

SMART

MOBILITY

DIGITA TU CÓDIGO DE ACCESO
TYPE YOUR ACCESS CODE



British Embassy
Mexico City



ITDP

SMART MOBILITY

DIAGNOSIS OF THE PRESENT SITUATION IN MEXICO



British Embassy
Mexico City



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ACRONYMS AND ABBREVIATIONS

APP.....	Mobile application
TOD.....	Transit-Oriented Development
UDG	Urban Distribution of Goods
EDN.....	National Digital Strategy (acronym in Spanish)
SUMS.....	Sustainable Urban Mobility Strategy
CEDN.....	National Digital Strategy Coordination (acronym in Spanish), Office of the Presidency of the Republic
TFL.....	Transport for London.
USA	The United States of America.
GPS	Global Positioning System
GTFS.....	General Transit Feed Specification, real-time feed with public transit information
ICT.....	Information and Communication Technologies
GIS.....	Geographical Information Systems
SEDATU.....	Ministry for Agrarian, Territorial, and Urban Development (acronym in Spanish)
INEGI.....	National institute of Statistics and Geography (acronym in Spanish)
INAI.....	National institute of Transparency, Access to Information and Data Protection
IFT.....	Federal Telecommunications Institute

EXECUTIVE SUMMARY

Mexican cities experience disorderly and disperse growth alongside insufficient territorial and mobility planning. This has resulted in an urban environment that undermines the quality of life of its inhabitants: road congestion, noise pollution, increase in deaths due to traffic events, loss of productivity, social fragmentation, and an increase of climate change-related emissions due to an excessive use of private motor vehicles are just a few examples of the detrimental effects this causes on society.

“Smart mobility” can provide different solutions to these challenges. Examples of these are improving the efficiency of public transit by offering alternatives and real-time information to users, as well as managing transit by means of smart traffic lights or automated parking meter systems. Another effect could be reducing logistical costs for companies (that transport people or goods), among others. The examples of London, Boston, Singapore, Chicago, illustrate the use of Information and Communication Technologies (ICTs) as well as massive data use and open data for such purpose.

The promise of “smart mobility” is the interconnection between the public, the different infrastructures and vehicles used for mobility in a city. Particularly, this “smart mobility” would be made possible by the generation of massive amounts of open data. The purpose of the above is to improve mobility, however, many other purposes could be achieved, such as higher sustainability and improved economic performance in a city.

In Mexico’s case, with the information collected and the cases analyzed it is possible to identify that the top innovations on this field come from private parties and not directly from government. Although this situation is not bad in itself, it does require clear and specific rules of operation. Otherwise, so-

cially adverse situations might arise or full benefits for the public could not be realized. An example of these rules could be binding the private sector to share the databases created in open formats when operating government concessions or offering public services for urban mobility.

Additionally, diverse local efforts and good practices for the development of smart mobility projects from government have been found in the cities of Mexico, Hermosillo, and Leon, among others. Nevertheless, in Mexico, support for this type of policies at the local level is quite limited, as is the case with sustainable urban policies or data openness. This implies a double challenge and an opportunity since today, it is not only necessary to have in place policies that foster urban development and sustainable urban mobility centered on walking, biking, and public transit. Simultaneously, it is necessary to include the use of information and communication technologies in order to maximize social benefits. Given the fact that we are at a time when the mobility paradigm is shifting, it is also time to foster the use of CITs to give rise to truly smart mobility.

PRESENTATION

Societies gain enormous benefits from the ability of moving people and goods over space and time. Efficient transportation facilitates interaction of people and the exchange of goods and thus underpins globalization and human development.

However, major challenges are linked to transportation. On the global level climate change is recognized as a major threat to human civilization caused by the extensive use of fossil fuels. The transport sector is uniquely dependent on oil and has grown considerably in the last 50 years. More than a quarter of overall energy use is allocated to the transportation sector. As one of the main emitters of CO₂ the transport sector contributes significantly to global warming. Increasing emissions from the transport sector have the potential to undermine efforts to meet economy-wide, long-term emission reduction targets. On the local level, air pollution, noise and motor vehicle accidents pose significant threats to human and ecosystem health. In the context of accelerating urbanization, existing infrastructures cannot cope with large increases in traffic volume. Congestion is becoming an increasing problem, especially in urban areas. Simultaneously, demand for mobility is growing. The same applies for emissions from transport, with much of this growth taking place in the non-OECD world.

Future global transport and mobility will be fundamentally affected by the need to create more resource-efficient, clean transport technologies and to deploy and maintain sustainable transport systems. A long-term transformation of transport infrastructure and services is required to meet climate change mitigation challenges as well as the travel needs and requirements of a rapidly growing global urban population, but also to enable sustainable economic growth with sustainable freight transport links between global agglomeration and periphery.

Significant efforts are under way to advance post-fossil mobility systems deploying alternative propulsion technologies and integrating renewable energy sources with transport infrastructure. New energy and materials technologies are enabling new forms of post-fossil transport. ICT-enabled web and mobile applications are spawning a plethora of new mobility services. Traditional mobility markets are in flux and new players are emerging with disruptive service offerings. These are challenging traditional demarcations

between public transport and private mobility and will increasingly necessitate a co-production of mobility services by both traditional public and new private providers. In addition, demographic trends such as ageing populations in some key world regions, significant public health implications, and the need to maintain economic growth as well as basic equity in mobility provision to all social groups provide for complex transport politics. The politics and governance of land-use provide an additional contested policy arena.

The combined effect of these developments will have far reaching impact on the way public transport, private mobility and logistics will be organized in the future. Shaping this new public space will be a strategic opportunity and challenge for cities, regions and governments globally.

Given long investment cycles for transport capital investment, governments will be increasingly faced with competing claims on future transport infrastructure and long-range investment pathways. Identifying and evaluating cost-effective, equitable and successful policy regimes and switch-over strategies for transport systems is a central urban policy challenge. Understanding and differentiating the performance and potential of emerging new and innovative transport and mobility systems will be fundamental in implementing successful and sustainable transformation paths.

In spite of modest, evolutionary innovations, transport continues to represent over 20% of CO₂ emissions and is projected to continue to rise significantly to 2050 even in benign scenarios. Most significantly, transport's share of overall CO₂ emissions continues to increase in current linear projections. Recent scenarios offer little confidence that the policy mix currently deployed towards mitigation will have sufficient decarbonization impact. Projections toward 2050 appear to offer a stabilization of current absolute CO₂ emissions from global transport at best and a rather more probable increase of CO₂ emissions, albeit with a reduced rate of increase.

Notably, these scenarios do not yet fully incorporate the innovation dynamics of recent years. A key requirement is for new mobility services to build on zero- and low-carbon technologies, and to contribute to modal shift, efficient demand management and sustainable land use.

Digitization is currently reshaping the sector. ICT-enabled web, mobile and big data applications are enabling new mobility and transport services and

systems. Mobility-as-a-Service (MaaS) will increasingly catalyze the public-private co-development and co-delivery of mobility and transport systems and services, as well as shared and open use of public space, data and infrastructure.

The principal prospects for decarbonization are strong better utilization of underused assets in transport fleets and infrastructures can accommodate increasing demand and reduce the share of unsustainable travel modes. Smart mobility systems and services have the promise to contribute to the needed decarbonization of the transport sector and might also help address persistent problems of congestion and accessibility. However, new innovations in technologies and use need to optimize the whole transport system not road-based car travel only to make a long-term contribution to decarbonization.

Based on current scenario projections, a radical transformation of transport systems is required and will become a key policy challenge. Transport transformation and innovation scenarios currently focus mainly on fuel efficiency, fuel substitution, and end-of-pipe carbon capture as levers for decarbonization. Future efforts need to focus on the combined and synergistic effects of integrating urban energy, infrastructure and mobility systems including via modal-shift measures, expansion of public transport options, and sustainable land use governance.

So far, policy and innovation efforts remain overwhelmingly focused on incrementally optimizing existing private motorization modes (“default car”) and automobile technologies rather than on leveraging integrated transport and mobility strategies. Breaking this path-dependency is a key innovation challenge.

The potential carbon mitigation performance of emerging new technologies and services such as intelligent transport management as well as multi-modal, electric, autonomous, low-altitude aerial, vertical and on-demand mobility has not yet been extensively evaluated, in particular in their integrated application. They can strongly support a shift to transport decarbonization, or further lock in unsustainable travel behavior. A key task will be to es-

establish empirical validation of the sectorial and systemic decarbonization impacts of such technology, systems and services innovation, and ensure that technologies and service innovations are not taken forward for their own sake, but in view of achieving a transition to a low-carbon, efficient and accessible transport system.

This publication by ITDP provides an in-depth analysis of the potential for intelligent and sustainable transport systems for implementation in Mexico. It offers a detailed overview of existing intelligent traffic management, innovative public transport solutions and active travel strategies in Mexican cities. It will enable policy makers, industry and cities to make informed choices on the development of future intelligent mobility systems.

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1

INTRODUCTION

For somebody to be considered an expert in public transit routes within a city, including the safest and more direct routes; or for somebody to drive cargo trucks, many years of experience with different options and around the streets of the city would be required.

The promise that the future holds is the interconnection between the public, the different infrastructures and vehicles used for mobility in a city. Particularly, this “smart mobility” would be made possible by the generation of massive amounts of open data and its use by all stakeholders. The purpose of the above is to improve mobility, however, many other purposes could be achieved, such as higher sustainability and improved economic performance in a city.

Mexican cities have experienced disorderly and disperse growth alongside insufficient territorial and mobility planning. This has resulted in an urban environment that undermines the quality of life of its inhabitants: road congestion, noise pollution, increase in deaths due to traffic events, loss of productivity, social fragmentation, and an increase of climate change-related emissions due to an excessive use of private motor vehicles are just a few examples of the detrimental effects on society produced by this situation. Thus, “smart mobility” can provide different solutions. Examples of these are improving the efficiency of public transit by offering alternatives and real-time information to users, as well as managing transit by means of smart traffic lights or automated parking meter systems. Another effect could be reducing logistical costs for companies (that transport people or goods), among others.

To achieve this, an effort will be necessary, not only to implement ICTs to improve mobility of Mexican cities but also to massively analyze data (Big Data) and make it open (Open Data) in order for the promises of smart mobility to be fulfilled.

In this regard, ITDP Mexico, with the sponsorship of the British Embassy in Mexico and the United Kingdom Prosperity Fund, has undertaken to perform a diagnosis of the current situation of smart mobility in the country to understand how close, or far, we are from best international practices and the benefits observed therein.

With such aim, the report is divided in 8 sections. This introduction comprises the first section. Section two explains what is smart mobility and which are its benefits. Afterwards, the differences between the two key concepts for the understanding of smart mobility i.e. big data and open data. Section four, exemplifies the best international practices on smart mobility. Section five explains which is the national policy that would frame smart mobility and open data. We shall allude to the National Digital Strategy. Section six the results of the national level urban mobility analysis shall be presented; for this purpose, we showcase the use of open data and apps for urban mobility developed by diverse stakeholders; present the results of a survey to the governments that comprise Red Mexico Abierto (Open Mexico Network); and identify best practices in the country. Section seven comprises a series of public policy recommendations to foster urban mobility. Conclusions are offered in the final section.



2

WHAT IS SMART MOBILITY AND WHY PROMOTE IT

The term “Smart Mobility” applied to mobility within cities is recent and has become widespread in the past decade. It is possible to use said term in varied contexts and for different purposes without a clear idea of its content. For this purpose it is necessary to establish and define what smart mobility means.

To this end we can resort to the works of ARUP (2013), Okuda *et al.* (2012) and Benevolo *et al.* (2016) to construct a robust definition of what it is, what it includes, and what benefits it might bring.

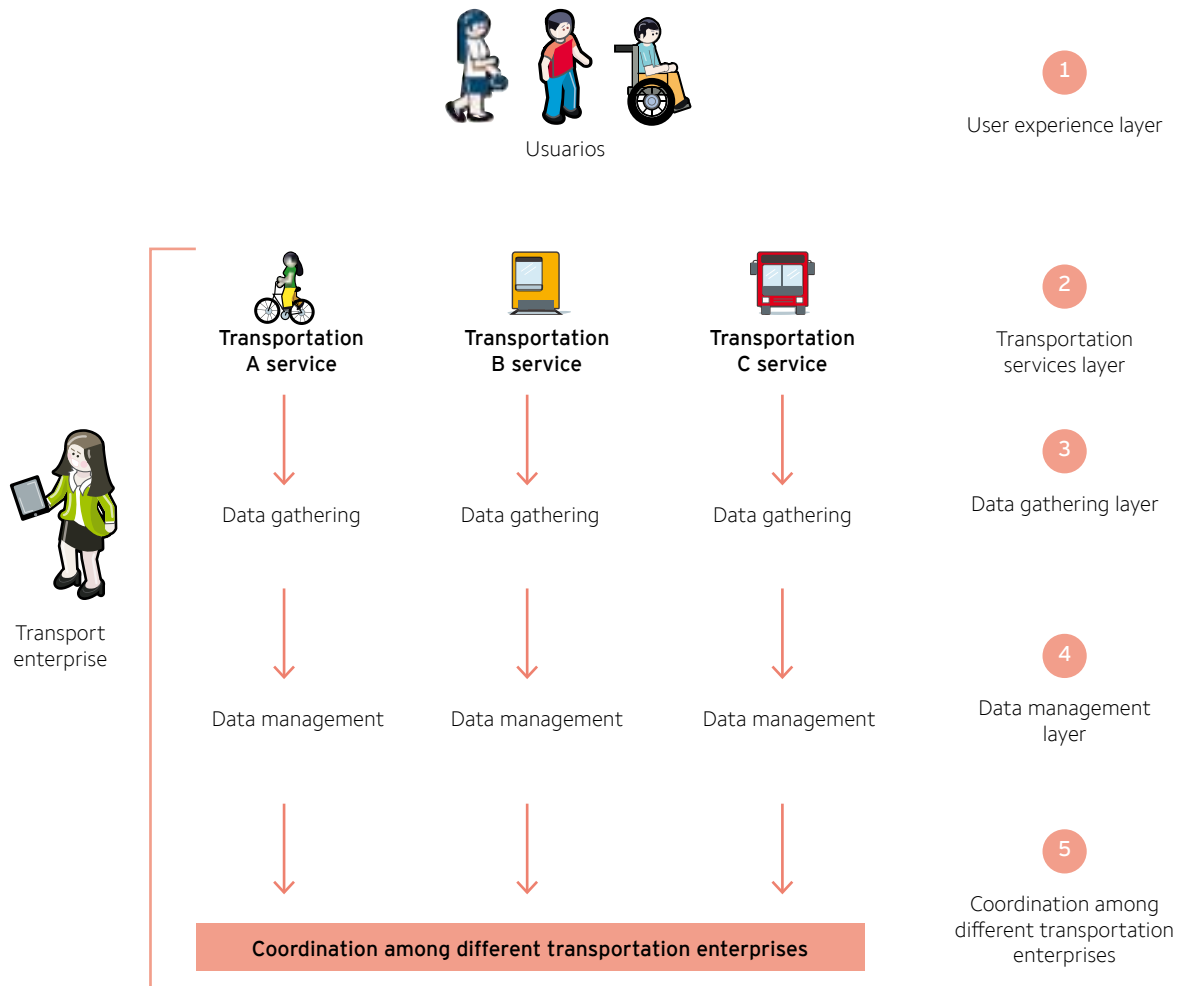
Smart mobility is defined as Information and Communication Technology-based systems that provide a city's inhabitants with higher control to their access to transit as well as more efficient use of their time. Conversely, the authorities in charge of managing a city are equipped with more efficient planning and control of different urban transportation options.

The purpose is to facilitate mobility of individuals and goods within a city, which in turn generates six benefits:



The benefits listed above give rise to additional, secondary benefits such as a reduction in logistical costs for transit, which is beneficial to the economy in general.

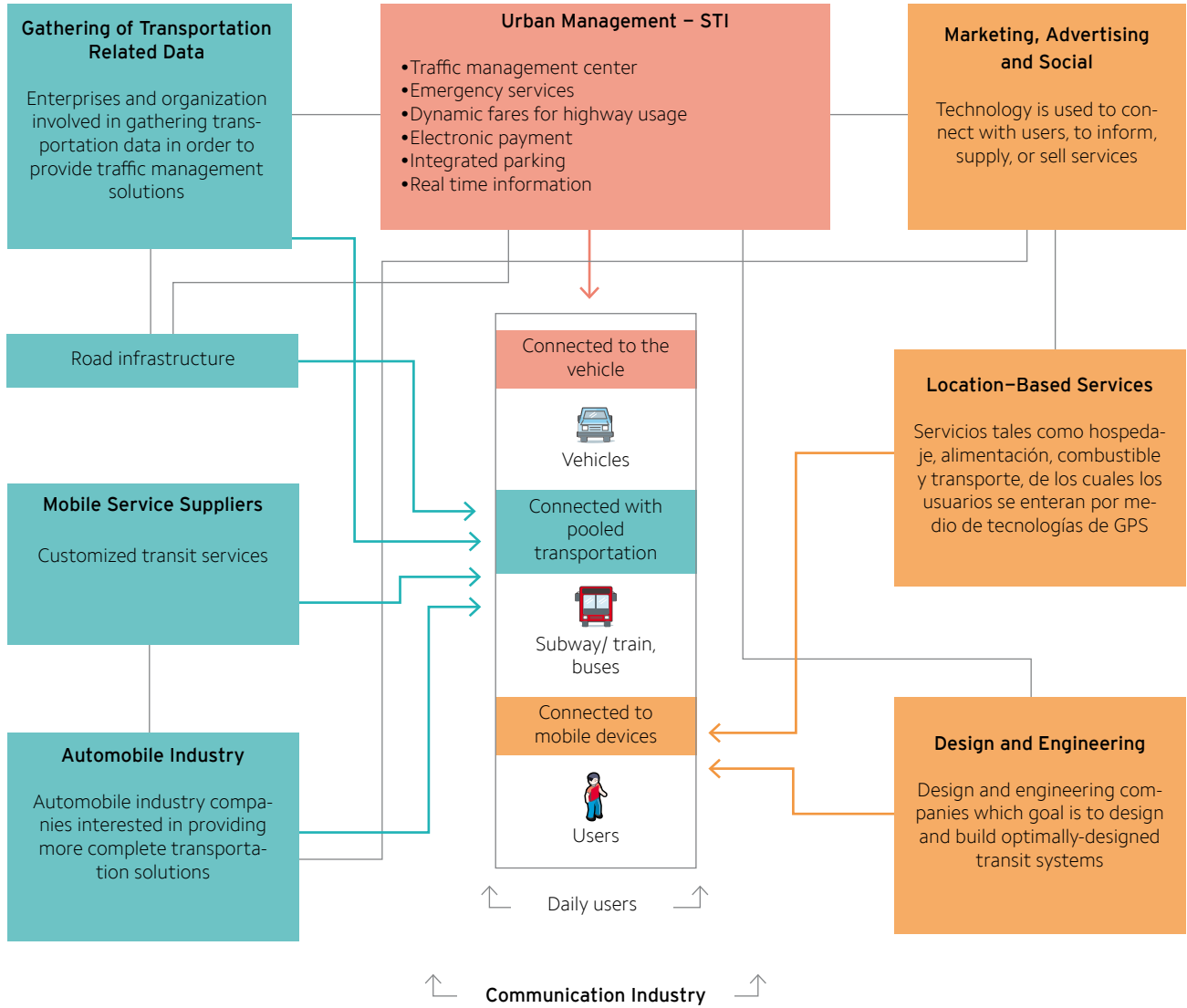
FIGURE 1. FIVE LAYERS OF SMART MOBILITY FUNCTIONS



Source: Okuda *et al*, 2012.

Building smart mobility is achieved by means of technological systems that enable coordination and information exchange among different modes of transit including buses, underground, public biking systems, and cargo, among others. Such systems require generation, control, operation, and access to Big and Open Data by means of any technology or platform. It is important to clarify that not all data should be open and that open data is not the main element in the development of smart mobility (see section 3). This, in turn implies constructing a network or a system that collects and analyzes the information from companies and public institutions operating in the city and that provides each party with information that can be put to use in optimizing the total system. This creates a system of five layers, illustrated in **Figure 1**.

FIGURE 2. SMART MOBILITY CHAIN VALUE



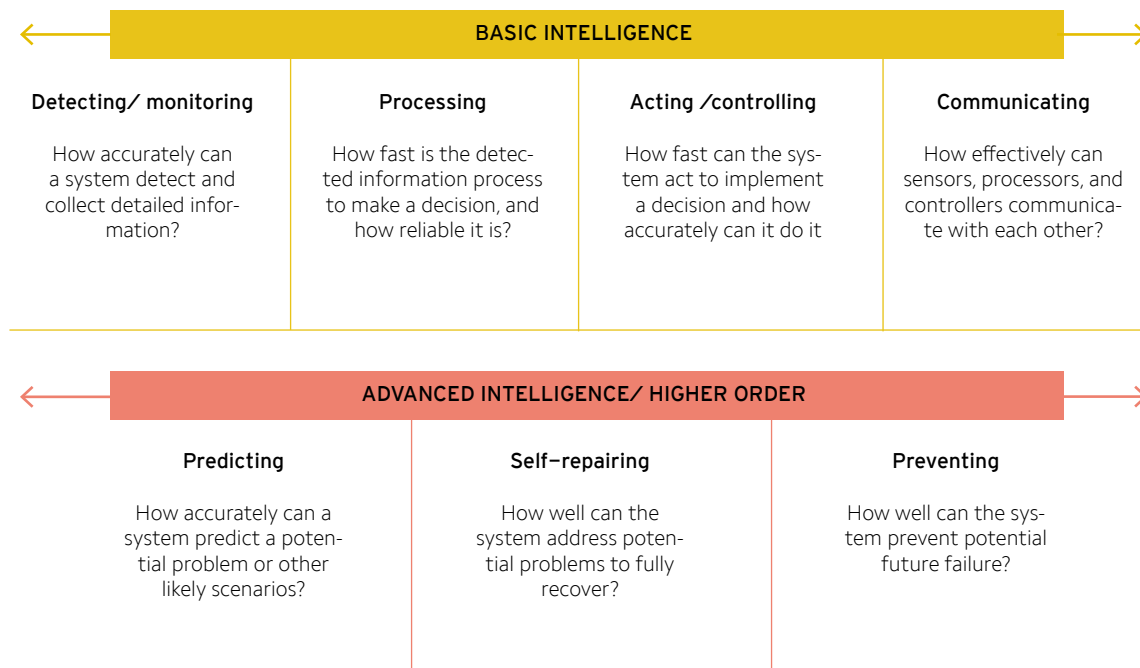
Source: ARUP, 2013.

Figure 2 shows another representation of said network prepared by ARUP (2013). From a perspective of how the elements in the smart mobility chain of value are put together we need to distinguish its multiple stakeholders. We begin with those that need the system on a daily basis: users, public and private transit companies, and the remaining organizations that support it. This interpretation clarifies how communication and exchange lines operate within a smart mobility systems as well as who are the stakeholders involved and which are their functions.

According to Debnath *et al.* (2014), in order to consider that the mobility system of a city is smart it is necessary that it is self-operating and self-correcting and requiring little or no human intervention. This not only implies a certain degree of system automation but also artificial intelligence (on its most advanced level).

Likewise, a smart system comprises three basic elements: sensors, command and control units, and activators. These should be able to provide basic smart capabilities: detection, processing and decision-making, action (control), and communication. Additionally, it could provide other advanced or superior "intelligence" capabilities including: prediction, self-repair, and prevention. In this regard, the attributes of a smart system have properties that reflect both basic and advanced levels of intelligence. The foregoing is illustrated in Figure 3.

FIGURE 3. CAPACITIES OF SMART SYSTEMS



Source: Debnath, *et al.*, 2014

2.1 SMART MOBILITY SOLUTIONS AND THEIR BENEFITS

A large number of smart mobility solutions exist, these require different types of technologies ranging from the most basic to the most specialized. It is clear, however, that not all will help realize all the benefits promised by smart mobility. In some cases it will be possible to achieve solely one objective and it would become necessary to use a high-tech solution, whereas in other cases, simpler solutions might be sufficient. For that reason it is necessary to be clear on the fact that every type of solution and technology package will yield different benefits. Benevolo, *et al.* (2016) has summarized this properly as illustrated on Table 1.

TABLE 1. SMART MOBILITY, INTENSITY OF ADOPTED TECHNOLOGIES AND BENEFITS

Mobility solution	Adopted CIT intensity		BENEFITS OF SMART MOBILITY					
			Reduction in pollution	Traffic reduction	Increased safety during travel	Noise reduction	Travel time reduction	Travel cost reduction
1. Public mobility: vehicles and innovating transit solutions								
Driverless vehicles		M			•			
Integrated management of pooled transit vehicles		M	•	•	•	•		•
Integrated ticketing system		M					•	•
2. Commercial and private mobility: innovative vehicles and transit solutions								
Shared motor vehicle use (georeferenced and geotagged)	B			•				•
Trip sharing services		M		•				•
Shared bicycles (georeferenced and geotagged)	B		•	•		•		•
Motor vehicle navigation system		M			•			•
3. Infrastructure and policies to support mobility								
Infrastructure, Changes and Approach for Mobility								
Integrated traffic lights		M		•				•
Parking guiding systems		M	•	•				
Speed management and control systems		M		•				•
Integrated policies to support smart mobility initiatives								
Smart cards		M						•
Integration of public and private transportation rates		M						•
Access regulation (pedestrian areas, time bands)		M		•		•		
Redesigning city schedules (public hours, school hours, etc.)		M	•	•	•			•

				BENEFITS OF SMART MOBILITY					
MOBILITY SOLUTIONS	Adopted CIT intensity			Reduction in pollution	Traffic reduction	Increased safety during travel	Noise reduction	Travel time reduction	Travel cost reduction
4. Systems to collect, store, and process data, information and knowledge designed to design, implement and assess integrated IM policies and initiatives									
Demand control systems to access restricted areas (cordon fees, congestion fees, electronic toll collection [with and without GPS])			A	•	•	•		•	
Integrated parking guiding systems		M	A		•	•	•	•	•
Variable Message Signs (VMS)		M	A		•	•		•	
Urban Traffic Control (UTC)		M	A	•	•			•	•
Video surveillance systems for area and environment security		M	A			•	•		
Integrated mobility management systems			A		•	•	•	•	•
Traffic data compiling systems (section control, variable speed limit control, ramp measurement)		M	A		•	•			
Expert systems for event filtering and correlation (Automated Interaction Detection- AID)		M	A		•	•		•	
Systems to direct and control urban and suburban traffic (section control, ramp measurement, variable speed limits, emergency lane activation in case of congestion)		M			•	•		•	
Fleet and logistical management systems		M	A	•	•			•	•
System for public transit fleet management adapted to UTC (system to plan, monitor and report public transit services, integrated electronic ticketing system, information system for pooled transit users).		M		•	•			•	•

Notes: B Low; M: Medium; A: high.

Source: Benevolo, *et al.*, 2016.



BIG AND OPEN DATA FOR SMART MOBILITY

3

Governments, institutions, organizations and companies dedicated to urban transport generate a large amount of information in the form of documents, databases, transcripts, and permits, among many others. This information has not historically been available or open to the general public.

Making this information available to the public, i.e. opening the data, could stimulate internal efficiency, community participation, and foster an ecosystem of innovation for citizen technology. Opening information enables any individual to use, reuse, and redistribute open data. Additionally, data openness can foster interoperability among stakeholders at different levels of government (inter- and intra- governmental, regional, national or international) (Eekhoff *et al.*, 2015).

Data openness is justified from a new government perspective because “it is recognized that data had already been paid by the taxpayer and restricting access by means of charges would limit its use and the potential to create added value” (Dictionary of Human Geography, 2013.)

However, for data to be deemed as “open” (Eekhoff *et al.*, 2015, p. 4) the following requirements must be met:

1. Complete - public data is available and not subject to valid limitations in terms of privacy, security, or privileges.

2. Primary - data is compiled from the source using the highest level of granularity.

3. Timely - data becomes available as soon as possible to preserve its value.

4. Accessible - available to a wide array of users for the higher range of purposes. They must be available online.

5. Machine manageable - structured in such a way that automated processing is possible.

6. Nondiscriminatory - available to all without subscription requirements.

7. Nonexclusive - no organization has exclusive control over the format of the data.

8. Without license - not subject to copyrights, patents, brands or regulations regarding trade secrets .

¹ “It is not possible to regard as open data, datasets containing personal, sensitive, and confidential information or data owned by a third party due to a copyright contract” (Eekhoff *et al.*, 2015, p. 4). A different form to address open data is located on the International Open Data Charter available at: <http://opendatacharter.net/>

² It is important to clarify that data could be subject to copyright but free-use licenses must be furnished, the data cannot be subject to any sort of legal protection to safeguard trade secrets. In this regard the International Open Data Charter states (Principle 3: Accesible and Usable) that an open and unrestricted license is required, i.e. copyrights are considered in the case of open data, but the data may be used freely.

On the other hand, the Helsinki Region Shared Information System (HRI) states that typically, the term open data alludes to the information generated by government, but other organizations and citizens can generate and share the data. Likewise, HRI states that the level of data openness is determined by how easy it is for any interested user to access and use the data. The openness level covers different aspects; the most important ones are technical accessibility regarding formats, free access, easy to find platforms, intuitiveness and simplicity. This would result in three benefits:

Transparency and democracy

Open data support the encouragement of active citizenship, research, and data journalism. An example is that thanks to this information in social media, it is possible to engage in a discussion using these sources of information as references.

Business and innovation

Providing free access to government information is good for companies by covering new markets and fostering innovation.

Efficient government

Higher data openness makes it easier for other agencies to share and use the information generated. Standardizing and harmonizing information management by replicating good practices facilitates information exchange.

In Mexico, the decree that puts in place regulations in terms of Open Data in Mexico (Federal Official Gazette 20/02/2015), sets forth that open data is "public digital data accessible online that can be used, reused, and redistributed by any interested party." Which have the following characteristics:

Free: Data is obtained without any consideration whatsoever.

Nondiscriminatory: Accessible without access restrictions for users.

Free usage: Citing the source is the only requirement for free usage.

Machine-readable: It must be fully or partly structured in order for the data to be processed and interpreted by electronic devices automatically.

Integral: It must contain the greatest possible level of detail and the necessary metadata.

Primary: From the source, the data shall be produced at the highest level of disaggregation.

³ HRI, About open data: <http://www.hri.fi/en/open-data/>

Timely: It must be updated regularly, as the information is generated.

Permanent: It shall be preserved through time, for this purpose, the relevant historical versions for public use shall remain available by means of identifiers suitable for such purpose.

We should not mistake the concepts of “open data” and “big data”. Big data alludes to an enormous dataset that is difficult to process with traditional database and software techniques; for example, the data generated by millions of trips and logged on a daily basis by electronic transit cards. On the other hand, ‘open data’ alludes to data that is available and accessible to the public. Even though open data could be “big” and vice versa, these concepts are not interchangeable (Eekhoff *et al.*, 2015).

In different cities around the world, many instances of open data usage by different stakeholders exist, from governments to cities and private businesses: real-time transit arrival times; smart traffic lights that make traffic flow more efficiently; predictive methods to improve public health and security; development of accessible applications for the general public for applications as diverse as taxi cabs, maps, and land prices; information to improve government transparency and many others (ARUP, 2013; Consorcio de Transportes Madrid [Madrid Transportation Consortium], s.f.; Eden, 2016; Fumega, 2016; Rojas, 2012; Socrata, 2016).

Making data open is not sufficient to further innovation in different sectors, to empower the citizenry, and improve democracy as certain authors and organizations suggest. Complementary processes are needed for data openness to yield such positive effects; it is not only necessary to make concerted efforts with data suppliers and with final users (Chakraborty *et al.*, 2015; Janssen *et al.*, 2012; Juell-Skielse *et al.*, 2014; Sieber and Johnson, 2015). In the same way, in order to foster smart mobility, more important than the existence of low-quality open data, is that government institutions (and other key related stakeholders) are able access big data and use it to obtain collective benefits.

Additionally it must also be pointed out that open data is not the same as open government. In fact, open data is not an end by itself; it is a step towards higher government responsibility and higher societal empowerment. Therefore, open data possibilities and the implications of their multiple uses require monitoring (Sieber and Johnson, 2015).



4

INTERNATIONAL EXPERIENCES

In Latin America as well as in Europe, Asia, and the United States, many successful examples exist regarding the way in which government has promoted a proper development of analytics and citizen participation for innovative open data usage.

4.1 USAGE EXAMPLES OF BIG AND OPEN DATA FOR SMART MOBILITY

An example is the government of Rio de Janeiro, Brazil, which has encouraged the development of applications and platforms that profit from sets of big, open data. Several open data portals exist in the city, each one fulfills a different function. In 2002, city architects and engineers, aware of the need to standardize data, created the gateway Armazém de Dados , to which they uploaded thousands of datasets for GIS (layers, maps, geo-referenced forms), all of which are publicly available. The effort to open more city data began in 2010 and was formalized by the 2014 Open Government Decree followed by the launching of the Rio data mine gateway. Another gateway is Portal Data.Rio , which began with more than 30,000 files in 1,200 datasets (Maia Ribeiro and Matheus, 2014).

Additionally, the government of Rio has fostered innovation regarding this large amount of datasets contained in the portals by organizing several Hackatons open to citizen participation. Regarding mobility, two successful outcomes of the Hackatons have been the BUUS platform and the EasyTaxi app . BUUS tracks Rio buses via GPS, and provides real-time information on transportation services to users. EasyTaxi, which thus far has been exported to 20 countries around the world, is a platform that connects a city's taxis to their users. An advantage for tourists is that users are given information regarding the languages spoken by drivers (Maia Ribeiro and Matheus, 2014).

Among the cities with open data policies, Chicago, has always held a position among the best given the breadth of its data gateway . The gateway has more than 600 datasets, all of which are open to the public regarding crime, health, and the salaries of public servants among others (Zaleski, 2016). They have several methods to use datasets used to improve transportation; for instance, a dataset on traffic that uses GPS tracking of public buses to update itself every 10 minutes (Socrata, 2016). Another tool that has been developed is the "TOD Calculator" , a program that uses public data to assess the TOD (Transit Oriented Development) potential of different projects or areas in the city (Eden, 2016).

⁴ Armazém de Dados: www.armazemdedados.rio.rj.gov.br/

⁵ Benfeitoria: <http://riomais.benfeitoria.com/palavras-chave/rio-datamine>

⁶ Data.rio: <http://data.rio/>

⁷ A type of event increasingly being used by governments or private entities in which technical experts and interested parties on a particular subject are invited to participate in an intensive problem-solving session. Usually, this implies the creation of applications, data release, creation of visualizations, and publication of analysis.

⁸ Buus: <http://www.buus.com.br/>

⁹ Easy Taxy: <http://www.easytaxi.com/>

¹⁰ City of Chicago Data Portal: <https://data.cityofchicago.org/>

BOX 1

MARKET PRICE FOR PARKING IN SAN FRANCISCO



SFpark¹² is the San Francisco parking meter system that uses an online digital platform for smart rating in order to optimize parking resources and allow drivers to find parking spaces easily. The SFpark system adjusts parking meter and garage prices according to demand, setting higher prices on more desirable locations at certain times of the day. This adjustment creates a more equitable distribution of cars, encouraging drivers to choose sub-used parking spaces and garages. The result is a reduction of demand in more congested parking areas.

¹¹ Grow Chicago: <http://growchicago.metroplanning.org/calculator>

¹² SF Park: <http://sfpark.org/>

Chicago is also known for its predictive use of its data portal. Algorithms are used to discover certain patterns on different datasets and, upon analyzing them; decisions are made regarding public health and security. Since 2014, for instance, this resource has been used to make health control visits more precise and efficient (Spector, 2016). OpenGrid was recently launched as a more accessible open data portal made for the average citizen (Zaleski, 2016).

On the other hand, London's open data platform was developed arising from a government commitment with the public nature of data, with general access to it, and with the economic benefits and potential for innovation that open data could spark. Five thousand developers have registered on the portal, which was created with an investment of less than £1 million. It is estimated that the benefits of said open data amount to up to £58 million per annum (resulting from the time users save) (Eeckhoff *et al.*, 2015.)

BOX 2

REGENT STREET CONSOLIDATION CENTER IN LONDON

The Regent Street Consolidation Center is a center where all orders for goods from the UK and Europe for Regent Street merchants, the busiest commercial corridor in London, arrive. These are organized to send all goods on a specific day on electric vehicles. This centralization makes a more efficient process possible, reducing the space used as well as the number of trips, emissions, and congestion (ARUP, 2013.)

¹³ Open Grid: <http://opengrid.io/>

¹⁴ London Data Store: <http://data.london.gov.uk/>

The organization of the local government in charge of most aspects of the city's pooled transport, Transport for London (TfL), has developed impressive analytics of their transport-related big data, which has resulted in more efficient processes and cost reductions for the government of the city and the citizenry. An example of this is the manner in which Source-Destination data is created. Typically, Source-Destination studies and surveys are costly and time-consuming. In London, this data is generated simply by the massive use of smart cards for public transit; afterwards, the remaining information needed to complete the study is inferred from the original dataset.



London's smart card is used in buses, trains (urban or inter-urban), and the city's cable car (users can also use an "app" instead of a card). Charges for the underground system are distance-based, due to this; users must scan their cards upon entering and exiting from the system. This had the unintended consequence of providing TfL with origin and destination data of the travelers that use the system. Nevertheless, London's buses charge a fixed rate per travel, users do not have to scan their cards upon exiting and therefore their destination data is not captured. In response to this gap, TfL has created a big data analysis tool that combines location data and bus tickets to infer origin-destination pairs in order to create a dataset on multimodal trips. The resulting information has been used to restructure transportation routes in certain areas of the city (Weinstein, 2016; Gordon, 2012).

TfL also applies its big data predictively to improve system management. In case that a transit route is blocked or closed, data is used to predict the event's impact on the network and inform users regarding the best alternative routes to take given the new situation (the least busy, the fastest, etc.) Historical big data is also used to calculate trends in order to make prediction and prevention of traffic accidents possible. Additionally, TfL participates in Hackatons and they maintain good communication lines with the city's universities and colleges (Weinstein, 2016).

BOX 3

HOW CAN KEY DATA FOR URBAN MOBILITY BE OBTAINED FROM TELECOMM NETWORKS?

In cities such as London and Singapore, where important investment on the latest telecomm and smart mobility infrastructure technologies exist (i.e.: GPS in each unit, smart cards that are received by the entire system) and open access to the massive mobility data produced by said systems, analytics intended to achieve more efficient urban mobility becomes easier. But, how can data regarding the movement of individuals and transportation units be obtained in cities with problems to upgrade existing infrastructure or where investment or data access are nonexistent?

Against barriers like the above, methods are being developed to generate and compile mobility data from mobile phone signals. The information produced includes estimated arrival times for buses, GTFS feeds, methods to optimize multimodal connections, ideal designs for public transportation networks; and traffic management among others. Different studies present a method to generate massive data using telecomm networks, which are useful for mobility analytics without the need to invest on large, costly, and time-consuming changes on mass transit infrastructure, and then to assess whether they were successful or not (Pinelli et al., 2016; Di Lorenzo et al., 2014; Calabrese et al., 2012; Coffey et al., 2012; Kloeckl et al., 2016; Sinn et al., 2012). These methods rely strongly on access to data stored by telecomm companies, and access to them is generally restricted and used exclusively by said companies.

It is also possible to use telecommunication networks to collect data on mobility in a simpler manner, but with a limited scope. In Mexico City, between January 29 and February 14 2016, a *Mapatón* was held, an initiative that uses crowdsourcing to map the routes of “microbuses”, buses, and wagons in Mexico City and upload them to an open database. In order to achieve this, the *Laboratorio para la Ciudad* (Laboratory for the City), alongside other government agencies and civil associations launched a city game offering prizes in cash and in kind for the people that managed to map the most transit routes during the two weeks that this game lasted. The game was open to all public with a 4.1 or higher Android smartphone. The outcomes of the game were 3,624 users, and more than 4000 lines that represent the mapping of 43% or 648 transportation routes (Landin, 2016) out of the 1,500 routes that SEMOVI (Ministry of Mobility) estimates circulate around the city on a daily basis.

The examples above prove that even in contexts where access and infrastructure are inadequate, it is possible to find not highly intensive approaches based on telecomm networks to collect data on mobility. However, it is worthwhile to mention that the datasets produced by these methods are not the most comprehensive. This data becomes static, and is not constantly updated. Due to this, these methods are used in cases when no other options exist, and therefore are a resource, not a goal.

¹⁵ “... externalizing the tasks that a single individual or entity typically performs to a larger group by means of an open invitation.” (*Laboratorio para la Ciudad*, 2016, s.p.).

In addition to the subject of urban mobility associated to the movement of individuals, it is also possible to better manage the distribution of goods in urban environments by avoiding unnecessary trips that translate into savings for businesses as well as lower traffic and less pollution. One of the cities that perform best in this regard is Barcelona, which monitors its logistics in real time to improve the distribution of goods around the city.

BOX 4

LOADING AND UNLOADING AREAS IN BARCELONA



Source: Ayuntamiento de Barcelona: <www.areaverda.cat/operar-pel-mobil/areadum/>

Management of loading and unloading areas in Barcelona employs Information and Communication Technologies for control purposes (AreaDUM). Vehicles used for deliveries are equipped with authorized devices that enable them to access spaces reserved for loading and unloading operations. Sensors that measure the time they remain parked monitor these vehicles, and once the authorized time expires, a signal is sent to the police to prompt its intervention. This system is supported by cameras (Alarcón, 2012).

An international referent related to smart mobility matters is the Metropolitan Area of Helsinki, Finland. The objective for the region is clear: in 2050 motor vehicles will become absolutely unnecessary for intra-urban travel. According to the strategy proposed by local transit authorities Helsinki Regional Transport Authority (HSL), the vision is that by 2025 the best and main alternative for its citizens everyday transit will be its integrated public transit system. In order to achieve this objective, clear short-term goals must be met, among which are:

Covering trips with the mass transportation network and feeder routes.

Providing real-time information before and during trips.

Compact urban development based on mass transit systems and the creation of attractive zones.

Additionally it proposes applying congestion charges, parking metering systems, goods distribution plans, information on traffic events, and encouragement of active mobility among other supplemental policies alongside higher funding for them.

Prior to achieving the 2025 goals, HSL has defined short-term goals among which are focusing part of its efforts in training their staff on technical matters in order to guarantee service quality.

¹⁶ HSL, 2015.



5

MEXICO: PUBLIC POLICY AND INSTITUTIONAL FRAMEWORK

The federal government's open data policy stems from the Plan Nacional de Desarrollo (National Development Plan, PND) 2013-2018; the overarching axis "Close and Modern Government" (sections VI.1 a VI.5), and the "Program for a Close and Modern Government 2013-2018".

5.1 INSTITUTIONAL FRAMEWORK

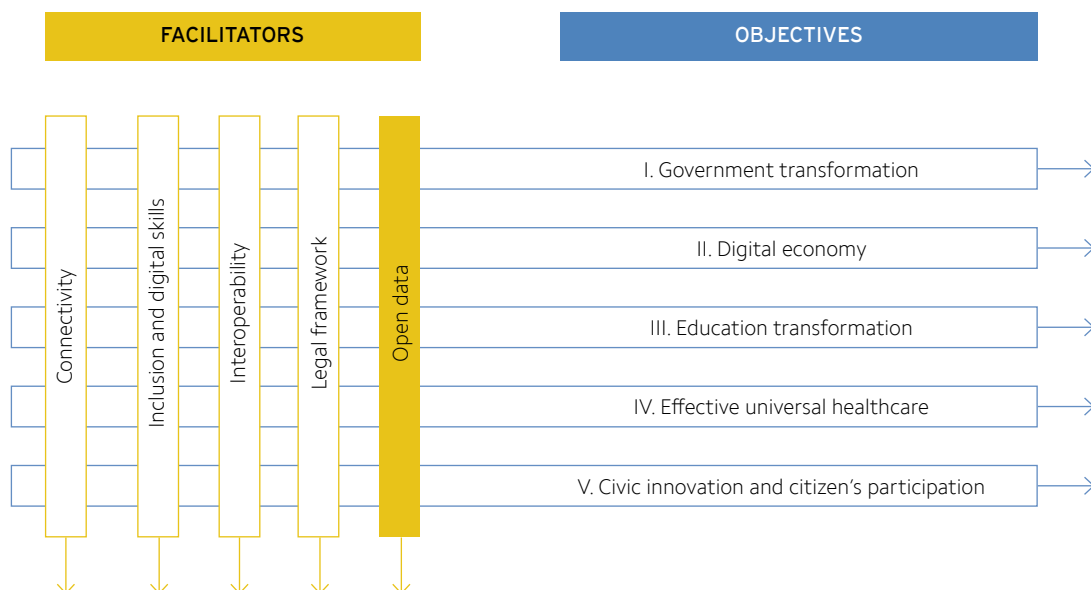
At a federal level, this program sets forth specific strategies for Open Data to be an enabler to achieve its goals.

Strategy 1.6 Encourage citizen participation by means of innovation CITs and open data.

- . **1.6.1** Fostering the use of open data by social, business, and government organizations at the three levels of government.
- . **1.6.3** Fostering open data source platforms that make citizen innovation possible.

Similarly, the program sets forth the creation of a National Digital Strategy (EDN, acronym in Spanish) with 5 objectives, and one of its key enablers is open data.

FIGURE 4. NATIONAL DIGITAL STRATEGY 2013–2018



Source: National Digital Strategy.

In addition, for the achievement of these objectives, the National Digital Strategy Coordination (CEDN, acronym in Spanish) was created as the leading institutions on this matter.

Regarding the use of technologies to foster smart mobility, nothing specific exists. Nevertheless, the END's objectives in terms of Government Transformation and Digital Economy can encompass said policies.

At the international level, since 2011 Mexico has been party to the National Open Government Alliance, which is a multilateral initiative in which the governments of 70 member states work alongside civil society to encourage citizen participation, increase transparency, fight corruption, and use technology as an enabler of this openness.

On the other hand, the Ministry of Agrarian, Territorial and Urban Development (SEDATU), which is the head organization for urban mobility, created the Sustainable Urban Mobility Strategy (EMUS, acronym in Spanish). EMUS objective 4, strategy 4.5 sets forth the generation of information and indicators to prepare public policies for urban mobility. Although the strategy's lines of action are not directly connected to "smart mobility", "big data" or "open data", it is clearly possible to create policies aimed towards that purpose that stem from it.

On the other hand, INEGI has created a subgroup for sustainable urban mobility within the Technical Committee Specialized on Information on Regional and Urban Mobility (INEGI, 2015) in order to drive forward changes in the surveys prepared by the institute and thus create data and indicators on urban mobility in the country. Highly useful information to orient the implementation of smart mobility policies.

TABLE 2. SUSTAINABLE URBAN MOBILITY STRATEGY, LINES OF ACTION FOR ITEM 4.5

STRATEGY 4.5. Generating useful information and indicators for decision-making in terms of mobility for government, social, and private stakeholders.	
Lines of Action	
1	Preparing and communicating studies that enable the understanding of urban expansion processes in Mexico and the associated mobility patterns.
2	Fostering the execution of origin and destination surveys, and indicators to monitor mobility at the local and metropolitan levels.
3	Disseminate information regarding impacts in terms of environment, productivity and quality of life stemming from sustainable urban mobility policies.
4	Incentivizing the participation of social and academic institutions in the design of public policies for sustainable urban mobility.
5	Furthering the creation of a CONACYT-SEDATU fund oriented towards the funding of urban development research and sustainable mobility.
6	Establishing monitoring indicators on urban quality, environmental performance, and mobility for cities alongside national academic institutions.
7	Creating sustainable mobility studies and their potential or mitigation and adaptation to climate change in different SUN cities (66).

Source: SEDATU.

5.2 INSTITUTIONS

Although the federal government’s leading organization for digital policy is EDN, it is not the only institution that can participate in fostering smart mobility. In fact, it would be worthwhile distinguishing among centralized public administration institutions, and autonomous organizations.

TABLE 3. INSTITUTIONAL AND REGULATORY FRAMEWORK OF CENTRALIZED FEDERAL PUBLIC ADMINISTRATION

AGENCY	SPECIALIZED DEPARTMENT	CORRELATED APPLICABLE REGULATIONS
Office of the Presidency of the Republic	National Digital Strategy Coordination	Program for a Close and Modern Government 2013-2018 and National Digital Strategy
Ministry for Agrarian, Territorial, and Urban Development	Sustainable Urban Mobility Strategy Coordination	Sustainable Urban Mobility Strategy
Ministry of Public Service (Secretaría de la Función Pública)	Digital Government Unit	Decree that sets forth regulations for open data
	Inter-ministerial commission for Electronic Government Development	Decree that set forth measures for efficient, transparent, and effective use of public resources, and budgetary discipline actions for public spending and to modernize Federal Public Administration
	Subcommittee for Open Data	Decree that sets forth the Interoperability and Open Data Framework for Federal Public Administration
Ministry of Communications and Transportation	Transportation Undersecretary's Office	Law for Roads, Bridges and Federal Carriers Decree that creates the Mexican Transportation Institute
	Directorate for Management Control and Information Technology	
	Mexican Transportation Institute	
Ministry of Education	National Council for Science and Technology (CONACYT, acronym in Spanish)	General Education Law
Ministry of Economy		Science and Technology Law

Source: Prepared by the authors.

TABLE 4. INSTITUTIONAL AND REGULATORY FRAMEWORK OF AUTONOMOUS CONSTITUTIONAL BODIES

AGENCY	SPECIALIZED DEPARTMENT	CORRELATED APPLICABLE REGULATIONS
National Institute of Statistics and Geography (INEGI)	Information Technology and Communications Unit (departments responsible for ICTs)	Law of the National Statistical and Geographical Information System
		INEGI Specific Organization Manual
		Technical standard for access and publication of national-interest statistical and geographical open data
National Institute of Transparency, Access to Information and Data Protection (INAI)	General Directorate for Open Government and Transparency	General Law of Transparency and Access to Public Information
		Decree that creates a Nation-Wide "One-Stop" Scheme for Government Procedures and Information
	Coordination of Personal Data Protection	Federal Archive Law Federal Law to Protect Personal Data Held by Private Individuals
Federal Telecommunications Institute (IFT)	Regulatory Policy Unit	Decree that amends and adds various telecommunication-related provisions in articles 6, 27, 28, 73, 78, 94, and 105 and the Political Constitution of The Mexican United States.
		Organic Statute for IFT
		Federal Telecommunications and Radio Broadcast Law
	Concession and Service Unit	Federal Law of Economic Competition Federal Law to Protect the Consumer

Source: Prepared by the authors.



6

STATUS OF SMART MOBILITY IN MEXICO

To understand the current status of smart mobility in Mexico, it has been analyzed from three standpoints.

On one hand, the existence of open data platforms and the use of mobility apps by different levels of government has been researched in order to determine if technologies that allow data generation that is available to the public are being used. Besides the existence of private mobility-related apps in Mexico. This is the most evident method to find out about the existence of policies and projects that foster smart mobility. On the other hand, a survey to the States and Municipalities that participate in the Open Mexico Network supported by the National Digital Strategy has been conducted in order to better understand the efforts made by local governments in this regard. Finally, good experiences with smart mobility projects in Mexico were identified and documented.

6.1 NATION-WIDE OPEN DATA ON URBAN MOBILITY

In Mexico it is necessary to distinguish between different stakeholders that generate open data. Government-wise, federal and local (states and municipalities) levels are distinguished. In the private sector, parties that have developed apps that address urban mobility issues have been identified, even if their interest is not necessarily creating open databases regarding mobility patterns. Additionally, civil associations or independent citizens addressing solutions for different urban issues frequently act as liaison between the different stakeholders.

FEDERAL GOVERNMENT AND OPEN DATA

The National Institute of Geography and Statistics (INEGI) is the main source of demographic, economic, and geographic data. Most information produced by it is available to the public. Regarding urban mobility, the institute has conducted surveys, even if the data is not necessarily open. For example, in 2007, in coordination with the former Ministry of Transportation and Roads (now SEMOVI), the first origin-destination survey in the Metropolitan Area of the Valley of Mexico (ZMVM, acronym in Spanish) was conducted by this institute. The database is not available to be downloaded by the public even though it is possible to obtain it by means of public information access requests to the government of Mexico City. Regarding other types of urban transit information, INEGI has kept a monthly historical registry since 1986 as part of the Economic Information Bank (BIE). The registry includes information on urban and passenger transit in Monterrey, Guadalajara, and the Federal District, besides keeping track of motor vehicles registered on each

municipality and state including motorcycles, private automobiles, passenger and cargo trucks. Similarly, statistics on road incidents per municipality and state are also available. Finally the inter-census survey of 2015 makes it possible to generate information regarding mobility patterns (breakdown per mode, reasons and times for trips) per metropolitan area and state. The data is available on INEGI's website.

On the other hand, the Ministry of Finance (SHCP, acronym in Spanish) developed a platform to share budget data by means of an expenditure observatory named *Transparencia Presupuestaria* (Budgetary Transparency). This includes mobility and transportation projects, specifically regarding the development status of infrastructure.

Finally, the federal government manages the portal *datos.gob.mx*, which was created in 2013 as part of "México Digital", a project led by the National Digital Strategy. In this platform it is possible to find data regarding energy and the environment, economy, education, infrastructure, security and justice, geospatial information, finance and contracting, health, sustainable development, culture and tourism, migration and demography, and other areas. This platform receives its information from the federal government, states, municipalities, and autonomous bodies.

STATE AND LOCAL GOVERNMENTS WITH OPEN DATA POLICIES ON MOBILITY AND TRANSIT

Data openness for mobility at local and state levels has not developed as much as at the federal level. This is due to several reasons, one of them is that no law exists to incentivize or compel the generation of standardized data or information sharing; the lack of technical capability; another is the lack of technical skills of public servants as well as the lack of resources to purchase technology and training; additionally, size constraints of population centers prevents the usage of technologies such as shared bicycles, mass transit systems, or parking meters. Moreover, governments arguably lack interest in sharing data since this issue has not yet been incorporated to the political agenda.

In Mexico city, Laboratorio para la Ciudad, the Ministry of the Environment (SEDEMA, acronym in Spanish), and Oficialía Mayor (General Secretariat), have an official platform in which it is possible to access open data on mobi-

¹⁷ INEGI. Banco de Información Económica (Economic Information Bank). <http://www.inegi.org.mx/sistemas/bie/>

¹⁸ INEGI. (2015). Encuesta Intercensal 2015 (Inter-Census Survey 2015). Available at: <http://www.inegi.org.mx/est/contenidos/Proyectos/encuestas/hogares/especiales/ei2015/>

¹⁹ *Transparencia presupuestaria*. Expenditure 'observatory'. http://www.transparenciapresupuestaria.gob.mx/es/PTP/Datos_Abiertos

²⁰ It is worthwhile clarifying that it is often necessary to perform extra analyses to determine how the public budget for mobility, including public transit, and public space is being used.

lity and transit. Other agencies such as the Urban Management Agency have also attempted technological innovations by creating a mobile app to inform of road events in real time, but no repository exists to freely download this information. SEDEMA, agency in charge of Ecobici, is the most advanced in terms of openness of mobility data. In its app it is possible to find the location of stations and the number of bicycles available at any time in each station. At the end of every month, a database including origin-destination data for each trip during the month is made available to the public on its website.

Certain databases on mobility and public transportation at the local and state level can be accessed by means of public information requests in federal or local transparency portals. It is important to clarify that, since these are customized information requests, they do not match the guidelines for open data.

In addition to the information contained in the portal Infomex at the state level, only the Government of the State of Sonora has a platform that takes urban mobility information available. Specifically, this information regards public transit routes, and user information, which makes better tour planning possible. This information is concentrated on an app named UNE developed by the government.

It is also possible to find open mobility data produced by the Municipality of Puebla regarding commercial establishments that encourage the use of bicycles (by mapping bicycle parking locations) and public transit routes in the area surrounding the Municipality. The Municipality of Xalapa provides information on trip times and public transit routes. The Municipality of Ahome provides access to its mobility plan.

²¹ National Transparency Platform <https://www.infomex.org.mx/gobiernofederal/home.action>

TABLE 5. STATE AND MUNICIPAL GOVERNMENTS THAT HAVE MADE MOBILITY DATA OPEN

LOCAL	STATE	WHERE?	OPEN DATA		WHO?	LINK
			Mobility and transit	Other		
•		Ahome	•	•	Municipality of Ahome	http://datos.gob.mx/busca/organization/ayuntamiento-de-ahome
•		Mexico City	•	•	Laboratory for the City	http://datos.labcd.mx/dataset
•		Mexico City	•		Ministry of the Environment	https://www.ecobici.df.gob.mx/es/informacion-del-servicio/open-data
		Mexico City	•	•	General Secretariat (Oficialía Mayor)	http://www.gobiernoabierto.cdmx.gob.mx/sigdata/index.php/Publicacion/index
•		Minatitlan		•	Municipality of Minatitlan	http://datos.gob.mx/busca/organization/ayuntamiento-de-minatitlan
•		Puebla	•		Municipality of Puebla	http://datos.gob.mx/busca/dataset?theme=Geoespacial&organization=ayuntamiento-de-puebla&tags=movilidad+urbana
•		Puebla	•		Municipality of Puebla	http://datos.gob.mx/busca/dataset/rutas-de-transporte-publico
•		Xalapa	•		Municipality of Xalapa	http://datos.gob.mx/busca/dataset/movilidad-en-la-ciudad-de-xalapa
	•	Sonora	•		Government of the State of Sonora	http://bus.sonora.gob.mx/indicadores/rutas.html

Source: Prepared by the authors

Likewise, few apps by local governments regarding mobility exist. These would be indicators that a sort of smart mobility solution exists. Existing apps are for current public cycling systems in the country. An important gap in terms of public transit applications exists. Only the State of Sonora, with UNE Transportes, and the State of Guanajuato with Optibús have this sort of applications available. This is a very strong indicator of the lack of smart mobility policies for massive public transit in Mexican cities.

TABLE 6. URBAN MOBILITY APPLICATIONS DEVELOPED BY GOVERNMENT

AGENCY	APPLICATION	CATEGORY
Ministry of the Environment	Ecobici	Nonmotorized Transit
Government of the State of Sonora	UNE Transporte Sonora	Public transit
Government of the State of Jalisco	MiBici	Nonmotorized Transit
Government of the State of Mexico	CycleFinder (Huzi Toluca)	Nonmotorized Transit
Urban Management Agency	AGU móvil	Routes
Ministry of Communications and Transportation	SCT Traza tu ruta (Chart Your Route)	Routes
Government of the State of Guanajuato	Elige tu ruta Optibús (Choose Your Optibus Route)	Public transit

Source: Prepared by the authors by searching app stores for Android and iOS.

CIVIL SOCIETY

Lacking an open data platform for different city-related issues, several civil society organizations have promoted platforms for data openness.

Global Open Data Census is a platform pushed forward by Open Knowledge International, and developed by Codeando México, and SocialTIC that places Mexico on the 13th place globally in terms of data openness. The platform operates by crowdsourcing and makes it possible to assess data availability and openness in the country's data. In the case of Mexico, 11 local governments share their databases but only two governments share data regarding mobility.

Datamx from Codeando México through the Data Openness Center (CAD, acronym in Spanish), which brings together 57 organizations, compiles Mexican public databases. Regarding Mobility and Transit, it is possible to find data on Modal Transfer Centers (CETRAM, acronym in Spanish), transit routes and cycling infrastructure (bicycle lanes, cycle parking, and cycling stations).

²² Datamx: <http://datamx.io>

FIGURE 5. OPEN DATA CENSUS FOR MEXICO



Source: Open Knowledge Foundation.

YOUTH FOR PUBLIC TRANSPORT (Y4PT)

FIGURE 6. MOBILITY HACKATON



Source: <http://www.y4pt.org>

Y4PT is an organization that fosters the participation of young people around the world to generate impact on matters related to urban mobility. By means of campaigns such as Breathable Cities and Healthy Mobility they disseminate and further sustainable mobility around the world with the distinguishing feature that young citizens lead their activities. One of their more interesting campaigns is the Transit Hackaton that will take place simultaneously in 17 cities worldwide. Winners will present their projects in one of the yearly meetings of the International Public Transport Association (UITP).

This is an example that the citizenry in various regions of the world is committed to urban mobility. The solutions that have been proposed include diverse actors related to this matter. A fundamental aspect for the proper development of smart mobility policies is reaching out to civil society and work in collaboration.

EXISTENCE OF URBAN MOBILITY APPLICATIONS DEVELOPED BY PRIVATE PARTIES

A large number of private companies have begun to develop mobile applications for smartphones offering mobility-related services. These applications are usually intended to bridge information gaps that users might experience while en route.

Three main categories of mobile apps may be distinguished in this regard: private taxi, point-to-point routes, and public transit. Out of these categories, only public transit applications use information that could be public in nature; however, often public transit is not fully or properly mapped by a public entity, and private entities often need to supplement or create information. However, not many applications serving pedestrian and cycle markets exist that offer, for instance, information on cycling routes infrastructure, or trip logging.

The business model of these applications makes the service free for the user and revenue is obtained from advertising on the applications themselves. In the case of private transit applications, these companies make profits by receiving a fraction of the revenue obtained from service users. Below, we show a list of applications developed by private parties.

TABLE 7. URBAN MOBILITY APPLICATIONS DEVELOPED BY PRIVATE PARTIES

DEVELOPER	CATEGORY
ADO Móvil	Public transit
Ally	Routes
Apple Maps	Routes
AutoStop	Ride share
Avant	Taxi
AvisaMB	Public transit
Biko	Movement tracker
BlaBlaCar	Ride share
Cabify	Taxi
Carrot	Taxi
CityDrive	Taxi
CityMapper	Public transit
ClickBus	Public transit
Easy Taxi	Taxi
ETN	Public transit
Google Maps	Routes
HERE WeGo	Routes
Map My Ride	Movement tracker
MásMetrobúsMX	Public transit
MásMetroMx	Public transit
Metro - Metrobús	Public transit
Metro DF México	Public transit
Metro y Metrobus de Mexico	Public transit
Metroplex Mexico City	Public transit

DEVELOPER	CATEGORY
Mexico - Offline Map & City Guide	Routes
Modayzer	Movement tracker
Moovit	Public transit
Moves	Movement tracker
Móvil PUEBLA	Routes
NLife Mexico	Routes
Primera Plus	Public transit
Red Transporte DF	Routes
RepuBikla	Nonmotorized Transit
Rutadirecta	Routes
Rutas DF	Routes
Rutas GDL	Routes
Rutas Queretaro	Routes
Strava	Movement tracker
Taxis Libres	Taxi
Tuzo App	Public transit
UbberBus	Private mass transit
Uber	Taxi
Urban360	Public transit
ViaMX	Public transit
Vinden	Public transit
Waze	Routes
Wikicleta	Nonmotorized transit
Yaxi	Taxi

Source: Prepared by the authors by searching app stores for Android and iOS

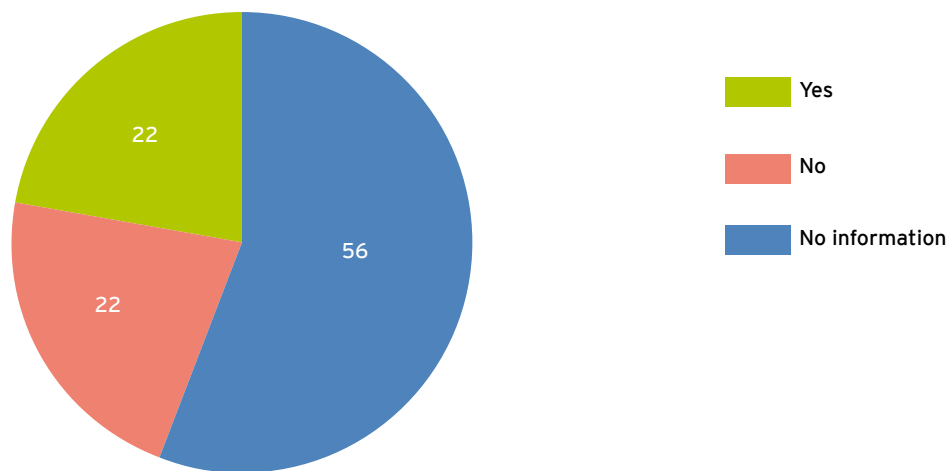
It is worthwhile pointing out that these applications do not generate public databases. This is due to the fact that in Mexico no regulation exists to compel or encourage open data practices in private entities.

6.2 SURVEY RESULTS

In order to conduct a detailed national diagnosis, a small survey was performed with the municipal governments that comprise *Red México Abierto* (Open Mexico Network) since they have invested resources and trained part of their staff for better information management, in most cases, open databases related to public management and covering many urban matters of concern.

Responses for this survey were obtained from 75% of the municipalities that comprise it. One hundred percent of the governments that responded had a portal, microsite, or another platform to share open data. Eighty-nine percent of all respondents indicated having a department in charge of collecting and monitoring data on transit and urban mobility. Nevertheless, only 45.6% of the surveyed municipalities have a portal, microsite, or another platform that includes open data on urban mobility. Besides different limitations, only 56% of these municipalities has a download feature.

FIGURE 7. BESIDES MAKING IT POSSIBLE TO VISUALIZE OPEN DATA ON MOBILITY, CAN THIS DATA BE DOWNLOADED?



Source: Prepared by the authors.

It is important to highlight, that given the limited integration of local governments to the network (25 municipalities), results must be considered carefully given the limited number of respondents.

²³ Twenty-five municipalities comprise Red México Abierto, and responses were only received from Oaxaca, Los Mochis, Toluca, Torreón, Xalapa, Morelia, Guadalajara, Campeche and Colima.



SMART MOBILITY SUCCESS STORIES IN MEXICO

7

There are several success stories to be told in Mexico, particularly in Mexico City. An example would be Ecobici. However, there are other success stories throughout the country that exemplify the use of new technology and data in the improvement of urban mobility, public transit, parking management and stoplight management. Here are a few cases that exemplify best practices throughout the country.

ECOBICI

WHAT IS IT?

Ecobici is a bicycle-sharing system. It opened in Mexico City in 2010. Currently, Ecobici has stations in 42 neighborhoods of the Benito Juárez, Cuauhtémoc and Miguel Hidalgo boroughs, over a total surface of 32km.²

MAIN CHARACTERISTICS

- **Infrastructure:** the program has 444 bicycle stations and more than 6000 bicycles. Stations are distributed in such a way that the distance between one bike station and the next will never be more than 300 meters.
- **Bicycles:** the bikes are designed for cities. Features include frontal and back mudguards, headlights, backlights, and a basket for carrying objects.
- **Electronic payment:** to obtain a bicycle, users require a smart RFID (Radio Frequency Identification) card. These cards allow the system to identify subscribers. Subscriptions can be purchased for one year, one week, three days, or one day. Subscription includes unlimited trips lasting 45 minutes or less. If the duration of the trip is more than 45 minutes, the user must pay a penalty. However, once a bicycle has been returned, the user only has to wait two minutes before requesting a new one.
- **Bike station locations:** through a mobile app and a web application, users can locate all bicycle stations and check the number of available bicycles (or available dock stations for returning them).
- **Customized routes:** the mobile application allows users to trace a route. The app also allows users to review their trip history.
- **Reporting an issue:** the application allows users to report issues related to bicycles, bike stations, or problems with the service.
- **Operations:** Clear Channel Outdoors operates the system through its SmartBike division.



UNE - URBAN TRANSIT IN SONORA

WHAT IS IT?

UNE is a new smart transit system currently operating in the Hermosillo, Ciudad Obregón and Navojoa municipalities, in the state of Sonora. It will eventually extend to the other municipalities of this state. It works for 100% of the routes of these three municipalities. Of these, 54 are run by private concessionaries; 6 lines (all of them in Hermosillo) are run by the government.

MAIN CHARACTERISTICS

- **"Prepaid cards"**: a smart card that allows users to pay for bus fares in all three municipalities.
 - These plastic cards have a chip and an antenna, and contain the name, user type, balance, validity, and trip history.
 - The card is provided free of charge when users register with UNE. This can be done at government offices located in the central area of the municipalities. The average time it takes to register is 36 minutes.
 - The card can be loaded at convenience stores.
 - The system automatically applies fare discounts when applicable (students, senior citizens and persons with disability pay 4 pesos per trip instead of 7).
- **Mapped routes**: the UNE website includes maps of all 31 bus lines of Hermosillo, whether they are run by the government or privately. The routes for Ciudad Obregón and Navojoa (12 and 11 bus lines, respectively) are not mapped on the website (they can be consulted through an "app").
- **Bus schedules**: the website includes arrival times for buses in Hermosillo.
 - Because all units are equipped with GPS technology, Hermosillo buses can be tracked in real time.
- **"App" UNE Transporte Sonora**²⁵: this "app" can be downloaded for free for iOS and Android. Users can use the app to check:
 - Maps of the bus routes in all three municipalities: 31 in Hermosillo, 12 in Ciudad Obregón, and 11 in Navojoa.
 - GPS location of all Hermosillo bus routes, one Ciudad Obregón bus line, and one in Navojoa (other units are not equipped with GPS).
 - Duration of each trip.
 - Frequency at which the buses come for each route.
 - Length of each trip.
 - Number of buses serving each route (each day).
 - The time at which each route begins operations (each day).
 - The time at which the route ceases operations (each day).



²⁴ UNE Transporte Urbano Sonora: <http://une.sonora.gob.mx/>

²⁵ App UNE Sonora (iOS) <https://itunes.apple.com/mx/app/une-transporte-sonora/id958417972?mt=8>; App UNE Sonora (Android) https://play.google.com/store/apps/details?id=com.bigbangdev.bussosonora&hl=es_419

CHOOSE YOUR OWN ROUTE – OPTIBUS LEÓN

WHAT IS IT?

A virtual platform –available online and through an app – that maps all 133 bus routes and bus stops in the metropolitan area.

MAIN CHARACTERISTICS

- **Electronic payment:** a smart card allows users to pay for bus fares on all routes.
- **Locating a loading station:** locations where the smart card can be loaded can be seen on the map.
- **Customized routes:** users have the option of entering their point of departure and final destinations, and the platform will provide different bus and transfer options.
- The platform does not present real time information, approximate trip durations, arrival times, or bus frequency information.



²⁶ Elige tu ruta Optibús: <https://advser1.biz/>

²⁷ App Elige tu ruta Optibús (Android): <https://play.google.com/store/apps/details?id=adv.optibus.leon&hl=es>; App Elige tu ruta Optibús (iOS): <https://itunes.apple.com/mx/app/optibus-leon/id741966488?mt=8>

PARKIMÓVIL – Digital Parking and Parking Meters in Puebla and Tlaxcala

WHAT IS IT?

A virtual platform –an “app” – that helps users locate and pay for parking using their mobile phones. The service is currently available in Chignahuapan, Zacatlán de las Manzanas and San Martín Texmelucan (state of Puebla), and in Huamantla (state of Tlaxcala). It’s also available in the Sonata by Lomas and Centro Mayor shopping districts of Puebla.



MAIN CHARACTERISTICS:

E-payment: there are two electronic payment options. One requires the user to send an SMS to the Parkimóvil number, and parking fare will be deducted from the cellphone balance. The other option is for the customer to enter his credit card data into the app.

- **Cash payment:** the customer can pay for parking in cash at authorized business locations, or a nearby collection center.
- **Mapped parking:** the user can check to see if there are any nearby parking spaces available, in real time.
- **Remaining time:** the user can use the app to check how much time he has left on his parking space. In certain cases, the user can add more money through the app.
- **Generar recursos locales:** more than 70% of the money collected by Parkimóvil goes to the municipality, and to local businesses through its commission scheme.

²⁸ Parkimovil: <http://parkimovil.com/>

²⁹ App Parkimovil (iOS): <https://itunes.apple.com/mx/app/parkimovil/id954503274?mt=8>; App Parkimovil (Android): <https://play.google.com/store/apps/details?id=com.parkimovil.app>

SMART STOPLIGHTS FOR THE COSTERA MIGUEL ALEMÁN AVENUE

WHAT IS IT?

All stoplights of the Costera Miguel Alemán Avenue, Acapulco's most important road and tourist corridor, were replaced with smart stoplights in 2015.

MAIN CHARACTERISTICS:

- 18 intersections, with stoplights.
- 350 new stoplights, including pedestrian stoplights.
- 108 new posts. Each includes a stoplight, camera, antenna, and signage.
- Control center that can communicate bi-directionally with each intersection.
- Use of video detection cameras to count vehicles in real time. They can be programmed to adapt to traffic flows or any other need (emergencies).
- These traffic lights reduced the average time it took to drive the length of this avenue by 26% (from west to east) and by 10% from east to west in the mornings. In the afternoon, average travel times were reduced 16% and 46%.
- This is the only road in the city with these types of stoplights.
- The municipal government of Acapulco undertook this project.
- The total project cost was 20 million pesos.



³⁰ Created with information provided by Eyssa.



8

PUBLIC POLICY RECOMMENDATIONS

Promoting smart mobility in the city requires federal policies, as well as state and municipal policies that take into account new technologies, and the needs of cities and their inhabitants.

This requires a series of policies that aim to improve not only mobility at a country level for reasons of sustainability and equality, but also the inclusion of ICTs, Big Data generation, and public dissemination. Adopting these types of measures is urgent. If not, the market and technological innovation will generate dynamics that may lead to current public policy becoming obsolete. It may also create adverse effects among the population if new technologies and stakeholders in the sector are not cautiously regulated. The surge in the number of car summoning applications –for taxis, and other vehicles– as well as other shared mobility options, or the future appearance of self-driving cars, create huge challenges –but also opportunities– to improve mobility, sustainability and equality in cities.

Smart stoplights, self-driving cars, and car summoning applications may incentivize the use of cars and reduce the use of public transit. This is a socially undesirable effect

Current information property schemes and personal data protection laws also give those who generate and store data somewhat of a private monopoly to exploit information. If we consider the high cost for users to abandon a network (network de-economy), this helps increase “information monopolies”. Today, for this reason, it’s very important to consider these topics in the state regulations pertaining to property and in the use of data generated with the purpose of promoting smart mobility. This not only occurs with mobile taxi applications. It also occurs with other types of government agreements between cities and private individuals. This may include concessions, payment for service schemes, public-private partnerships, which exclude issues such as data property, and for issues such as parking management, speed camera fines, traffic lights, public transportation, among others.

Giving the government property or free access to data and information –and providing this to private citizens as well– would allow for a better monitoring and evaluation of mobility, in such a way that it would create collective benefits. It would also ensure that private operators of mobility services provided the best possible services to the public. A lack of regulations often provides leverage and bargaining power to companies (and hurts the government), which in turn means less social benefits.

FEDERAL PUBLIC POLICY

At the federal level, SEDATU, which leads the sector, has created the Sustainable Urban Mobility Strategy (EMUS, in Spanish); however, it does not include, in its main axes, the use of ICTs, Big Data, or Open Data in an attempt to improve urban mobility. Likewise, the National Digital Strategy aims to promote the use of open data; urban mobility is not one of its areas of direct expertise. There are other institutions dealing with and managing mobility data that are not necessarily working on these issues. For this reason we suggest:

Financing the budget of the Sustainable Urban Mobility Strategy of the SEDATU, and integrating a smart mobility approach as a cross cutting element of its main actions.

Creating a continuous evaluation on open data from state and local governments, just like the Data Census of the Open Knowledge Foundation does.

Promoting greater participation of state and local governments in the Red México Abierto (Open Mexico Network), because today number of participants is low. There are also governments that have made great progress, such as those of León y Hermosillo, and do not belong to the network. There are also more state and municipal governments feeding urban mobility information into the data portal.

Promote standardization of datos.gob.mx for urban mobility throughout the country (traffic incidents, non-motorized infrastructure, public transportation routes, etc.), along with the standardization of these events in such a way that a large amount of users may use them.

Create, through CONACYT, a mixed fund for the research and development of smart mobility programs. And for researching the economic and social effects of cutting edge solutions (Big Data analysis, shared mobility, implications of self-driving cars, etc.)

Apply a smart mobility approach to the financing of mass transit projects, and to the dissemination and generation of open data.

Promote guidelines for compiling and sharing data with the government, (who should be the final owner of the information) obtained from concessions, public-private partnerships and contracts for the payment of services related to urban mobility solutions. This must be done without affecting possible private incentives for the creation, compilation and storage of data.

POLICIES FROM STATES AND LOCAL GOVERNMENTS

Making it compulsory for public transit concession-holders to employ technologies enabling real-time location and generation of open data based on location.

Releasing big data generated by public transit systems operated by government.

Regulating the regular update of information regarding public transit routes (lines and units) by those that render transit services.

Disseminating different databases such as those from public cycling systems, parking meters, and traffic lights.

Setting smart cards and/or mobile applications as payment methods for public transit and other mobility services.

Digitalizing and releasing data regarding traffic events.

Binding taxi companies (including service providers such as Uber, Lyft, EasyTaxi, and Yaxi, among others) to share their data.

Creating an obligation for public-private partnerships and service contracts for urban mobility solutions to generate data deliverable to the government.

Creating citizen observatories supported by organizations to validate information and monitor specific database openness requests.

Feeding local data portals with urban mobility information alongside urban development data in order to improve, not only mobility planning, but also urban planning.



CONCLUSIONS

Today, smart mobility is a tool that enables changes on urban mobility in order to realize a series of social benefits that go from the environment to the economy. Examples of this are the cities of London, Singapore, Boston, and Chicago among others.

According to the cases analyzed, and the information collected, it is possible to identify that the main innovations on this field come from private entities and not directly from government. Although this situation is not bad in itself, it does require clear and specific rules of operation. Otherwise, socially adverse situations might arise or full benefits for the public could not be realized if the private sector withholds the data created.

Due to this, Pentland (2009) states that the greater challenge regarding the process to generate, store and collect data and information involves the concepts of privacy and ownership. It is not desirable for the government to store large amounts of data while barring the public from it, however it is also not desirable for private parties to monopolize information preventing the realization of social benefits. For this reason, a regulatory and institutional framework that prevents the exclusive storage of information is needed alongside the development of economic incentives to collect, store, and use said information.

Finally, it is important to highlight that diverse local efforts and good practices for the development of smart mobility projects from government have been found in the cities of Mexico, Hermosillo, and Leon, among others. Nevertheless, in Mexico, support for this type of policies at the local level is quite limited, as is the case with sustainable urban policies or data openness. This implies a double challenge and an opportunity since today, it is not only necessary to have in place policies that foster urban development and sustainable urban mobility centered on walking, biking, and public transit. Simultaneously, it is necessary to include the use of information and communication technologies in order to maximize social benefits. Given the fact that we are at a time when the mobility paradigm is shifting, this is the right time to foster the use of CITs to give rise to truly smart mobility for sustainability and social equity.

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Helsinki, Finland: <http://www.hri.fi/en/open-data/>

International Open Data Charter: <http://opendatacharter.net/>



British Embassy
Mexico City

