help of digital technology: a digital platform integrates vehicle telematics, driver preferences, relay station status and client requests. The method can also be seen as a echoing the heritage of Mumbai's Dabbawalas, delivery men distributing lunch boxes and other goods based on a system of codes for start and collection points, destinations and handling at destinations.

The second case study in this chapter highlights the electrification of two- and three-wheelers. This will have a significant impact in countries where these vehicles represent a large share of the total fleet, such as the emerging economies of Asia; they are an important part of the transport heritage. Increasingly, electric two- and three-wheelers will have an impact on mobility in other world regions, because they are small, lightweight, affordable and ideally suited to cover shorter-distance transport needs. With added technological features and upgraded designs, two- and three-wheelers may also contribute to the (re-)introduction of agile mobility options for urban first- and last-mile transport in the Global North and help stimulate a new micromobility culture there.

A further case study provides an example of how innovation can result from developing an new use case and business model for old technologies the application of cable cars (or aerial lifts, in US usage) for urban transport show how established technologies, reimagined in a different context, can solve current problems. Cable cars have been used to transport humans for over a century. But their use was mostly restricted to ferrying tourists to mountain summits in alpine regions. Only in recent decades have cable cars been used in urban contexts and they have become a popular mode of public transport in some Latin American cities in particular. These urban cable car systems are cost-effective, much more environmentally-friendly than some traditional transport modes and can provide a capacity similar to grade separated BRT services.

While grounded in a specific socio-cultural transport heritage, the upgrading of such practices can answer pressing on-the-ground needs – in these instances the widespread shortage of long-haul drivers, the need for more sustainable options for short-distance trips and the need for a public transport solution that can deal with difficult geographical and land use issues. The solutions presented in these case studies also contribute to improving human well-being. The truck relay system regularises drivers' working hours and normalises their living conditions, thereby reduces the downsides of long-haul truck driving and increases the attractiveness of this profession. Some of the electrification projects for three-wheelers take their starting point from the fact that many of the drivers live in poverty, with extremely low-calorie diets, so that electric pedal assistance could considerably benefit them.

Most of these solutions that have developed in the Global South are also innovative in a more classical sense of the term in that they increase productivity. Shortening the duration of a truck trip or providing a last-mile solution where mobility options are scarce enhances transport efficiency. In the case of two- and

three-wheelers, reduced energy consumption and more efficient use of available road capacity compared to car-based transport must also be taken into account.

More often than not, the transport challenges for countries in the Global North and in the Global South are similar. From climate change to urban congestion, issues are increasingly global. Innovative local solutions, often rooted in a specific heritage, can inspire global answers to these global challenges. Relay trucking is a good example of this, with many countries in the Global North also facing driver shortages and the need for more efficient freight transport. Urban transport has also started to go small in developed economies, with light electric vehicles rapidly becoming part of cities' transport landscape. Policy makers everywhere find themselves confronted with similar questions regarding the regulation of new services and their integration with existing transport offers. By studying the experience of other countries and regions and learning from them, they may find common answers - and often shortcuts to surprising, but tested solutions.

Approached with an open mind, tradition will not be a barrier to innovation, but often a solid basis for innovative solutions. There are many ways in which socially and culturally embedded mobility practices can be transformed and thus pre-conceptions about the nature of innovation are best avoided. Transport innovation does not even have to be disruptive and create new demand, as is often thought. The pan-Indian relay truck system, for instance, defies the innovation paradigm associated with Uber or Airbnb, in which ownership of physical infrastructure is avoided and the focus is solely on a digital service. Similarly, the recent difficulties encountered by Chinese dockless bike-share firms show that a business model based mainly on harvesting user data may not be viable in the short and mid-term. The central lesson imparted by the diversity of the solutions presented in the following case studies is that there is no one-size-fits-all model for innovation.

For policy makers, two main takeaways follow:

First, the right incentives are needed to ensure the transformation of traditional transport modes happens in ways that support the policy priorities of the present. The Global South has been adept at such transformations; the Global North has not fully taken advantage of these opportunities.

Second, policy makers should harness knowledge about the marginalised, often forgotten modes of transport in the Global North. Few people know, for instance, that many large European cities operated subterranean pneumatic tube networks to send mail and parcels deliver mail to city quarters, or that trams used to have freight compartments used for last-mile delivery of groceries and other goods. Such knowledge is crucial for adapting traditional transport solutions to address current challenges.

Box 3. Notes from the Field – Melinda Hanson

Melinda Hanson heads sustainability at Bird, the shared e-scooter company. She has worked for sustainable transport for over a decade, including at National Association of City Transportation Officials, Asian Development Bank and the ClimateWorks Foundation.

Transport in the Global North is starting to look more like that of cities in the Global South. What's changed? Urban transport has started to go small.

For decades, the automobile has dominated streets in the United States. Here, more than 75% of commuters travel to and from work by car, alone; just 5% commute by public transport, and less than one percent by bicycle.

Mode share is remarkably different in low- and middle-income countries. While working on transport projects in the Philippines and Ethiopia, I saw that what is sometimes perceived as a chaotic system made up of multiple shared modes could actually add up to be a much more efficient way to get around.

Dockless e-scooters hit US streets in 2017, and they have become extremely popular. In the first year, shared e-scooter ridership in the United States surpassed bike-share, replacing car trips about one-third of the time. Suddenly, we are seeing travellers in Denver and Baltimore opt for these small electric vehicles for reasons similar to why people take rickshaws in Delhi or moto-taxis in Bangkok: they are convenient, inexpensive, and get you where you need to go.

Reinvented in Santa Monica, California, but with roots in the Global South, micromobility is a big idea that has the potential to remake urban transport. That is great news for our cities, and I look forward to continued exchanges with international colleagues as we work to fight climate change and bring affordable, shared, and electric micromobility to cities around the world.

Pony Express revisited: How relay truck service in India reconciles resource optimisation, fast delivery and driver well-being

Drivers and their trucks at a relay station. *Source: Udit Kulshrestha/Bloomberg/Getty*

The recent introduction of relay trucks in India has changed the way the country's logistics industry operates. Since 2014, Rivigo, a start-up based in Gurgaon near Delhi, has established a network of 70 relay stations for trucks across the country, enabling a pan-Indian service. In this new approach, a single shipment is transported not by one, but by several drivers. The first driver picks up the freight at its home station and drives it to the next relay station. There, the driver liaises with a second driver, who has stopped at the same station with a shipment going in the opposite direction. The two exchange trucks and each continues to the next station on the route to the shipments' final destinations. The relay continues until the shipments are delivered.

Rivigo uses sensor-equipped trucks and Big Data analytics to coordinate this "logistical ballet". The individual drivers only make round-trips from their home base. In this way, they complete the same amount of kilometres as in a non-relay system, but they can go home after their working day and stay with their families overnight (The Economist, 2017).

What is the innovation aspect?

This innovative system optimises resources resulting in major productivity gains. Rivigo's trucks are permanently on the road and essentially never stop moving. Trip durations are thus drastically shortened. A journey from Bangalore to Delhi takes 96 hours with conventional methods, but only 44 hours with the relay truck system. On average, Rivigo's turnaround times are 50% to 70% shorter than transport by traditional trucking methods (Rivigo, 2017).

The relay system also significantly improves working and living conditions for truck drivers. Driving approximately 800 kilometres back and forth to their home stations, 92% of Rivigo's drivers are able to return home every night of the week (Rivigo, 2017).

Rivigo's unique success has expanded on the models of other logistics start-ups in India, Viet Nam, and China which connect drivers with shippers. These other players identified both the importance of on-road freight to the economy, and how to mitigate inefficiencies for both parties. While there are a lot of similar initiatives in the logistics industry in the Global North, the efficiency gap in the Global South is much wider. For example, in Viet Nam, logistics costs make up 23% of GDP, with 90% of trucks owned individually (e27, 2019). In India, roughly 28% of the 8.5 million active trucks nationwide sit idle, resulting in a USD 60 billion loss per year (IRU, 2018). This underutilisation is due partly to a driver shortage caused by poor job conditions, and partly to an extremely fragmented marketplace where drivers who own their own trucks cannot connect with shippers.

BlackBuck, another Indian logistics start-up, has addressed the latter problem by facilitating direct connections between businesses in need of shipping with truck owners and freight operators (IFC, 2017). Logivan, in Viet Nam, similarly connects trucks with spare capacity to shippers in an effort to improve logistics efficiency, reducing both cost and pollution (Business Insider, 2018). Logivan itself took inspiration from Manbang, a Chinese start-up that applies advanced algorithms and big data to find optimal prices for arduous services such as long-haul journeys (Dai, 2019).

While each of these start-ups has improved the efficiency of road freight logistics in its respective countries through a more streamlined marketplace, none of them owns its own trucks or maintains its own stations. Rivigo has done both, making the relay system more reliable for shippers and less demanding on drivers, drastically reducing delays and long-haul journeys. This makes driving more attractive, ensuring stability and predictability for workers. Rivigo's model goes far beyond optimising supply and demand. It addresses the core problems vexing Indian logistics by elevating the quality of life for drivers while simultaneously mitigating the driver shortage. It makes for a healthier workforce, industry and economy.

What are the benefits? What challenges exist?

Rivigo currently employs 4 000 drivers and the size of its workforce is growing exponentially (Rivigo, 2017). Leading logistics companies from the Global North have recognised the potential of the relay truck system. Amazon is using Rivigo to deliver its products and DHL is considering a similar approach for the Indian market (The Economist, 2017).

But India faces an estimated shortage of one million truck drivers (Iqbal, 2016), and the Global North suffers from a severe shortage as well. A survey of Indian drivers found that roughly half of drivers' trips are over 12 hours (Castrol 2018). These conditions result in poor access to food, rest or hygiene, and long spells of social isolation away from family and community. This enormous stress has dropped the truck-to-driver ratio in India from 1.3 drivers per truck in 1982 to 0.6 today. By 2022 it is expected to dip below 0.5 — all while the share of on-road freight has increased among transport modes (IRU, 2018). Meanwhile, the gap between available supply of drivers and demand from haulers is projected to reach 0.8 million in Europe and the United States combined by 2030 (ITF, 2017b).

The relay truck service could offer a way to address these issues by making the driver profession more attractive, including for women. A 2017 survey of the US trucking industry found women represented less than 8% of the workforce, and several Indian news outlets have reported that less than a handful of woman drivers exist in the country (Women in Trucking, 2018). A network of relay stations would make the job more appealing for all people, but women might benefit particularly from being able to return home each night thus avoiding the safety concerns related to sleeping on the road. It might also be especially suited to

areas like the European Union and the United States, where freight transport over long distances falls under common regulation and trade is free.

What does the future of self-driving trucks mean for current drivers and for the driver shortage? Many industry experts suggest that automation may not affect driver jobs. Paradoxically, many suggest it may create new ones thanks to increased demand. Self-driving trucks are almost ready for long, straight expressways, but far from being able to independently navigate dense urban areas (Clevenger, 2018). Incorporating automated trucks into a "transfer-hub" relay system such as Rivigo's could vastly reduce need for long-haul trips by drivers.

Platooning is a form of semi-automated transport where a caravan of two or more trucks travel together in close proximity, with only the lead vehicle manned by a driver. The subsequent trucks are automated and follow the lead of the first (Clevenger, 2019). The Japanese government is already promoting platooning in order to address its own driver shortage and increase efficiency. Studies suggest platooning can also reduce greenhouse gas emissions (ACEA, 2017). When paired with a Rivigo-like relay system, the benefits might multiply; clients could receive their freight more quickly and at lower costs and emissions, while also improving job attractiveness for drivers. In such a multifaceted system, a single driver could transport multiple loads along expressways until reaching a suitable relay station. There, either a local driver would take over parts of the load, or the unmanned truck would queue at the relay station to be platooned by another relay driver.

What do policy makers need to know?

The relay truck system, based on a historic transport practice, is an innovation that is disrupting India's logistics industry. Relay trucking addresses a number of issues that many countries face in similar ways, such as working conditions, driver shortages and the need for more efficient freight transport.

Rivigo is a reminder that innovation in the transport sector is sometimes built on contradictory concepts. Central to the company's strategy is full ownership of its trucks and infrastructures, which stands in stark contrast to the Uber-pioneered innovation paradigm that sheds any ownership of physical infrastructure and focuses solely on providing a digital service. Some global logistics companies are developing Uber-like platforms to link truck drivers with cargo shippers. This approach may respond to some needs, but it is not likely to solve the critical problem of current and future driver shortages.

The rickshaw of tomorrow: How agile mobility provides clean and affordable last-mile commutes in Viet Nam, Colombia and France

An ADB pedicab outside a monastery in Nepal. *Source: Khashing Rai/ADB*

"Agile mobility" describes the use of any design of light vehicles. In the Global South, two- and three-wheelers – some pedal-powered, some engine-powered – are widespread because they offer affordable mobility adapted to poorly serviced areas (Mbara, 2016; Boquet, 2017). In Hanoi, the capital of Viet Nam, light vehicles make up 94% of the total fleet; in Kathmandu in Nepal, their share is 74% (Gota, 2018). The emerging economies of Asia have the highest density of two- and three-wheelers, but other continents are seeing their share of these and other light vehicles increase exponentially. In Cartagena, Colombia, a city of one million inhabitants, the number of two-wheelers grew five-fold between 2008 and 2015, while that of private cars only increased by a factor of 1.74 (ITDP, 2017a). Those agile mobility devices are not only used for first-last mile passenger trips and goods delivery, but also as moving market platforms, e.g. adapted tricycles being the backbone of Mexico's tianguis (mobile markets) since their inception.

What is the innovation aspect?

Two- and three-wheelers are not a thing of the past. Instead, they are moving to the forefront of mobility innovation. Electrification of three-wheelers is happening on a massive scale in the Global South. Around 50 million electric three-wheeled light vehicles operate in the world today (IEA, 2019), most of these in China. In India, 1.5 million battery-powered three-wheelers operate and around 11 000 new electric tricycles ("e-trikes") hit the country's streets every month (Ward and Upadhyay, 2018). The Pedicab project launched by the Asian Development Bank in Nepal in 2017 seeks to make them an attractive alternative to the private car by modernising the image of three-wheelers, notably through contemporary design features, electric propulsion and new business models that integrate e-trikes with formal public transport providers.

Across the Global South, there is undeniable demand for motorcycle taxis, called moto-taxis. From Viet Nam to Nigeria to Colombia, these two-wheel taxis are a response to intense traffic congestion, expensive fare for traditional cabs, limited public transport and pollution. While the increased modal share of fossil fuel-powered light vehicles alone can help reduce traffic, pollution, and commuter costs, electrically powered light vehicles could help greatly decrease greenhouse gas emissions.

MAX, a motorcycle transport start-up based out of Lagos and expanding across West Africa, is piloting electric two- and three-wheelers with support from Yamaha, and negotiating with electric grid operators to establish charging stations across Nigeria (Bright, 2019b). In India too, traditional industry leaders are competing alongside start-ups to put electric and alternative-fuel sourced vehicles on the road. TVS Motor, a well-established Indian motorcycle manufacturer, has launched an ethanol-fuelled motorcycle (Hindu Business Line, 2019). Virya Mobility 5.0, an electric vehicle charger manufacturer and supplier who produced India's first electric car in 2001, has partnered with nascent clean energy company SUN and Microsoft to form SUN Mobility (SUN Mobility, 2018). The group will integrate Microsoft's cloud technology into its energy infrastructure to put batteries in e-rickshaws and connect drivers to charging stations, allowing them to swap out dead batteries for charged ones without long waits (Bahree, 2019).

While two-wheel moto-taxis may be slightly cheaper and more agile than three-wheel rickshaws, the latter provide unique benefits. Three-wheelers can carry multiple people, people who might require more privacy or space when riding, or perform last-mile delivery for appliances or furniture (Peters, 2018). Electric rickshaws can help drivers cover more ground in less time, shorten commutes for passengers, supplement public transport by feeding last-mile trips, and reduce congestion. E-rickshaws also mitigate pollution by replacing fossil fuel-powered auto rickshaws. In February 2019, India's government allotted USD 1.4 billion over the following three years to subsidise and support the electric vehicle industry in order to battle air pollution (Bahree, 2019).

The use of two- and three-wheelers is not just limited to passenger transport. Some regions in the Global South have ingeniously applied the concept of two- and three-wheeled carts for commercial purposes, thus blurring the lines between cargo-transport and market stalls. Three- and sometimes four-wheeled handcarts selling fruits and vegetables, street food, tea or accessories are a common sight in the Indian subcontinent. These push carts or *thelas,* as they are called in the local language, are an integral part of the urban economy in the region.

In Mexico, vendors use cargo tricycles, many of them electrified, to sell goods. They have become the backbone of the capital's many mobile markets. But they are becoming more than just a combination of market stalls and cargo vehicles.

Exquisite Triciclo is a cargo tricycle outfitted with equipment to engage children in activities like drawing, writing, recording and sculpting. The project was deployed in Mexico City in the mid-2010s and led by MIT Media Lab scholar Edwina Portocarrero. Instead of goods, it provides a service. It brings play to families, often those in poor areas, who do not have access to the playgrounds in the city. This traveling play area echoes the Tianguis – open-air bazaars held on certain days in smaller towns – and makes one wonder if they may still have a competitive advantage over established formal markets (Hernandez Rodriguez, 2017).

Similarly, bicycle and tricycle carts for selling goods on the move have proliferated in several cities of the Global North. These range from ice-cream carts to coffee carts and even to delivery e-bikes and e-trikes. The transformation of two- and three-wheelers to serve as mini moveable-shops is a simple yet innovative way of adapting an old concept to serve the modern needs in a cost-effective and sustainable manner. Many Global North cities that have invested in cycling infrastructure have seen a significant increase in the number of two- and three-wheeled cargo bikes used by individuals. In Copenhagen, for instance, 25% of all families with two or more children own a cargo bike (City of Copenhagen, 2017).

What are the benefits? What challenges exist?

More and more, light vehicles in the Global South are powered by electric engines. They provide mobility that reconciles convenience, affordability and sustainability. This trend also presents a major opportunity for urban travel in the Global North. There, two- and three-wheelers could help bridge the first- and last-mile gap for public transport users, in addition to improving air quality and reducing congestion. With electrification, they can increase the acceptable range of bicycle use for occasional and regular commuters, as they have done in the Netherlands, Germany and Denmark (Plazier, Weitkamp, and van den Berg, 2017; Castro et al., 2019; Aslak et al., 2017). That said, two- and three-wheelers are often associated with chaotic and dangerous traffic, and obvious safety issues must be addressed wherever they operate. In Kigali, Rwanda, for example, the ride-sourcing company Safemoto uses telematics devices to track driver behaviour and adapted incentives to ensure safe operation of its two-wheeler fleet (ITDP, 2017b).

Some entrepreneurs are seizing the opportunity: they enhance mobility in cities of the developed world with light vehicles. Electric two- and three-wheelers, like Paris's free-floating moto-taxis and London's e-tricycles, have rapidly taken hold – especially for tourist trips – pushing into markets that conventional taxi and delivery services, limited by heavy regulation and high-priced, have not covered. Electric tuk tuks have come to English cities like Coventry and Liverpool, while the Royal Mail delivery service is piloting e-tricycles in London and Cambridge, all as part of a concerted public effort to reduce emissions (Davis, 2018; PPTI, 2019).

Historically, these three-wheel vehicles have been considered a nuisance exclusively used by tourists, but recent negotiations between operators and regulators have put more on the street. With proper enforcement, e-trikes could evolve from a tourist attraction to providing regular last-mile services. As Mexico's Triciclos show inherent mobile tools and instruments allow for the providing of services and goods in cities with limited available public space. Three-wheelers can even be transformed into self-driving vehicles for autonomous deliveries, as demonstrated by MIT Media Lab in Chinese Taipei (MIT, n.d.). The self-driving tricycle could be integrated into the public system in a way similar to bike-shares. The vehicle will be able to efficiently transport passengers and deliver goods without human guidance.

Prioritising the conversion of two- and three-wheel vehicles to alternative fuel sources is a logical approach to reducing greenhouse gas emissions in the Global South, given their prevalence there compared to four-wheel cars. But investing in such agile mobility could also help the highly car-dominated cities of the Global North reach the objectives of the Paris Agreement, while simultaneously cutting commute times and costs. Agile mobility can also compliment Global North mass transport systems, boosting ridership by providing feeder service for first- and last-mile and poorly-served areas at a much lower cost than expanding lines.

What do policy makers need to know?

Keeping light vehicles a relevant mobility option is paramount in the Global South, especially as rising incomes translate into more and more cars on the streets. In the North, a shift to agile mobility is already underway. Shared or individually owned micromobility vehicles and cycling options are being massively adopted in cities as users become more aware of their ability to provide clean and convenient last-mile mobility. Supported by innovation-friendly regulations, two- and three-wheelers can become "key facilitators of long-lasting structural and systematic changes towards shared mobility services, electrification, and autonomous driving" (Gota, 2018).

A collaborative and welcoming approach from Global North authorities may mean the difference between successful integration and messy backlash. In Colombia, the Ministry of Transportation banned the motorcycle taxi app Picap despite a clear demand for its service, while the Mexican government has authorised a Picap pilot programme (Cortés, 2019). The start-up plans to run cost-free trials across Latin

America in order to respect regulations and demonstrate demand, hoping that authorities will note its potential contributions to local transport.

In Thailand, a prolonged lack of regulation of moto-taxi services has led to a chaotic moto-taxi market, at times turning violent. In the absence of government action, app-based moto-taxi service providers like Grab have intensified competition among drivers, leading to a rise in unregistered drivers, inconsistent enforcement, and mafia-style groups who control activity. Rival groups have violently clashed in the streets, drawing international attention.

In stark contrast, the Philippines' government – which had originally banned the moto-taxi platform Angkas in 2017 – formed a Technical Working Group (TWG) in order to build consensus. The TWG included regulatory and enforcement bodies, advocacy groups, motorcycle manufactures, and legal advisors. It decided to allow a six-month pilot of motorcycle taxis, during which they must meet safety, labour, data and legal requirements.

This measured approach in the Philippines engaged all stakeholders and produced quality guidelines that will allow innovation to improve people's lives. Besides such working groups, authorities can apply typical push/pull techniques like providing parking spots for light vehicles, investing in alternative energy sources and facilitating their inclusion at gas stations, and securing space for battery-charging stations. This can also be seen in India, where the government's push for light e-mobility has helped create the right environment for these passenger and non-passenger modes to flourish in a space predominantly occupied by handcarts and tricycle rickshaws – a practice that can be adapted in the Global North in order to allow for mobile market platforms to become an integral part of the urban economy adequately reflected in transport regulations.

Innovation is in the air: How Colombia is transforming urban mobility with cable cars

Cable cars along the Metrocable Line J of the Medellin Metro. *Source: Alexander Canas Arango/Shutterstock*

Cable cars were only thought of as tourist transport options for many years, and mostly associated with the world's tallest mountains. The cable car systems in the French Alps and Mérida, in the Venezuelan Andes range, come to mind. Perceptions changed drastically when local authorities in Medellin, Colombia made the groundbreaking decision to integrate a cable car system into its existing public transport network. Cable cars in Medellin became part of a wider strategy to decrease social inequalities in the city in an economically and environmentally sustainable manner.

Inspired by this example, many cities of the Global South have followed suit. Constantine, Algeria in 2008, Caracas, Venezuela in 2010, and La Paz, Bolivia in 2014 are but a few examples of places where cable cars have contributed to strategies to respond to cities' transport needs, often crossing barriers that sever communities. Similar systems have also been implemented in various Global North cities. Cable car systems began in London, United Kingdom in 2012, and in Rennes, France in 2016, albeit to provide a low-volume service, primarily for tourists.

What is the innovation aspect?

Innovations can sometimes be found when looking at old practices in a new light. The first urban passenger cable car system appeared in New York in 1967. The system was a temporary fix for connecting commuters to Roosevelt Island, before the opening of a new subway station. After the station was finished, authorities decided to keep the cable car as a picturesque alternative to the existing network – again relegating the

urban cable car to a tourism attraction (New York State, 2019). New York's experience was positive for the city but remained an anecdotal example that did not spread massively to other countries.

The turning point for cable cars as a transport solution came when authorities in Medellin realised its potential to address structural barriers within the city. In Medellin, like other Latin American cities with hilly landscapes, most low-income inhabitants live in hillside favelas, areas that are hard to reach by traditional public transport modes. Cable cars became a tool for complementing the existing transport network. Metrocable's first two-km-long line opened in 2004 to serve 35 000 people daily. Medellin showed the world how a tourism infrastructure, sometimes believed to be reserved for high-income earners with money to spend on leisure activities, could improve transport services and living conditions for the entire community.

After Medellin, cities have begun to consider cable cars as a credible solution for urban mobility. In 2014, the world's largest cable car system opened in La Paz, Bolivia with the capacity to transport more than 80 000 people daily (Suárez-Alemán and Serebrisky, 2017). Cable car systems are currently in construction in the African cities of Lagos, Nigeria and Mombasa, Kenya. Likewise, a new cable car system is being designed for Kathmandu, Nepal. Global North cities are also following suit. In Portland, Oregon in the United States, a cable car system opened in 2006 to increase connectivity between the city and Oregon's Health and Science University, the city's main employer. Similarly, a new cable car system is being built in France to enhance connection between Paris and peripheral municipalities (Val-de-Marne, 2019).

What are the benefits? What challenges exist?

Cable cars can be economically viable and environmentally sustainable public transport solutions when specific geographical and urban planning conditions are met. Cable cars can be more affordable, quicker to build and provide similar or higher capacity than other traditional public transport modes. In Toulouse, France, a 2.6-km-long cable car system would be faster to build than a bus system, cost three times less and have a higher capacity, transporting 1 500 travellers per hour per direction verses 1 200 (Ladier, 2017). The compared affordability of cable cars *vis-à-vis* other modes can be higher in hard-to-reach places. In Caracas, a cable car system was the most affordable way to increase connectivity of informal neighbourhoods in the city's hills. Other alternatives would have entailed higher infrastructure costs and required demolishing considerable sections of informal settlements (McGuirk, 2014). Cable car systems can also contribute to reducing CO_2 emissions linked to the transport sector. This is the case, for instance, in Bogotá, Colombia, which has seen a yearly decrease of 756 tCO2/eq since its cable car system was installed (Alcaldía de Bogotá, 2017).

Cable cars have the potential of spearheading social change in urban areas when integrated into public transport systems. They increase access to opportunities and play a part in wider strategies to increase well-being. The TransmiCable system was opened in 2018 in Bogotá in order to increase connectivity of one of the city's lowest-income neighbourhoods, at the top of a hard-to-reach mountain. The system reduced travel time from almost one hour to 13 minutes and has been directly linked to an increase of up to 25% of access to job opportunities of local inhabitants (IDB and ITF, forthcoming).

On top of their direct impact, cable cars have the potential of becoming catalysts for social change when implemented as part of wider strategies to increase well-being of people in the recipient communities. In Medellin, investment in cable cars were planned to include investments in cultural infrastructure and public spaces around the stations. At the same time, the cable car was integrated into the public transport tariff so as to increase the affordability of the system for local residents. These changes, along with an increased access to employment opportunities, contributed to a 79% decrease in violence between 2003 and 2004 in the area of implementation (UN Habitat, 2012).

Successfully implementing cable car systems requires including citizens in all stages of development. Current proposals for expanding New York City's transport network with cable car systems have been met

with public concern, most notably regarding the adaptability of the infrastructure to the city's climate challenges (Bendix, 2019). Effectively communicating with the public how their concerns are being taken into account can encourage wider support for the project from the start. Failure to do so can handicap the project from the outset with strong public opposition and doubt in project's suitability and viability.

Authorities also need to engage with citizens during the planning process so that the system can be adopted by local residents after its construction. In Rio de Janeiro, Brazil, a cable car system was built in the favela of Providência without resident involvement during the planning process (Dias Simpson, 2013). The favela's only public space was destroyed as a result (Braga, 2016). Resident adoption of the system was low when it opened in 2014, and operations halted entirely in 2017.

Finally, it is important to think about those who will have to be relocated when implementing cable car projects. This is particularly essential in informal settlements, such as those in Bogotá, Caracas and Medellin. Although less invasive than other options, the installation of cable cars may still require the displacement of some residents, which authorities must address (McGuirk, 2014).

What do policy makers need to know?

Cable cars show how readapting a common practice from another sector to address pressing transport problems can improve mobility outcomes in Global South and North cities alike. Cable cars can be a comparatively cheap, fast to build and environmentally sustainable transport mode that respond to a city's particular needs.

These systems' main benefit is, however, linked to connecting hard-to-reach places in a way that, until recently, was unheard of. Beyond just increasing connectivity, cable cars have the potential of spearheading social change, particularly in low-income communities. For this, cable cars need to be part of wider strategies that integrate transport and land-use, while taking into account local conditions. Most importantly, unlocking the full innovation potential of cable cars for transport requires planning the network in partnership with all relevant actors, and most importantly, with local residents themselves. These systems must be built in a context where they serve a real transport need that currently is not – or cannot reasonably be – fulfilled with other transport solutions.

In the pursuit of innovation for changing mobility cultures, this relatively common practice in the Global South could be revisited. For instance, if cable cars have disrupted urban passenger transport, why not use them to reshape freight as well?

Expanding transport policies: How to be an innovative policy partner

Transport policy makers consult widely with the traditional transport stakeholders that provide the infrastructure and mobility services in order to make informed regulatory decisions. Today, they need to include a growing number of actors from outside transport as well, as changes in other sectors affect the way mobility services evolve. The impact of new technologies and innovative business models that originate outside the transport sector on the demand for mobility, the cost of transport and on accessibility need to be taken into account to ensure that the sector is prepared this forthcoming (r)evolution and the resulting opportunities are grasped at the right moment.

The transport sector is already grappling with the massive transformation fuelled by the advent of electric vehicles, automation and on-demand mobility. In the Global North, much of the discussion within the transport sector over the past decade has centred on the impacts of technological innovations such as app-based mobility services, new drivetrain technologies and automation across all transport modes.

Innumerable start-ups are challenging the traditional transport and mobility models, initiated sometimes by government funded innovation hubs. They can be classified into three groups: first, start-ups that develop a new generation of vehicles; second, those which approach mobility a service; third, those who combine both (Stoupy, Boutayeb and Sabarly, 2018). Ride-sourcing companies like Didi, Uber, Ola, Grab or Lyft changed the way taxis were hailed, for example, forcing the incumbent taxi companies to venture into app-based ride-hailing themselves. Similarly, Bla Bla Car has become a substitute for taxis, buses, trains, delivery services and even flights.

Outside he transport sector, and therefore often under the radar of transport policy makers, a wide range of new business models are taking root which rely on on-demand transport. Moving people or goods is not necessarily their core business proposition, yet they have acquired the market power to shape transport practices. This is because transport has become the backbone of the platform-based on-demand service industry. Such developments are not exclusive to the Global North, however. Innovation hubs and the rise of on-demand services industry are creating the same trends in the Global South, as the case studies presented in this chapter highlight. New service models have proliferated there as well, as digital platforms easily connect supply with demand and market entry costs have fallen drastically. The handyman, the physiotherapist or the laundry service are only an app download away (OECD, 2017c).

But they still have to reach the client, and thus the shift to an on-demand economy relies heavily on transport. In the United States, online marketplaces (such as Amazon and Ebay) lead the spending for on-demand services with at USD 36 billion annually, followed by transport sector in at USD 5.6 billion (Colby and Bell, 2016). Several sectors of the economy that were previously entirely detached from digital technologies are now difficult to imagine as not being linked to on-demand app-based sectors, such as grocery shopping, furniture and homeware stores as well as the cosmetics and pharmaceutical industries. E-commerce has already transformed shipping and warehousing logistics. An unprecedented transformation of the transport industry as well as supply chain logistics is likely, as Amazon is exploring the introduction of drones and autonomous vehicles for deliveries in the foreseeable future.

Within the transport sector itself, the rise of on-demand services has been a disruptive force, too, notably in the form of shared access to a fleet of vehicles. In San Francisco, for instance, the Yellow Cab Cooperative filed for bankruptcy in 2016 after struggling to compete with new ride-hailing services. Similarly, Indian cities like New Delhi and Mumbai have seen repeated strikes by taxi and auto-rickshaw unions against ride-hailing services in the past few years. Similar conflicts arose in Korea, France, Spain, the United Kingdom

and elsewhere, providing evidence that the new business models are threatening the incumbents in the sector everywhere.

Once more, the disruption is not limited to the Global North. On-demand services are equally booming in emerging economies, illustrated for example by the success of Go-Jek, an integrated on-demand multiservice platform in Indonesia. From its origins as a cab and motorbike-hailing service Go-Jek has expanded into an electronic payments, food delivery, grocery shopping and even medicine delivery service, to name but a few of the services offered.

The Global South has in fact been a particularly fertile ground for the digitally-driven sharing economy, for reasons that lie in some of its characteristics. Cities in the Global South, for instance, are densely populated and are growing fast but often lack efficient public transport. The business models the sharing economy has developed in the transport sector help meet the demand and reduce congestion.

Innovation in telecommunications, banking and finance also change how transport is accessed and fares are collected. Notably mobile payment is reshaping mobility practices in many countries in the Global South. Ethiopian Airlines offers ticket purchases through mobile payment in six African countries and in China, for instance. The potential is enormous: over 172 million active mobile money accounts exist in the Global South. They make cash-less payment an option even for those who have no bank account (Chironga, De Grandis and Zouaoui, 2017). Mobile payment and micropayment-enabled services could enhance access to mobility in unprecedented ways and trigger more innovative business models.

The impact of out-of-sector innovations on transport is also highlighted by the following case study that discusses the implications of biometric technologies and e-identities. The government of Delhi in India is implementing a digital biometric ID system as the foundation for an automated driver test. This could potentially improve road safety to dramatically and also eradicate corruption associated with the current system of driver licenses. The system will provide a test case for digitising other verification processes related to transport, which could be applied also to licensing public transport operators, aircraft crew, or truck drivers, as well as ID and payment management for passengers.

This chapter highlights two important takeaways for transport policy makers:

First, transport regulators should establish mechanisms to identify non-traditional and external actors who could impact the evolution of the transport sector. Ways also need to be devised to include these actors, once identified, in discussions on future transport policies.

Second, policy makers ought to ensure that regulators remain relevant as the transport landscape changes. As transport evolves, so must regulators. Regulating for the future with the tools of the past will become more and more challenging, if not impossible.

Box 4. Notes from the Field – Cezanne Maherali

Cezanne Maherali is the Head of Policy for Uber East Africa, supporting cities in Kenya, Uganda and Tanzania to move towards smart mobility. She previously worked as an Engagement Manager with McKinsey and Co.

There are over 250 000 boda bodas in Kampala. These motorcycles used for passenger transport move millions of people around Uganda's capital every day. Over 54% of road crashes involve boda boda, and less than 4% of drivers have licenses. This has created one of the biggest policy challenges for Uber in Africa - but also one of the biggest opportunities to transform the sector.

A partnership begins by declaring it. Ahead of launching UberBoda, we informed regulators of our commitment to safety and our intention to put a fully compliant product on the road - and that we were the only player that was doing this.

Getting momentum is hard. Over the past year we have been sensitising policy makers about the biggest challenge to scalability: the prohibitive cost of a driving license. In Uganda it will cost USD 60, compared to USD 20 in neighbouring countries. Yet a typical boda driver only makes USD 5 a day.

So Uber has partnered with local driving schools to train drivers and guide them through the process of acquiring a license. We are also contributing to upfront costs. We work with the police to offer road safety training, have provided drivers with an extra helmet for the passenger, and have paid for injury protection insurance to cover the rider and driver.

We pride ourselves in working to raise standards in the sector. Yet the sustainability of such investments will remain a challenge until policy makers not only acknowledge the efforts, but also play their part in creating an enabling environment for growth.

Lifestyle on-demand: How Indonesia's on-demand transport supplier Go-Jek grew into a full service provider for upwardly mobile urbanites

Go-Jek bikers on the streets of Jakarta. *Source: findracadabra/Shutterstock*

Go-Jek started in 2010 as a call centre for booking motorcycle taxis in Jakarta. Since then, it has expanded into an on-demand multi-service platform. More than 200 000 drivers work as independent contractors for Go-Jek and its app registered 108 million downloads since 2015. Go-Jek operates in 167 cities and districts in Indonesia, as well as in Viet Nam, Thailand, Singapore and the Philippines (Google Cloud, 2018). Today, the company is valued at more than USD one billion, making it one of two transport unicorns in Indonesia.

What is the innovation aspect?

Go-Jek quickly understood the central role transport plays in all other service markets. Having started out as a taxi call centre, it has continually broadened its services to meet varied and evolving demands. In a first step, Go-Jek moved from dispatching taxis to offering a ride-sourcing service called Go-Ride. It then started to deliver food with its Go-Food service and convenience goods via Go-Mart. Go-Med offers home delivery for health products and urban logistics services are provided by Go-Send and Go-Box.

Today, Go-Jek even integrates a wide range of lifestyle services through its secondary app, Go-Life. With just one smartphone application, users can order services from Go-Massage, Go-Clean, Go-Auto, Go-Glam, Go-Fix and Go-Laundry, all delivered on-demand to customers' homes. This type of service integration in a single app is reshaping the understanding of app-based mobility services globally: rather than non-transport sector players using transport providers as service, Go-Jek has used its in-depth understanding of how transport works as a springboard for expanding beyond its original business model, in the process

flipping traditional roles on their head by sub-contracting non-transport businesses rather than being itself sub-contracted.

Go-Jek's ease-of-use and consolidation of services make it an industry leader in the Global South, but similar start-ups throughout the Global South are not far behind. Lagos-based competitors MAX Go and Gokada started as moto-taxi services, but both are expanding into on-demand delivery (Reuters, 2019). Picap of Latin America and Angkas of the Philippines are two popular moto-taxi services currently working through regulatory hurdles—but should they clear those hurdles, the next step may be entering the on-demand economy (Cortés, 2019; PhilStar, 2019). FilKhedma of Cairo came to the on-demand economy from another angle. The home maintenance service understood the crucial role of transport in service delivery, and assists its tradesmen in acquiring motorcycles. Whether it is a service provider like FilKhedma or a transport provider like Go-Jek shuttling contractors to appointments on motorcycles, transport plays a huge role in the on-demand economy. This may mean changes in traffic patterns, different types of vehicles on the road, and new approaches to insurance.

What are the benefits? What challenges exist?

Go-Jek also features a cashless payment system called Go-Pay. Go-Pay enables users to pay offline, transfer money and even purchase insurance or take out micro-loans with their app. Half of Go-Jek's transactions in Indonesia pass through Go-Pay. This volume testifies to the attractiveness of using smart payments in the field of on-demand service delivery in the Global South (Russell, 2019). But digitisation and banking rates of citizens where Go-Jek operates remain a challenge: in Viet Nam, digital payment services are used by only about 25% of the population (e-Conomy SEA, 2018). The Asian Development Bank estimates that increasing financial inclusion could raise the GDP of countries like Indonesia and the Philippines by up to 14%, or as much as 32% for Cambodia (ADB, 2017). Go-Jek plans to address this underserved portion of the market through its new partnership with Visa in order to further diversify payment systems.

On-demand services from dog walking to house maintenance also exist in the Global North. There, however, they are accessed through a fragmented landscape of dedicated apps, such as Zeel, TaskRabbit, Handy, or Wog. In the United States, the fragmentation has grown along with the on-demand economy itself: as of 2014, 76 companies operated in just six industries; by 2016, there were 280 companies serving 16 industries, (Colby and Bell, 2016). Yet on-demand services captured only 5.1% of the addressable market in 2016, while 35% of the United States workforce reported performing a freelance job the same year—leaving tremendous potential for growth (Upwork, 2016; Ratcliff, 2017).

With the insecurity of conventional jobs, the gig economy, and the disposable income of millennials all on the rise, combined with lingering unemployment in parts of the European Union, the Global North is primed for an explosion of the on-demand economy. The ubiquity of smartphones, bank enrolment, and digital payments in the Global North, plus its shift toward a service economy, make it ideal for this type of market disruption (OECD, 2017a). However, issues like workers' rights must be assessed and addressed by regulators, as well as potential impacts on the transport sector.

The integration of personal mobility, delivery, lifestyle services and payment services in one single app pioneered by Go-Jek and Go-Life thus have the potential to create synergies and significantly enhance urban transport efficiency, not only in other cities and regions of the Global South, but in the Global North as well (UBA/GIZ, 2017).

An important challenge exists, however: if logistics information is not shared across public and private players, it could be counterproductive and lead to a huge increase in trip numbers. Studies of ride-sharing apps and self-driving cars in Global North cities suggest that they likely increase traffic, rather than reduce it (Schaller, 2017; Millard-Ball, 2019). Many users of these services reportedly would have otherwise taken

public transport, non-motorised transport, or not made the trip at all. The rise of e-commerce has increased freight volumes, and along with it, congestion (Schoder and Campos, 2016). This suggests that increased on-demand activity may also add vehicles to the street.

What do policy makers need to know?

The service industry around the world is experiencing a major shift towards mobile-based on-demand business models (Colby and Bell, 2016). A growing number of tech companies claim to be the "Uber for this" or "Uber of that" by aspiring to connect demand to supply in some market or niche. One result is the rise of the "gig economy", meaning the reliance on more or less independent contractors to provide labour and infrastructure.

This represents a regulatory challenge, both in the Global North and South. Concerns include minimum worker pay, caps on surge pricing, equity in gender and payment modes, safety protections for both drivers and clients, and effects of market disruption on employment. In other cases, pre-existing regulations may simply be outdated, and authorities may want to collaborate with on-demand service providers to modernise policies that reflect marketplace innovation. Both Global South and North should also evaluate how on-demand delivery services might affect the transport sector as a whole, as well as what measures could help fight congestion and increased emissions due to larger number of trips generated (ITF, 2019a).

The growing market of on-demand services may also offer opportunities. In the Global South, to improve the welfare of workers in the informal sector; in the Global North, to create more flexible job opportunities.

Mobile payment for mobile people: How Ethiopian Airlines uses fin-tech to make aviation more accessible

Women operate a phone repair and mobile-money recharge shop at a market in Kampala, Uganda. *Source: Sarine Arslanian/Shutterstock*

Mobile payment refers to an electronic commercial transaction conducted through mobile devices. Mobile payment requires some sort of "e-wallet" function on a smart phone, which can then be charged with actual money and used to purchase information, services or goods (Di Pietro et al., 2015). Mobile payment uses smart phones to store electronic cash that can be spent anywhere and on anything. It goes far beyond electronic cash systems run by individual supermarket chains or transport companies, with which you can only buy their products. Africa's largest aviation company, Ethiopian Airlines, has offered the possibility to buy tickets through mobile payment in Kenya, Nigeria, Uganda and Ghana since 2010 (Korhonen, 2018). In recent years, this option has become available in Ethiopia and Zimbabwe, and a partnership with China's AliPay has enabled Ethiopian Airlines to reach its Chinese customers in the same way.

What is the innovation aspect?

Mobile payment options improve access to transport services to the significant share of the Global South population that is unbanked. In Africa and the Middle East, over 61% of the population is excluded from traditional financial services – even middle-income earners in these regions often have no such access (Manyika et al., 2016). This was a concern for Ethiopian Airlines, as these regions are part of the company's main market (Bekele, 2018b). Mobile phones and cellular subscriptions are ubiquitous in both regions. By offering a mobile payment option, Ethiopian Airlines has made air travel accessible to those in the region who can afford it, but could only pay cash in the few existing brick-and-mortar travel agencies.

In Kenya, M-Pesa, the hugely popular mobile payment system, has jolted the country's economy by providing a convenient alternative to inefficient banking systems (Fick and Miriri, 2018). Used by 20 million Kenyans and now operating in nine other countries, M-Pesa allows users to avoid cash, pay instantly by text messaging, and make frequent small purchases without penalty. Consumers and merchants alike are able to avoid fees, lengthy trips to bank branches, and transfer delays. M-Pesa also virtually eliminates the risk of theft or loss of cash, making it more secure and efficient for buyers, sellers, and borrowers. Unlike many mobile pay systems, M-Pesa does not even require a smartphone. (Manyika et al., 2016)

In sub-Saharan Africa, more people hold mobile money accounts than traditional bank accounts (Gahigi, 2017). Mobile payment access has pulled 194 000 Kenyan households out of extreme poverty and empowered women in the workforce, as well as rural communities who lack access to banking or marketplaces (Logan, 2017).

What are the benefits? What challenges exist?

There are over 172 million active mobile money account owners across the Global South (Chironga, De Grandis and Zouaoui, 2017). They could gain much improved access to air travel if they were offered mobile payment as an option. Some European airlines started to experiment with mobile payment for in-flight services after realising that 65% of the 100 million Chinese tourists travelling abroad every year use mobile payments (Garcia, 2018; Wilson, 2018).

Mobile payment and micropayment options can be easily integrated into urban public transportation as well, with huge potential benefits for riders and operators in both the Global North and South. The digitisation of passes would save money by eliminating the printing of paper tickets and save time by eliminating the inefficient process of exchanging cash and receiving change (Gemalto, 2019). These mobile payments would also reduce wait and travel times for customers, while lowering costs and the risk of theft for operators by reducing the need to handle cash or run their own payment services. In the global North, the Netherlands are among a few countries already looking into mobile payment technology for urban transport systems across the whole country (Cheng, 2017).

Mobile pay can also boost ridership, and thus operator revenue, by improving customer experience and increasing access for travellers while minimising losses. The sewage authority of Dar es Salaam, Tanzania reported a 38% increase in revenue collection after enabling payment through mobile money services; by contrast, Nairobi paratransit operators lose up to 30% of their earnings a day due to the vulnerabilities of a cash system (Gahigi, 2017; How We Made it in Africa, 2015). Despite the ubiquity of cell phones worldwide, Nairobi's initial effort to transition its 20 000 paratransit matatus to mobile pay failed. Similarly, in 2015, only 3% of in-store payments in Europe were conducted via mobile pay, despite Western Europe having the highest smartphone penetration in the world (Cash Matters, 2019; Fung Global Retail and Technology, 2016). While mass transport is ideal for mobile pay integration due to the low price, high frequency, and high volume of purchases, authorities may need to subsidise upfront transition costs for private operators and incentivise riders to switch through discounts (Retail Dive, n.d.).

What do policy makers need to know?

Mobile payment can generate new business models such as the pay-as-you-go model adopted by many providers in the energy sector. Go-Jek in Indonesia and Didi Chuxing in China have proven that mobile payment is a major factor for the success of ride-sourcing platforms. However, the mobile payment ecosystem is dominated by players that lack a good understanding of mobility issues. Mostly, these are banks and telecommunication companies, tech or retail giants such as Facebook and Apple or Alibaba (Ong, 2017). Yet their impact on mobility is already palpable and their role in shaping transport policy will certainly grow.

Partnerships may be necessary between public authorities, private tech firms, and private operators in order to seamlessly integrate mobile pay into transportation. From the perspective of public transport authorities, integrating the mobile money service directly with a transport system's app could be highly beneficial, as this allows it to build its brand, gain mobility data for better infrastructure and service planning, and gain access to customers for direct communication (Gemalto, 2019).

The improved ridership, savings, and tax revenue for authorities, as well as faster boarding times and happier clients, greatly outweigh any short-term costs associated with enticing operators or users to take up mobile pay. Purchases made through a mobile device in Europe tripled between 2015 and 2016 (E-commerce News, 2016). Traditional transport authorities must move into the future with their clientele if they are to compete with private micromobility and ride-hailing apps for ridership.

Automated Driver Test Tracks: How India is altering road safety with biometric identity

A man takes a retinal scan to link his Aadhaar card with the National Register of Citizens in Barpeta, India.
Source: David Talukdar/Shutterstock

Today, 1.1 billion people around the world do not officially exist. Without legal identification, citizens may be excluded from vital social benefits like health care, education, and financial services. Since 2010, India has addressed this challenge through Aadhaar, a biometric identity system that provides digitised IDs to residents based on unique physical characteristics. Biometric recognition technology has the potential to replace legacy systems, increase citizens' access to resources and reduce authorities' exposure to fraud.

Before Aadhaar, approximately 58% of food goods subsidised by the Indian state did not reach the intended recipient. Since the transition, food pilfering has been drastically reduced and the state has saved USD 10 billion over just 2.5 years (OECD, 2018). The new system has doubled the number of women with bank accounts to 90%, and has helped open one billion new mobile phone accounts. India's Aadhaar biometrics-based ID system is the largest of any in the world, with 1.2 billion Indian residents registered, including 99% of all Indian adults—expanding access to crucial services for the marginalised, while increasing state efficiency and reducing corruption.

The impact of Aadhaar is now extending to transport. The government of Delhi is currently launching the digital biometric ID system as the foundation for a fully automated driver test that has the potential to dramatically improve road safety and eradicate corruption. The system will therefore be able to

demonstrate its potential to revolutionise other verification processes related to transport, whether it is licensing for private individuals, public transport operators, aircraft crew, or truck drivers, as well as ID and payment management for passengers (Bertrand et al., 2006).

What is the innovation aspect?

In 2013, there were approximately 207 551 road traffic deaths in India, and the country expects 50 million new drivers on the roads between now and 2025. (WHO, 2013) One way India has tried to address this issue is by using the Aadhaar ID system in conjunction with automatic driving tests.

Driver's license applicants register for the driver's test and pay online, then confirm their identity using their unique Aadhaar number. They receive a code, enabling them to enter the test centre. Once their identity has been biometrically confirmed, they are issued RFID tags that track them and their vehicle through a series of test manoeuvres, for which they are scored instantly based on readings from sensors and CCTV cameras. The Aadhaar database prevents fraud by ensuring that the person who registered for the test is the same person taking it, and video processing is able to track the car's movements along the track without a human monitor present. The system includes instant evaluation, enabling users who have successfully executed a manoeuvre to access the next test area, in conjunction with RFID and facial recognition technologies.

Idemia, a technology firm specialised in augmented identity, has been working with leading Indian technology specialists and transport policy makers to develop a technology that will allow Indian residents to take driving tests without any human involvement. They are experimenting with a combination of biometrics, video analytics, machine learning, and radio frequency identification (RFID) technologies. The new system will increase test capacity while enforcing higher road safety standards and virtually eliminating the potential for corruption. By removing the human element, test takers will not be able to offer bribes to instructors for a passing score, minimising the number of dangerous drivers on the road. The twenty essential driving skills that correspond to India's Central Motor Vehicle Rules can be codified into the software, guaranteeing that only qualified drivers receive a license (Hindustan Times, 2019). The biometric element also prevents fraud, ensuring that the same person applying for the license is driving the car.

Automated test tracks premiered in Punjab in 2015, and are currently operating at over 50 locations across northern India. They have proven so successful that the country plans to do away with manual testing altogether before the end of 2020. Full adoption may help address road safety, truck driver demand, public sector inefficiency, and corruption in India—demonstrating how a digital biometric database can be leveraged to improve transport.

Governments in both the Global North and South have been exploring biometrics and facial recognition uses as well—but the former has focused on security issues, while the latter has already implemented basic ID systems similar to Aadhaar for other services (Simonite, 2019; Burt, 2019). For instance, Nigeria is exploring biometric registration for flood planning and emergency responses, framing digital identification as a catalyst for reaching United Nations Strategic Development Goals (Hersey, 2019). Similar programmes may help in other countries where corruption around licensing is a serious problem, such as South Africa (Hornberger, 2017; Corruption Watch, 2017).

What are the benefits? What challenges exist?

Road safety is one issue. But the growing Indian logistics industry requires between 700 000 and 800 000 new truck drivers each year, and currently faces an estimated shortage of one million drivers (Iqbal, 2016). Extending the automated driving test to trucks could help boost economic activity and employment without putting a significant burden on the state. By eliminating the need for inspectors, test capacity is no longer limited by scheduling: automatic sensors and self-contained zones with dedicated exit lanes enable test

tracks to accommodate multiple users. Biometric identification also helps prevent fraud, ensuring that the person getting the driving license is the same person taking the test. A detailed report can be generated for all applicants, adding transparency to the process. Codifying road regulations into the automated system helps to ensure only safe drivers receive a license, virtually eliminating bribes in the process. While the failure rate for manual driver tests in India was 16%; on the first day of Delhi's automated driving test, 90% of applicants failed (Singh, 2019). This number has now stabilised at 49%, but it still reflects the new, stricter standard with less opportunity for corruption.

Several challenges may hinder widespread adoption of automation and biometrics in India's licensing procedures, despite their proven effectiveness. The programme is costly. The costs required for the technology itself, installation, operation and maintenance may be met with resistance. Additional costs may also be incurred for capacity building in the test centres and transitioning an entire population onto a new digital system. Demonstrating the long-term savings, as well as reduced security risks, may be crucial in convincing authorities to transform their legacy identification systems that underpin driver tests and other aspects of transport.

Other concerns are with the readiness of the technology data privacy issues. In June 2019, the United States Government Accountability Office concluded that the FBI's facial recognition technology was not yet sufficiently accurate, and needed to be improved before being fully scaled (Neus, 2019). There are also equity concerns. A July 2019 National Institute of Standards and Technology (NIST) test found that biometric technologies are much more likely to erroneously match the faces of people with darker skin, as well as women (Simonite, 2019). Other changes to appearance like glasses or beards may confound the technology, as well (Neus, 2019).

What do policy makers need to know?

Roads in the Global South are being inundated with unprecedented growth in car usage. In India, car manufacturer Maruti has estimated that the country requires 20 000 driving schools to meet growing demand, compared to less than 6 000 in operation today (Mathur, 2015). The manual driving test system will be challenged to handle this increase, and it is already failing to preclude unprepared drivers from reaching the road. Idemia's automated driving test will help address both issues by increasing capacity, improving road safety, reducing government spending, and eradicating corruption.

Countries in both the Global North and South concerned about increasing vehicle rates, road safety, license access, and corruption could benefit from closely monitoring India's implementation progress. Public entities dealing with state retrenchment might also explore automated driving tests in order to economise budgets long-term.

Taking knowledge exchange beyond traditional perceptions and boundaries

The global transport sector is undergoing a comprehensive transformation. Digital technologies, once considered high-tech innovation of the Global North, are disrupting economies on local, national and international scales. In the Global South, however, these innovations have not been blindly adopted. Rather, they have been reconfigured, remodelled and reshaped into new transport solutions. And these adaptations are now showing their potential to change mobility in the Global North in turn. Is the Global North ready?

The Global South has often quickly and successfully adapted technologies devised in the Global North to work as solutions for their own transport challenges. However, this agility is sometimes lacking in the Global North. The ability to quickly transform their own transport systems inspired by practices and new technology-based business models from the Global South could be highly beneficial. The case studies in this report demonstrate how solutions from the Global South could help provide a more sustainable, efficient and citizen-oriented transport system while helping to tackle a wide range of challenges: from employee well-being to user safety.

At the same time there are instances of innovation in the Global South being suppressed by government intervention to preserve the interests of incumbent transport operators, just as in the Global North. Nurturing regulatory environments that support innovative services should be developed and supported. This can be fostered by bringing transport experts, technology developers and policy makers together to solve transport problems that are common throughout the world.

Countries in the Global South and the Global North face a similar problem: they often lack knowledge of the toolset required to solve the challenges they face. Countries in the Global North often resort to different toolsets than those in the Global South to address transport challenges (Srinivas and Sutz, 2008), when the right solutions may not be so different. In the Global North, micromobility provides a sustainable alternative for more and more people just as light vehicles are a relevant option in the Global South, despite rising income levels. Similarly, innovative solutions that address the shortage of truck drivers in logistic industries in the United States and India may be relevant across large parts of the Global South and North.

Policy makers around the world face similar problems. They seek to provide their citizens and economies with safe, sustainable and equitable transport solutions. Might looking beyond traditional sources for inspiration help? Could looking to different places for interesting ideas that have already taken root mitigate a classic risk of early adopters: that of picking the loser over the winner in the innovation race?

Initial research into transport solutions in the Global South gave rise to a number of important questions that were highlighted in the introductory report *Expanding Innovation Horizons: Learning from transport solutions in the Global South* (ITF, 2019a). These questions were addressed to transport policy makers in the Global North. This report has attempted to answer those questions, after further research and discussion with stakeholders.

How can economic growth be aligned with creating a sustainable transport system for all?

In the recent past, there has been significant progress towards making transport sustainable. The development of low carbon technologies, sustainable transport infrastructure, integrated pricing and new tolling systems, more efficient public transport and many other measures are aimed at reducing the impact of the use of private vehicles. It is important for policy makers to apply innovative measures to ensure that the uptake of these sustainable transport measures is economically viable by ensuring favourable regulatory frameworks based on sound principles of fairness, equity and efficiency.

At what governmental level should policies fostering innovation be implemented to maximise impact?

The level of government at which these policies are formulated and implemented can determine their effectiveness. In some cases it is better to have local governments design policies tailored specifically to the local context. For instance, in large and diverse countries such as India, a policy implemented at the local level, catering to context-specific challenges will be more effective than a policy designed and implemented at the federal level. At the same time, some policies might be more impactful when they are implemented at the national level. This is especially the case when uniformity in transport systems or regulation is desired.

What policy framework must be established to ensure that digitalisation is adapted to serve specific local mobility needs?

A policy framework should not only encourage the digitalisation of mobility services but do so in a way that enhances its applicability to local transport challenges. Implementing innovative digital solutions tailored to the needs of the local transport system, e.g. its existing public transport system or informal transport economy, is something that policy makers must keep in mind to ensure maximum benefit from these innovations.

How can a regulatory environment ensure that existing mobility services and new market entrants are treated equally?

The significance of having a regulatory environment that ensures equality between innovative models and the existing business models cannot be stressed enough. Regulations must aim at providing a level playing field to all players in the market in terms of opportunities, market access and the room to further develop their services. Authorities will have to constantly adapt regulations to make sure that all market players, at any given point, are being treated equally.

Is competitive pricing of app-based transport modes enough to persuade commuters to use shared services?

Competitive pricing alone cannot maximise the uptake of shared services. Transport policy makers will need to explore additional ways to incentivise the use of shared services where these make sense from a public policy perspective. Such incentives can take the form of restricting access for private vehicles in certain zones, electronic kilometre charges for congestion, charges for the use of roads and curbs more broadly including charges for the occupation of public space that go beyond priced parking. Another option might be to impose restrictions on vehicle ownership itself.

What incentives might be put in place to encourage the upgrade of traditional transport modes and ensure customer adhesion in existing markets or (re-)adoption in the Global North?

While it is necessary to encourage the adoption of new technologies to solve the mobility challenges of the present, at the same time policy makers must try to devise plans to upgrade existing systems. This can be achieved by adapting the traditional modes of transport by using innovative practices (digital or otherwise). Thus it is possible to ensure maximum utilisation of traditional modes and their transformation into modern and sustainable options before they are deemed redundant.

How can cities harness knowledge about marginalised transport models of the past to tackle current challenges in the transport system?

It is important to identify ways in which knowledge about forgotten and often marginalised modes of transport can be re-discovered. Once this knowledge is acquired, putting it to best use to overcome the

challenges of the present-day transport system is essential. For example, China has implemented policies to bring bicycles back on the road, using a marginalised mode of transport to tackle a present-day challenge.

How can regulators identify the unconventional actors who are making an impact, and in what capacity can they bring them to the discussion?

With the growth of the on-demand app-based service industry, it became obvious that the transport and mobility landscapes will undergo a transformation. However, the rise of the digitally mediated on-demand app-based service industry is not the only sector that has an impact on transport. Changes in the energy sector, the growth in mobile banking and technological developments in other fields are bound to have an impact on the transport sector. Regulators must factor in these changes taking place outside the transport sector by including the relevant actors from these sectors in discussions that shape the policies which will govern the transport sector of the future.

How will regulators remain relevant in the radically changing transport landscape?

Regulators and transport policy makers are endowed with the responsibility to mitigate the negative impacts that a new technology or business model might engender. They also have a responsibility to regulate in such a way that their interventions are kept to the minimum necessary to carry out their mandates. For regulators to remain relevant in today's fast-paced changing transport landscape, they will have to resort to agile and adaptive regulation that allows rapid adjustment and iteration. In this context of change, the goal of delivering certainty on the *exact nature* of a regulation may become superseded by the necessity to provide expectancy and transparency on the *process* whereby regulations are iterated.

Implementing innovation in the transport sector requires a set of cross-cutting practices and processes. The Global North can benefit from investigating successful innovative solutions in the Global South. Similarly countries in the Global South can further their own initiatives by looking at what has worked elsewhere and profit from South-to-South learning. Expanding the global discussion will help to accelerate the delivery of better mobility for all.

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