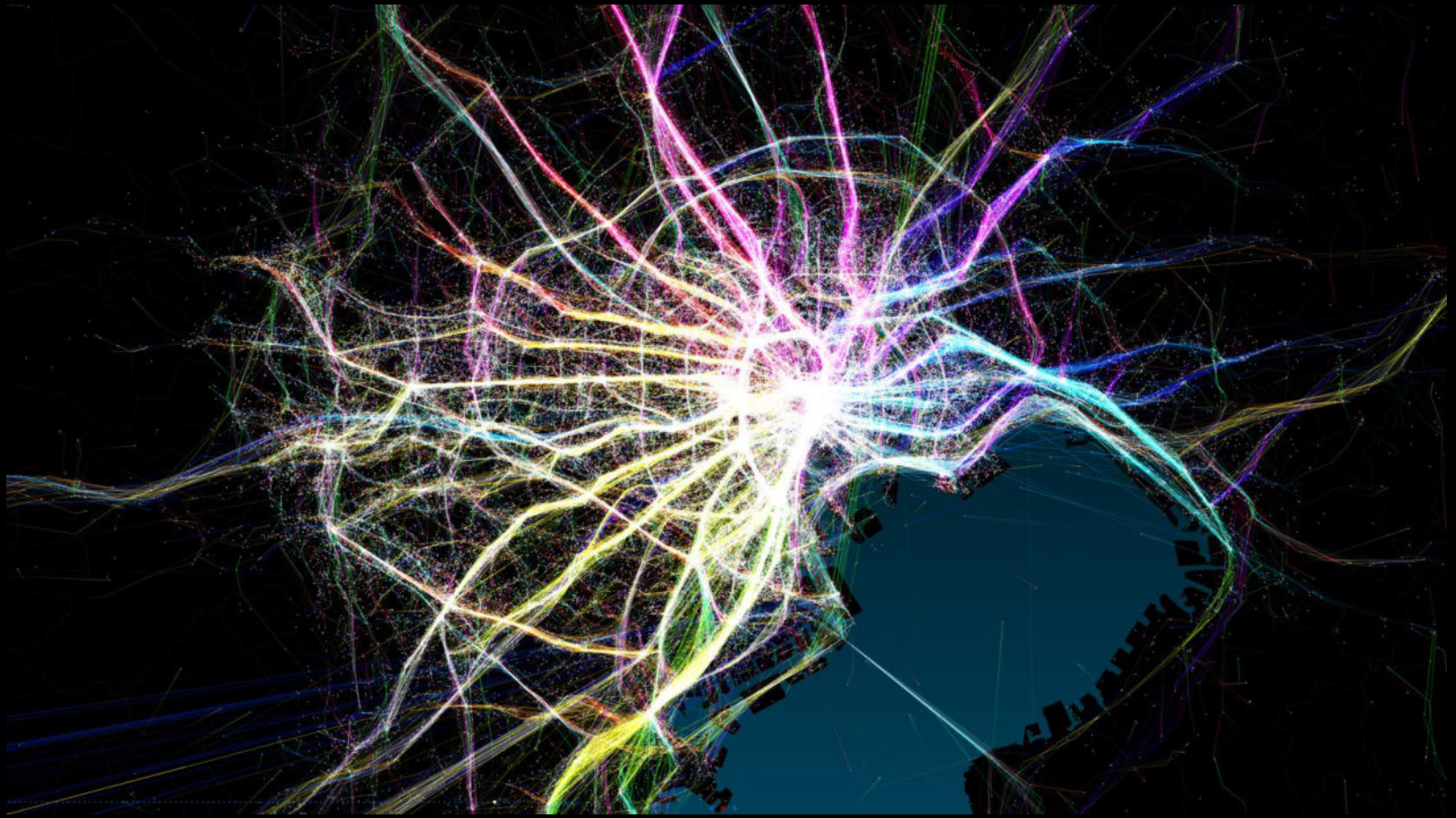
Title: Harnessing Integrated Data Sources for Enhanced Green Transportation Planning: A Focus on Active Transport and Public Transit Accessibility

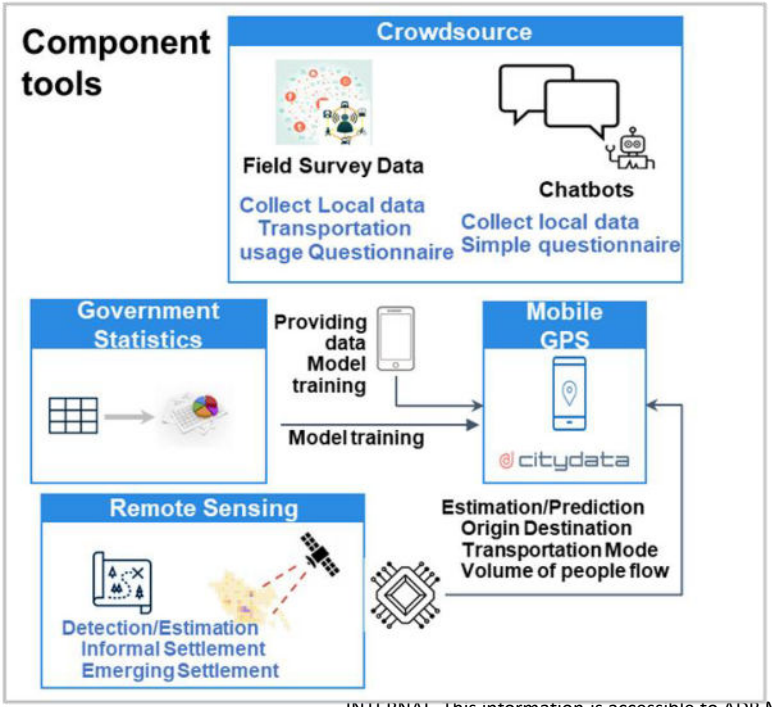

Support
Better-Informed
Decision-Making in
Plan
Do
Check
Act
For Green Mobility

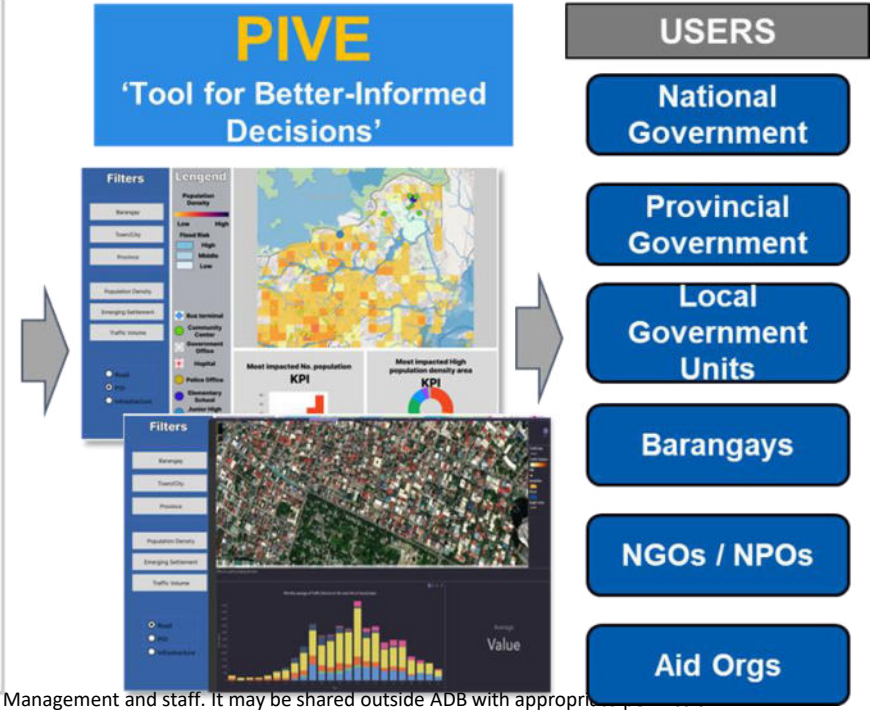


Tokyo, 8:00 am, April 11, 2014, before the earthquake of 2011-03-11
Source: Mass Disaster Data Hiroshi Abe, NHK special production team "Mass disaster data", 2014, NHK Shuppan

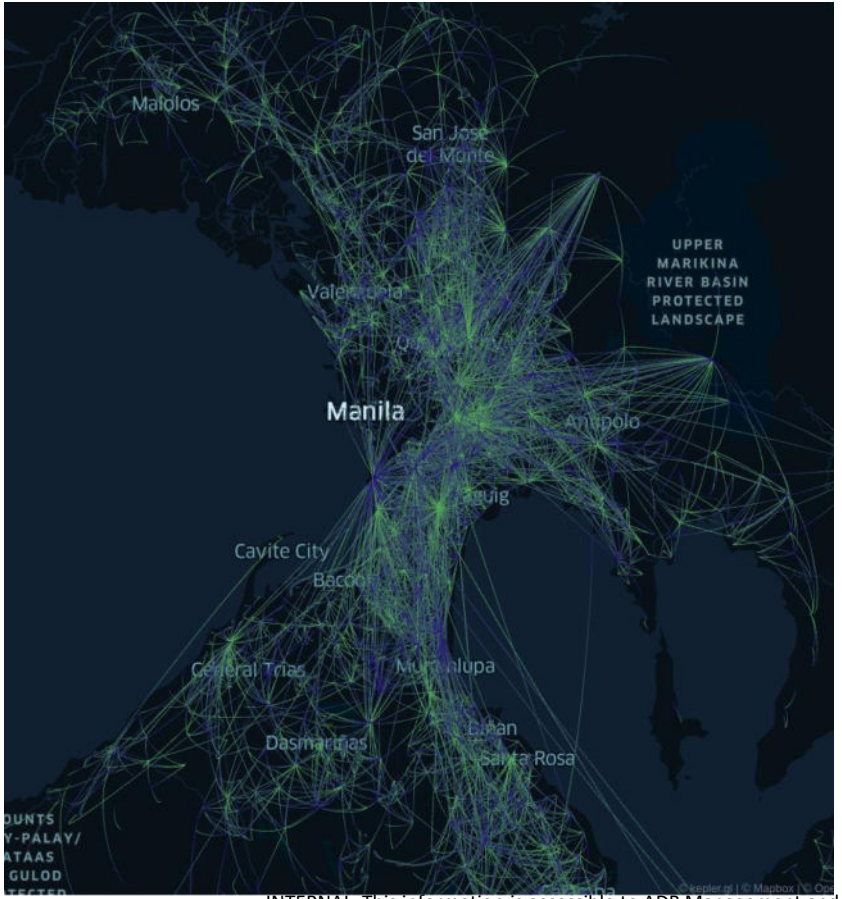
Objective

To present a comprehensive approach that **integrates household surveys, crowdsourced data from field survey applications, and big data derived from mobile GPS trajectories** to determine travel patterns and preferences, with a specific focus on walking, cycling, and public transit accessibility, using **PIVE (Poverty Impact and Vulnerability Estimator)**





GPS Data: Origin – Destination



Macro level user's mobility can be analyzed by establishing user Origin-Destination (OD) across the city. The illustration shows the aggregated OD of the user in the Metro manila region and the surround province.

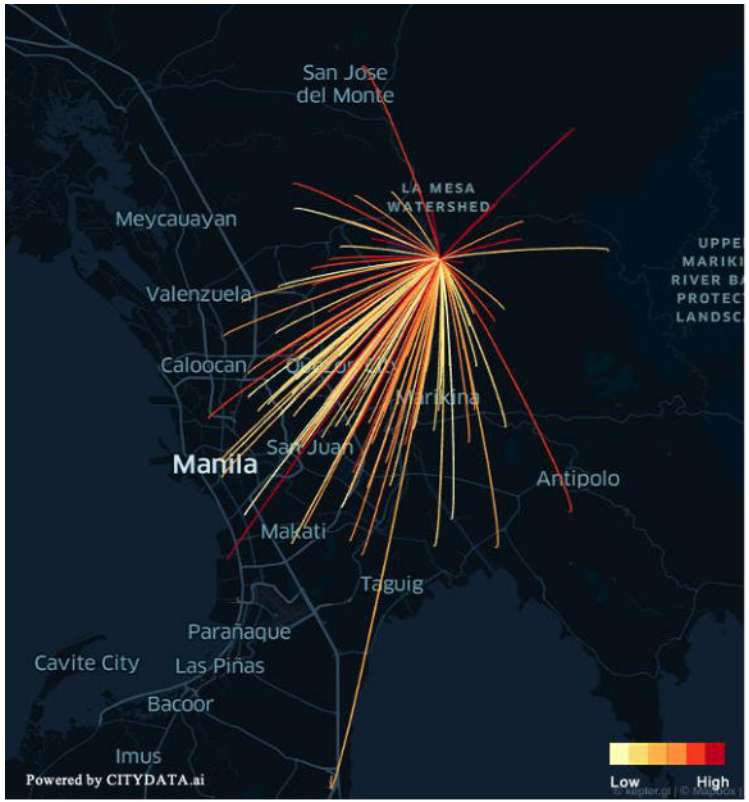
Looking at the illustration entire data can give the general idea regarding of the people mobility.

However, individual barangay level OD can show more detail level of user's mobility.

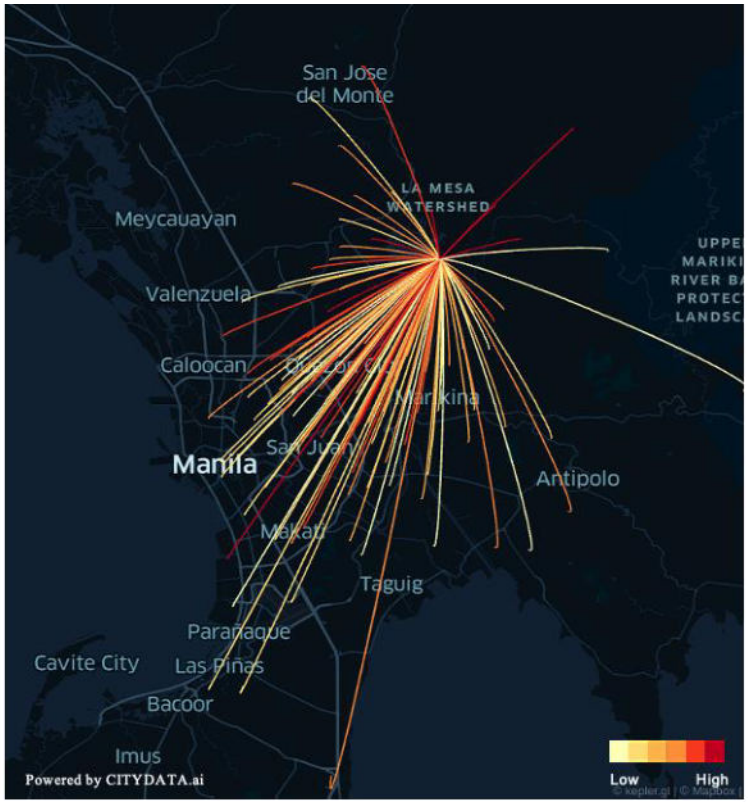
Mobile GPS data are acquired from a data broker that collects and cleanses location data from various applications and devices that received consent from the users.

The PIVE project acquired data from mid 2019 to December 2022.

GPS Data: Payatas OD Trip



OD illustration of trip moving toward Payatas



OD illustration of trip moving from Payatas

GPS Data: OD for different cities

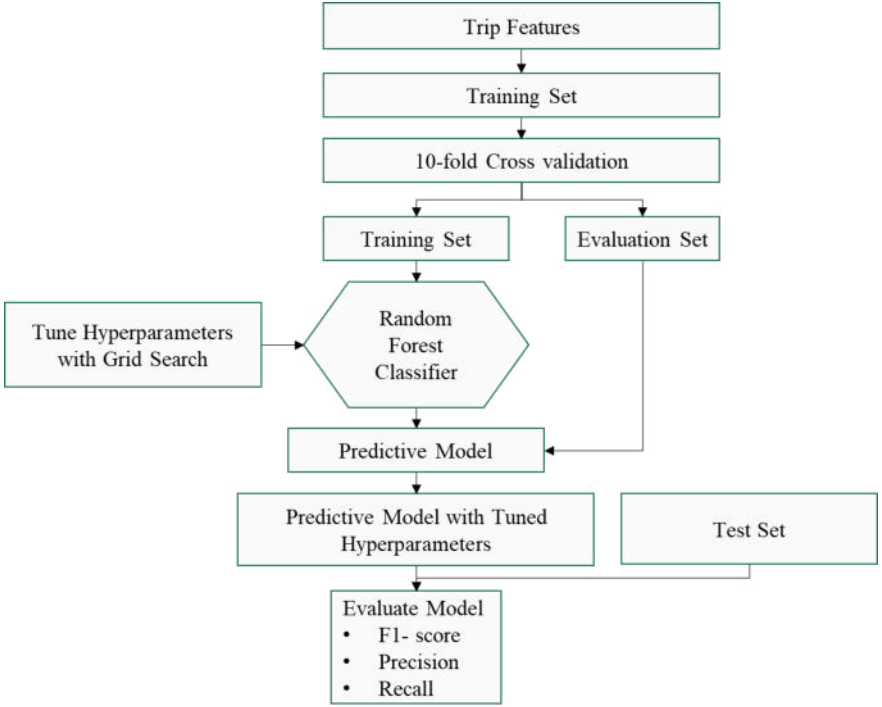
Iloilo city OD map

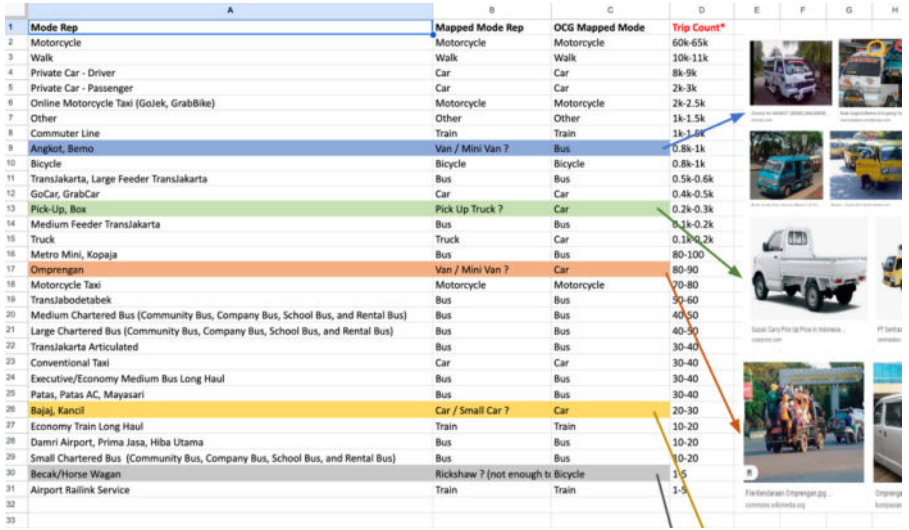
General Santos city OD map

PIVE

Poverty Impact and Vulnerability Estimator

Transport mode estimation: concept





	Mode Rep	Mapped Mode Rep	OCG Mapped Mode	Trip Count*
2	Motorcycle	Motorcycle	Motorcycle	60k-65k
3	Walk	Walk	Walk	10k-11k
4	Private Car - Driver	Car	Car	8k-9k
5	Private Car - Passenger	Car	Car	2k-3k
6	Online Motorcycle Taxi (GoJek, GrabBike)	Motorcycle	Motorcycle	2k-2.5k
7	Other	Other	Other	1k-1.5k
8	Commuter Line	Train	Train	1k-1.5k
9	Angkot, Bemo	Van / Mini Van ?	Bus	0.8k-1k
10	Bicycle	Bicycle	Bicycle	0.8k-1k
11	TransJakarta, Large Feeder TransJakarta	Bus	Bus	0.5k-0.6k
12	GoCar, GrabCar	Car	Car	0.4k-0.5k
13	Pick-Up, Box	Pick Up Truck ?	Car	0.2k-0.3k
14	Medium Feeder TransJakarta	Bus	Bus	0.1k-0.2k
15	Truck	Truck	Car	0.1k-0.2k
16	Metro Mini, Kopaja	Bus	Bus	80-100
17	Omprengan	Van / Mini Van ?	Car	80-90
18	Motorcycle Taxi	Motorcycle	Motorcycle	70-80
19	TransJabodetabek	Bus	Bus	50-60
20	Medium Chartered Bus (Community Bus, Company Bus, School Bus, and Rental Bus)	Bus	Bus	40-50
21	Large Chartered Bus (Community Bus, Company Bus, School Bus, and Rental Bus)	Bus	Bus	40-50
22	TransJakarta Articulated	Bus	Bus	30-40
23	Conventional Taxi	Car	Car	30-40
24	Executive/Economy Medium Bus Long Haul	Bus	Bus	30-40
25	Patas, Patas AC, Mayasari	Bus	Bus	30-40
26	Bajaj, Kancil	Car / Small Car ?	Car	20-30
27	Economy Train Long Haul	Train	Train	10-20
28	Damri Airport, Prima Jasa, Hiba Utama	Bus	Bus	10-20
29	Small Chartered Bus (Community Bus, Company Bus, School Bus, and Rental Bus)	Bus	Bus	10-20
30	Becak/Horse Wagan	Rickshaw ? (not enough t	Bicycle	1-5
31	Airport Railink Service	Train	Train	1-5
32				
33				

Transport mode estimation: validating overall mode-share after application

Jakarta Project


```
+----------+-------+
|      mode|  count|
+----------+-------+
|Motorcycle|1670383|
|       Car| 385806|
|       NMT|  16090|
|       Bus| 205483|
|     Train|  26655|
+----------+-------+
```

Motorcycle = 72.49%
car = 16.74%
Motorcycle + car = 89.23%
Bus = 8.92%
Train = 1.16%
NMT = 0.7%

Table 164 Modal Share in JABODETABEK

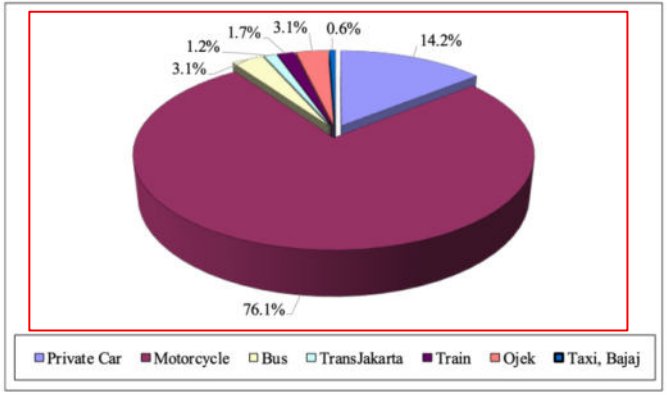
Transport Mode	All Modes	
	No. of Tour ('000)	% Share
Private Car	4,281	14.2
Motorcycle	22,896	76.1
Bus	934	3.1
Transjakarta	368	1.2
Train	502	1.7
Ojek	944	3.1
Taxi, Bajaj	176	0.6
Grand Total	30,102	100.0

Note:

- Estimation made excluding the tour with NMT and Other as representative modes.

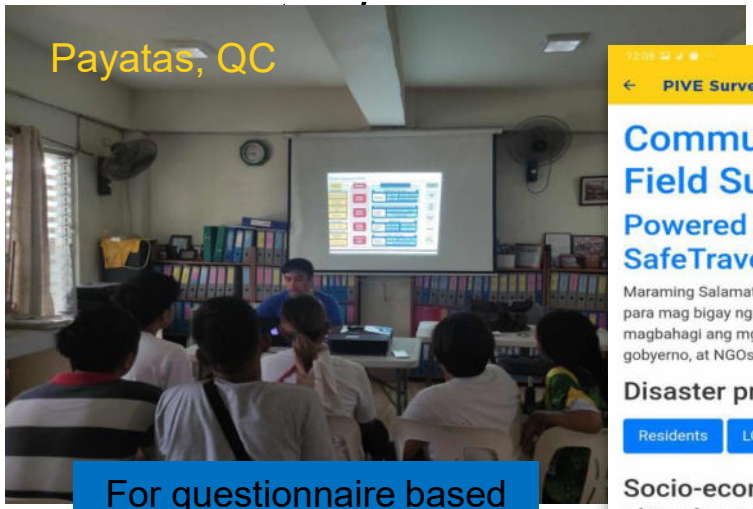
- Public Transport (PT): Conventional Bus, Transjakarta, Commuterline (Train), Ojek, Taxi, Bajaj.

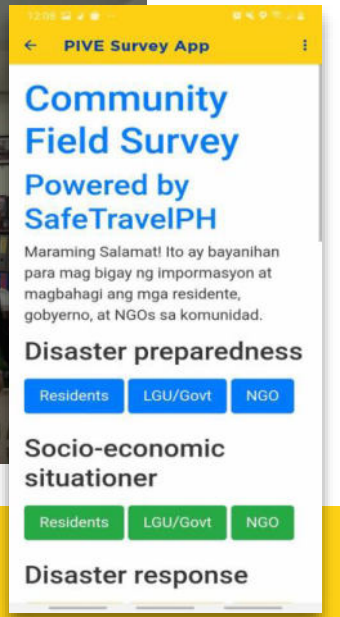
Source: JUTPI 2



Survey App: Complementing Big Data with Detailed individual community sensing and mobility data

Fully-engaged

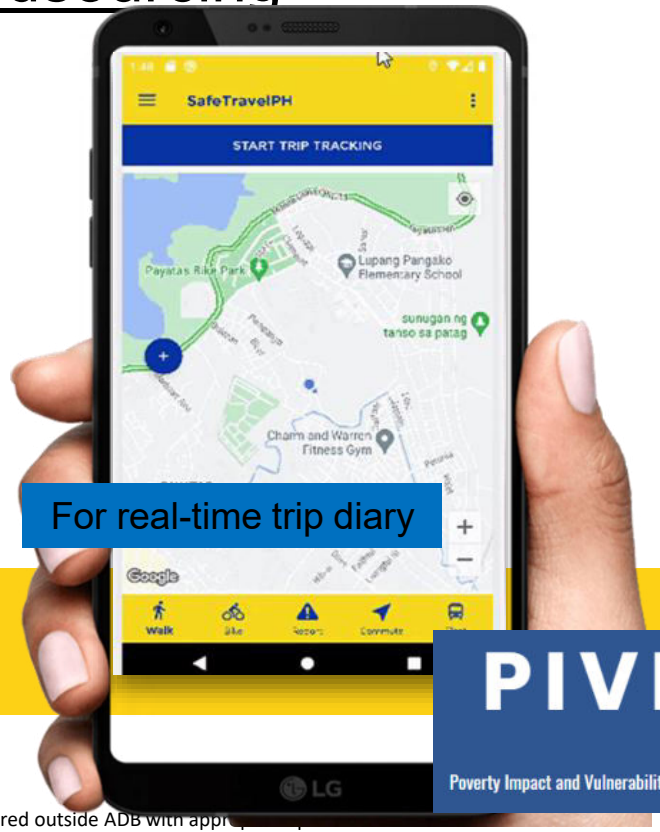




For questionnaire based data

… in the absence of shareable community census data from the local government, a rapid community surveys can be deployed with NGO or

Crowdsourcing



For real-time trip diary

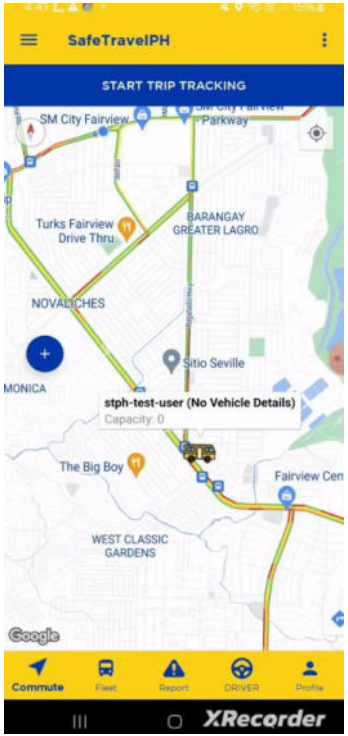
PIVE
Poverty Impact and Vulnerability Estimator

Survey App - From Real-time Mobility Information Exchange Platform to Control and Planning Data

Commuters gets real-time location and occupancy of transport vehicles

Residents get real-time location and better anticipation of response vehicles during disasters

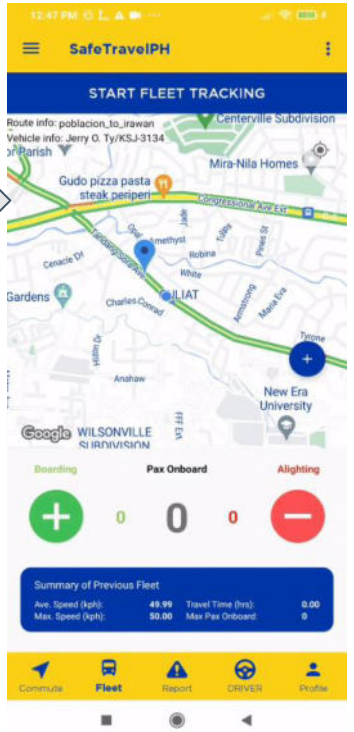
Public transport providers and government response vehicles broadcasts their location



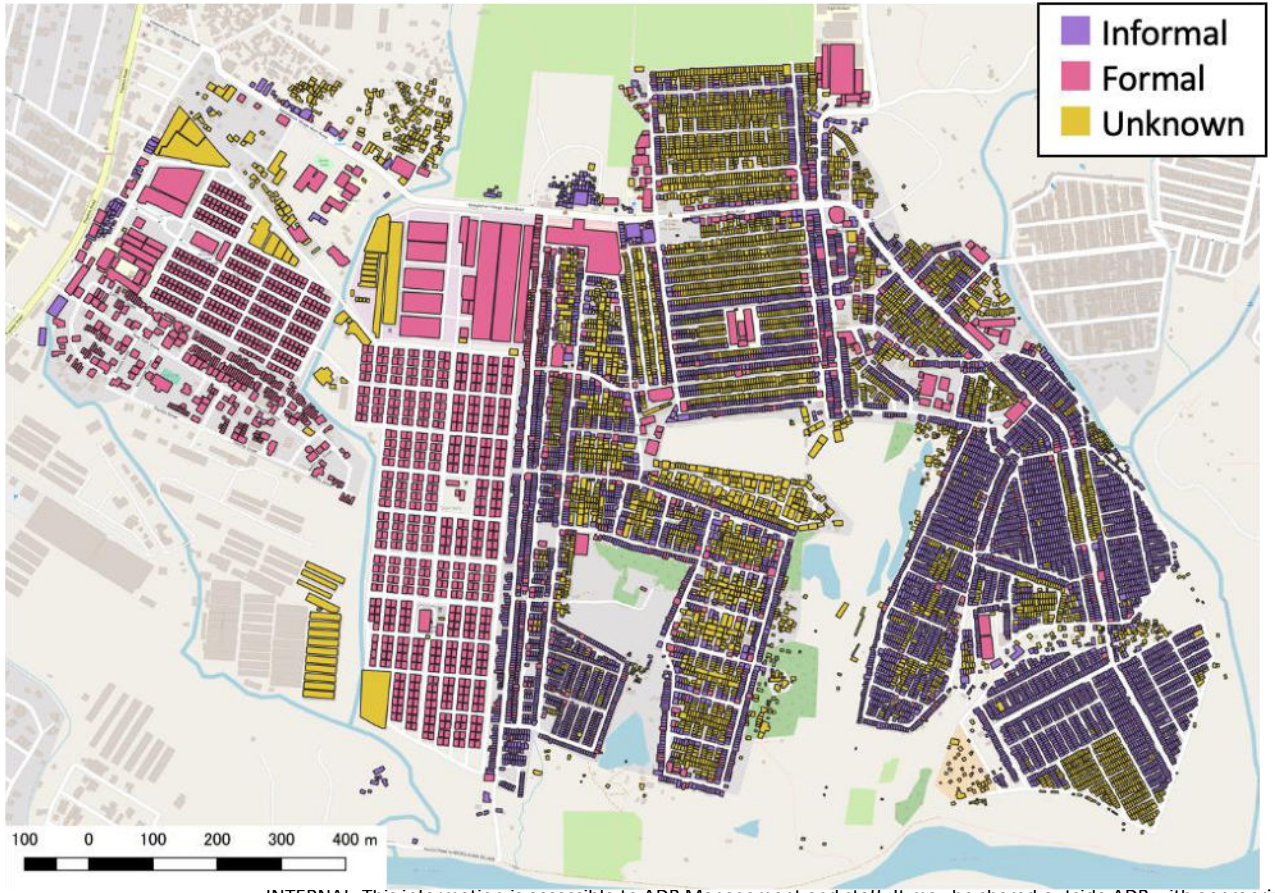
AS WE SHARE DATA, WE CAN GET TO COLLECT DATA TO BE USED FOR PLANNING **(1 hz - 1 datapoint/sec)**

Accurate estimation of …

- ★ Travel time
- ★ Rideship (revenue data)
- ★ Geotagged location of actual boarding/alighting (stops)
- ★ Speed profile and trip behavior
- ★ Actual transport mode
- ★ Tracked route
- ★ many more…

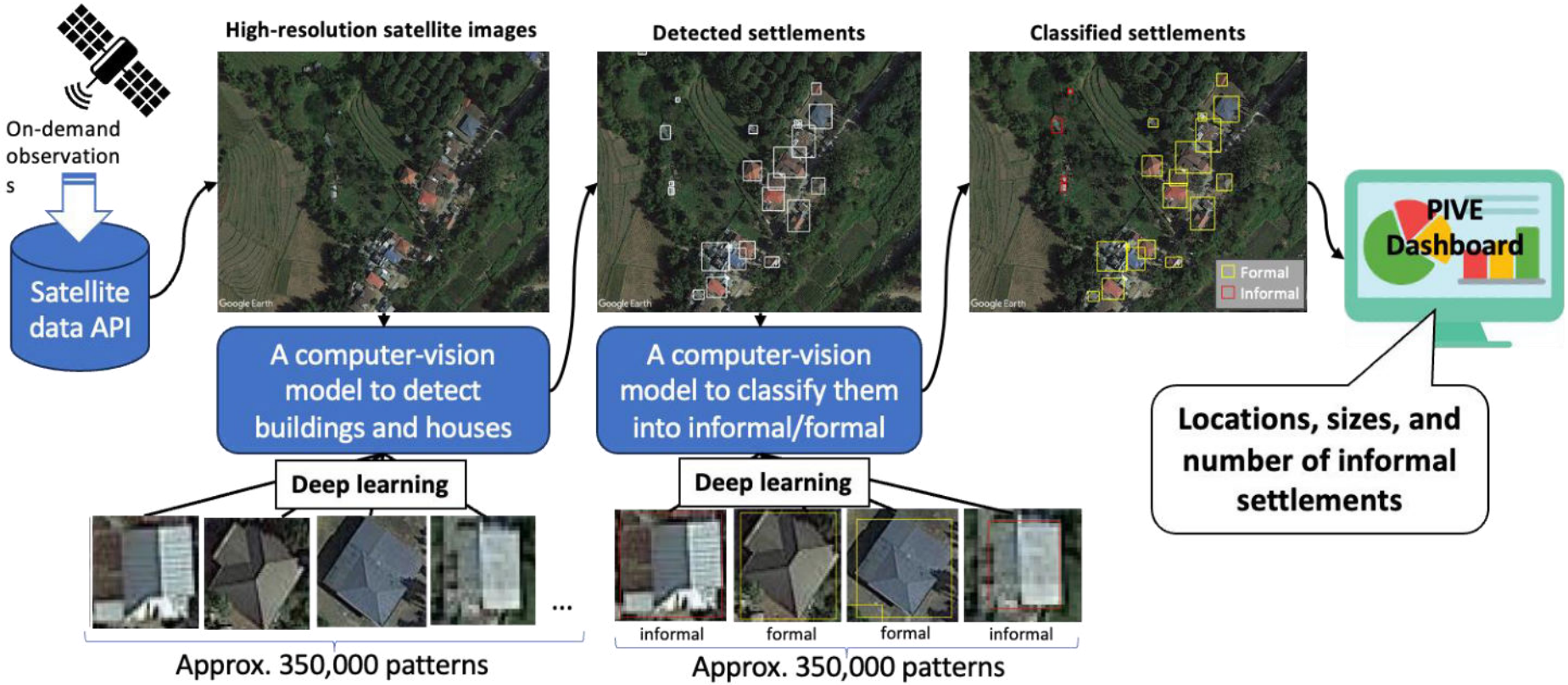


Satellite Data: Mapping emerging settlements via visual interpretation



PIVE
Poverty Impact and Vulnerability Estimator

Satellite Data: Data processing pipeline for automated detection of emerging settlements in classified land uses



PIVE Traget Users

PIVE	Typical application domains	Example users
GIS Dashboard as a showcase • Help potential users handle diverse data and recognize what they can do with PIVE	Public transportation planning/management ***(GPS+Field S. App)***	• National gov. • LGU • Operators ***+ADB***
Scalable/easy-to-apply digital tools 1. **GPS-based mobility analysis** 2. **Field survey app** 3. (Chatbot for emergency communication) 4. **Satellite** data analysis for "Informal" sector **mapping**	Poverty survey and vulnerability assessment ***(GPS+Field S. App+Sat. Map)***	• National gov. • LGU • NPO ***+ADB*** *(e.g. Poverty Mapping Project)*
	Support to vulnerable people ***(Field S. App, Chatbot+Sat. Map)***	• LGU • NPO ***+ADB***

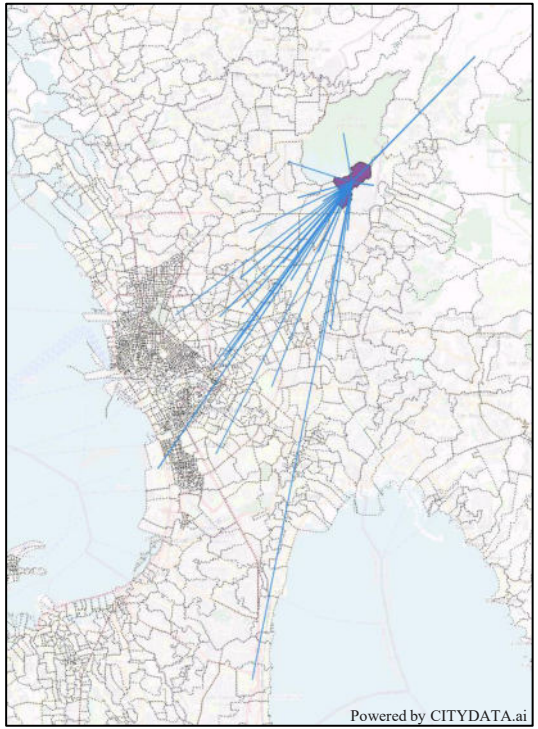
Output: Datasets

Estimation of walking and non-walking modes per smallest administrative unit in the case of the Philippines–Barangay).

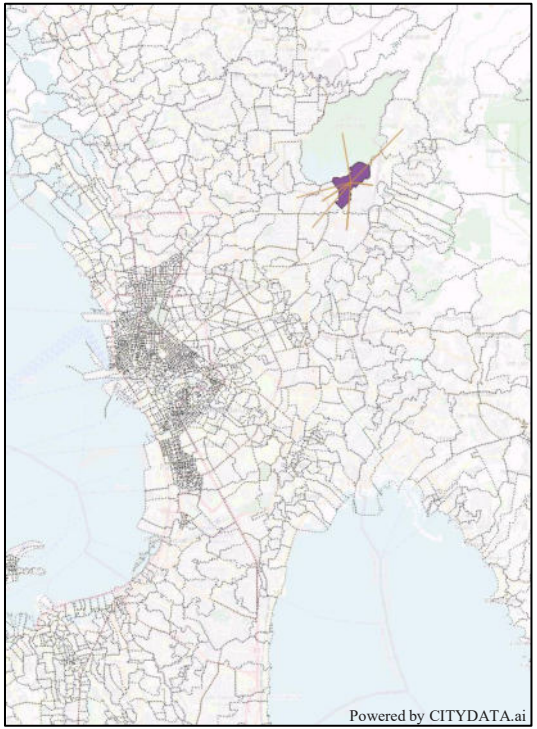
yearmon	Origin	Destination	mode	daily_trips	distance_per_trip_per_day_KM	Geometry
2022-10	Abangan Norte	Abangan Norte	walk	6859	2.40	LINESTRING (120.93546059048067 14.769141133268427, 120.93546059048067 14.76914113326
2022-10	Abangan Norte	Abangan Norte	non-walk	2917		LINESTRING (120.93546059048067 14.769141133268427, 120.93546059048067 14.76914113326
2022-10	Abangan Norte	Abangan Sur	walk	938		LINESTRING (120.93546059048067 14.769141133268427, 120.93950622509298 14.76256348793
2022-10	Abangan Norte	Ibayo	walk	593		LINESTRING (120.93546059048067 14.769141133268427, 120.95623195061049 14.75407115655
2022-10	Abangan Norte	Ibayo	non-walk	545		LINESTRING (120.93546059048067 14.769141133268427, 120.95623195061049 14.75407115655
2022-10	Abangan Norte	Karuhatan	non-walk	228		LINESTRING (120.93546059048067 14.769141133268427, 120.97559880469134 14.68848377587
2022-10	Abangan Norte	Lolomboy	walk	1310		LINESTRING (120.93546059048067 14.769141133268427, 120.93489633604983 14.77782221521
2022-10	Abangan Norte	Lolomboy	non-walk	358		LINESTRING (120.93546059048067 14.769141133268427, 120.93489633604983 14.77782221521
2022-10	Abangan Norte	Malhacan	non-walk	417		LINESTRING (120.93546059048067 14.769141133268427, 120.96893447091226 14.74148253664
2022-10	Abangan Norte	Pandayan	walk	192		LINESTRING (120.93546059048067 14.769141133268427, 120.9660732157534 14.751537014626
2022-10	Abangan Norte	Pandayan	non-walk	223		LINESTRING (120.93546059048067 14.769141133268427, 120.9660732157534 14.751537014626
2022-10	Abangan Norte	Poblacion II	walk	196		LINESTRING (120.93546059048067 14.769141133268427, 120.94420209810552 14.75818124465
2022-10	Abangan Norte	Poblacion II	non-walk	332		LINESTRING (120.93546059048067 14.769141133268427, 120.94420209810552 14.75818124465
2022-10	Abangan Norte	Saog	non-walk	230		LINESTRING (120.93546059048067 14.769141133268427, 120.95515937702699 14.76238498510
2022-10	Abangan Norte	Tabing Ilog	non-walk	466		LINESTRING (120.93546059048067 14.769141133268427, 120.94928397132392 14.76818345593
2022-10	Abangan Norte	Tabing Ilog	walk	882		LINESTRING (120.93546059048067 14.769141133268427, 120.94928397132392 14.76818345593

Ongoing data collection in pilot sites to further define transport modes; to collaborate with government agencies to get travel demand surveys to help calibrate the big data.

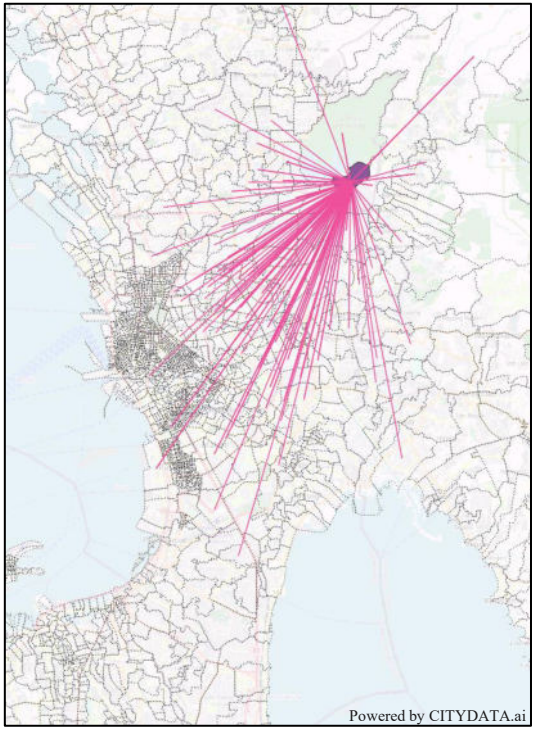
Output: Datasets



Mode = Jeep



Mode = Tricycle



Mode = Others

With enough field surveys user's OD movement can also be categorized based on the different transportation mode usage. The illustration shows the mobility using Jeepney, Tricycles and other modes from the trip coming from Payatas, Quezon City.

Information Exchange Platform

- Public transport network map; GTFS enhancements
- PT service schedule

We can collect data and interview them through Field survey app.

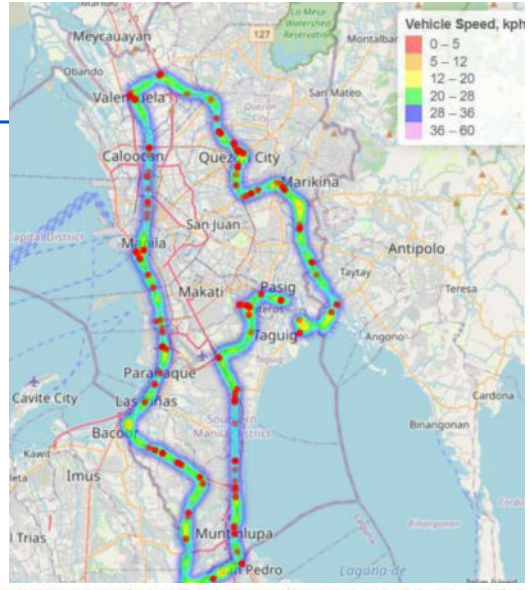
1)To grasp PT user movement through Field survey app

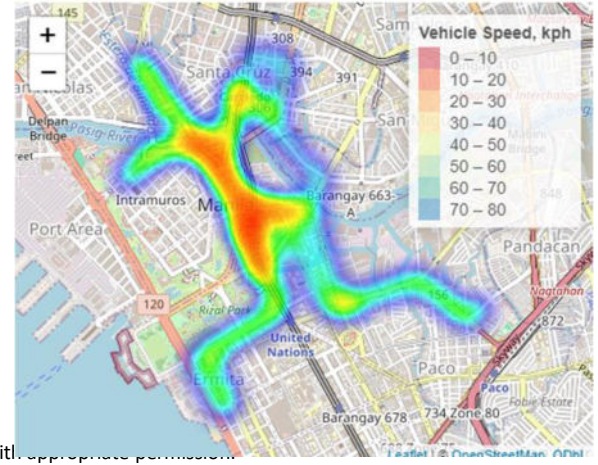
2)PT Operator Interview

At the same time, we can train our model for estimation on transportation mode or purpose using data through field survey app as training data with very granular data (1 datapoint per second)

Then, we can associate individual's movement data with their response on questionnaire about transportation service and socio-economic status etc.

3)Consolidate the above materials





Output: Dashboard

The published edition is for PC/Laptop at the moment. Smartphone edition are not published yet.

https://tinyurl.com/PIVEdashboard

ArcGIS Online Dashboard

- Traffic Volume
- Population Distribution
- Emerging Settlement Area

https://tinyurl.com/PIVEkpi

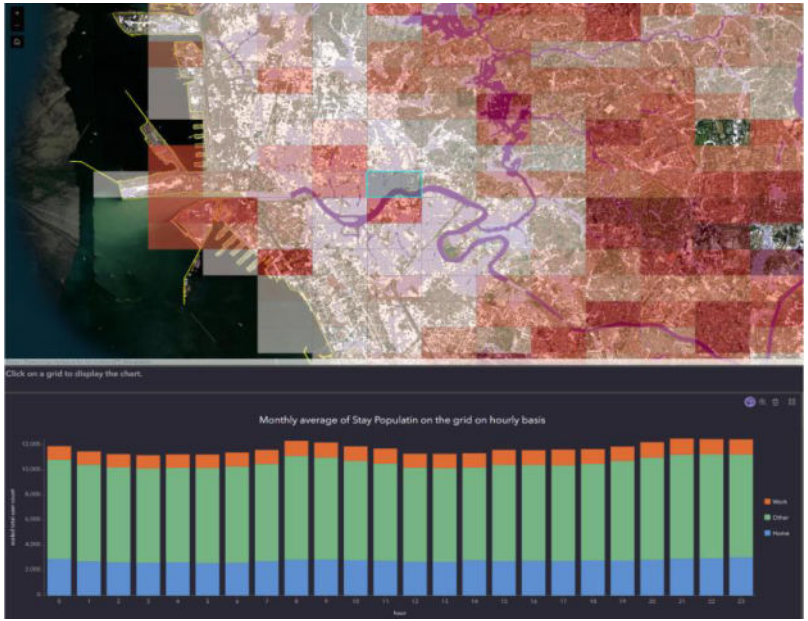
ArcGIS Online Dashboard

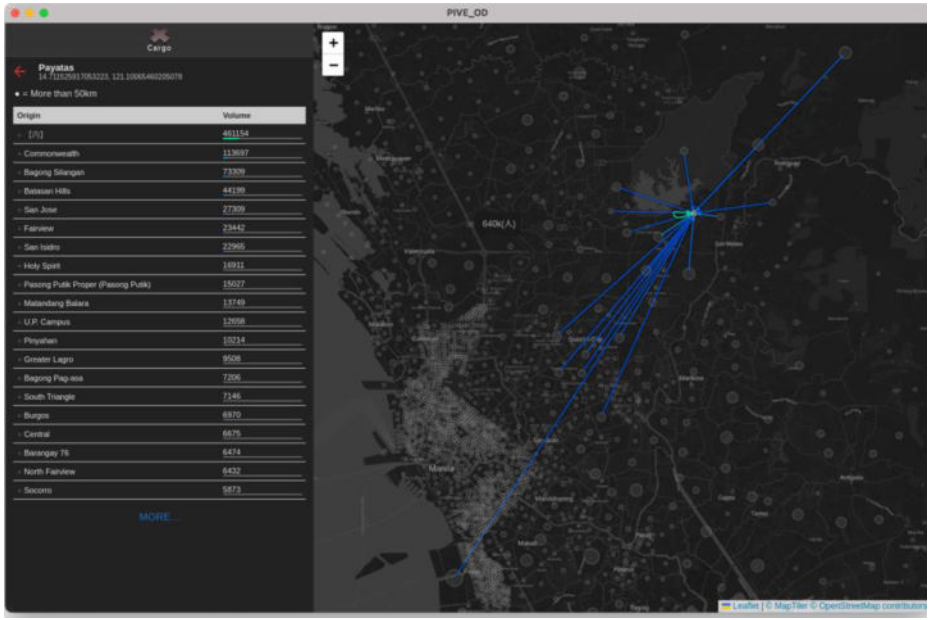
- Key Performance Indicators(NGO/NPO View)

Where are people and where do they need to be?

tinyurl.com/PIVEdashboard

- Distribution and density of people;
  - GPS data analysis and dashboard

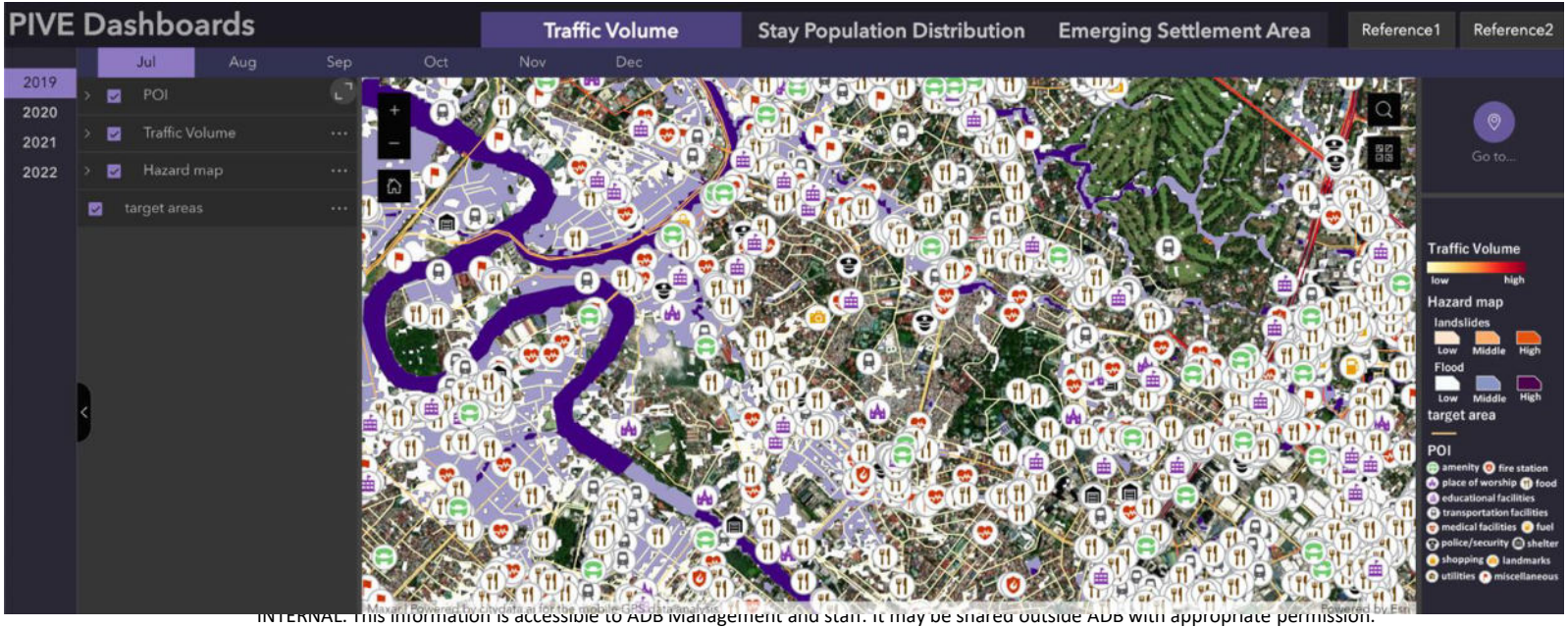




Where are people and where do they need to be?

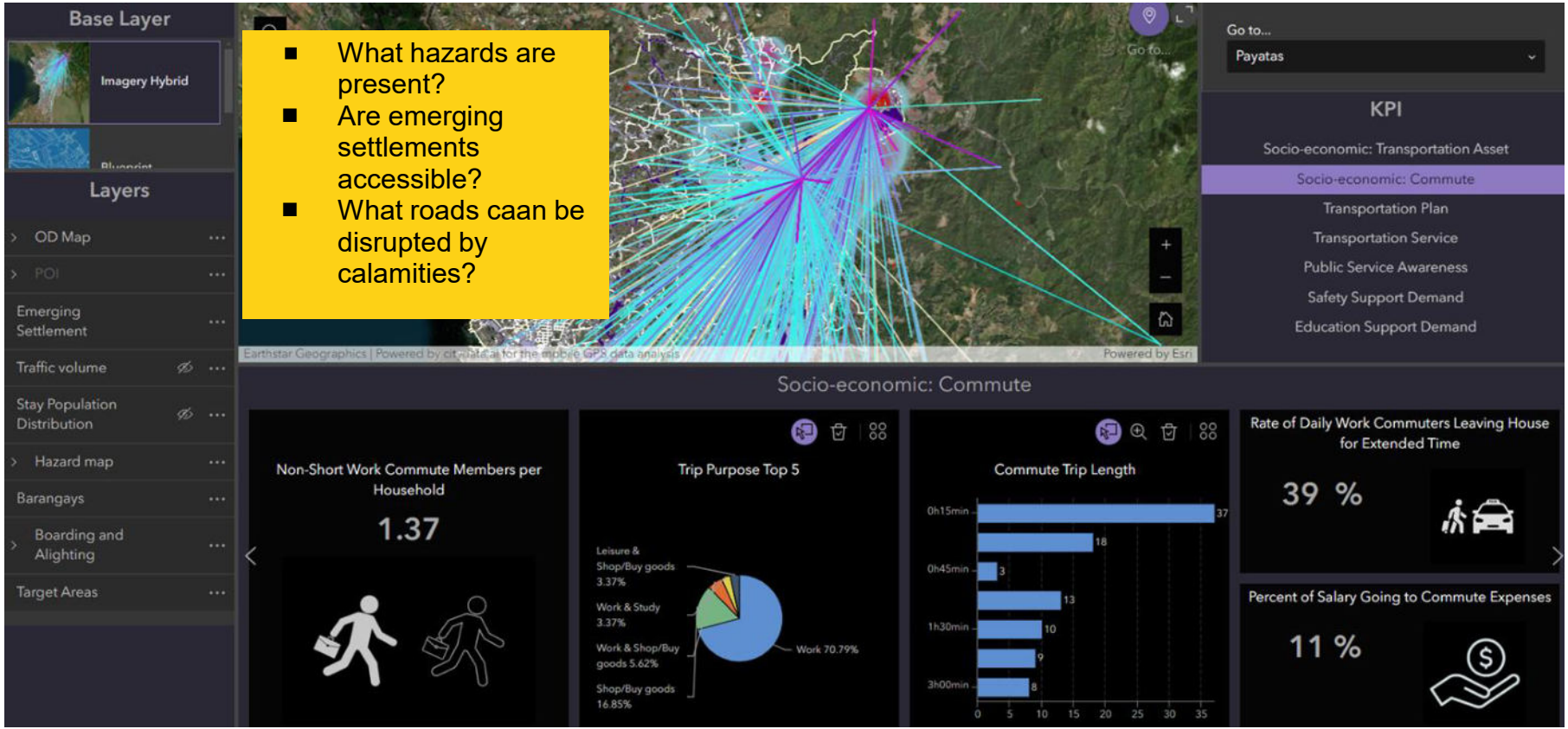
tinyurl.com/PIVEdashboard

- POIs
  - We use POIs from OpenStreetMap.
  - We can collect POIs on the specific area using Field Survey application (for example on Payatas/Kasiglahan)
  - We should design how to cost-effectively update POIs on wider area.



How's the level of mobility and accessibility of residents?

tinyurl.com/PIVEkpi



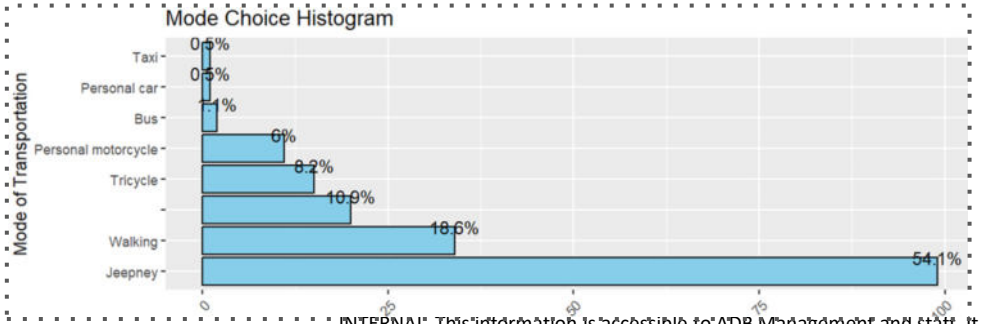
- What hazards are present?
- Are emerging settlements accessible?
- What roads caan be disrupted by calamities?

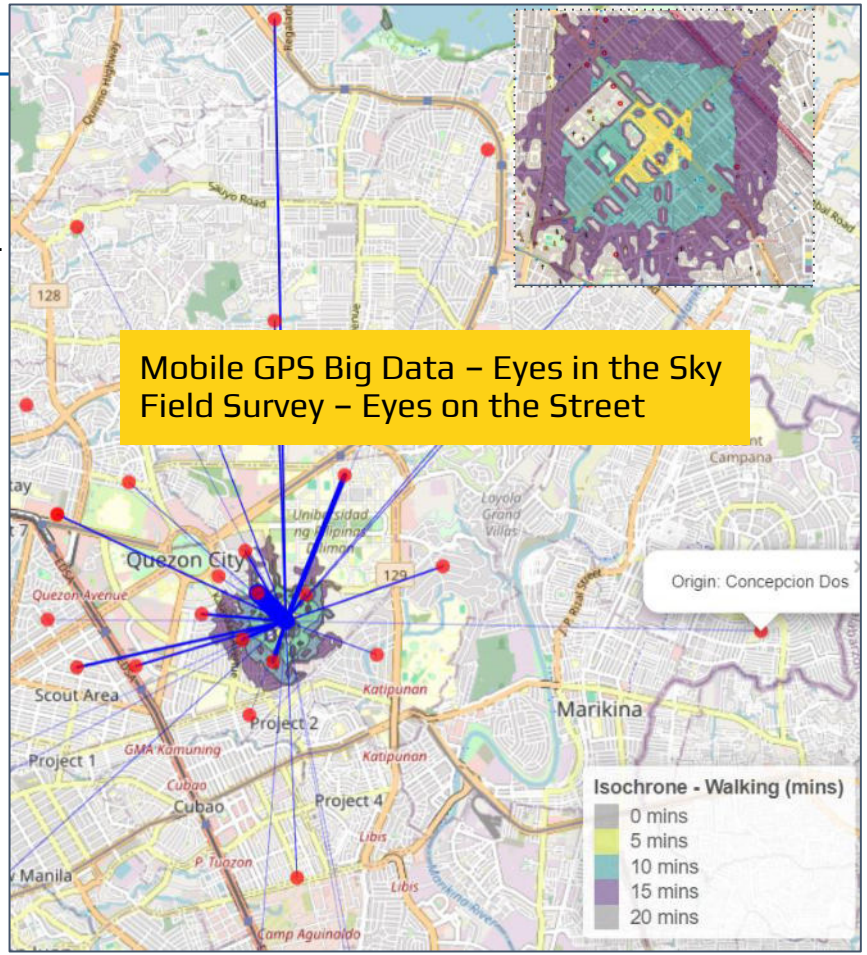
Output: Big Data + Community-based Surveys

The combination of analysed **Mobile GPS** origin and destination and walking and non-walking mode estimations, with **community-based rapid surveys** can provide very targeted evaluation of accessibility and resource allocation.Community field surveys calibrates these information.

Local context specific solutions for sustainable transport can be re-imagined and studied. Answers…

1. Where to put public transport around busy places to minimize car use and encourage more walking?
2. How much investment is needed for a community to improve public transport?
3. How we can access better the essential services (hospitals, schools, markets) in 15 minutes?
4. Are we can reallocate resources knowing the vulnerabilities, capacities of households, and socio-economic indicators?





Sample summaries of survey data

- Relating family purchasing capacity with transportation access

```
budget_daily_family_food primary_mode_of_transportation
Min.    :  50.0          Length:183
1st Qu.: 200.0          Class :character
Median : 300.0          Mode  :character
Mean   : 318.4
3rd Qu.: 400.0
Max.   :1000.0
NA's   :36
is_public_transportation_sufficient feels_safe_when_travelling
Length:183                          Length:183
Class :character                    Class :character
Mode  :character                    Mode  :character
```

(More representative number of data being collected; currently N=200)

Sample summaries of survey data

- Indicators of community infrastructure quality and household capacity and vulnerability

```
survey_resident_code age_of_oldest_household_member
Length:183           Min.   : 1.00
Class :character     1st Qu.:37.00
Mode  :character     Median :49.00
                     Mean   :48.94
                     3rd Qu.:60.00
                     Max.   :90.00
                     NA's   :38
monthly_income_family_last_year type_home_ownership
Min.   : 3000                   Length:183
1st Qu.:10000                   Class :character
Median :12166                   Mode  :character
Mean   :16136
3rd Qu.:15000
Max.   :72000
NA's   :36
rating_of_community_water_supply rating_of_cleanliness
Min.   :2.000                    Min.   :1.000
1st Qu.:4.000                    1st Qu.:4.000
Median :4.000                    Median :4.000
Mean   :3.837                    Mean   :3.789
3rd Qu.:4.000                    3rd Qu.:4.000
Max.   :4.000                    Max.   :4.000
NA's   :36                       NA's   :36
```

(More representative number of data being collected; currently N=200)

Sample summaries of survey data

- Transport ease-of-use and cost

```
how_often_transfer percentage_of_monthly_budget_public_transport
Length:183         Min.    : 0.00
Class :character   1st Qu.: 0.00
Mode  :character   Median :10.00
                   Mean   :11.33
                   3rd Qu.:20.00
                   Max.   :50.00
                   NA's   :144
percentage_of_monthly_budget_private_transport submission_coordinates_uc4
Min.    : 0.000                                Length:183
1st Qu.: 0.000                                 Class :character
Median : 0.000                                 Mode  :character
Mean   : 8.528
3rd Qu.:12.750
Max.   :50.000
NA's   :147
```

(More representative number of data being collected; currently N=200)

Sample summaries of survey data

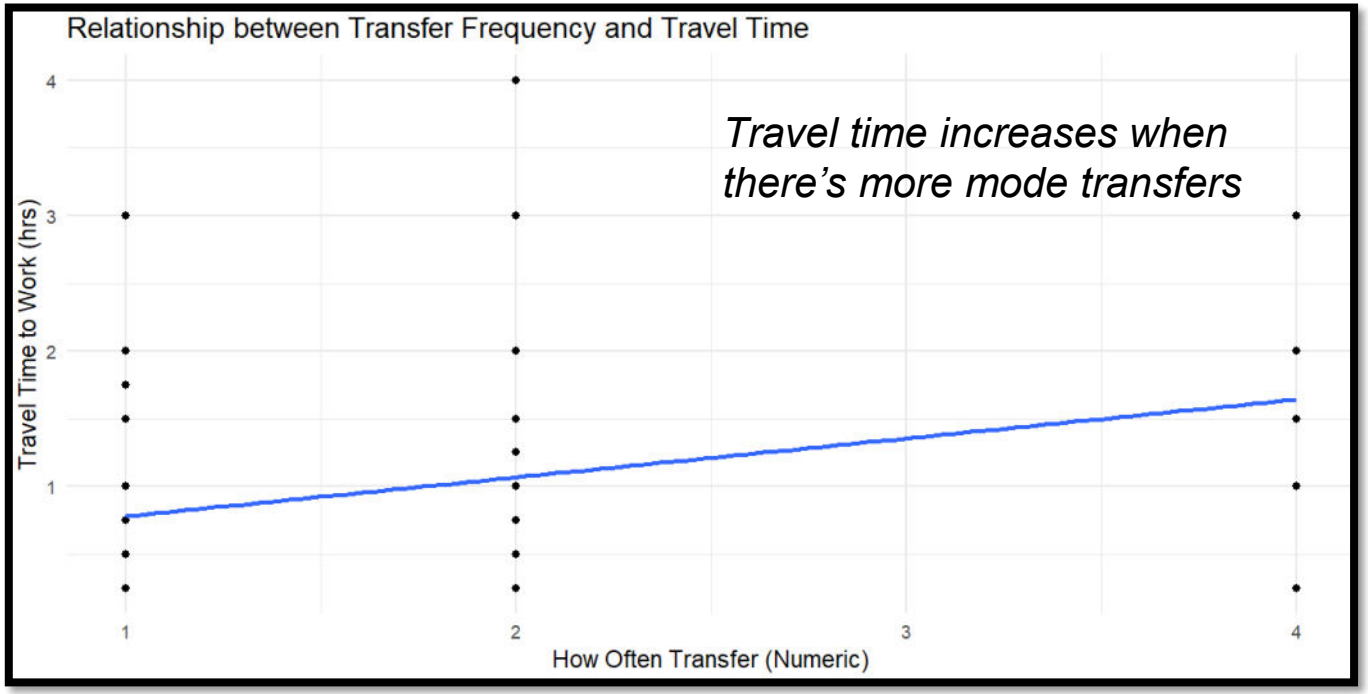
- Data for workers' travel experience quality

```
travel_time_to_work_hr leave_for_work_time return_home_from_work_time
Min.   :0.25           Length:183          Length:183
1st Qu.:0.25           Class :character    Class :character
Median :0.50           Mode  :character    Mode  :character
Mean   :0.95
3rd Qu.:1.50
Max.   :4.00
NA's   :83
number_of_household_members_leaving_house_for_more_than_8_hours_for_work
Min.   :0.000
1st Qu.:1.000
Median :1.000
Mean   :1.497
3rd Qu.:2.000
Max.   :5.000
NA's   :10
purpose_for_travel destination_when_leaving_house_for_long_period_of_time
Length:183         Length:183
Class :character   Class :character
Mode  :character   Mode  :character
```

(More representative number of data being collected; currently N=200)

What the field surveys can tell us?

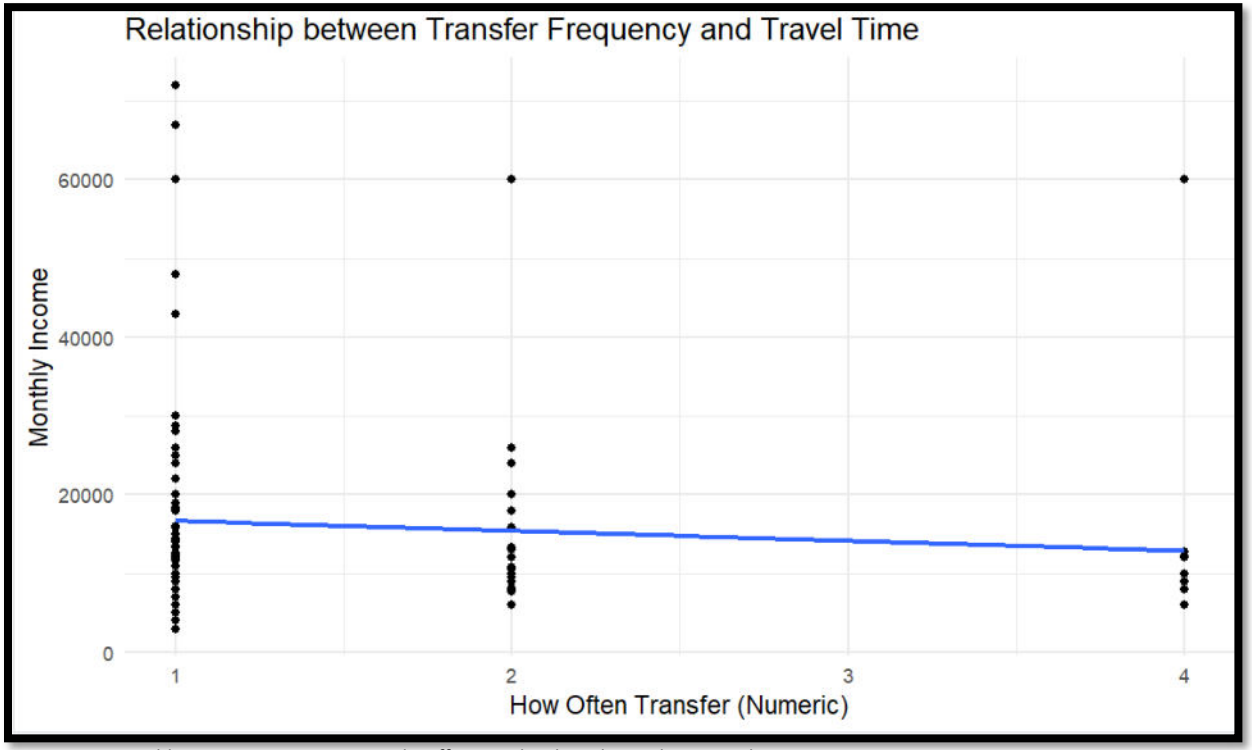
- Public transport as the more sustainable mode must must be more direct and easy to access
- Minimizing transfers, minimizes total vehicle kilometer



(More representative number of data being collected; currently N=200)

What the field surveys can tell us?

- Lower income households may be suffering more with higher number of transfers



(More representative number of data being collected; currently N=200)

What the field surveys can tell us?

- Clustering or segmenting the population based on the results of the surveys.
- To identify special interventions for each group based on their demographics and capacities and vulnerabilities.

Cluster	Oldest Age of Household Member	Monthly Income	Number of members with regular work	Daily Family Food Budget	Travel Time to Work (in Hrs)	Percentage of Income going to Public Transport Expenses	Number of Transfers in Public Transport
1	38.3	22000.0	1.3	433.3	0.9	8.3	1.7
2	40.8	8125.0	1.1	225.0	0.8	17.5	2.0
3	44.4	15855.6	1.4	294.4	1.3	8.6	1.1

Cluster	Oldest Age of Household Member	Monthly Income	Bus - Mode Share	Jeepney - Mode Share	Personal Motorcycle - Mode Share	Walking - Mode Share
1	38.3	22000.0	0%	67%	0%	33%
2	40.8	8125.0	0%	75%	0%	13%
3	44.4	15855.6	0%	78%	22%	0%

Cluster	Oldest Age of Household Member	Monthly Income	Mortgaged - Home Ownership	Owned - Home Ownership	Renting - Home Ownership	Sharing with another family/ relatives - Home Ownership
1	38.3	22000.0	0%	33%	33%	33%
2	40.8	8125.0	13%	38%	38%	13%
3	44.4	15855.6	0%	89%	11%	0%

Cluster	Oldest Age of Household Member	Monthly Income	Study - Trip Purpose Share	Work - Trip Purpose Share	Shopping Goods - Trip Purpose Share
1	38.3	22000.0	0%	67%	33%
2	40.8	8125.0	13%	88%	0%
3	44.4	15855.6	0%	89%	11%

What the field surveys can tell us?

- Clustering or segmenting the population based on the results of the surveys.
- To identify special interventions for each group based on their demographics and capacities and vulnerabilities.

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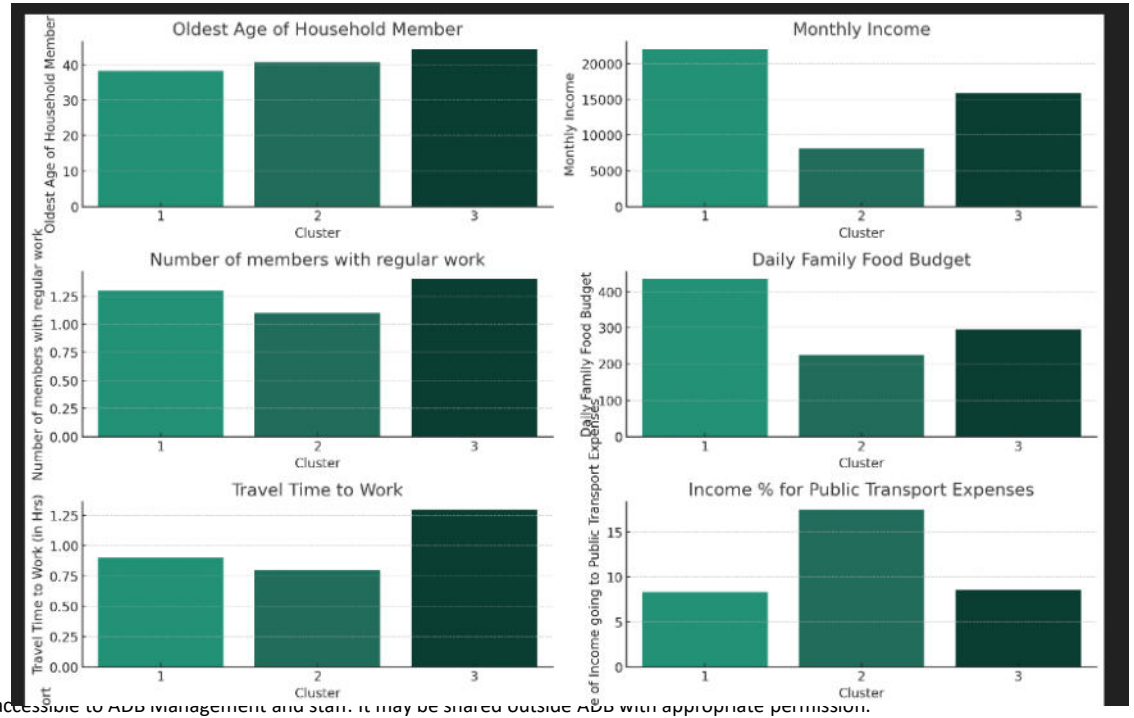


Use Cases with Philippine Government Agencies

We conducted workshop for review of the tools and data, and discussed for our contribution. (DOTr, NEDA, DHSUD, MMDA, DILG, CSOs…) last April 25-26 at ADB Innovation Hub.

Agency	Existing Systems and Data/Innovation Project	PIVE Project Contribution
DHSUD (housing)	PlanSmart and AutoCAM for land use monitoring and resiliency planning	• Knowledge and tools in building AI-based tools for satellite image data processing • Big data pipeline and analytical frameworks • **Transit Oriented Development (TOD) interventions**
DOTr (transport)	Greater Capital Region Transport Demand Analysis (ongoing)	• Travel behavior estimation from Big Data (Origin-Destination; Mode Transfers/Shares Distance metrics; Road Linke Traffic/Volume) • **Big ticket infrastructure impact monitoring; Veh-Km-Travelled (VKT)/GHG estimation**
NEDA (economy)	Philippine Transport Strategic Master Planning (for procurement)	
DILG (reslience)	Project GRASP (Governance for Resilient & Adaptive Social Protection)	• Use of Community Vulnerability Estimators and Household-level risk data to inform programming of budgets for social protection and climate resilience. • Big Data from PIVE for baselining.
MMDA (metro, traffic)	Metro Manila Traffic Management Master Plan (JICA)	• Real-time data collection and analysis for better monitoring • Big Data from PIVE for traffic volume baselining.

Use Case for Real-time Data

- We are examining the usefulness of Real-time data and checking the quality of that.

- Real-time data of Transportation / People flow are getting important especially in disaster response / support for evacuation or urban transportation planning in Japan.

- There are some real-time visualization service from data providers' which provide data at a interval of every 15 mins(*of the last 15 minutes*).

- The PIVE Philippine partner, SafeTravelPH NGO from University of the Philippines provides real-time monitoring of Public Transport trips for commuters, PT operators/drivers, and emergency response vehicles.

Our contribution

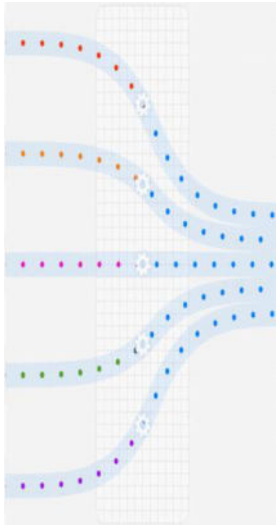
- Tools and datasets can be used separately or integrated with existing systems thru APIs or raw data.
- Consolidation on GPS data analysis / Satellite image analysis /Crowdsource through field survey and chatbot or even the CBMS for the LGUs.
- We can illustrate land cover or detect building from satellite image analysis and enrich the information of land use through people plow or transportation behavior from gps data analysis.
  - ➢ Settlement Area Map / Emerging Settlement map etc.
- We can connect the insight through GPS data analysis with the results on survey of transportation service or usage of Public Transportation to grasp Public Transportation User's behavior through the survey app.
  - ➢ KPI performance Dashboard etc.
- We can interview with Public Transportation service providers and information about service through the survey app and help with planning Public transportation services.
- PIVE could calibrate the Mobile GPS data with the record of usage of Public Transportation through the survey app or your asset data.

Smart and Sustainable Mobility Planning Tool for Public Transport Optimization

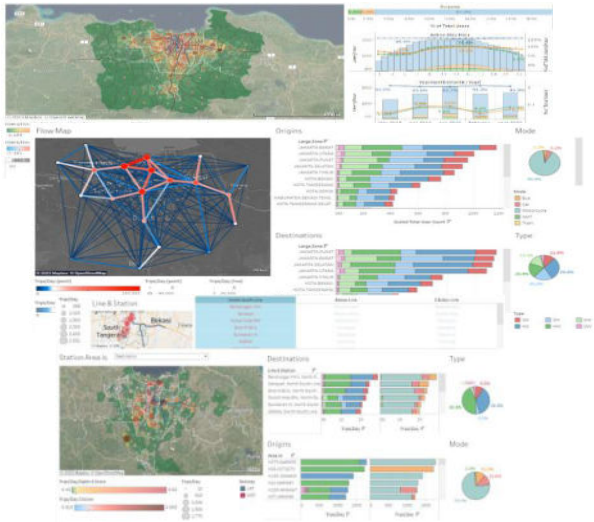
- Online dashboard tool to support data-driven decision-making of public transportation operations and planning through the integration and visualization of transport-related data
- Analysis function using mobile big data to identify potential travel demand not only for mobility improvement for tactical and operational decisions by operators, regulators, and, financers

Data Integration

- Smart Card Data
- Operation Data
- Mobile Big Data
- GeoData and Stats Data, etc.



Data Visualization



Decision-making

- Optimization Planning of Current Services
- Future Route and Service Planning
- Monitoring and Management
- Data-driven Advertising / TOD