Agence Française de Développement / Accra Metropolitan Assembly
AccraMobile Initiative – Phase 3

Recording, Mapping and Analyzing the Performance of Paratransit Services

A Trotro Data Guide

February 2018

TRANSITEC

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1. Introduction

In the wake of the Ghana Urban Transport Project, assemblies of the Greater Accra have created Departments of Transport (DoTs), with the main mandate to regulate urban passenger transport services at the local level. As a secondary function supporting this objective, DoTs have the responsibility to "carry out studies, investigations, data collection and research into urban passenger transport services, necessary for the improvement of the services" (urban passenger transport services by-law, 2008). Yet, very little data is currently available on these services: most assemblies maintain registries containing the name of active operator groups and limited information on the routes that they ply (generally, in the form of origin-destination pairs), but this data is too limited to be useful in the exercise of their functions. Not only is this lack of data an impediment to the effective regulation of paratransit services (trotros and taxis), but it also makes it difficult to plan and organize public transport at the metropolitan level.

Efforts to remedy this situation have been initiated by the DoT of Accra Metropolitan Assembly (AMA) through the AccraMobile initiative – a collaborative project involving AMA, Concordia University, and AFD. The first phase of this initiative consisted in mapping Accra's trotro network using GPS-enabled smartphones in 2014. This was successfully done in less than two months and with limited resources through the exclusive use of digital technologies for data collection. The second phase of AccraMobile consisted in assessing the quality of service on a sample of routes by analyzing the predictability of travel times, itineraries, and departure headway – it found that trotros were overall more reliable than one might have expected.[1]

While rich in lessons learnt, these two phases required a certain amount of technical manipulations and the use of sophisticated GIS software. The data format and type of storage used in the first phases of the project also prevented a wide range of potential users to have access to the data. This is why the third phase of AccraMobile aims to develop a streamlined methodology that can be deployed autonomously – and thus brought to scale – by DoTs, and makes the data freely accessible to everyone on an open data platform.

2. Objectives and Scope of Work

The present document is a how-to guide prepared by Transitec Consulting Engineers as part of an assignment financed by AFD in keeping with previous phases of the AccraMobile initiative. The purpose of this assignment was to strengthen the data collection and analysis capabilities of the Department of Transport of Accra Metropolitan Assembly. The expected outcomes of this work are:

- for AMA's DoT to be able to carry out future data collection and campaigns in an autonomous manner using digital technologies;
- for AMA's DoT to have the capacity to maintain a transport database up to date through regular update work;
- for other DoTs to easily replicate the work done in AMA by following a streamlined protocol.

In order to describe and understand paratransit services in a meaningful way, several dimensions of the transport system have to be looked at jointly. In addition, these various dimensions can be approached from different angles: that of the transport operator, travelling public, and public authorities. This how-to guide does not have the ambition to provide exhaustive directions on how to study the many characteristics of this system for each category of actors, but provides operational guidance on how to record and analyze two main dimensions of paratransit operations.

These two dimensions developed in this guide are the following:

- Describing the spatial configuration of the network – that is to say, detailing the itinerary of the routes, and the location of the stops and terminals. This first step is a prerequisite for further analyses

[1] Fickle or Flexible? Assessing Paratransit Reliability with Smartphones in Accra, Ghana. Simon Saddier, Zachary Patterson, Alex Johnson, and Natalie Wiseman. *Transportation Research Record:* Journal of the Transportation Research Board, No. 2650, 2017, pp. 9–17. http://dx.doi.org/10.3141/2650-02

because it provides the structure of the network on which vehicles and passengers travel. It can be used to identify underserved areas, overlapping routes, neighborhoods with high densities of stops – but it does provide much information on the services offered on the network. This step depicts the skeleton of the network but does not indicate how flesh is distributed on top of it.

- Describing the supply of transport services – that is to say the number and capacity of vehicles, their frequency, average travel time, fares, etc. These indicators can further be calculated at different scales: by route, corridor, neighborhood/area, operators' association – and over different time periods. They are crucial from a transportation planning and regulation perspective in that they describe the performance of services both quantitatively and quantitatively. These metrics can be used to revise fare and licensing policies, inform investment decisions, or help target enforcement efforts.

The core of this document consists in step by step instructions to collect different types of data on trotro operations with limited means using smartphone-based solutions. It is addressed to transport planners working for local authorities or metropolitan institutions tasked with mobility planning and /or regulation.

Lessons Learnt

This guide takes into account the lessons learn by AMA's DoT during the previous phases of the AccraMobile initiative, namely that:

- because trotro services are not institutionalized and adapt to a constantly evolving demand, the DoT needs to collect data on routes frequently to keep its dataset up to date;
- methodologies that require a lot of manual manipulation or advanced GIS skills are not well suited to carry out regular updates;
- counting on foreign partners for data collection and storage is not a sustainable solution for the DoT because it makes it dependent on external/intermittent funding;
- collected data must be stored and made available in a format and through a platform that is easily accessible to all (in particular, one that does not require advanced GIS skills);
- future uses of the data should determine the nature, format, depth and breadth of collected data, and not the other way around.

3. Data Collection

3.1 Approach

This section presents the protocol to be followed by the DoT for its data collection campaigns using smartphones and an online collaborative mapping platform. The scope of this protocol is to collect data describing the main attributes of an urban paratransit network. A preliminary version of this protocol was tested on the ground in July 2017 and enriched to form this "how to guide". This methodology developed in this protocol is tailored to best fit the needs and capacities of a metropolitan or municipal DoT. It focuses on paratransit services, commonly known as "trotros" in Ghana, but can also be used to collect data on other collective modes of public transport such as shared taxis and buses.

Two main methods of data collection are presented in the following subsections:

- **Onboard data collection,** where a collector boards a minibus as a regular passenger and records a set of variables during his/her trip. This method can be used to obtain detailed information on typical trips (itinerary, location of stops, fare paid, commercial speed, and number of passengers boarding and alighting). However, it is rather time-consuming since collectors have to take actual trips onboard vehicles – often involving long travel and waiting times. For this data to be statistically significant, several trips have to be recorded on any given route, at different times of the day (during peak and off-peak periods). If there is a large set of routes to survey (as was the case in AMA), it

might not be possible to use this method systematically. However, since data collection does not require a high level of qualification, the total costs of doing this may not be excessively high (even for a large number of routes) in countries where the cost of labor is limited.

- **Static data collection at transport terminals,** where a collector is posted at the gate of the station and records information on all departing vehicles. This method is used to obtain a general picture of operations at a given terminal but does not provide any information on what happens on each route. It is particularly useful to estimate flows of passengers travelling in different directions for a given origin station. While it is not as resource-intensive as onboard collection, this method requires the cooperation of transport operators since collectors are posted at the terminal for extended periods of time.

The table below summarizes the main features of these two methods.

	Onboard data collection	Static data collection
Scope	Route or vehicle level	Terminal/station level
Characteristics measured	For each trip: - Itinerary (GPS trace) - Travel time - Location of stops - Passengers boarding and alighting - Fare paid	For each departing vehicle: - Time of departure - Destination/route number - License plate number - Passenger onboard
Characteristics inferred	- Commercial speed - High demand locations - Vehicle load factor - Fare box revenue per trip - Routes characteristics	- Frequency (headway) of departures by route/hour - Rotations per vehicle - Daily passenger flows - Estimated daily revenue
Advantages	Actual trips are measured (i.e. reliable information), fine-grained spatial data	Quick estimation of passenger volumes and revenues, actual and reliable data
Disadvantages	Need to record several trips to carry out significant analysis (at least: morning and evening peak periods + off peak period)	No information on what happens after vehicles leave the station.

Table 1 – Comparison of data collection methods

These two methods are complementary and need to be used jointly to produce certain analyses. A ruling principle in determining which one best suits you need is that efforts made to collect data should be proportionate with benefits expected from the use of the data. If the baseline situation is that little to no data is available on existing transport services, collecting detailed data on vehicle occupancy for each route might not be an immediate priority – especially if no action is going to be taken based on it.

3.2 Choosing the Right Tools

The right choice of tools is crucial in preparing a data collection campaign because it will determine the ease of use, interoperability, and quality of collected data. In keeping with the principles described in section 0 (

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), the digital tools proposed in this section were selected for their simplicity, openness, and compatibility with a range of popular file formats. In order to select relevant technological solutions, an initial needs assessment has to be conducted to define:

- what the data is going to be used for;
- who is going to use it;
- how should be it accessed or shared.

Based on the answer to these questions, a "reverse engineering" can be adopted to define the tools and processes best suited to produce the desired outputs. The following two main components of the system can then be considered successively:

- **1/ data storage and rendering;**
- **2/ data collection and transmission.**

Considering storage and display before collection and transmission may be counter-intuitive, but avoids the risk of technological lock-in (where data would be collected in a format that later proves unsuitable for display or analysis).

3.2.1 Data Storage and Rendering

The following requirements were defined through the successive phases of AccraMobile.

- **Accessibility:** the data needs to be stored on a platform providing a visual interface (so that the map/data can be accessed without a GIS software);
- **Openness:** the platform shall be freely accessible to the general public (as opposed to solutions requiring the payment of a license or subscription);
- **Collaboration:** the platform shall enable additions/modifications by multiple users to make it easier to maintain;
- **Interoperability**: the platform needs to accept data in different spatial formats and data stored on the platform has to be easily retrievable in popular GIS file formats.

The best storage platform currently available that responds to these criteria is Open Street Map (OSM - https://www.openstreetmap.org/). OSM is a free and collaborative mapping platform allowing users to map any location in the world. The OSM map and underlying data can be accessed and used for free by anyone. It differs from other mapping platforms and services in that it is not owned by a private company, but rather created and maintained by a community of users in a free and open fashion.

OSM allows users to contribute by adding items of different nature (roads, buildings, landmarks, etc.) to the map. All the information stored on OSM is referenced ("tagged") following norms defined by the community via the OSM Wiki. A specific set of norms has been defined by OSM users for items constituting the transport network. Because these norms are regularly revised, a specific Wiki page was created for the phase 3 of the AccraMobile initiative. It contains detailed information on how the data was mapped on coded and can be accessed at the following address: http://wiki.openstreetmap.org/wiki/AccraMobile3

The ODbL Lincense

Data uploaded onto OSM becomes available to anyone under the Open Data Commons Open Database License (ODbL). The terms of this license are as follows:

You are free:

- *To Share: To copy, distribute and use the database.*
- *To Create: To produce works from the database.*
- *To Adapt: To modify, transform and build upon the database.*

As long as you:

- *Attribute: You must attribute any public use of the database, or works produced from the database, in the manner specified in the ODbL. For any use or redistribution of the database, or works produced from it, you must make clear to others the license of the database and keep intact any notices on the original database.*
- *Share-Alike: If you publicly use any adapted version of this database, or works produced from an adapted database, you must also offer that adapted database under the ODbL.*
- *Keep open: If you redistribute the database, or an adapted version of it, then you may use technological measures that restrict the work (such as DRM) as long as you also redistribute a version without such measures."*

https://opendatacommons.org/licenses/odbl/summary/

3.2.2 Data Collection

Experiences in Ghana (through AccraMobile phases 1 and 2) and internationally have established that the use of smartphones as data collection tools was well adapted to campaigns focusing on the transport network. Smartphones embed sophisticated sensors (GPS, accelerometer, gyroscope) suitable to record spatial data and offer various connectivity options to upload this data onto different platforms and formats (through 3/4G data connection or wifi). The proposed methodology therefore relies on the use of entry-level smartphones – the models used in Accra cost less than 100 US dollars. As using the GPS functionality of the phone throughout the day will drain batteries quickly, it is recommended to pair each phone with a portable power bank, and to charge each phone and power bank every night.

Various smartphone applications can be used to record spatial, numeric or text data. In order to choose the right app for collecting data, it is important to consider the desired output and display format of the data. The guiding principle in defining the data collection protocol has been to design a methodology that would be as streamlined as possible. To achieve this, minimizing the number of manual operations needed between data collection and visualization on a storage platform is key. It is therefore recommended to use an app for data collection that can send the data directly from the smartphone to the OSM platform. This saves a lot of time in comparison to methods previously used (for AccraMobile 1 & 2) because it reduces

the need to retrieve data manually and import it in GIS format. The data is uploaded on the platform by the collectors, and mappers responsible for transforming the raw data into clean transport routes can start their work immediately. This also allows for the mapping work to be done almost on the fly.

A rapid benchmark of existing data collection apps was conducted (see Appendix 1) and OSM Tracker was deemed to be the most suitable solution at the time. OSM tracker is an app that can be installed on any Android smartphone and send recorded data directly onto the OSM platform. It allows users to record the GPS coordinates of a wide variety of items, and to create GPS traces to register transport routes. The app is easy to use and its interface can be customized to display only selected buttons.

OSM Tracker can be downloaded on Google PlayStore or accessed at the following address: https://play.google.com/store/apps/details?id=me.guillaumin.android.osmtracker&hl=en

Turning to commercial solutions

Where a wide scope of work has to be covered and financial resources are available, commercial solutions can be a good alternative to organizing data collection in-house. Several providers offer services ranging from data collection to integrated solutions creating and consolidating various transport data into a single feed. When turning to commercial solutions, the following dimensions care critical:

- Breadth and depth: do you need systematic and fine-grained data on all your transport routes? What is the optimal level of detail vs. cost ratio for you?
- Output format: in which file format/standard is the data made available to you? Can it be opened/converted by the other programs that you normally use?
- License of use: are you paying for data itself or for the use of a platform? Can you freely reuse and distribute the data that you are paying for?

4. Planning Your Campaign

4.1 Scope of Work

The first step in planning your data collection campaign is to clearly define what it is that you want to collect. The scope of your campaign needs to be defined both in terms of quality and quantity:

- **Quality:** what characteristics of the transport network are you interested in (location of stops, itinerary of routes, number of passengers boarding and alighting, fare, etc.)? Do you want to describe the structure of the network in a static manner or do you want to assess the performance of specific routes?
- **Quantity:** how many routes/vehicles/terminals do you want to survey? How many trips of each route/vehicle do you want to record (this depends on the characteristics you are trying to measure)? Alternatively, what is the spatial perimeter you are interested in?

Preparing your registry

In order to answer these questions, you will need to analyze the registry listing all routes and operators active in your assembly. If the registry of your assembly is only available in paper form, you will need to digitize it (that is, type all the information it contains into a spreadsheet) as this will greatly simplify your work later on.

Even if you registry is already digitized, you will probably need to clean it up to precisely define your scope of work. The objective of cleaning up your data is to:

- remove inactive routes;
- remove duplicates;
- count the number of unique active routes in your assembly;
- attribute to each route a unique identifier (number) that will be used consistently thereafter.

Digitizing and cleaning up your route registry can be a tedious exercise, but it will save your collectors a lot of time looking for inexistent routes (and calling you for assistance!).

What if there is no registry?

In case there is no registry of routes available, the first step will be to establish one. A simple way to do this consists in identifying the main transport terminals in your city and sending enumerators to list all the routes operated out of these terminals.

Approach the executives of the different operators' associations at the terminal and ask them to list the various destinations served by their vehicles. Also ask for an estimation of how many vehicles depart daily for each destination to get a sense of which routes are the most active (some routes may barely register any departures). A number of these destinations may also be terminals that you will need to investigate. After visiting a several terminals, the general structure of the network with its main nodes and corridors will become apparent.

To successfully conduct this investigation phase, you will need a team with strong local knowledge. Enumerators should speak the local language and be familiar with the geography of the city. They should also be regular users of the transport system.

The present protocol is defined to collect data describing the main attributes of Accra's trotro network. The scope of work is defined as follows:

- Quality: record route itineraries, location of departure and arrival terminals, location of stops, fare paid for a full trip on a route

- Quantity: all the trotro routes registered with the DoT will be surveyed – over 300 routes (that is, in theory, all trotro routes emanating from a terminal located within the administrative boundaries of AMA)

In our case, the objective of the data collection campaign is to map the entirety of the network. The focus of the exercise will therefore be on describing the structure rather than the performance of the network. Because the scope of work is quite large in quantity (having 300+ routes to survey), it would be difficult to study each route in detail, and priority is given to exhaustiveness. Each route will therefore be surveyed one time in each direction during this data collection campaign.

4.2 Quantifying Resources

Once your scope of work is clearly defined, identify the resources that you will need to carry out the data collection campaign. Consider that a collector can survey between 2 and 3 routes per day in each direction (round trips). An average of 126 man-days would therefore be needed to survey 315 routes.

The next step is to define the phasing of your campaign:

- Do you want to do a data collection "blitz" and collect the data within a tight time frame? If that is the case, you will most likely need to hire external collectors to have a larger team of collectors surveying different routes simultaneously. This raises the question of paying your collectors and managing them (do you have the funds to pay them and the time to supervise them?). In addition, the more collectors working in parallel, the more data collection equipment is needed – each collector needing to have his/her own smartphone.
- Do you want to roll out your data collection efforts progressively, without being pressed for time? If that is the case, you will need fewer collectors (one person might even be sufficient), working over a longer period of time. In this configuration, you would more likely be able to use internal workforce (instead of hiring external consultants). This is a good option if you have limited financial resources but idle human resources. Having only one or two collectors is also easier to manage for the DoT, and allows the collector to gain experience over time.

In the case of the present assignment, it has been assessed that 6 collectors, working in parallel for about a month (collectors work on Saturdays), would be able to record the 315 routes. This is summarized in Table 1.

Total number of routes to record	315
Avg number of routes recorded per collector and per day	2.5
Number of man-days needed	126
20% provision for contingencies (days)	25.2
Number of collectors mobilized	6
Duration of data collection campaign (days)	**25.2**

Table 2 – Dimensioning Resources

4.3 Preparing to Launch

To prepare the launch of your data collection campaign, you will need to go through the following steps.

- **1. Define a timeline:** think about how much time you will need to get everything ready for your campaign (see steps below). Identify what the best time is for carrying out data collection in your area. Take into account:
  - the weather, since transport operations are often disrupted during the rainy season;
  - the availability of your data collectors, since university students may not be free during the term;
  - holiday periods, since this might affect mobility patterns (this is particularly important if you are trying to assess the performance the network).

- **2. Inform other stakeholders:** other departments of your municipality might be interested in learning about your data collection campaign. See if the Depts. of Urban Roads, Physical Planning, and Works would like to take part in the training session that you will organize, for instance (see below). A good practice is also to inform transport operators through the unions that you will be collecting data onboard their vehicles. In theory, you could simply send your surveyors to the field and nobody would notice them, but engaging the operators in the process will be instrumental in fostering constructive relationships with them.
- **3. Recruit collectors:** if you are going to put your data on OSM, send a message to your local OSM community through the relevant mailing list (http://wiki.openstreetmap.org/wiki/Mailing_lists). OSM contributors are generally savvy with GIS and data collection tools. This is also a good way to make contacts in the community, which will be useful when the time comes to map the data. Make sure that you have adequate funds to remunerate them before you start the campaign. It is a good idea to save some of the funds available to pay a bonus at the end of the data collection campaign. This creates an incentive for collectors to stay onboard for the whole duration of the campaign.
- **3. Prepare the equipment:** acquire smartphones and equip them with the necessary apps and accessories. It is recommended that you have one or two extra phones handy during the data collection phase, in case one of the phones you use stops working. Install the data collection app that you are going to use (in our case, OSM Tracker) on each phone. To download the app from the PlayStore, you will need to create a Google account. Beware that you might not be able to create several Google accounts in a row using the same phone number for activating the account – so plan ample time to go through this step before the launch. Then link each OSM Tracker app to a different OSM account with an easily identifiable name (here, we will use AccraMobile1 to AccraMobile8). If possible, test each phone by recording a short trip with it before the actual data collection campaign. Finally, it is recommended to pair each phone with a power bank. Heavy use of the phone's GPS capabilities tends to drain its battery quickly and you will need this extra source of power to go through a full day of data collection.
- **4. Prepare work plans for the collectors:** based on the cleaned route registry, prepare work plans for each collector for your first week of data collection. Consider that you will ask your collectors to record three routes per week – if they work 6 days a week that makes 18 routes per week. Nevertheless, to allow for contingencies and give more flexibility to the surveyors, add a few extra routes and list 25 routes per collector. This way, if a route is inactive or cannot be found, the surveyors can move on to another one. Each work plan should contain a set of routes that is representative of all your routes (do not include only short routes or only long routes in a surveyor's work plan). You will ask your collectors to start recording their routes in the order in which they are listed, so if you have several routes leaving from the same terminal, give them to the same collector to avoid extra trips between terminals. At the end of the week, if a surveyor has completed 18 routes (as per the plan), transfer the remaining 7 routes to his/her work plan for the following week. In addition to the route id/number, work plans should indicate the origin and destination of the route, as well as the name of the operator's association. An example of work plan is provided in Appendix 2.
- **5. Organize a training session:** start your data collection campaign by training your collectors for one day. Start by making a presentation of the objectives of the project, the methodology, and the tool that will be used and answer any questions the collectors might have. Then distribute phones to the collectors and go over the different buttons and functionalities of the app that you will use. Finally, go out on the field and record a couple of test rides with the collectors. Go to a station and board a departing vehicle, following the different steps described below. When this is done, go back to the office with the collectors, upload the data and review it with the collectors. If you successfully reach this step, you are ready to go into actual data collection the following day!

5. Collecting Route Data Onboard

As mentioned above, collectors will by default record routes in the order in which they are listed in their weekly work plan. It is therefore important to list routes in a relevant and convenient order. Some level of flexibility can be left to the collectors in deciding the order in which they will work routes, but avoid a situation where all the "easy" routes would be collected at the beginning, leaving difficult ones for the end of the campaign (which is likely to created delays).

Naming conventions

It is crucial that all collected data be labelled consistently to be retrieved easily by other project members on the OSM platform (in particular, for mappers). To that effect, each recorded trip will be coded as follows: *route_number-direction-initials_of_collectors*

- *route_number* is a three digit figure (it is better to have a fixed number of figures, so route 18 would be coded as "018")
- *direction* is a letter distinguishing outbound from inbound trips. Trips leaving from the "home station" of the operator are coded "A". Trips returning to the "home station" of the operator are coded B.
- *initials_of_collectors* are two letters identifying the data collectors. If two collectors have the same initials, the coordinator of the DoT will propose alternative initials.

For instance, record 018-A-PA is a trip taken on route 18, leaving from the home station, and recorded by collector Patrick Asante.

Ask the collectors to call you if they have trouble identifying a route or are unsure about what to do at any time. In some instances, it might be difficult for them to locate the correct terminal or loading point. Someone from the DoT with good knowledge of the operators should be available on call to assist the collectors. In some instance, calling the welfare chairman of the station might be necessary to ascertain whether a route is active or not.

Table 3 describes all the steps that a collector needs to follow to record a route. Print this list for all collectors on the first day of work and go through it with them during the training session. Detailed instructions for each of these steps are provided in Appendix 3.

1	Go to the origin station listed for the first route on your list
2	Identify the loading points for trotros going to your destination
3	Make sure that the operator is the one on your work plan
4	Open OSM Tracker and click on the "plus" symbol on the upper right
5	Wait until the indicator on the upper right hand corner turns red (GPS fix)
6	Board the vehicle (do not board before you have a good GPS fix!)
7	Sit by the window and close to the mate if you can
8	Note "departure" when the car starts moving
9	Tap "bus stop" when the bus stops to let pass. board or alight
10	Immediately after, note the name of the stop (ask mate if needed)
11	Note the cost of the ride when you pay it (ex. "2 GHS")
12	Note "arrival" when the car stops moving at the destination station
13	Alight the the vehicle
14	Tap the save button (floppy disk icon)
15	Connect the phone to the internet (hotspot or wifi)
16	Select the first record on the list in OSM Tracker
17	Do a long tap on the name of the record
18	Click the "Upload to OSM" button
19	Edit name to "*route number–direction–initials*" (e.g. "018-A-PA")
20	Enter "Accra trotro network" in Description
21	Tag the record "AM3"
22	Change "private" to "identifiable" (important!)
23	Tap "save and upload"
24	Repeat for return and following trips

Table 3 – Steps for Recording a Route

6. Recording Departures at the Station

6.1 Principles

In addition to data collected onboard vehicles, it is useful to collect data on departures at various trotro stations in order to gain an understanding of the vehicle and passengers flows going in different directions.

On most routes, trotros only depart from their origin station when they have reached their maximum complement of passengers. Since the provision of vehicles dynamically adjusts to the number of passengers departing on a route, the observed supply of vehicles roughly equates passengers' demand. One way to measure this demand is to place static data collectors at the exit gate of a station to record of all departures. The steps that were taken to accomplish this under the AccraMobile initiative are as follows:

- **1. Meet with the branch/local union executives** to explain why you are seeking to collect data on their operations and obtain their permission to do so. Securing their cooperation is key since they might otherwise disrupt the data collection process. During this meeting, ask them to list the different destinations served out of the terminal and the fares for these destination, and enquire about working hours.
- **2. Organize for two collectors to work in shift** to cover complete days of work (6 AM to 9 PM). The first collector should be at the station before the first car departs and the second one should stay there until the last car leaves. You might need to arrange transportation by taxi for your collectors as they travel to and from the station outside of regular operating hours.
- **3. Choose a representative day or week to carry out data collection.** Organize the survey outside of school holiday and special events. If data collection is limited to one day, avoid Fridays as they typically exhibit different patterns from other weekday (Tuesdays and Thursdays are generally representative days).
- **4. Position the collector** in a spot where he or she can see every vehicle leaving the station and ask for its destination if needed. In small and organized stations, the collector can be located at the gate and monitor vehicles on scale and departing from there.
- **5. For every departure, collectors will record:**
  - the license plate number of the vehicle;
  - the destination/route that it is plying;
  - the number of passengers onboard;
  - the time of departure.
  -

6.2 Using Tap Log

A convenient way to record this information is to use a smartphone equipped with the Tap Log app, a free personal event logger that can be downloaded on Google Play.[2] Tap Log allows the user to create and customize buttons to record different types of variables (spatial, text, figures). Using Tap Log reduces the amount of manual input required by letting the collector choose a route number from a pre-defined list and automatically adding a time stamp to each record.

The following steps can be followed to use Tap Log for the purpose of recording vehicle departures:

[2] https://play.google.com/store/apps/details?id=com.waterbear.taglog&hl=en

N°	Step
1	Create a different button for each of the routes operated out of the study station
2	Name each button with the name of the destination of the route
3	Edit the buttons to tick the text and number boxes
4	Each tap a vehicle departs from the terminal, tap the button named after the vehicle's destination
5	Enter the license plate number in the text field
6	Enter the number of passengers onboard in the figure prompt
7	Use the "send by email" menu to transfer data at the end of each day

The main data quality problem that you will face with this method comes from having to key in license plate numbers. In order to minimize the risk of errors and have consistent records across surveyors, it is recommended to shorten licenses plates to the first or last four characters, and ask collectors not to include spaces or dashes. This will simplify your work later when you aggregate results by vehicle.

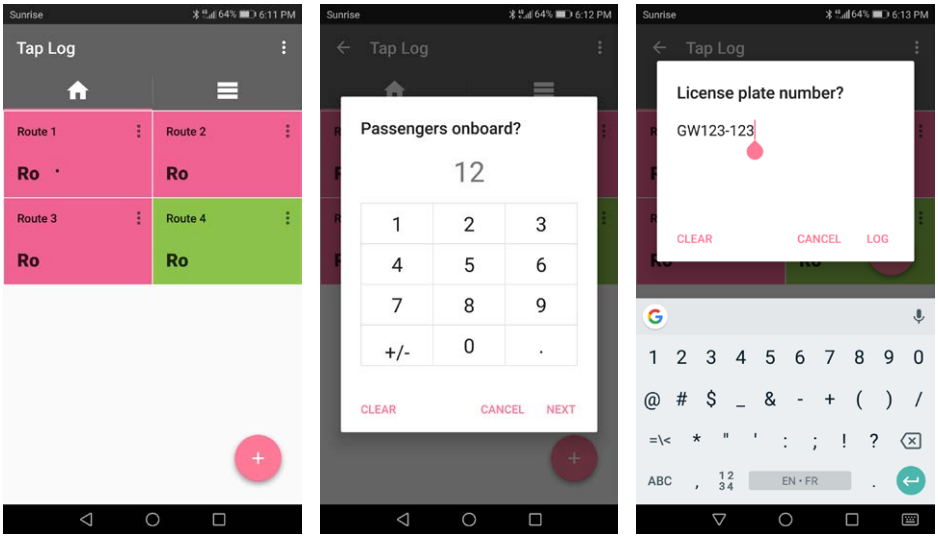


Figure 1 – Screenshots of the Tap Log mobile app interface

7. Analyzing the Data

This section presents analyses based on data collected through the methods described in previous sections. The purpose of these analyses is to provide insights on the performance of trotro operations through different metrics. In the medium term, it is hoped that the DoTs of Ghana's main urban area will develop data collection and monitoring capacities to fully carry out their transport regulation an organization functions. Analyses presented in this section are drawn from the three phases of the AccraMobile initiative, with a particular emphasis on a series of performance metrics produced in the third phase of the project. Detailed analysis was carried out for a sample of six routes operating out of a particularly active trotro station located in the Kaneshie market area and operated by the Kaneshie Branch n°2 of GPRTU.

For ease of reading, the main types of analyses developed through this initiative are presented in the form of one-page records, including methodological guidance and application examples. In addition to these examples, it should be kept in mind that all the indicators presented can be calculated for different population subgroups or spatial levels. It is therefore good to store data in a format that is as disaggregate as possible, in order to allow for analyses at different scales. A summary table of these different scales and indicator is presented below.

	By route	By corridor	By zone/area	By association
Commercial speed				
Peak hour freq.				
Vehicle.km				
CO2 emissions				
Daily revenue				
Rotations per day				
Daily driving time				
Load factor				
Daily pax.				
Fleet size				

7.1 Route Characteristics

Output indicators	Input data	Mode of acquisition
Commercial speed	Route length ➔	Embarked collector
Vehicle.km travelled by route/day	Mean travel speed ➔	Embarked collector
	Daily departures by route ➔	Gate counts

Methodology

- A **basic profile** can be established for each route by crossing data from embarked and static collectors. Information from this profile will be used in subsequent analyses and contains the key characteristics of the route.
- **Commercial speed is calculated based on route length and average travel time.** Average travel time is obtained by calculating the mean travel time of three or more trips on the same route recorded during the same period. Travel time and commercial speed should be calculated separately for morning peak, evening peak, and off-peak periods.
- To calculate vehicle.km travelled, the length of each a route is doubled (to account for the return trip) and multiplied by the daily number of departures on that route – as obtained from gate counts. This does not account for trips made outside of registered routes (for instance, from the operator's home to the station), but provides a rough estimate.

Example

Displayed results are rounded	1. Mortuary Rd	2. Korle Bu	3. Chorkor	4. Shallom	5. App. Dan.	6. Alhaji
	Means for round trips (n = 254)					
Route length	12 km	9 km	11 km	10 km	9 km	10 km
Travel time	34 min	33 min	42 min	36 min	29 min	40 min
Commercial speed	21 km/h	16 km/h	16 km/h	17 km/h	19 km/h	15 km/h
Passengers boarding	26.6	30.0	31.6	27.9	25.8	26.5
Passengers / hour	48	55	45	47	53	40
	Means for week days (n = 3,526)					
Number of departures	105	76	138	67	61	24
Vehicle.km travelled	1,265 km	680 km	1,516 km	668 km	547 km	244 km
Passengers (both directions)	2'810	2'270	4'350	1'860	1'570	650
Fleet size	31	38	61	36	35	15

Relevance/potential uses

- **Commercial speed is a key performance indicator** for the transport system. It can be compared across routes or over time for a same route. It is important to keep in mind that it is calculated based on total travel time, which includes stopping times. A reduction in the number of stops might therefore improve the commercial speed of vehicles while degrading the quality or accessibility of the service for passengers. The objective of improving commercial speed should therefore not be pursued at all cost.
- Vehicle.km travelled can **subsequently be used to estimate CO2 emissions.** This is needed when trying to quantify the benefits of a project in terms of climate change mitigation. As this subject is increasingly important for governments and donors alike, this metric can be required to obtain financing for a transport project (fleet renewal or network optimization, for instance).

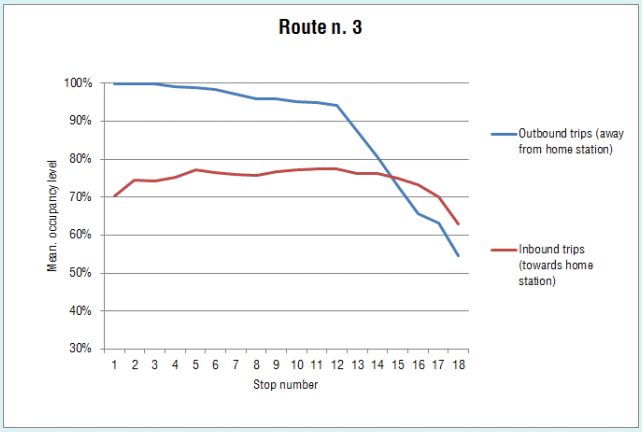
7.2 Load Factor Analysis

Indicator	Input data	Mode of acquisition
■ Mean vehicle load by route segment and direction	Route itinerary ➔	Embarked data collectors
	Location of stops ➔	Embarked data collectors
	Boardings and alightings ➔	Embarked data collectors

Methodology

- Order and number stops on the route in both directions. Use data on boardings and alightings on the route obtained through embarked data collectors. Associate a stop name and stop order to each boarding/alighting record. Using several sample trips, **calculate the mean number of passengers onboard for each segment** between two stops (do this separately for peak period trips and off-peak period trips). If vehicles with different capacities operate on the route, express the number of passengers onboard as a percentage of the maximum vehicle payload.
- Represent load factor by route segment and by direction through line thickness proportional to the mean number of passengers onboard. Alternatively, **represent load factor as a graph,** with stop names or stop order on the x axis.

Examples



Relevance/potential uses

- Load factor analysis illustrates **how vehicle capacity is used** along a route. It is particularly useful to identify segments where 1/ vehicles are systematically full and therefore cannot pick up additional passengers on their way or 2/ vehicles are under-occupied and thus not used optimally.
- Load factors by route segment are **used as input for other types of analyses.** Once the typical characteristics of a trip on a route are known, it becomes possible to extrapolate other operational features (passenger throughput or daily revenue, for instance)

7.3 Revenue Analysis

Indicators

- Estimated revenue per vehicle
- Estimated revenue per route
- Revenue variations over day of the week
- Revenue disparities across operators

Input data

Fare by route ➔

Daily departures by route ➔

(Load factor by route/segment)

Mode of acquisition

Interviews w/ operators

Gate counts

(Embarked data collector)

Methodology

- On the majority of the routes surveyed in Accra, most passengers boarded trotros at the origin station and the share of passengers boarding after the start of the trip was limited. Most vehicles only depart when they are full, so it can be assumed that the **number of passengers carried on each trips equals the capacity of the vehicle.** If you are not sure that these assumptions apply to the routes that you want to study, start by doing a load factor analysis to know the distribution of boardings and alightings along your route.
- Use the csv file generated by Tap Log containing all the departures recorded at the station during a day or week. For each departure, multiply the recorded number of passengers onboard by the fare paid for a full trip on the route. This will give you the **estimated revenue generated by each outbound trip.** Estimate revenue collected on the inbound trip either based on previous load factor analyses, or simply by applying a ratio to the outbound trip revenue (for instance, 0.5 if the operator indicates that the vehicle is half as full on the way back to the station).
- After adding a revenue variable to each record in your original departure table, **create a pivot table** to calculate revenue by vehicle, day of the week, route, hour of the day, etc.

Example

Distribution of weekly revenue over days (70 vehicles)	**WEEK**	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Total collected revenue	**GHS 129'700**	GHS 19'000	GHS 18'800	GHS 18'800	GHS 19'300	GHS 17'200	GHS 21'200	GHS 15'400
Max. revenue by vehicle	**GHS 3'740**	GHS 610	GHS 680	GHS 560	GHS 620	GHS 560	GHS 680	GHS 660
Mean revenue by vehicle	**GHS 1'860**	GHS 280	GHS 280	GHS 280	GHS 280	GHS 250	GHS 320	GHS 250
Median revenue by vehicle	**GHS 1'780**	GHS 290	GHS 270	GHS 270	GHS 260	GHS 250	GHS 320	GHS 270
Standard deviation in revenue	**GHS 490**	GHS 110	GHS 110	GHS 100	GHS 100	GHS 90	GHS 100	GHS 110

Distribution of weekly revenue over routes (70 vehicles)	**TOTAL**	1. Mortuary Rd	2. Korle Bu	3. Chorkor	4. Shalom	5. App. Danquah	6. Alhaji
Total revenue	**GHS 129'700**	GHS 26'500	GHS 19'800	GHS 39'800	GHS 19'900	GHS 16'900	GHS 6'800
Max. revenue by vehicle	-	GHS 1'800	GHS 1'000	GHS 1'500	GHS 1'100	GHS 1'200	GHS 900
Mean revenue by vehicle	-	GHS 400	GHS 200	GHS 300	GHS 200	GHS 200	GHS 100
Median revenue by vehicle	-	GHS 200	GHS 200	GHS 200	GHS 200	GHS 100	GHS 100
Standard deviation in revenue	-	GHS 400	GHS 200	GHS 300	GHS 200	GHS 200	GHS 200

Relevance/potential uses

- This method will give you an idea of **disparities in income distribution** across vehicles. In the example provided above, the best earner made twice as much as the lowest earner! Vehicles with abnormally low number of rotations or working days were removed from the sample.
- Data on revenue is particularly useful to **model the economics of a typical transport operator** at the study terminal. Once the revenue side of the equation has been estimated, operating costs and amortization of the vehicle can be factored in to estimate profit. This information can then be used to simulate the financial conditions at which operators can afford to replace their vehicle.

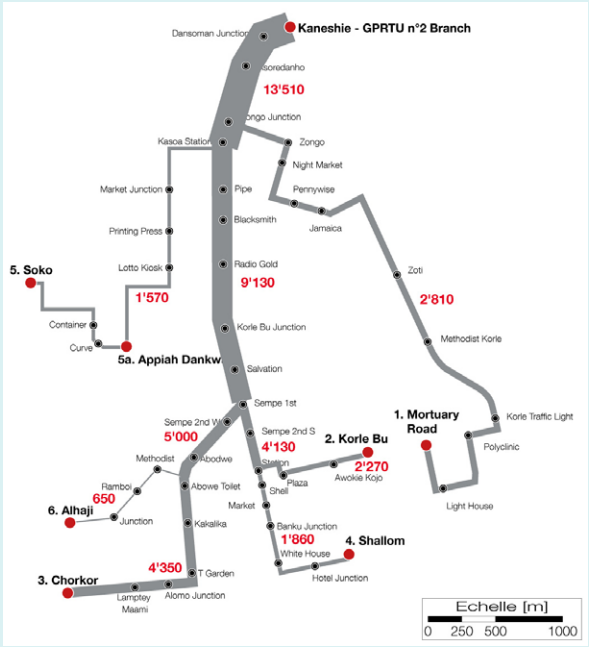
7.4 Passenger Flows Analysis

Indicators	Input data	Mode of acquisition
■ Daily passengers by route	Itinerary of routes ➔	Embarked data collector
■ Daily passengers by corridor/road segment	Daily departures by route ➔	Gate counts
	(Load factor by route/segment)	(Embarked data collector)

Methodology

- On the majority of the routes surveyed in Accra, most passengers boarded trotros at the origin station and the share of passengers boarding after the start of the trip was limited. Most vehicles only depart when they are full, so it can be assumed that the **number of passengers carried on each trips equals the capacity of the vehicle.** If you are not sure that these assumptions apply to the routes that you want to study, start by doing a load factor analysis to know the distribution of boardings and alightings along your route.
- Use the csv file generated by Tap Log containing all the departures recorded at the station during a day or week and sum passengers onboard (recorded for each departure) by route and by day. This gives you the **daily number of passengers on outbound trips** for each route. Estimate passenger volumes on inbound trips as a ratio of outbound passengers. This ratio can be obtained through load factor analysis or by interviewing the operator.
- **Compile passenger flows by road segment**. Adjust the width of each road segment to be proportional to the flow of passengers carried using a GIS software. In the example below, six routes share the same initial road segment. Daily passenger volumes on that segment are therefore equal to the sum of daily passenger volumes on all six routes. Apply the same method to other segments, subtracting passenger flows from the main trunk as different routes branch off from it.

Example



Relevance/potential uses

- This method of analysis is useful to represent the comparative weight of different routes. A regular map of the network will give the impression that all routes are equally important when there are actually important differences in volumes across routes.
- Spatial representation of this data can be used to target investment measures, maintenance works, or enforcement efforts, for instance.

7.5 Rotations Analysis

Indicators

- Daily rotations per vehicle/day/route
- Estimated driving vs. waiting time

Input data

Daily departures by route/veh. ➔

Mean travel time by route ➔

Mode of acquisition

Gate counts

Embarked data collectors

Methodology

- Use the csv file generated by Tap Log containing all the departures counted at the gate during a day or week. **Tabulate departures by vehicle,** route, and day of the week for the first part of the rotation analysis.
- Create a new variable called "travel time" containing the mean travel time in minutes of a round trip on the route where the vehicle is departing - each departure is now associated with a duration. **Sum travel times by vehicle,** route, and day of the week.
- This analysis can be **completed by observations at the station** at different times of the day to measure the length of vehicle or passenger queues, revealing an over- or under-supply of vehicles.

Example

Rotations analysis	**WEEK**	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
Mean rotations by vehicle	**38**	5.6	5.5	5.5	5.7	5.1	6.2	4.6
Max. rotations by vehicle	**87**	12	15	12	13	11	14	14
Estimated driving time / veh.	**23h**	3h30	3h25	3h25	3h25	3h	3h55	3h05
Total number of rotations	**2'667**	389	385	384	397	355	436	321
Number of vehicles operating	**70**	67	68	68	70	70	67	63

Relevance/potential uses

- The number of rotations that a vehicle makes per day is an important **indicator of the performance of the transport system,** both for the operator and for public authorities. In the example above, a low number of rotations per day associated with long queues of vehicle at the station reveals a major **oversupply of vehicles.** The oversupply of vehicles reduces revenue for individual operators, increases competition for passengers on the road, and creates congestion in streets surrounding the station. These indicators therefore reveal the existence of an important potential for system optimization (through fleet reduction, in particular).

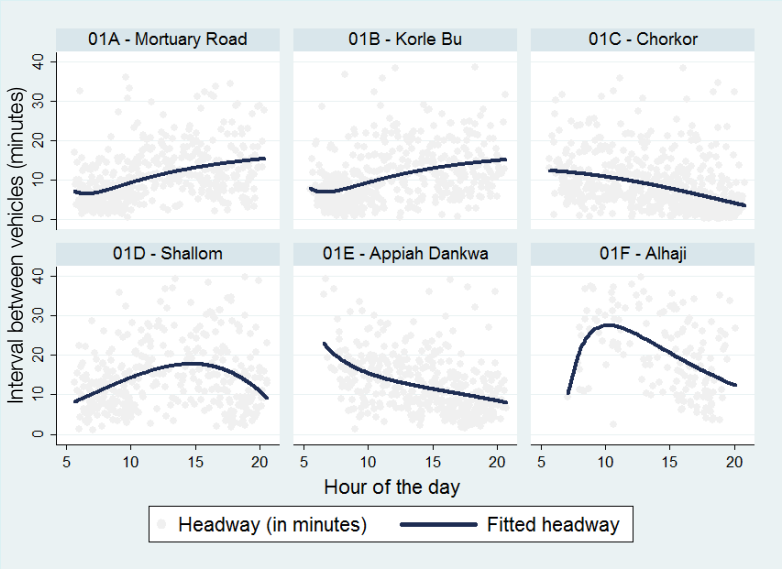
7.6 Headway Analysis

Output indicators	Input data	Mode of acquisition
■ Typical headway for peak- and off-peak periods ■ Headway variations over time by route	Daily departures by route ➔	Gate counts

Methodology

- The first step consists in **calculating intervals** between successive vehicles departing on a route. To do this, use the csv file generated by Tap Log containing all the departures counted at the gate during a day or week. Sort this table by departure time and by route and calculate the time difference between each record and the next.
- **Define morning and evening peak hour periods,** off-peak periods, and calculate mean vehicle headway by route for each of these periods.
- **Run regression analyses** on headway and time of the day to visualize trends in the evolution of time intervals between vehicles throughout the day. Examples below were produced using Stata.

Examples



Headway analysis	1. Mortuary Rd	2. Korle Bu	3. Chorkor	4. Shallom	5. App. Dan.	6. Alhaji
	Means for week days (n = 3,526 departures recorded)					
Morning peak hour headway	5 min	8 min	12 min	11 min	43 min	*n/a*
Evening peak hour headway	11 min	14 min	3 min	8 min	7 min	13 min

Relevance/potential uses

- Interval between departing vehicles expressed in minutes is a good indicator of the **level of service** offered on different routes, since it determines the average waiting time for passengers. Since trotros only depart when they are full, it also gives an indication of the **level of demand** on a route.
- Regression analysis graphs offer insight in **hourly variations in the intensity of demand and supply** of vehicles across routes. The graph above illustrates how different routes operated out of the same station have complementary demand patterns throughout the day. While some routes offer more frequent departures in the morning, others are more active during the evening peak period.

APPENDICES

Appendix 1 – Benchmark of Selected Data Collection Apps

App	GPS Traces	Bus Stops	Pass. Count	Free	Sends to OSM	Note
DataMobile/Itinerum	Yes	No/partially	No	Yes	No	- Developped by the TRIP Lab at Concordia University and used for Phases 1 & 2 of AccraMobile - Renamed Itinerum, now allows institutions to carry out their own mobility suvey - Better suited to collect data on the mobility habits of a survey population than to describe the transport network
TapLog	No	Yes	Yes	Yes	No	- Personal event logger used for Phases 1 & 2 of AccraMobile - Creates buttons that can be customized to record different types of data - Exports data as CSV that needs to be merged with GPS traces collected through another app, which requires manual manipulation
WhereIsMyTransport	Yes	Yes	?	No	No	- WhereIsMyTransport is primarily a transport data platform that allows public authorities to gather, access, and analyze all their transport data through a unique chanel - An app was also developped for data collection to map transport routes - It sends the data to the WhereIsMyTransport data, where it can be accessed at a cost by municipalities
GoMetro Pro	Yes	Yes	Yes	No	No	- Designed to map and collect operational data on minibus routes in South Africa - User-friendly interface, easy to use for collectors, allowing for recording of detailed route characteristics - Developped as a commercial service by the company that also offers to carry out the data collection itself
TransitWand	Yes	Yes	Yes	Yes	No	- Well designed app developped with support from the World Bank for a project in Mexico City - Allows for onboard data collection of all relevant route characteristics - Data can easily be downloaded as CSV and shapefiles via web interface
OSM Contributor	No	Yes	No	Yes	Yes	- Aimed at editing general OSM data on the field, not focused on transport data - Suitable to record bus stops but not bus routes (no tracking capability) - Edits can be sent directly to the OSM platform
Jungle Bus (beta)	No	Yes	No	Yes	Yes	- Derived from OSM Contributor, this app is focused on the recording of bus stops - Allows for accurate location of bus stops since the pin is placed by the used rather automatically located - Beta version does not include vehicle tracking yet
OSM Tracker	Yes	Yes	Possible	Yes	Yes	- App widely used by OSM contributors to record various types of data on the field - Not focused on transport but allows for trace and stops recording - Ease of use, buttons can be customized and data is sent directly to OSM

Appendix 2 – Work Plan Template

WORK PLAN Week starting on the: *17th of July* Name of surveyor: *John*

Task	Route	Origin	Destination	Operator	Note
1	072	Accra New Town	Caprice	Accra New Town Timber Market Branch of GPRTU	
2	442	Okponglo	Bawaleshie	Okponglo Co-operative Transport Society	
3	325	Kwashieman Junction	Santa Maria	Kyere Wo Do Branch of PROTOA	
4	201	Circle	Newtown	Ayawaso Co-operative Transport Society Limited	*The origin station is located behind the filling station*
5	167	Atico	Kaneshie	Bubuashie Trotro Branch of GPRTU	
6	437	Odorkor	South Odorkor	Odorkor Branch Of GPRTU	
7	391	Accra New Town	Nima Maamobi	Newtown Nima Maamobi Local (Ayawaso Taxi)	
8	313	Kwashieman	A Lang	Kwashieman Taxi Local of GPRTU	
9	210	Circle	Teachers Hall	UTC- Circle Taxi Branch of GPRTU	*Not active during mornings*
10	357	Mallam Attah	Kotobabi Down/Polo	Lido Overhead Mallam Atta Local of Kotobabi Down Branch of G.P.R.T.U	
11	436	Odorkor	Official Town	Odorkor Branch Of GPRTU	
12	269	Kaneshie	Bubuashie	Kaneshie Honesty GPRTU Branch	
13	202	Circle	Novotel	Adabraka Co-operative Transport Society Limited	
14	395	Nima	Circle	Nima Mamobi Circle Overhead Branch of G.P.R.T.U	
15	200	Circle	New Melcom	Biakoye Taxi Union Branch of G.P.R.T.U	
16	159	Alajo Junction	Kotobabi Police Stati	Nkwahia Co-operative Transport Society Limited	
17	296	Kaneshie Takoradi Statio	Russia Last Stop	Okaikwe Taxi Drivers Union	
18	178	Bubuashie Ayigbe Town	Accra CMB	Bubuashie Trotro Branch of GPRTU	*Ask the station master for loading point*
19	317	Kwashieman	Abeka Lapaz	Kwashieman Brothers Branch Of PROTOA	
20	326	Kwashieman Junction	Sowutuom	Kyere Wo Do Branch of PROTOA	
21	449	Orgle Street	Kaneshie	Orgle Street Post Office Local of Kaneshie Circle Trotro Branch	
22	295	Kaneshie Takoradi Statio	New Russia Last Sto	Okaikwe Taxi Drivers Union	
23	265	Kaneshie	Sukura	Katamanto Zongo Trotro Drivers Union	
24	056	Abeka Lapaz	Race Course	Lapaz No.2 Branch of G.P.R.T.U	
25	343	Abeka Lapaz	Race Course	Grace PROTOA Lapaz Taxi	

Appendix 3 – Step by Step Instructions for Embarked Collectors

TRANSITEC
optimized mobility · since 1954

AMA CITY HALL

July 2017

AccraMobile 3
Putting Accra's Transport Network on OSM

AFD

Background

- Department of Transport of Accra MA created in 2015
- Tasked with regulating trotro services at the municipal level…
- …but no information on the shape or nature of the transport network

⇒ Need to collect data on the itinerary and characteristics of each route!

- Objectives of this project:
  - Map and collect data on all trotro routes operating out of AMA
  - Using smartphones and embarked collectors
  - Put the data on OpenStreetMap so that it can be used by anyone

AccraMobile 3

- New phase **starting this week in Accra to:**
  - update existing data (it is already two years old);
  - put the trotro network on OpenStreetMap.
- 319 routes to survey, one round trip on each
- Six collectors on the field for a month
- OSM Tracker for data collection and public upload to OSM
- Two mappers to clean up raw traces, create stops and relations

Expected outputs:

- All trotro routes on OSM by the end of the summer
- Valuable data for the DoT, passengers, operators, developers
- Presentation of results at workshop organized by AFD in Nov.

Working with your smartphone

- Please do not use a SIM card on the phone
- Do not change any of the default setting
- Open OSM Tracker on your phone
- Go to Parameters, GPS Interval
- Set recording interval to 5 seconds

- Charge your phone well at night
- A battery pack will be given to you, also keep it charged
- Notify Alex in case of any problem (024 469 5112)

Your work plan

- Your work plan lists 53 routes that you will have to record
- Each route has to be recorded in two trips (outbound, inbound)
- The first trip, away from the origin station is called an “A” trip
- The trip on the way back to the origin station is called “B”

- You have to record a **minimum of 18 routes every week (3/day)**
- But you can do more if you want to work longer day
- Remuneration is based on number of routes your record
- 25 GHS per route (3 routes = 75 GHS)
- 200 GHS in bonus when you complete your work plan
- In total over 1,500 GHS per collector
- An advance of 220 GHS will be given to you to cover trotro fares

1 Go to the origin station listed for the first route on your list

- Ask Alex if the name of the station is not entirely clear to you
- Organize your workflow as it suits you best
- But do not record only short routes for a week!

2 Identify the loading points for trotros going to your destination

- Ask around at the terminal
- **Important: make sure to ask the driver "what is your final destination?".** If you ask him "are you going to *this place*?", he might say yes because the place is on his way but it is not the actual destination of his route.
- If you learn that the route no longer exists, make a note of it and inform Alex later
- If the route is inactive at the moment (for instance, it only runs morning), come back when it is active

3 Make sure that the operator is the one on your work plan (ask driver)

- There might be more than one operator branch/local running a route
- You want to make sure that the car you are going to board is operated by the right operator group
- Drivers or other union members at the terminal will be able to confirm this to you

4 Ask driver what is the average frequency of departures on route

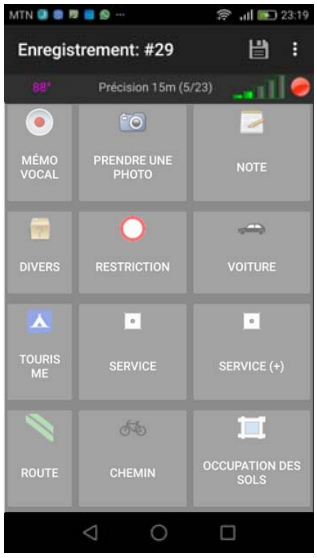
- You want to estimate the frequency of departures during morning peaks (around 8 AM)
- 5 minutes precision is enough (e.g. 15 minutes or 35 minutes)
- If the answer you receive is not convincing, ask someone else
- Passengers might also be a reliable source of information
- Remember this information, you will need it later

5 Open OSM Tracker and click on the "plus" symbol on the upper right

- Tapping this button starts a new record
- You will create a new record for each direction of each route

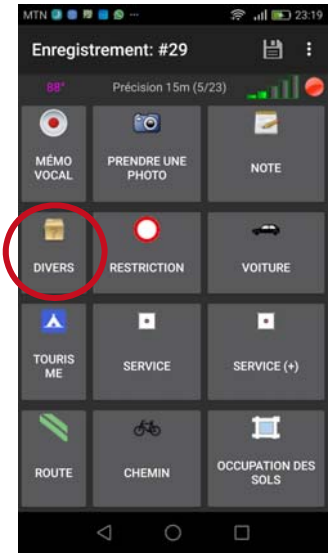
6 Wait buttons become clear (GPS fix)

- Buttons will be grey until you get a good GPS fix
- Stand outside, far away from buildings or tall structures
- Do not board a trotro before you get a good GPS fix
- The circle on the top right corner will turn red when you are moving
- If you don't have a good GPS fix, the app will display "searching for GPS signal"



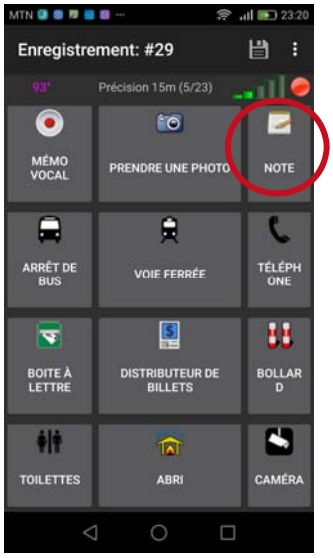
7 Tap the "misc." button

- Tapping this button brings you to a second page of buttons
- We will only use that second page



8 Tap "note" and write "Frequency X min." (as reported in step 4)

- A text query appears when you tap the button
- Enter the number of minutes in the following format: “10 minutes” (*amount in figure* + minutes)
- Then tap OK



9 Board the vehicle (do not board before you have a good GPS fix!)

10 Sit by the window and close to the mate if you can

- Try to sit on the right hand side by the window and close to the mate
- This way you can better see upcoming stops
- And ask the mate about the names of the stops if need be
- Being by the window will give you better GPS reception

11 Note "departure" when the car starts moving

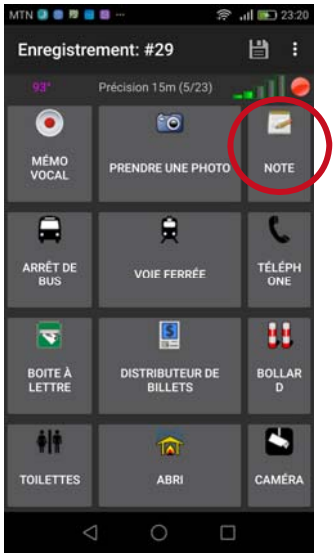
- Tap the “note button”
- Enter “Departure + *name of station*”
- E.g. “Departure Kaneshie”
- Even if the trotro is taking a long time to leave the terminal, tap the button when the car moves

12 Tap "Bus stop" when the bus stops to let pass. board or alight

- Tap the bust stop button when the car has completely stopped
- Do not anticipate or tap too late
- The GPS pin is going to be placed exactly where you tapped
- A message at the bottom of the screen will inform you that the tag was created
- **Note: we only record regular bus stops. If a car stops randomly to pick up someone on the street, that is not a bus stop**
- If the trotro drives by a bus stop that you know if part of the route but does not stop, you can tag it when you pass right in front of it

13 Immediately after, note name of stop (ask mate if needed)

- Tap the “note” button immediately after tapping the bus stop button
- Type the name of the stop (ask mate if needed)
- Tap OK
- Note: try to enter stop names that refer to the name of a unique place (for instance “Last stop” or “Curve” might be confusing to other users)



14 Note the cost of the ride when you pay it (ex. "2 GHS")

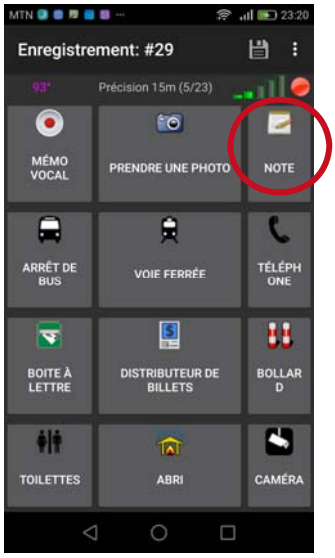
- After you pay for your ride to the mate, tap “Note” again
- Enter the amount you paid + “GHS”
- Tap OK

15 If the trotro ends the trip at a station, note "arrival + name of station"

- If the trotro stops inside/at a designated station, then note “arrival + *name of the station*”
- You can do this before alighting or right after, at the exact location where you alight

16a If the trotro drops you outside the station note "alighting" and walk to station…

- If the trotro drops you a bit outside of the station, note “Alighting” and walk to the station…
- You can create the note right before or right after you alight the trotro



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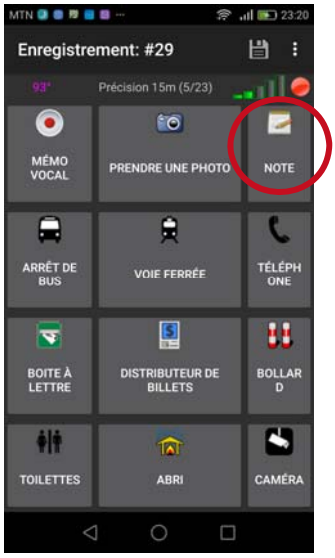
16b … then note "arrival + name of station" when you are in the station

- If you alighted outside of the station, walk to the station
- Once inside the station/yard, tap note and type "arrival + name of station"



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17 Tap the save button (floppy disk icon)

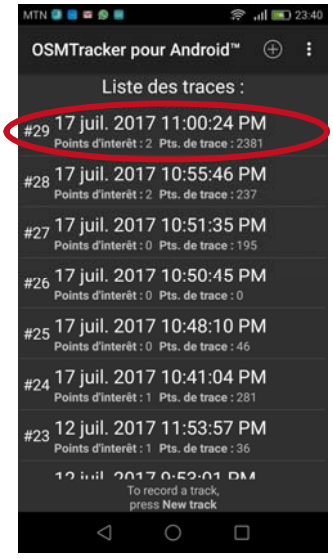
- This brings you back to the first screen with the list of records

18 Connect the phone to the internet (hotspot or wifi)

- Use your own smartphone as hotspot to connect the survey phone to the internet
- The data that you will transfer is light and will not use much credit
- If you cannot activate a hotspot, go somewhere with WiFi or to the DoT

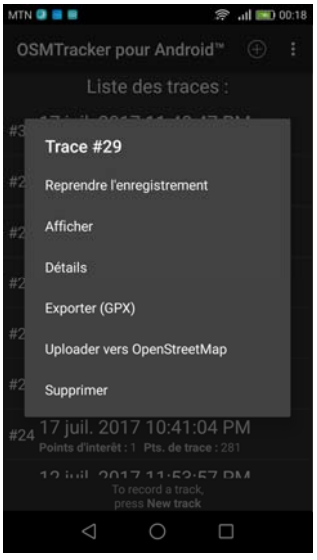
19 Select the first record on the list in OSM Tracker

- The first record on the list will be the most recent one



20 Do a long tap on the name of the record

- This will open a pop-up menu



21 Tap the "Upload to OSM" button

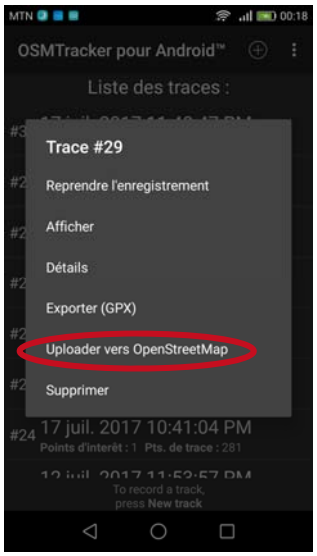
- If you encounter a connection problem, try the following:

1/ Check that the time and date is correctly set

2/ Go to setting and tap “Reset OSM Authentication and Confirm”

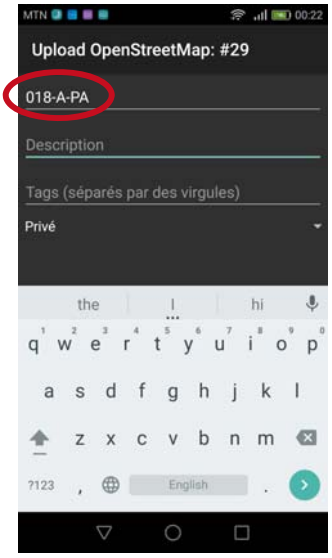
3/ Try to upload again

4/ Use the credentials sent to you by email



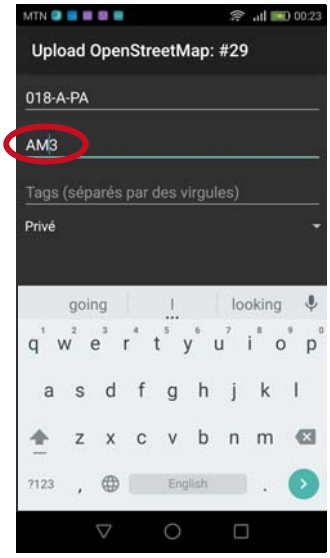
22 Edit name to "route number–direction–collector code" (e.g. "018-A-C2")

- Follow the naming format closely as this will allow us to identify records easily
- Do not forget the dashes between the codes



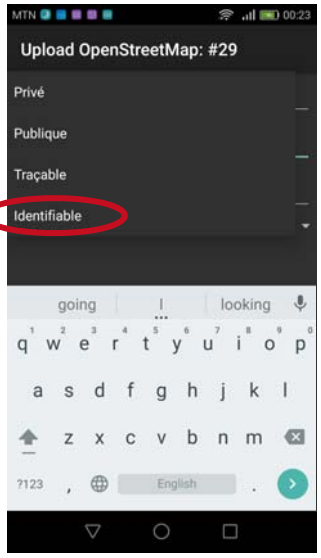
23 Enter "AM3" in Description

- This marker makes it easier for people following the project to identify records produced through AccraMobile 3



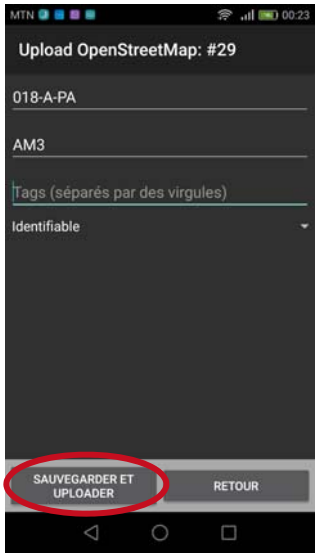
24 Change "private" to "identifiable" (important!)

- This makes the information on your trip public
- It helps mappers reconstitute your itinerary



25 Tap "save and upload"

- This will send the data to OSM
- You should get a confirmation message that your data has been sent
- We will also receive an email informing us that you have uploaded your data



26 Repeat for return and following trips

- You may send all your tracks at once at the end of your shift if it is more convenient for you
- But do send tracks every day that you work (do not wait until the end of the week)

Thank you for your attention

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