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Asia
Urban Transport and ICT Capacity Building

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"Detailed and accurate maps are so fundamental to sound urban planning, so essential to making smart decisions about where to build the next library, clinic or bus station, that it's hard to believe how often they don't exist."

-- Joana Mikulsi, NextCity

"35 percent of the 100 largest cities in the world do not have complete maps of their transit networks. Of the 25 largest low and low-middle income cities, 92 percent do not have maps. As international development practitioners working on urban transit programs, we have to ask ourselves, what have we been doing all this time?"

-- Holly Krambeck, The World Bank

RESOURCE-CONSTRAINED TRANSPORT AGENCIES

Resource-constrained transit agencies in developing countries are faced with many common challenges – entrenched informal transit networks; generally unpredictable and low service quality; unavailability of publicized route maps, fare schedules, or operating hours; and widespread low-income populations that are difficult to reach. As motorization rates balloon and low-income populations move further from urban centers, the need for these transit agencies to find solutions grows more acute each year. Whether formalizing jeepney stops in Manila, making buses more accessible to low-income people in Haiphong, or optimizing bus routing in Dhaka, agencies often are at a loss as to where to begin, for one simple reason – these cities, and hundreds like them in the Asia region, do not know where their transit routes are.

What these cities have in common is that none have accurate maps or databases that represent their public transit networks. Without knowing where their routes are, how can cities be expected to improve them? The quality of transit planning, operations, and management is directly correlated with the quality and availability of underlying transit network data, as well as a transit agency's capacity to manage and analyze them. But very often, transport

agencies in developing countries do not have the financial resources or technical capacity to collect, manage or analyze these data, impeding their ability to make evidence-based planning, policy and investment decisions.

Starting in 2012, collaborating with the Department of Transportation and Communications in the Philippines, the project team undertook an experiment – developing Manila's first integrated, multi-modal maps and database of their public transit network using a data standard that was not remotely intended to solve transit challenges in developing countries – the General Transit Feed Specification (GTFS).

The General Transit Feed Specification

The GTFS is an open data standard for transit service data, which was originally designed for the sole purpose of supporting on-line transit trip planners. Static data types covered by the standard include route and stop locations (for modes with fixed routes), headways and/or frequencies, operating schedules, and fare schedules.

The GTFS may be thought of as a template – a series of tables to be filled in with basic information about transit system service – route and stop locations, operating schedules, and fare schedules. More information about the specification may be found here:

http://bit.ly/GTFS_Training

The standard is free and freely available, without the need to register or pay licensing fees to view or use it. The GTFS is heavily documented and clearly defined, and there is a community of global practitioners who voluntarily contribute to improvements. But more importantly for our purposes, because the standard is open and widely supported, there is a growing community of developers creating innovative solutions to transit challenges using GTFS data.

By developing an application for one city, that same application can be used in any other city that has adopted the same standard – **in business and in international development, this is a very powerful concept.**

It is this expanding library of validation and visualization tools and software applications that led the project team and our counterparts to believe that by building their first transit databases and maps using this standard, sufficient local and global support would be available to ensure sustainability and use over the long term.

Mapping Manila Transit

Untangling the Spider Web

Nearly 70 percent of all trips made by Metro Manila's 12 million residents are made using public transit. And yet, surprisingly, until 2012, there was no map of this transit system. That is, not only were there no maps available to the millions

In support of institutional capacity building, the World Bank team devised a technical solution relying on three "open transport" principles:

- *Open data standards*—the team adopted an open international standard for transit service data, the General Transit Feed Specification (GTFS), a well-documented, clearly defined standard that benefits from a global community of practitioners who voluntarily contribute improvements and innovative solutions.
- *Open-source software*—the team supported development of an open-source mobile phone application, TransitWand, with which transit agency staff members could generate route data in the GTFS format at substantially lower cost than with conventional methods, as well as GTFS Editor, an open-source web-based application for managing the transit data. GTFS-Editor allows multiple agencies with minimal technical capacity to view and edit a single database covering all public transit modes in the city.
- *Open data*—After a media-intensive launch, the DOTC has made its GTFS data publically available on its website, supporting the growth in local third party applications to help passengers more easily and effectively navigate the system. Opening the data creates accountability for data maintenance.

of people using transit to identify routes or look up schedules, but no map was available to the government agencies responsible for planning and managing the system. Without this map, it was nearly impossible to determine whether transit was reaching the populations that need transit services the most, or to effectively plan new modes of transit, like bus rapid transit systems (BRTs) or metro rail extensions.

Leveraging a grants from Australian Aid, the Bank Team worked with the Department of Transportation and Communications to build Manila's first multi-modal transit map and service database. But there were challenges -- cities that do not already have maps of their transit networks usually do not have these maps for a reason. And in the Philippines, these reasons were many:

- Cultural: the government agencies never had transit route maps before and there was concern that there would not be sufficient willingness to use them;
- Institutional: transit data for Manila is maintained by five different government agencies – substantial work would need to be done to get these agencies to collaborate on one database;
- Technical: none of the participating agencies had staff experienced in using geographic information systems (GIS), a fundamental skill for mapping transit, and few had sufficient resources for managing modern databases; and
- Financial: there had not been a budget before for managing a transit database, so new sources of funding would need to be identified.

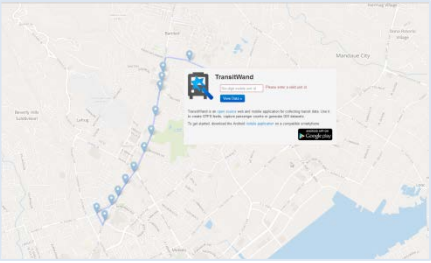
The Mapping Manila Transit project quickly became much more than just drawing a map – it became a technical and institutional undertaking for overcoming these long-time barriers to coordinated transit planning.

Overcoming Challenges

Technology and Institutions

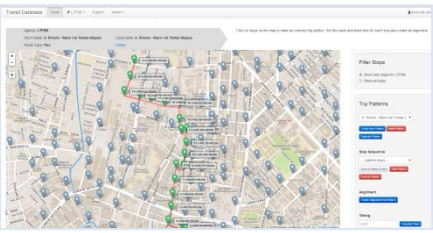
Multi-modal transit databases are not new. Cities have been mapping their transit systems and maintaining scheduling and operating information about them for many years. Over time, as transit networks have grown more complex, the technology for creating, managing, and updating these maps and databases has also grown more sophisticated. Technically-speaking, it would be easy to introduce these existing technologies and best practices to developing countries – but financing these systems, and ensuring they are supported and maintained in the long term, is not practical in resource-constrained environments.

Thus, the project team needed to devise a new way to map transit systems and maintain transit databases. The methodology would have to cost very little, require minimal technical expertise to use, and minimize the level of effort required for cross-agency collaboration.



Screenshot from TransitWand, web-based tool for visualizing data collected from the TransitWand mobile application

To this end, a three-part technical solution was adopted. First, agreement was reached that the database would be centrally hosted by the Department of Science and Technology and that it would be built using an international standard – the General Transit Feed Specification (GTFS) – which, although not intended for building transit databases, has the benefit of being internationally-recognized and compatible with a growing library of applications. Second, the Team, working with a transport planning firm and an open-source software developer, developed a mobile phone application, TransitWand (http://transitwand.com/), for use by transport agency staff to map transit routes in the GTFS format. This application substantially reduces the man-hours and technical resource requirements for building GTFS databases from scratch (particularly where existing route locations are not known), as well as for updating and maintaining them. Third, the team developed an open-source platform, GTFS Editor (https://github.com/WorldBank-Transport/gtfs-editor), to enable multiple agencies with minimal technical capacity to view and update the database – and critically, to facilitate multi-agency collaboration on a single transit database for the city, rather than separate databases, as was done in the past.



Screenshot from GTFS-Editor, web-based platform for multi-agency visualization and management of GTFS data

SUSTAINABILITY

To support the longer term sustainability of the program, the DOTC and Bank team organized a national transit app competition (http://philippine-transit.hackathome.com/), where the GTFS database was introduced to the public and more than 480 local developers registered to build consumer-based trip planning applications that rely on the database. The event was media-heavy and high-level, with the Secretary of Transportation, Under-Secretary for the Department of Budget Management, Director of the Department of Science and Technology, and other senior government officials participating as judges, speakers, and signatories to a Memorandum of Agreement, solidifying, publically, their agencies' commitment to maintain the database. By building public-facing GTFS-based platforms, the government agencies become more accountable for ensuring that the data remains up to date. The GTFS database is open, and may be downloaded from the DOTC's new open data portal: http://www.dotc.gov.ph/

Judges and winners from the 2013 Philippine Transit App Competition, including Transportation Secretary Joseph Abaya

The Map

The map generated revelations about the Manila transit system. Prior to the project, the DOTC and the Land Transportation Franchising and Regulatory Board (LTFRB) each maintained mismatching route databases and neither knew for certain which routes were active or where they went. By comparing the discrepancies between expected routes and the routes drivers were actually operating, the DOTC had a clearer picture of where true demand for services is. The new database also revealed the level of route redundancies in the system – after many decades of continually adding routes without mapping them, the ratio of operating bus route length to service in Manila is about *six times* higher than that of cities with comparable populations, such as Beijing, Singapore, and New York.

Screenshots from TransitMix, a third-party application, with visualization of the Manila GTFS data

Since completing the transit database and setting up the management system, the database has been put to work. There have been more than 14,000 downloads of the database since it was first made public in July 2013, and the database is used in a wide array of web, smartphone, and traditional mobile phone based consumer applications, such as *Sakay*, an open-source, web and SMS-based multi-modal trip planner that includes jeepneys (http://sakay.ph/)[1] and *Transitmix*, a tool for crowd-sourcing proposals to improve transit-routing (http://www.transitmix.net/).

Further, now that the DOTC can visualize the extent of the current system, the DOTC has commissioned a full jeepney and bus route rationalization plan, to be partially implemented over a two-year period, which would substantially reduce the redundancies in the current network – by nearly 90 pecent. The database has also been used to support a Japanese International Cooperation Agency (JICA) transport master plan for Manila, planning for a new mass rapid tranist corridor, and development of an open-source real-time bus tracking system.

Open Transit Indicators

In addition to supporting the development of open-source tools for building and maintaining transit service maps and databases in the GTFS format, in collaboration with the Chinese Academy for Transportation Science under the Ministry of Transportation, the team has also supported the development of open-source tools for using GTFS data to generate comparable transit service indicators and to support transit planning.

[1] Note, application is optimized for Chrome and may not function in Internet Explorer

The Challenge

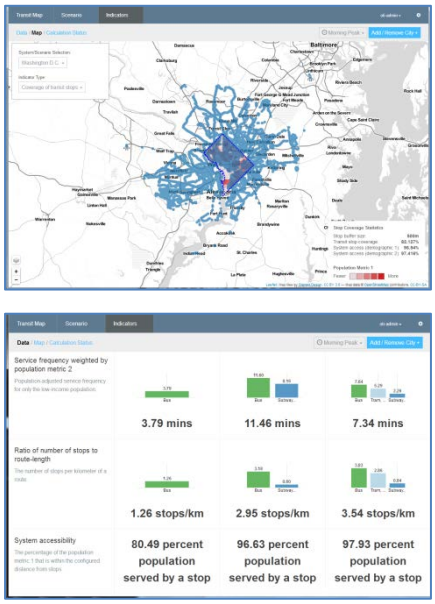
In most of the cities where the World Bank works, complex networks of microbuses and informal transit provide transport services to millions of passengers, who are often among the poorest urban populations. Resource-constrained transit agencies have been challenged to improve these services, at first because they often did not even have visual maps of where these services were offered. But now that the Bank has been tackling this issue by leveraging open data standards and supporting the development of open-source tools to lower the costs and technical barriers, the next step is to help transit agencies put these maps to meaningful use.

There is a different but related challenge at the provincial/state/national-level, where government agencies seek to provide subsidy support for urban transit systems but require comparable data about these systems to optimize resource allocation. As cities adopt the GTFS standard and build transit service databases, opportunities arise to vastly simplify this process through automated indicator generation.

An Open-Source Solution

To overcome these challenges, the team conceived and supported the development of Open Transit Indicators, a user-friendly, open-source and web-based platform that combines GTFS transit route information (including operating schedules and fare data), real-time vehicle GPS data (where available), and GIS demographic data to:

- Generate 25 indicators, comparable across cities, on transit system service characteristics, performance, and accessibility;
- Generate interactive maps that help users visualize service performance and accessibility indicators, including job accessibility; and
- Support scenario building, so that users can see how adjustments to transit routing and service -- schedules, stop locations, routes, or modes -- will impact these indicators.



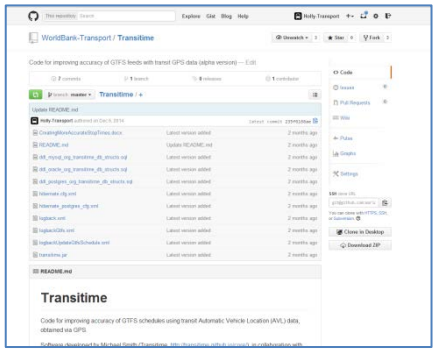
Screenshots from Open Transit Indicators (showing data from Washington, DC; Zhengzhou, China; Chicago, IL; and Philadelphia, PA

Given the reality that transport planning departments in low and low-middle income countries do not always have the technical resources necessary to use GIS and statistical modeling applications to support planning decision-making, the software (https://github.com/WorldBank-Transport/open-transit-indicators) has been designed with the objective of increasing the capacity of these resource-constrained departments. Specifically, the platform is intended to enable planning departments, with little training, to use data to prioritize

resources for deeper planning-related survey work, as well as to support benchmarking and comparative analyses between systems.

The completed platform is a first step, intended primarily for demonstration purposes, to clearly communicate the viability of building an ecosystem of GTFS-based and open-source applications to build capacity to plan using data. As of time of writing, the team is collecting feedback from initial platform testers on the application's utility and recommendations for improvement, and is also using the platform to prepare transit planning analyses for Zhengzhou (China) and Haiphong (Vietnam). The purpose of these analyses is to demonstrate OTI's utility in ensuring transit reaches those populations that require these services the most, as well as in reducing the labor costs associated with generating meaningful supply, performance, and accessibility benchmarks across cities.

Solving the Scheduling Challenge



Screenshot of TransitTime open source code on GitHub for generating more accurate GTFS schedule data.

An inherent challenge in using GTFS data to support planning work is the general inaccuracy of transit scheduling data. In the Philippines, scheduling data does even not exist for most modes, and in Chinese cities, bus schedules are so disconnected from actual arrival times, they are rarely made publically available. Since the value of the outputs of GTFS-based planning tools is correlated with accuracy of the GTFS scheduling data, the team supported the development of an open-source algorithm that combines GTFS data with a sample of bus GPS-location data to analyze the variances between scheduled and actual arrival times and generate a new GTFS schedule that more accurately reflects true arrival times (https://github.com/WorldBank-Transport/Transitime). The outputs of this algorithm may be directly imported into the Open Transit Indicators platform or used on their own to analyze service reliability (e.g., variation in dwell time, arrival times, and headways).

On-Going Work

As of time of writing, the first platform version has been completed and is currently under testing by Zhengzhou, the Chinese Academy of Transportation Science, and a number of independent researchers from North American universities. By December 2015, the Team will prepare a report on the outcomes and findings of this new type of open-source solution.

Global Impact

Transport agencies and NGOs in China, Vietnam, Mongolia, Mexico, Brazil, Egypt, and the US are currently utilizing the tools developed under the Manila pilot to support development and management of their own GTFS feeds. To further support this trend, the project team has initiated a wiki repository for multi-lingual GTFS training materials (http://bit.ly/GTFS_Training), and in November 2013, the team co-organized GTFS for the Rest of Us, an international workshop for practitioners on improving the standard to make it more readily adoptable in developing countries (http://www.gtfsfortherestofus.net/).

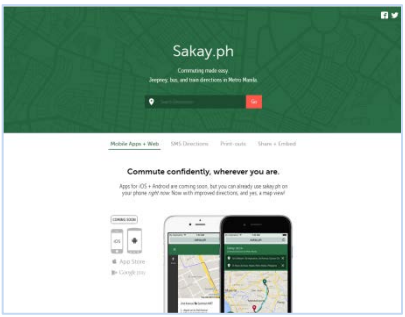
Lessons Learned

Through this work, the World Bank team learned two things: (1) GTFS databases do have the potential to help developing cities overcome, for the first time, challenges they had faced for many years; and (2) GTFS databases are very difficult to establish and maintain in developing countries.[2]

The project team has also gained a deeper understanding of the types of developing country transit challenges that GTFS databases can support and which kinds they cannot. These are presented, below.

Observed GTFS Benefits

Following are four distinct GTFS use-cases that have been realized through the program:



Screenshot from sakay.ph, the winning open-source application from the Philippines Transit App Competition. Sakay.ph is the world's first web and SMS-based application to provide trip-planning services for informal transit systems

Providing Transit Service Information to the Public in a Low Cost Manner

The GTFS databases developed through the program have helped the Philippines DOTC provide integrated transit service information to the public at a low cost. The DOTC has created an "Open Data" page on their website (www.dotc.gov.ph), which features the downloadable GTFS feed (more than 14,000 page views and/or downloads to date) and GTFS-based transit apps created by local developers through a national app competition. Some of these apps are smartphone and web-based, while others support SMS features or

[2] Further details on the latter may be found in a US National Academy of Sciences Transportation Research Board (TRB) paper, "Towards an Open Transit Service Data Standard in Developing Asian Countries," written by project team members Holly Krambeck and Li Qu and presented at the 2015 Annual TRB Meetings.

map printing tools. In this way, the DOTC has been able to provide a wider range of services to the public than would have been possible without the GTFS feed.

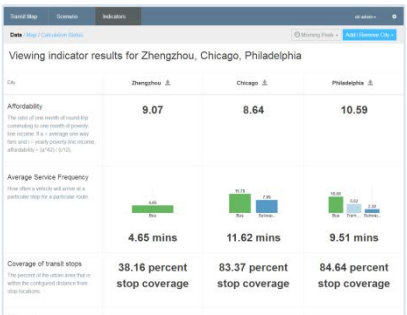
Increasing Transit Planning Capacity within Resource-Constrained Agencies

In mid-2014, the Philippines DOTC completed a jeepney and bus route reorganization plan, drawing upon its GTFS database and leveraging an open-source mobile phone application for collecting en route passenger survey and count data for GTFS routes. The plan would result in a **90% reduction in the total number of routes and reduce annual GHG emissions by 23%**, from 2.16 million tons GHG per year to 1.66 million tons. The total route reduction will have a substantial impact on traffic congestion, and this benefit will be monitored through an ancillary project being led by the project team. The plan will be partially implemented over the next two years, marking the first time the transit route network has been substantially adjusted in nearly 50 years.

Inspired by the success of the pilot program, the DOTC has more recently hired its own app developers (winners from the national app competition) to build a low-cost, open-source bus monitoring system, which integrates the GTFS data with AVL data and, where possible, draws upon existing open source code and applications. Through these activities, we can conclude that the GTFS has played a key role in building the DOTC's internal capacity to plan and manage transit.

Manila and the participating Chinese cities now have access to a limited but growing range of open-source tools that utilize GTFS data to support high-level planning – Open Transit Indicators, Open Trip Planner Analyst, TransitMix, and others. Time will tell whether these applications have sufficient functionality to support meaningful impacts on planning decision making.

Supporting Transit Service Benchmarking across Cities



Screenshot from Open Transit Indicators, showing benchmark service comparisons between three transit agencies.

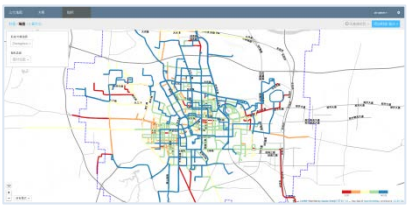
In China, the Bank team was requested by the Chinese Academy of Transportation Science (CATS) to support their national transit database initiative by evaluating the potential of using GTFS data to automatically derive transit benchmarks and indicators across a large number of cities simultaneously. To this end, the team worked with three cities – Nanchang, Jinan, and Zhengzhou to derive GTFS databases from existing transit datasets.

Based on preliminary tests of the Open Transit Indicators platform, it is confirmed that the GTFS, when combined with some simple demographic data,

can be used to derive a wide range of indicators related to network size, service, and accessibility.

Comparative Performance Evaluation

Analyzing on-time performance in any transit system is a typically capital and labor-intensive task, and generating comparable benchmarks is rarely, if ever done, for lack of coordination between transit agencies, especially outside of the most developed countries. In China, where automatic vehicle location (AVL) data is readily available, the team worked with Zhengzhou to convert its AVL data to a GTFS-related standard for real time data, GTFS-RT. The team then used the TransitTime algorithm (https://github.com/WorldBank-Transport/Transitime) to convert actual arrival data into more realistic GTFS schedule data, which in turn, provides a means to evaluate on-time performance and benchmark across cities. The initial results of this work are extremely promising, and the team recommends further research be undertaken in bringing this work into the mainstream.



Screenshot from Open Transit Indicators, showing real-time performance comparisons between different bus routes

GTFS Limitations

It should be made clear that GTFS databases are not a panacea for transit planning challenges in developing countries. First, the best feature of the GTFS is that it is an open standard. Beyond that, its benefits are limited, as its format is not directly compatible with the fixed-route / no fixed-stop systems commonly found in developing countries, and its stringent requirements for scheduling data (to the minute and second) are not realistic in most lower income countries.

Further, the team emphasizes that GTFS databases can be exceedingly challenging to build and maintain. Thus, for any GTFS initiative to be successful, it must be accompanied by substantial training, institutional management, careful budgeting, and early establishment of meaningful data uses.

Fixed Route, Non-Fixed Stop Systems

The GTFS was originally designed for use in transit systems where stop and station locations are clearly defined, as well as specific expected arrival and departure times for each stop. However, a substantial portion of transit services in the developing world are provided through microbus systems, which may operate on fixed routes but without fixed stop locations. While the GTFS

community is actively working on adjusting the standard to meet this urgent need, in the interim, various solutions have been employed.

In Manila, to translate the extensive vehicle jeepney network into the GTFS format, stops were manually encoded using a GIS program every 200 meters along the route. However, this method is extremely labor intensive, as the stops need to be labeled. To overcome this issue in the future, the dual TransiWand mobile application and GTFS-Editor platform were conceived to make this process easier. But this process is only truly effective in cities where no route data exists. If route data is already available, an alternative method is required for creating stop data.

One method put forward by the GTFS community is to adopt the shapes.txt files included in the standard, which are based on GPS point-data, as the stop files. However, this method also poses challenges, as without stop names, trip planning applications – especially SMS applications -- may not be very useful. Also the shapes.txt files are not typically available in developing county contexts. Another method, inspired by Chae Won Lee, a 2013 World bank summer intern working on an Open Transport project in Cebu, would leverage an open-source Python code that can be imported into QGIS (open source GIS platform) that labels road intersection points with the intersecting road names.

In summary, while there are work-arounds, adopting the standard for the most common transit mode in low income countries is not straight forward today.

Fixed Schedule vs. Non-Fixed Schedule Systems

The GTFS requires either arrival time data, by stop, or frequency information, by time of day – either of these requirements can be onerous in a developing country context. Jeepneys in Manila, for example, do not have fixed schedules or frequencies. Buses in Zhengzhou do not have fixed schedules, due to uncertainty of the real-time road congestion. As an example of a work-around, in Manila, frequencies were estimated using average traffic speeds (10 km per hour) and the number of vehicles plying each route.

To support generation of more accurate schedules, the project team has supported the development of open source code, TransitTime (https://github.com/WorldBank-Transport/Transitime) to calculate the optimized stop arrival times based on real-time AVL GPS data. This would provide improved schedule data to be feed into GTFS format.

Fare Schemes

Many fare schemes are not currently supported by the GTFS format, such as discounts for transfers between routes or modes, and many distance-based schemes. In Zhengzhou, for example, the BRT system allows free transfers between BRT lines only when the branch BRT line and the circle BRT line are running in the same direction. It has been recognized by the GTFS community that GTFS fare schemes will need significant improvement in the future. In the interim, manual work-arounds have been developed to support planning applications.

Summary of Program Outputs

Using the GTFS data, the Philippines Department of Transportation and Communications created an optimized Metro Manila transit route plan, which is currently under phased implementation. If the plan is completely realized, it would remove a substantial portion of route redundancies and introduce mass rapid transit corridors. The plan would **reduce the total number of transit routes by 90% and reduce annual GHG emissions by 23%**, from 2.16 million tons GHG per year to 1.66 million tons.

The following table presents a summary of technical outputs from this program, which was supported by an Australian Aid grant of US$350,000, as well as an additional US$200,000 that was leveraged from other sources.

Output	Description	Location
Philippines Transit Information Service	Locally-hosted Manila GTFS database and documentation	http://www.dotc.gov.ph/index.php/2014-09-02-05-02-46/transit-data
Zhengzhou GTFS Database	Locally-hosted Zhengzhou GTFS database	Not publically available
GTFS-Editor	Locally-hosted open-source web-based application for editing GTFS data	https://github.com/WorldBank-Transport/gtfs-editor
TransitWand	Open-source web-based application for collecting GTFS data and passenger counts at a substantially lower cost than through traditional means	https://github.com/WorldBank-Transport/transit-wand
TransitTime – GTFS Schedule Updater	Open-source code for transforming GTFS schedule data and actual performance data derived from bus GPS data into a more accurate schedule.	https://github.com/WorldBank-Transport/Transitime
Open Transit Indicators Platform	Open-source web-based platform for supporting transit planning decision	https://github.com/WorldBank-Transport/open-transit-indicators

	making with GTFS data	
Philippines Transit App Competition	National app competition with 480 registered local developers. Winning apps featured on DOTC website, and winning firm hired by DOTC to undertake further work.	http://philippine-transit.hackathome.com/
GTFS for the Rest of Us Workshop	International workshop addressing how GTFS needs to evolve to better suit conditions in developing countries	http://www.gtfsfortherestofus.net/
GTFS Training Materials	Wiki repository of multi-lingual GTFS training materials	http://bit.ly/GTFS_Training
Transportation Research Board Paper	"Towards an Open Transit Service Data Standard in Developing Asian Countries" by Holly Krambeck and Li Qu.	94th Transport Research Board Annual Meeting Compendium of Papers, 2015, Washington, D.C.

Additional Information

Additional information about the project and similar initiatives may be found here: http://bit.ly/OpenTransport_Draft

Acknowledgments

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Philippine Transit Information Service

The project team, comprised of **Ms. Holly Krambeck**, **Mr. Victor Nonong Dato**, and **Ms. Natasha Beschorner**, expresses its sincere thanks to **Atty. Jim Feliciano,** Assistant Secretary of the Department of Transportation and Communications (DOTC), for entrusting the team with executing this large and unprecedented program, as well as DOTC's **Ms. Patricia Mariano**, for her unwavering support and extraordinary leadership in coordinating the efforts of multiple stakeholders, securing resources and hosting services for sustaining the program, creating the DOTC's first open data portal, and implementing the highly successful Philippine Transit App Competition.

The team is extremely grateful for the strong support provided by **Mr. Denis Villorente** and his team with the Department of Science and Technology for hosting the GTFS database and GTFS-Editor application and providing on-going technical support the participating government agencies. The team would like to thank **Undersecretary Richard Bon Moya**, Undersecretary of the Department of Budget and Management and **Undersecretary Rene Limcoco**, DOTC, for their participation in and continued critical support for the project. The team is also

particularly thankful for the support of **Mr. Alex Macalaba**, the project point-person from the Land Transportation Franchise and Registration Bureau (LTFRB), who definitely has the largest responsibility moving forward for ensuring the bus and jeepney data continue to be maintained.

The team thanks **Dr. Ric Sigua** and **Dr. Dayo Montalbo**, University of the Philippines National Center for Transportation Studies, and their courageous students for collectively spending hundreds of hours with their GPS data loggers, riding the tangled web of jeepneys and buses in Manila. The team also thanks **Mr. Neil Taylor** and **Mr. Ian Stott** of ITP for the many, painstaking man-hours spent manually encoding the GPS data and transforming it into a viable GTFS database. A special thanks also to **Mr. Kevin Webb**, founding principal of Conveyal, for his trailblazing work on the development of open-source tools to support longer term updating and maintenance of the GTFS database – TransitWand and GTFS-Editor.

The team is grateful for the support of **Mr. Ernesto Juned Sonido** for helping us secure an impressive range of sponsors and successfully reach out to the local tech community for the Philippine Transit App Competition, and also for the guidance, branding, and beautiful web design from **Ms. Anna Sfairopoulou** and her entire team at DotOpen. The team is also thankful for the 19 mentors who volunteered to support the app competition developers, as well as the 8 judges, representing public and private sector agencies (you know who you are!).

The team thanks the World Bank Manila Office's **Ms. Kritsine Chinkie Ante** for her diligent and exhaustive efforts in managing the logistics for the complex Philippine Transit App Competition launch and awards ceremonies, as well as our remarkable summer intern, **Ms. Linghong ZOU**, for providing training to more than 70 government officials on GTFS-Editor and TransitWand.

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Open Transit Indicators

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AND…

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