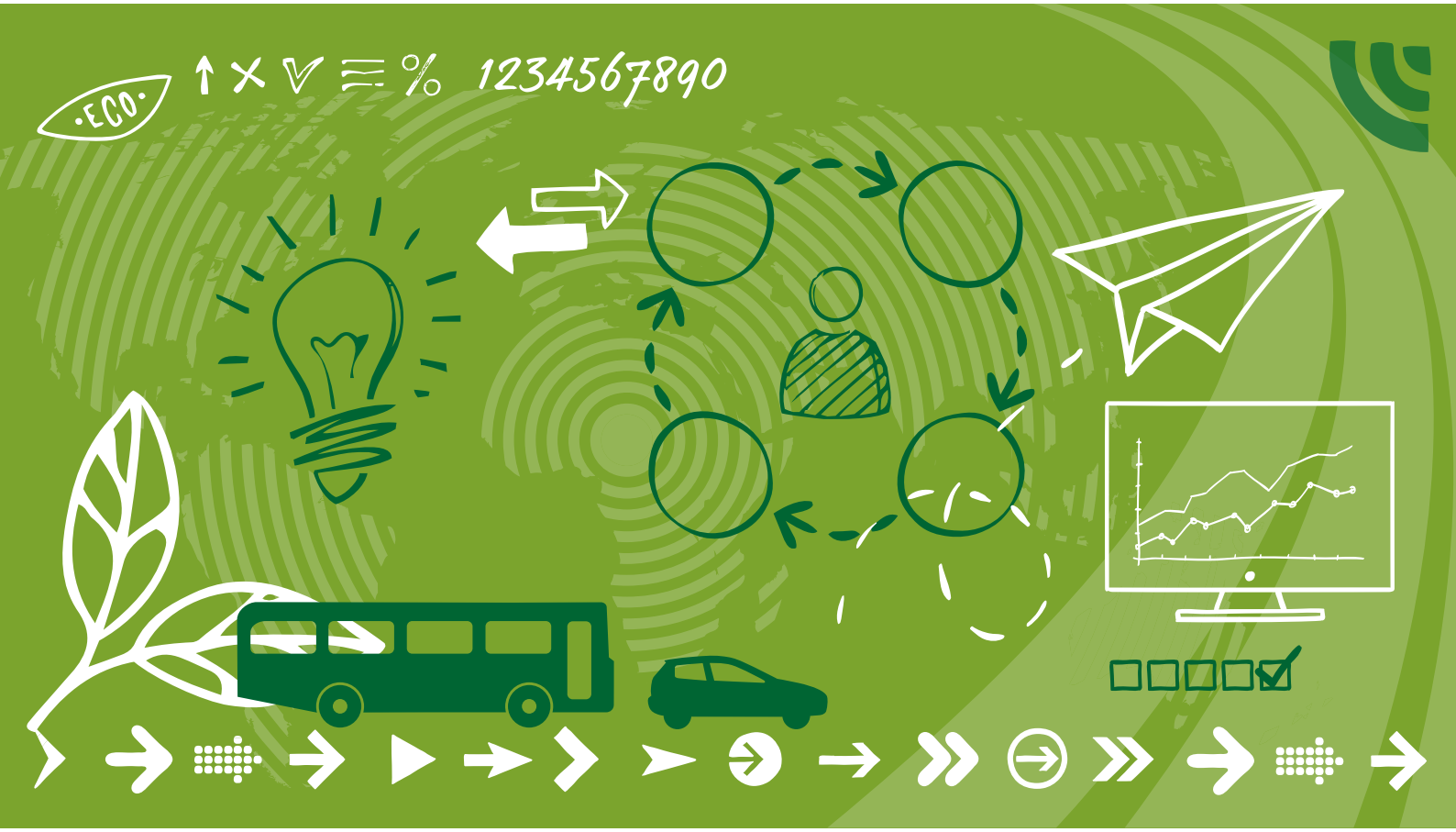


The Role of Open Data in Sustainable Transport

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of
Federal Ministry for Economic Cooperation and Development


·ECO·

Content

1. What is Open Data?

What does it mean for a city or agency to open its data? How does Open Data influence people in their everyday life? Through digitalization and new technologies, vast amounts of data are already being collected by governments and although much of that data is public by law, it is often not yet available in a form that is easy to use. The concept of "open data," or free access to information, has been emerging in different fields and has started to become mainstreamed since 2009 when various governments announced initiatives towards opening up their public information. Still, this trend is still new to many people. A lack of knowledge and clarity can create hesitation and wariness towards opening data when, in fact, open data may help to make governments more transparent and efficient and could unlock the potential of official data to enable new services that, in turn, improve life of citizens.

1.1 Definition

Governments and organisations generate data in the form of documents, databases, records, transcripts, etc., but historically this information has not always been available or open to the broader public. Opening data to the public can drive internal efficiency, spark community engagement and fuel a civic tech ecosystem[1]. Open data can be freely used, reused and redistributed by anyone, generally only requiring reference to the original source. In that way, opening up data can also inspire interoperability between various actors of different levels, for instance inter- and intra-governmentally, regionally, nationally or globally.

In order for data to be considered open, it must be[2]:

1. **Complete –** all public data is made available, and is not subject to valid privacy, security or privilege limitations.
2. **Primary –** data is collected at the source, with the highest possible level of granularity.
3. **Timely –** it is made available as quickly as necessary to preserve the value of the data.
4. **Accessible –** it is available to the widest range of users for the widest range of purposes. It must be available on the Internet.
5. **Machine processable –** it is structured to allow automated processing.
6. **Non-discriminatory –** it must be available to anyone, with no registration requirement.
7. **Non-proprietary –** it is available in a format over which no entity has exclusive control.
8. **License-free –** it is not subject to any copyright, patent, trademark or trade secret regulation.

Open Data vs. Big Data

While open data refers to making data available and accessible to the public, big data refers to the phenomenon of extremely large data sets that are sometimes difficult to process using traditional databases and software techniques. The big data discussion is framed by "volume" (the amount of data), "velocity" (the speed of information generated and flowing into the enterprise) and "variety" (the kind of data available).[3]

The term big data can refer to both the volume of data, but also the technology that is required to handle the new large amount of data. Standard tools and procedures are not designed to search and analyse massive datasets such as those generated by smartphone use. It is important to remember that big data can be open, and open data can be big. The concepts are related, but not identical.

What is not Open Data

For many people, the concept of Open Data is daunting as concerns about data privacy are generally high. It is important to clarify what Open Data is not in order to improve knowledge about the opportunities of Open Data and resolve hesitation and wariness towards opening data. Data that contains personal information about passengers, for instance travel histories or contract details, genuinely sensitive or confidential information, or data where the copyright is contractually owned by a third party would not be classified as Open Data.

[1] Civic Technology encourages citizens to participate in public good development, enhances citizen communications and improves government infrastructure. Developers create matching apps using the data provided by the government on open APIs in non-proprietary formats. Later these new solutions can be included in an open government platform to be used by both, citizens and governments.
[2] Definition taken from Open Government Working Group *(http://opengovdata.org/)*
[3] *http://www.webopedia.com/TERM/B/big_data.html*

2. Open Data and Transport

Public transport users increasingly demand smarter cities that provide digital information, particularly real-time updates on their journeys. In the context of transport, the concept of smart cities revolves around a more integrated approach of data and urban transport provision. Open data can save both time and money in collecting such information about routes. Real-time service information including route and stop locations, passenger volumes by location and time of day, planned schedules, service disruptions, pricing and fare products, and average travel and dwell times can all be collected automatically or manually by staff. This information can then be automatically uploaded to an accessible, central server. In comparison, traditional methods require far more staff hours, manual work to record and upload information and advanced computer knowledge of programs such as TransCAD or GIS.

Open Data has impacts on public transport, but can also support individual transport development (apps on traffic information, parking) and environmental issues (noise and air pollution). This paper focuses mainly on public transport improvements.

Opening data can empower resource-constrained transport agencies to collect **high-quality transport data with minimal effort and cost,** as well as to conduct **robust data analyses with minimal formal training** in transport engineering and planning. In addition, providing access to official data for developers can support employment, entrepreneurship and user input in the development of new and innovative technology applications for users – benefits that government agencies may not have the time, resources or expertise to develop. Overall, open data can thus improve the efficiency and effectiveness of government services and create new products and services that incorporate knowledge from combined data sources and patterns. Open data does not only benefits individual transport users through the provision of personalised and relevant travel information, but also the economy, as the economic value of open data is estimated at several tens of billions of Euro annually in the EU alone[4]. In the long term, Open Data is expected to create a virtuous cycle, where new products further increase the demand for Open Data which in turn catalyses the release of more data, services, and applications.

The General Transit Feed Specification (GTFS) has emerged as the standard to release public transit data around the world. GTFS was co-developed by Google and TriMet, the transit agency in Portland, Oregon.

Types of Data Collection

- **Traditional**: household surveys, field traffic counts
  - time-consuming and labour intensive
- **Intelligent Transportation Systems (ITS)**: dedicated, sensor-based systems
  - costly, high technical requirements
- **Open Transport**: crowd-sourcing, existing ICT systems (cellular networks, Internet connectivity), open-source, license-free applications

[4] Open Knowledge Foundation, 2012

Transport Instrument	Traditional Method	Open Transport Method
GIS Route and Station/Stop Locations	• Collect data using dedicated GPS device • Manually upload data to desktop computer • Use specialised GIS software to relate collected data to city's road network, enter details about the route • Manually enter route meta-data • Can only be updated by a GIS specialist	• Staff ride transit route using mobile app • Enter route and stop details using the app as they ride • Data and meta-data automatically uploaded to accessible, central server • Can be updated via a web-based graphical user interface
Passenger Volumes by Location and Time of Day	• Stop locations manually marked on map, as well as alightings and boardings • Stop locations plotted in GIS platform • Passenger counts manually updated in GIS for each surveyed location	• Survey staff can record boardings and alightings along entire route using mobile app. Data is saved with route information and automatically updated
Average Travel and Dwell Times	• Staff ride transit routes and measure travel time between pre-determined points on route map • Travel time data manually entered on each route segment	• Travel time automatically recorded and linked to route file
Total Time Needed	On Route: 2 hours x 3= 6 hours Additional data entry: 1 hour x 3 = 3 Total: 9 hours	On Route: 2 hours Additional data entry: 0 hours Total: 2 hours
Total Time and Cost for Metro Manila	9 hours x 900 routes= 8,100 hours	2 hours x 900 routes= 1,800 hours

Source: World Bank Open Transport Team

What is the General Transit Feed Specification (GTFS)?

GTFS is a standardised free and open template for entering data related to basic transit system services. It consists of a package of comma-delimited text files for use in a spreadsheet application, each of which contains one aspect of the transit information and a set of rules on how to record it. There are six mandatory files (agency, stops, routes, trips, stops times, and calendar) that every agency must provide and seven optional files (calendar dates, fare attributes, fare rules, shapes, frequencies, transfers and feed info).

Example GTFS Feed (source Google Transit)

Each aspect of transit information has a required format that allows developers and applications to work compatibly across cities and datasets. These templates are provided by Google Transit. An example of the information is below:

2.1 Transit Stops (stops.txt)

```
stop_id,stop_name,stop_desc,stop_lat,stop_lon,stop_url,location_type,parent_station
S1,Mission St. & Silver Ave.,The stop is located at the southwest corner of the inter-
section.,37.728631,-122.431282,,,
```

An example of stop information is shown above.
The required information is:

- Stop ID (stop_id)
- Stop Name (stop_name)
- Stop Description (stop_desc)
- Stop Latitude (stop_lat)
- Stop Longitude (stop_lon)
- Stop URL (stop_url)
- Location Type (location_type)
- Parent Station (parent_station)

However, if a piece of information is not known, it can be left blank. Providing as much information as possible, however, will make the GTFS data more useful by allowing for a broader set of applications. The example above describes a stop that has been labelled as S1 and is located at Mission St. and Silver Avenue. The description gives more detailed information about where it is located at the intersection, and the latitude and longitude allow for precise map locations.

2.2 Transit Routes (routes.txt)

```
route_id,route_short_name,route_long_name,route_desc,route_type A,17,Mission,“The
„“A““ route travels from lower Mission to Downtown.“,3
```

The routes file asks for:

- Route ID (route_id)
- Route Short Name (route_short_name)
- Route Long name (route_long_name)
- Route Description (route_desc)
- Route Type (route_type)

The file above describes a route given the ID “A”. This ID is unique and no other route in this dataset can be given this name. The description notes that the “A” route travels from the lower Mission to Downtown. The short name is 17, while the long name “Mission” more logically describes the route. Finally, the route type describes the type of transportation used on the route. In this case “3” refers to bus. A more complete list can be found in the Google GTFS Reference.

2.3 What can it be used for?

GTFS feeds allow public transit agencies to publish their transit data in a format that is accessible to developers to access and write applications that consume the data.

GTFS data can be used for trip planners, timetable publishers and a slew of other applications that use public transit information in some way.

Because GTFS is an open-standard, applications that are designed for one city's GTFS data can be used with any other set of GTFS data. This means that applications or analyses performed for one city's data can easily be performed and adapted for another city.

It can be used not only to manage static transit information such as routes, stops and schedules, but GTFS-realtime (GTFS-RT) data feed specifications can provide live updates on transit fleets using Automated Vehicle Location (AVL) systems and static GTFS feeds.

Category	Description	Examples
Trip planning and maps	Applications that assist a transit customer in planning a trip from one location to another using public transportation	Google Maps, OpenTripPlanner, Bing Maps, Transit App for iOs, RouteShout, Tiramisu
Ridesharing	Applications that assist people in connecting with potential ridesharing matches	Parkio, Avego
Timetable Creation	Applications that create a printed list of the agency's schedule in a timetable format	TimeTablePublisher
Accessibility	Applications that assist transit riders with disabilities in using public transportation	Sendero Group BrailleNote GPS, Travel Assistant Device
Planning Analysis	Applications that assist transit professionals in assessing the current or planned transit network	OpenTripPlanner Analyst Extension, Graphserver, Transit Boardings Estimation and Simulator Tool, TransCAD 6.0
Interactive Voice Response (IVR)	Applications that provide transit information over the phone via an automated speech recognition system	BusLine, TransitSpeak, TravelSpeak
Real-time transit information	Applications that use GTFS data along with a real-time information source to provide estimated arrival information to transit riders	OneBusAway, NextBus, TransLoc, Moovit, next bus arrival signs at bus stops (e.g. in Santiago, Sao Paulo)
Dedicated SMS applications	Applications designed for feature phones without data capabilities	RouteShout, Transantiago's SMS Bus

Table 1: Technical Innovations Enabled by GTFS Feeds (Mehndiratta & Ochoa, 2014)

2.4 Case Studies

As of June 2013, approximately 1,050 transit operators released official GTFS feeds. Most of the feeds are from operators in the US, Canada, Europe, Australia, New Zealand and Japan, but some are from developing countries. London, UK has been a pioneer in opening up its public data, and is one of the most successful examples of open data use in public transport.

From Transport for London:

"All public TfL data ('or open data') is released here for developers to use in their own software and services. We encourage software developers to use these feeds to present customer travel information in innovative ways – providing they adhere to the transport data terms and conditions."

Source: https://tfl.gov.uk/info-for/open-data-users/

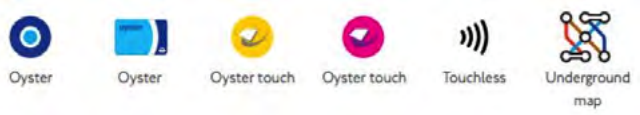
London

Open Data Use in London
(https://tfl.gov.uk/info-for/open-data-users/)

- 5,000 registered developers
- Hundreds of apps produced on all platforms
- 30 feeds and APIs including across modes
- Provided in non-proprietary formats
- Easy-to-navigate website *(tfl.gov.uk/info-for/open-data-users/)*
- Societal benefits due to open data use are calculated at up to £58m annually due to customer time saved
  - Based on investment of under £1m annually on Open Data

Why are we committing to open data?

- Public data – As a public body, our data is publically owned
- Reach – Our goal is to ensure any person needing travel information about London can get it wherever and whenever they wish, in any way they wish
- Economic benefit – Open data facilitates the development of technology enterprises, small and medium businesses, generating employment and wealth for London and beyond
- Innovation – By having thousands of developers working on designing and building applications, services and tools with our data and APIs, we are effectively crowdsourcing innovation



Source: https://tfl.gov.uk/info-for/open-data-users/our-open-data

2.5 Open Data in Developing Countries

The ODDC Project, launched in 2012 as a collaboration between the Web Foundation and the Canadian International Development Research Centre (IDRC), aims to provide a platform for researchers to connect and share results and methodologies.

		Mexico City	Santiago	São Paulo	Manila	Dhaka
City characteristics	City Population (thousands)	8,600	4,600	11,000	12,00	9,200
	Metropolitan population (thousands)	18,000	6,000	18,800	26,000	14,500
	Primary transit modes	Microbus, Metro, Bus	Bus, Metro	Bus, Metro	Jeepney, Light rail	Rickshaw, Bus
	Regulatory scale	National	National	National, local	National, Local	Local
	Transit trips per day (millions)	15	5.25	8.7	3.6	11.2
	Internet access (national level)	37%	59%	46%	32%	5%
	Mobile phone ownership (national level)	83%	118%	124%	99%	56%
	Smartphone ownership (national level)	13%	18%	28%	14%	<1%
Transit data outputs	Project initiator	City government, World Bank	City Government	City government	City government, World Bank	MIT, Urban Launchpad, Kewkradong
	NGO assistance	Yes	No	No	Yes	Yes
	Method	Android and iPhone apps, data management portal	AVL, AFC	AVL, AFC	GPS	Android app
	Data collection started	2012	2007	2008	2006	2012
	GTFS released	2013	2013	2012	2012	2013
	Routes included	475	376	1,329	906	78
	Difficulties encountered	Fixed stop locations, fixed schedules and headways, vehicle type	Group taxis not included due to their flexible operations	None – no flexible transit services	Fixed stop locations, fixed schedules and headways, vehicle types	Fixed stop locations, fixed schedules and headways, lack of agency websites

GTFS Data Collection Experiences Across Five Cities (Eros et. al, 2014)

Nairobi, Kenya

Population (city): 3.1 million people
Population (metropolitan region): 6.7 million people
Number of local government authorities: 15

Kenya Open Data Initiative *(https://opendata.go.ke/)*

- Government development, demographic, statistical and expenditure data available digitally on a website
- 160 datasets including 2009 census
- **Goal:** provide a "platform for innovation" to produce more efficient outcomes in service delivery, job creation and citizen feedback systems; enable data-driven and better-informed decision making processes; improve transparency and accountability in government operations

Main Challenges:

- many agencies do not have good data to share, or do not want to release existing data
- data often not provided at local scale, only at a regional scale

Organisation: Civic Data Design Lab

- Collaboration between researchers at MIT, UC Berkeley, and the Kenya Institute of Public Policy and Research Analysis (KIPPRA)
- **Goal:** Create GIS data and maps for Nairobi that can be shared openly
- Created online wiki space to facilitate download and discussion of data and its challenges
- Partnered with Virtual Kenya

Main Challenges:

- Difficult to reach community-based policy and planning groups in Nairobi
- Use of GIS excludes those without access to technology or training
- Difficult to connect with existing data communities

Lessons Learned from Kenya

- Need to build relationships with existing actors
- Need to consider the political landscape in which data is being collected and disseminated and establish trust in order to get organisations to open up data
  - Open data can seem threatening to relatively powerful governments and other entities
- Community engagement vital in order to maximise benefits of participatory data sharing

Mexico City, Mexico

Population (city): 8.9 million people
Population (metropolitan area): 20.9 million people
Number of local government authorities: 40+

Transport Overview

- Transport includes both heavily and loosely regulated operators
  - Colectivos (minibuses) make up 50% of motorised trips
- Route and stop location information collected and stored for services on dedicated infrastructure
- Loosely regulated private buses and minibuses have no digital means to collect ridership information
  - 30,000 vehicles in 121 different route associations
  - regulator has little information on routes, drivers or vehicles

World Bank and Open Data

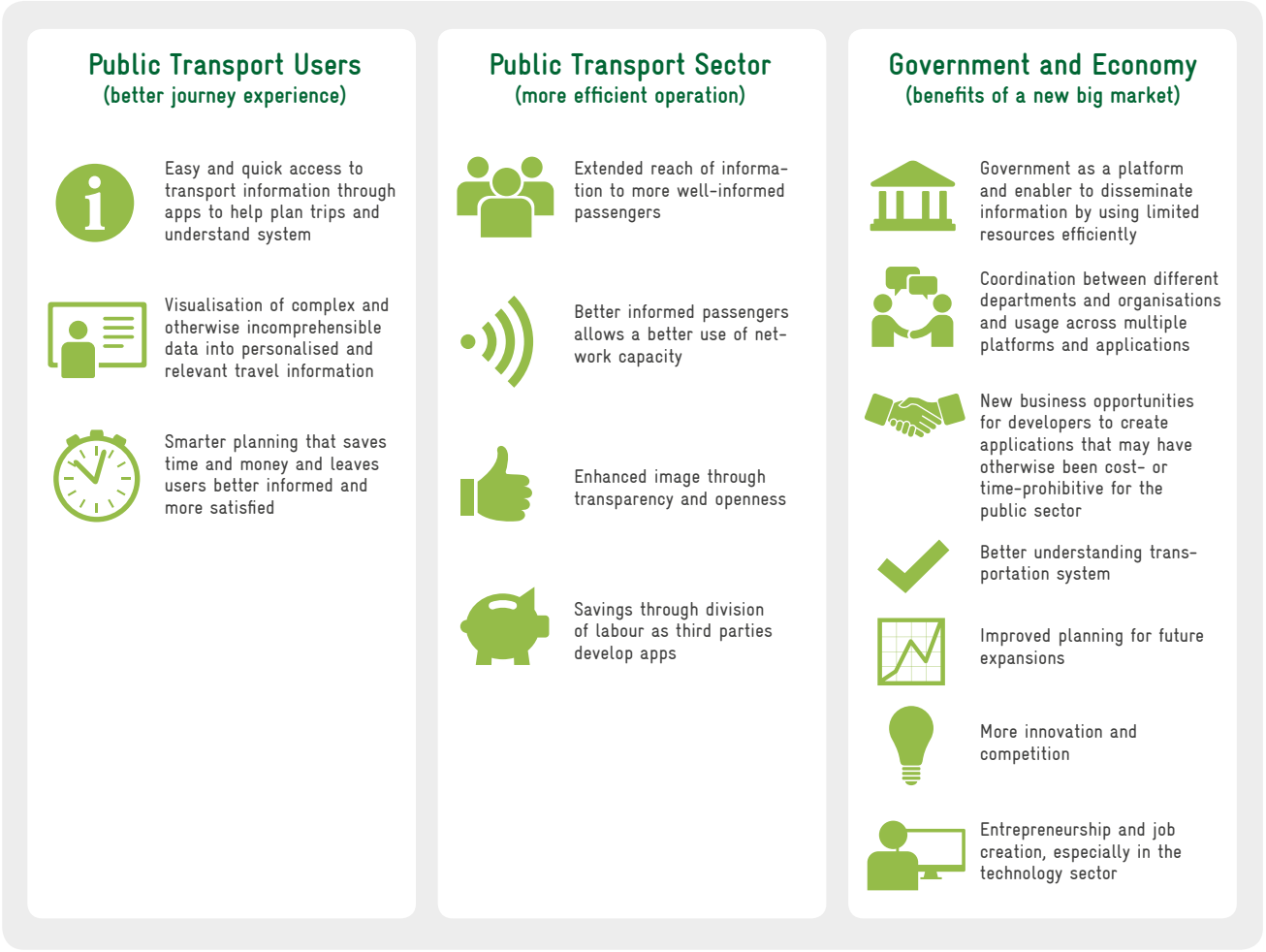
- Trial in spring 2013 to collect basic route data using mobile apps on 10 of the most formalised colectivo corridors
  - Route, travel time, passenger counts
- **Goal:** create a GTFS feed to integrate all transport agencies in Mexico City

Main Challenges:

- GTFS was not designed with flexible services with no fixed stop or schedule information (such as colectivos) in mind
  - Need to develop a workaround to estimate headways based on existing knowledge using vehicle counts and speed data
- Data collection is effort- and time-intensive

3. Why Use Open Data in Transport?

Open data in transport has led to technical innovations that allow agencies and providers to communicate with users in new ways, such as through mobile applications and regularly updated transport information. Open data can provide many benefits to a variety of users, including:



A move from tightly controlled data and their derived products to publically released data has allowed for applications that benefit users even when governments do not have the financial or technical capacity to provide these innovations directly. Open transport data allows the public to contribute to innovation and the betterment of public services through means that may be cost- or time-prohibitive for the public sector.

Traditional spatial and transport planning tools have often not been successful in developing cities. They are expensive, require high level of training and capacity, and can only be applied towards a single purpose. While they still play a role in large-scale transport planning, there are numerous license-free, expandable and translatable software packages available that can help to build capacity and a culture of data use.

Open data can help transit and planning agencies address questions such as "where can a city densify?" or "which link of transport infrastructure needs to be resilient to natural disasters?" using already existing data. Opening up data can help to achieve economies of scale in supporting wider and more efficient use of transit networks through releasing information to the public.

Challenges:

- Need for an institutional environment that prioritises keeping GTFS data up-to-date
- Users unaccustomed to having information and inaccurate/estimated information that may be unreliable could prove challenging

Even though some obstacles to a complete adoption of Open Data in the transport sector still exist, more governments and transport agencies have already embraced the concept and opened up their data. There are various benefits associated with Open Data in the transport sector, for users, public service providers, and the government and the economy.

4. Further Resources

Google Transit and GTFS:
https://developers.google.com/transit/

Open Data Handbook:
http://opendatahandbook.org/en/

Kenya Open Data:
https://www.opendata.go.ke/

Open Data Essentials from the World Bank:
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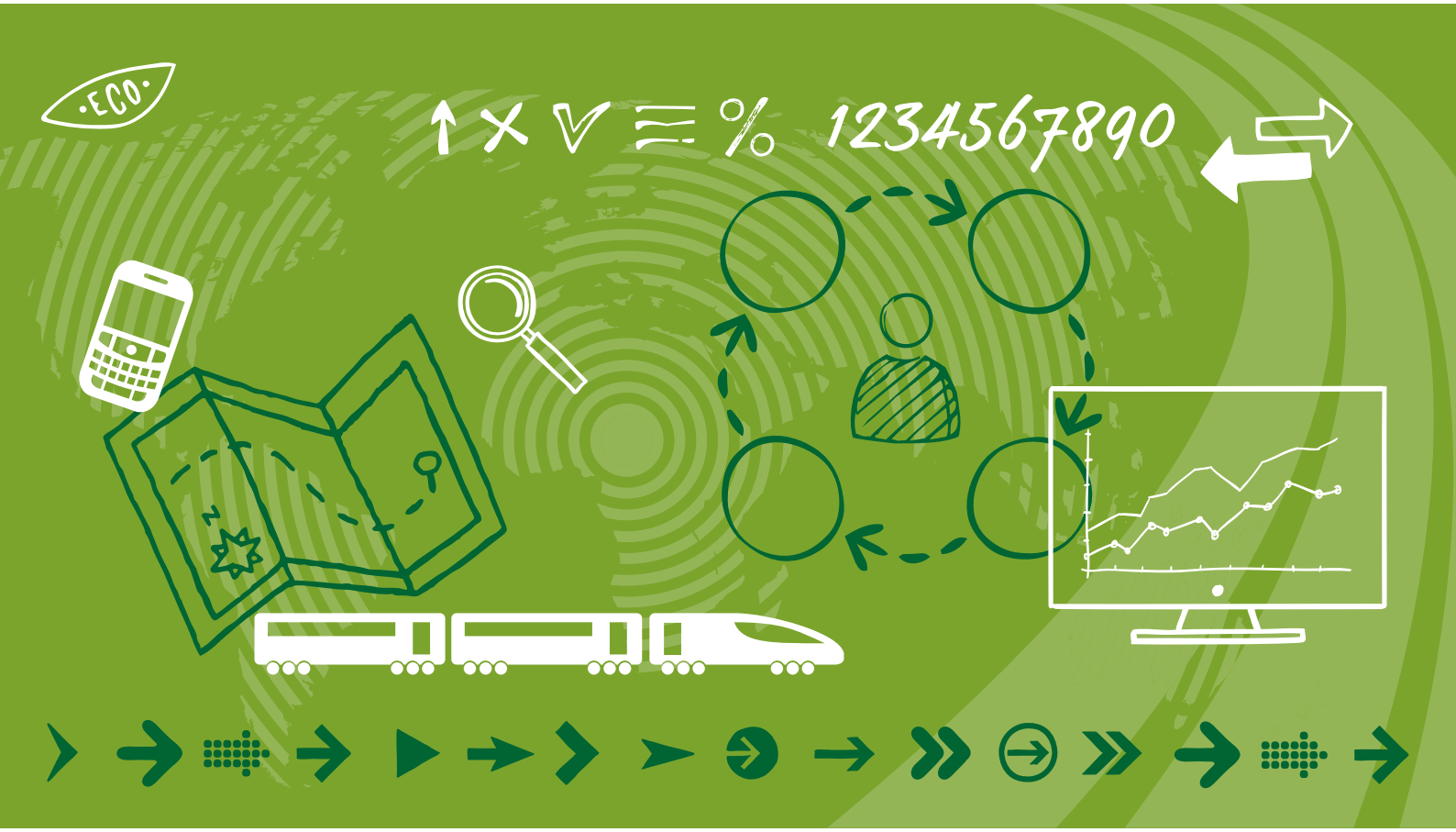

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