JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE PROJECT FOR COMPREHENSIVE TRAFFIC MANAGEMENT PLAN FOR METRO MANILA

TECHNICAL REPORT NO. 3 WAZE DATA DASHBOARD AND USER MANUAL

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ABBREVIATIONS

| CSV | comma-separated values |
|------|---|
| CTMP | Comprehensive Traffic Management Plan |
| GCE | google compute engine |
| GCP | google cloud platform |
| GCS | google cloud storage |
| IAM | identity and access management |
| JICA | Japan International Cooperation Agency |
| JPT | JICA Project Team |
| MMDA | Metropolitan Manila Development Authority |
| VM | virtual machine |

1 OUTLINE OF WAZE TRAVEL SPEED DASHBOARD

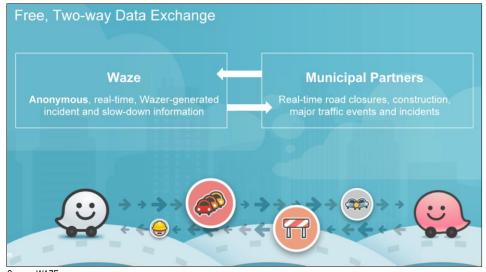
1.1 Introduction

On 3 November 2016, MMDA and Waze (under Alphabet [Google]) signed a memorandum of understanding (MOU) for a data-sharing partnership. Waze has been implementing a free reciprocal traffic information program, named "Connected Citizens Program" or CCP (it is now called Waze for Cities, https://www.waze.com/wazeforcities/), and as part of this program, it is working on a sharing initiative with MMDA.

Based on Waze data, there are 2.4 million active Wazers in the Philippines, who use the app for an average of 110 minutes per day. This number is about seven times more than the average of Wazers worldwide, which is about 15 minutes per day. While Wazers are on the app, GNSS location information acquired by each Wazer's smartphone is sent to the Waze server, indicating that a large amount of data is being collected by Waze.

In terms of data provision, instead of MMDA providing information on traffic restrictions, road construction, major traffic events, and traffic accident to Waze, Waze provides anonymized real-time travel speeds where traffic jams occur and traffic events that are collected from Wazers.

However, the utilization of Waze data had not progressed on the MMDA side. Hence, the JICA Project Team (JPT) deemed it necessary to acquire the data and create a database, i.e., a travel speed dashboard, to understand the temporal-spatial continuum of travel speeds on the road network in Metro Manila. The JPT developed a travel speed dashboard and used this database to identify bottlenecks causing traffic congestion. MMDA can use it for a before-and-after evaluation of the implementation of congestion countermeasures and traffic policies.



Source: WAZE

Figure 1.1: Connected Citizens Program

1.2 Concept of Travel Speed Dashboard

The JPT developed Travel Speed Dashboard based on the following concepts:

- (i) Store travel speed data from Waze;
- (ii) Visualize the travel speed situation on the road network in Metro Manila from a bird'seye view;
- (iii) Can search and retrieve data based on some criteria (e.g., year, month, day of the week, speed level, road type) and visualize the travel speed situation; and
- (iv) Can output data to create a time-space diagram to identify bottlenecks in each corridor.

1.3 Waze Data Specification

Data from Waze is provided in XML or JSON format via the Waze application programming interface (API), and real-time data is updated every 2 minutes.

A feed reader module has already been developed for MMDA by Waze's partner company Thinking Machines, which allows users to regularly retrieve and record data in a database via the Waze API.

| Element | Value | Description |
|------------------------------|---------------------------|--|
| pubMillis | Timestamp | Publication date (Unix time – milliseconds since epoch) |
| location | Coordinates | Location per report (X Y - Long-lat) |
| uuid | String | Unique system ID |
| magvar | Integer (0-359) | Event direction (Driver heading at report time. 0 degrees at North, according to the driver's device) |
| type | See alert type table | Event type |
| subtype | See alert sub types table | Event sub type - depends on atof parameter |
| reportDescription | String | Report description (supplied when available) |
| street | String | Street name (as is written in database, no canonical form, may be null) |
| city | String | City and state name [City, State] in case both are available, [State] if not associated with a city. (supplied when available) |
| country | String | (see two letters codes in <u>http://en.wikipedia.org/wiki/ISO_3166-1</u>) |
| roadType | Integer | Road type (see <u>road types table</u> in the appendix) |
| reportRating | Integer | User rank between 1-6 (6 = high ranked user) |
| jamUuid | string | If the alert is connected to a jam - jam ID |
| Reliability (new) | 0-10 | How reliable is the report |
| reportByMunici palityUser | Boolean | Alert reported by municipality user (partner) Optional. |

Table 1.1: Event Information and Travel Speed Data provided by Waze 1

Source: Waze

| Element | Value | Description |
|-------------------|--|--|
| pubMillis | Timestamp | Publication date (Unix time – milliseconds since epoch) |
| type | String | TRAFFIC_JAM |
| line | List of Longitude and Latitude coordinates | Traffic jam line string (supplied when available) |
| speed | Float | Current average speed on jammed segments in Km/h |
| length | Integer | Jam length in meters |
| delay | Integer | Delay of jam compared to free flow speed, in seconds (in case of block, -1) |
| street | String | Street name (as is written in database, no canonical form. (supplied when available) |
| city | String | City and state name [City, State] in case both are available, [State] if not associated with a city. (supplied when available) |
| country | String | available on EU (world) server (see two letters codes in http://en.wikipedia.org/wiki/ISO_3166-1) |
| roadType | Integer | Road type (see road types table in the appendix) |
| startNode | String | Nearest Junction/steet/city to jam start (supplied when available) |
| endNode | String | Nearest Junction/steet/city to jam end (supplied when available) |
| level | 0 - 5 | Traffic congestion level (0 = free flow 5 = blocked). |
| uuid | Long integer | Unique jam ID |
| turnLine | Coordinates | A set of coordinates of a turn - only when the jam is in a turn (supplied when available) |
| turnType | String | What kind of turn is it - left, right, exit R or L, continue straight or NONE (no info) (supplied when available) |
| blockingAlertUuid | string | if the jam is connected to a block (see alerts) |

Table 1.2: Event Information and Travel Speed Data provided by Waze 2

Source: Waze

1.4 Development of Pipeline for Aggregation

JPT developed a "pipeline" to generate data for the dashboard based on Waze data. The pipeline is shown in Figure 1.2, where the data from "Waze-Traffic-Data" is stored in the "Thinking Machine Waze Data Warehouse" every two minutes, and the data in the "JICA-MMDA Waze Data Warehouse" is stored once a month.

Waze data updates traffic information every two minutes. However, the dashboard is not intended to visualize real-time traffic conditions. After a certain amount of traffic data has been accumulated, it can be aggregated and analyzed to provide a bird's-eye view of the traffic condition on a road network that is continuous in time and space. Therefore, the dashboard is designed to be updated once a month based on Waze data.

Figure 1.3 shows the full data stream in the data warehouse. The blue boxes represent the pipeline tasks, while the yellow boxes represent the output tables generated by that specific pipeline task. It gets raw data from Waze, stores it in the jams table, then undergoes a series of data transformations before getting to the final road link lookup table.

| Open Data Sources | Google Cloud Platform | Google Cloud Platform |
|----------------------------|--|--|
| <u></u> | Thinking Machines Waze Data Warehouse | JICA-MMDA Waze Data Warehouse |
| Waze Traffic-data | App Engine Flask Web Service The provide the provided of t | Raw Waze Datasets BigQuery |
| | Cron Job (scheduled | |
| | every 2 minutes) App Engine | Boots Monthly Instance Schedule |
| | | |
| > Denotes movement of da | ta | |
| Facilitates another resour | ce | Dagster ETL Compute Engine |
| | | Ļ |
| | | Processed Waze Datasets BigQuery |
| | | Ļ |
| | | JICA Dashboard Cloud Run |
| | | |

Source: JPT

Figure 1.2: Diagram of the Data Platform

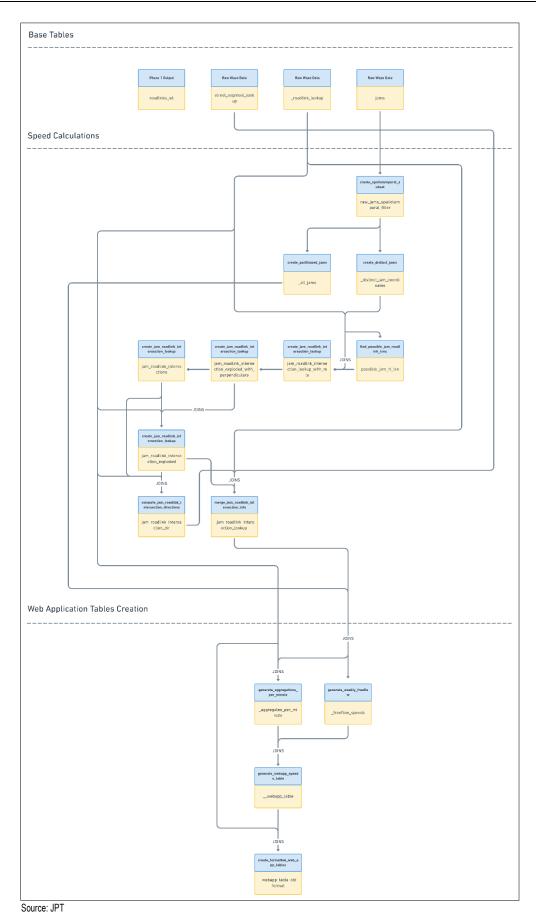


Figure 1.3: Data Flow for the Travel Speed Dashboard

1.5 Development of Travel Speed Dashboard

The Travel speed dashboard has functions of the visualization dashboard can be broadly divided into two: (1) color-coded display of travel speeds, and (2) color-coded display of the percentage of time for a given travel speed in a given period.

- (a) **Color-coded Display of Travel Speeds:** The dashboard calculates the travel speeds on each road link based on the difference between the travel speed data obtained from Waze data and free-flow speed data and displays them in different colors.
- (b) Color-coded Display of the Percentage of Time for a Given Travel Speed in a Given Time: In contrast, this function specifies, for example, that the percentage of travel speeds below 30km/h was 30% or more on a weekday in January 2021. The system then extracts and displays the road sections where the travel speed has been decreasing (going below 30km/h) for a long time (for more than 30% of the specified period). This function shows the more serious areas, or bottlenecks, where the slowdown continues for a long time.

The color-coding of travel speeds is based on the conditions in Table 1.3.

| | R | G | В |
|----|-----|-----|-----|
| 5 | 112 | 48 | 160 |
| 10 | 192 | 0 | 0 |
| 15 | 255 | 102 | 255 |
| 20 | 255 | 0 | 0 |
| 25 | 226 | 107 | 10 |
| 30 | 247 | 150 | 70 |
| 35 | 255 | 255 | 0 |
| 40 | 146 | 208 | 80 |
| 45 | 0 | 176 | 80 |
| 50 | 183 | 222 | 232 |
| 60 | 0 | 176 | 240 |
| 70 | 0 | 112 | 192 |
| 80 | 0 | 32 | 96 |

Table 1.3: Color Coding based on Travel Speed

Source: JPT

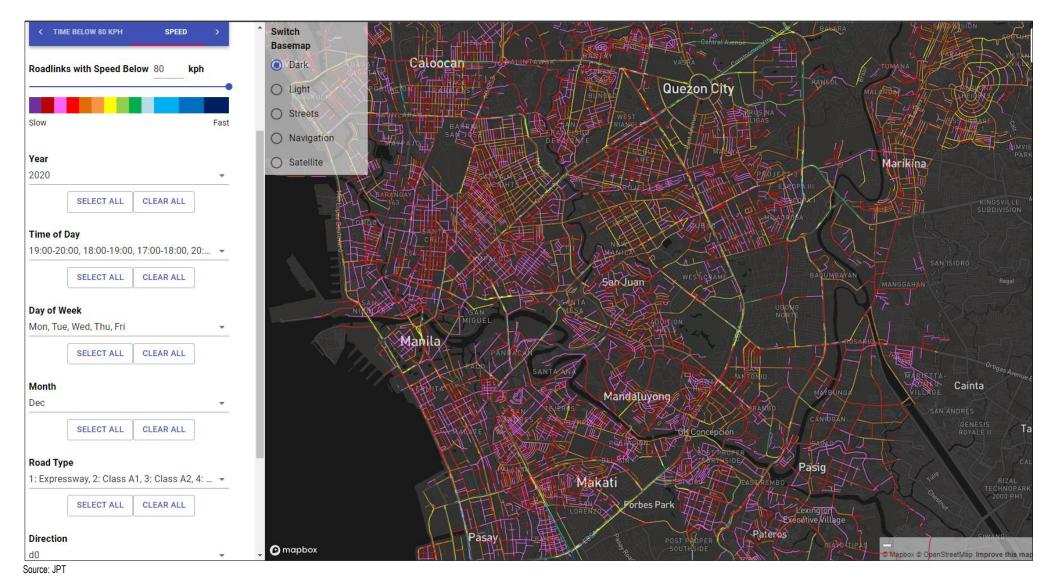
The dashboard visualizes jams at the road link level given the following parameters:

- (a) **Percentage of Time below a Given Speed:** Only displays the road links that meet the percent of occurrence.
- (b) **Speed:** Only displays the road links that are selected in the range.
- (c) Worst Road Links based on Percentage of Time: Narrows down the search to worst road links in terms of jams or delays.
- (d) **Road Links with Speeds below a Given Speed:** Only displays the road links that are selected in a range.
- (e) **Time of Day:** Selected time from the 24-hour data.
- (f) Day of Week: Selected day/s of the week.
- (g) Month: Selected month/s of the year.

- (h) **Road Type:** Selected road type (expressway, Class A1, Class A2, Class B, Class C, Class D, and Others).
- (i) **Direction:** d0 (eastbound/northbound) and d1 (westbound and southbound).

In addition, the dashboard has a function to visualize and display the aggregate results, as shown in Figure 1.4.

It also has a function to output the data being displayed as CSV data and to output CSV data to create a time-space diagram. After updating the map, the attributes of the entire road network and the space-time table of the circumferential and radial roads may be exported as CSV. It is also possible to output a CSV file to create a time-space diagram of bottlenecks in each corridor, as shown in Table 1.4.





| Table 1.4: E | Exported Data to Create a Time-Space Diagram |
|--------------|--|
|--------------|--|

| street_unique | | sp | beed s | peed_d0 s | peed_d1 | nours_bel hou | rs_wit perce | ntag roadTy | pe WKT | | | | | | | | | | | | |
|---------------------------|-----------|------------|------------|-----------|------------|---------------|--------------|--------------|-----------|-------------|-------------|-------------|--------------|-------------|-------------|-------------|--------------|-------------|-------------|-----------|-----------|
| Visitacion _s0_i1_m0 | | 6 | 6.684746 | 6.684746 | 10.94025 | 92 | 92 | 100 4: Class | B LINEST | RING(121.07 | 78923 14.54 | 9337, 121.0 | 78923 14.54 | 9524, 121.0 | 7891999470 | 02 14.55009 | 20013086) | | | | |
| Visitacion _s0_i1_m1 | | 6 | 6.691159 | 6.691159 | 10.85533 | 92 | 92 | 100 4: Class | B LINEST | RING(121.07 | 7891999470 | 2 14.550092 | 20013088, 12 | 21.078916 1 | 4.550847) | | | | | | |
| 145: C.M. Recto W _s0_i2 | 20_m1 | 6 | 6.693152 | 6.693152 | 10.24576 | 92 | 92 | 100 3: Class | A2LINEST | RING(120.96 | 5780094209 | 9 14.603151 | 3691485, 12 | 20.9675961 | 4.602929, 1 | 20.967465 1 | 14.6025205, | 120.967422 | 384671 14.6 | 024729870 | J88) |
| 145: C.M. Recto E _s0_i22 | 2_m1 | 6 | 5.921812 | 6.921812 | 12.95029 | 92 | 92 | 100 3: Class | A2 LINEST | RING(120.96 | 5751860127 | 1 14.602531 | 2963146, 12 | 20.967498 1 | 4.6025045, | 120.967206 | 14.602131, | 120.966977 | 006048 14.6 | 019239056 | 5777) |
| Doña Julia Vargas Ave | _s0_i1_m0 | | 7.21471 | 7.21471 | 20.31826 | 92 | 92 | 100 4: Class | B LINEST | RING(121.07 | 75903 14.58 | 331, 121.07 | 5517 14.583 | 564) | | | | | | | |
| 130: Sergeant Emilio Riv | | i6_m4 7 | 7.238297 | 7.238297 | | 92 | 92 | 100 3: Class | A2 LINEST | RING(120.99 | 653921306 | 9 14.644071 | 5949523, 12 | 20.9958271 | 4.644054, 1 | 20.995709 1 | 14.644051, 1 | 20.9956419 | 54524 14.64 | 404765521 | 45) |
| Doña Julia Vargas Ave_ | _s0_i0_m1 | 7 | 7.298587 | 7.298587 | 21.3512 | 92 | 92 | 100 4: Class | B LINEST | RING(121.07 | 7643379418 | 4 14.582966 | 9504693, 12 | 21.076422 1 | 4.582975, 1 | 21.075903 1 | 14.58331) | | | | |
| Doña Julia Vargas Ave | _s0_i2_m0 | 7 | .352681 | 7.352681 | 19.3313 | 92 | 92 | 100 4: Class | B LINEST | RING(121.07 | 75517 14.58 | 3564, 121.0 | 75168 14.58 | 3775, 121.0 | 74867 14.58 | 3914, 121.0 | 0748174329 | 77 14.58393 | 03313314) | | |
| | C1EB_1 | C1EB_2 | C1EB_ | 3 C1EB_ | 4 C1EB | _5 C1EB_6 | C1EB_7 | C1EB_8 | C1EB_9 | C1EB_10 | C1EB_11 | C1EB_12 | C1EB_13 | C1EB_14 | C1EB_15 | C1EB_16 | 6 C1EB_17 | 7 C1EB_18 | C1EB_19 | C1EB_2 | :0 C |
| roadlink_id | 3383 | 3384 | 4 338 | 35 33 | 86 33 | 387 331 | 3318 | 3317 | 3316 | 3315 | 3312 | 3311 | 3310 | 3309 | 3308 | 3307 | 7 3306 | 3305 | 3304 | 330 | 3 |
| street_unique | 145: C.M. | . 145: C.M | l. 145: C. | M. 145: C | .M. 145: 0 | C.M. 145: C.N | 1. 145: C.M | . 145: C.M. | 145: C.M. | 145: C.M. | 145: C.M. | 145: C.M | 145: C.M | 145: C.M | 145: C.M | . 145: C.M | l. 145: C.M | . 145: C.M. | . 145: C.M | 145: C.N | 4, 14 |
| corridor | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C1EB | C |
| route | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C1 | C |
| direction | 0 |) (|) | 0 | 0 | 0 1 |) (| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |) (|) (|) 0 | 0 | 1 | 0 |
| bearing | 46 | 6 46 | 6 6 | 45 | 46 | 44 22 | 222 | 221 | 221 | 221 | 228 | 251 | 256 | 256 | 256 | 286 | 5 290 | 291 | 291 | 29 | л |
| bq_roadlink_length | 94.32 | 94.32 | 2 73.6 | 35 73. | .61 73 | .68 89.63 | 2 67.86 | 72.2 | 72.2 | 72.2 | 92.26 | 89.9 | 82.59 | 82.59 | 82.59 | 82.72 | 2 82.77 | 78.52 | 78.51 | 78.5 | 31 |
| roadType | 3 | 1 3 | 3 | 3 | 3 | 3 : | 3 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |) 3 | 3 3 | 3 3 | 3 | : | 3 |
| start_point | POINT(12 | POINT(1 | 2 POINT | (12 POINT | (12 POIN | T(12 POINT(1 | 2 POINT(1) | POINT(12 | POINT(12 | POINT(12 | POINT(12 | POINT(12 | POINT(12 | POINT(12 | POINT(1) | POINT(1 | 2 POINT(1) | 2 POINT(12 | POINT(12 | POINT(1 | 12 PI |
| end_point | POINT(12 | POINT(1 | 2 POINT | (12 POINT | (12 POIN | T(12 POINT(1 | 2 POINT(1) | POINT(12 | POINT(12 | POINT(12 | POINT(12 | POINT(12 | POINT(12 | POINT(12 | POINT(1) | POINT(1 | 2 POINT(1) | 2 POINT(12 | POINT(12 | POINT(1 | 12 PI |
| 0:00 | 15.4 | 15.4 | 13. | 51 13. | .51 13 | .51 14.4 | 5 14.15 | 14.2 | 14.39 | 20.31 | 20.31 | 19.8 | 14.88 | 14.93 | 14.74 | 14.84 | 15.54 | 16.83 | 24.36 | 24.7 | 6 |
| 0:20 | 15.68 | 15.68 | 3 13.5 | 56 13. | 56 13 | .56 14.53 | 2 14.55 | 14.55 | 14.74 | 20.3 | 20.16 | 20.62 | 14.82 | 14.86 | 14.58 | 14.62 | 2 15.26 | 6 16.25 | 24.36 | 24.7 | 6 |
| 0:40 | 15.68 | 15.68 | 3 13.0 | 61 13. | .61 13 | .61 14.7 | 1 14.65 | 14.65 | 14.84 | 20.82 | 20.73 | 19.15 | 14.45 | 14.49 | 14.36 | 14.37 | 7 14.99 | 15.83 | 24.36 | 24.6 | 9 |
| 1:00 | 15.68 | 15.68 | 3 13. | 61 13. | .61 13 | .61 14.6 | 5 14.59 | 14.59 | 14.79 | 20.61 | 20.71 | 20.17 | 14.67 | 14.98 | 14.83 | 14.84 | 15.54 | 16.83 | 24.36 | 24.7 | 6 |
| 1:20 | 15.68 | 15.68 | 3 13. | 61 13. | .61 13 | .61 14.2 | 5 14.28 | 14.28 | 14.47 | 20.47 | 20.47 | 19.08 | 14.75 | 14.79 | 14.57 | 14.84 | 15.54 | 16.83 | 24.36 | 24.7 | 6 |
| 1:40 | 15.68 | | 3 13. | 61 13. | .61 13 | .61 14.8 | | | 14.91 | 21.36 | 21.36 | | | 14.98 | | | | | 24.36 | | |
| 2:00 | 15.68 | | 3 13. | | | .61 14.8 | | | 14.91 | | 21.36 | | | | | | | | 24.36 | | |
| 2:20 | 15.68 | | | | | .61 14.8 | | | 14.73 | | 20.45 | | 14.73 | | 14.64 | | | | | | - |
| 2:40 | 15.68 | | | | | .47 14.8 | | | 14.91 | | 21.36 | | 14.74 | | | | | | 24.36 | | _ |
| 3:00 | 15.68 | | | | | .61 13.6 | | | 13.87 | | 19.3 | | 14.93 | | | | | | | 24.8 | |
| 0.00 | 10.00 | 10.00 | | o. 10. | | | | 10.1 | 10.01 | 10.0 | 10.0 | 10.1 | 11.00 | 11.00 | 11.01 | 11.16 | . 10.00 | 10.00 | E | 27.0 | |

Source: JPT

1.6 Utilization of the Dashboard

By using the developed Travel Speed Dashboard, the following use cases are expected:

- (i) Understanding of the traffic situation in Metro Manila from a bird's-eye views
- (ii) Identification of potential traffic bottlenecks based on quantitative analysis;
- (iii) Analysis of traffic congestion at the corridor level;
- (iv) Evaluation of the effectiveness of countermeasures by comparing between before and after implementation; and
- (v) Analysis of the impact of severe incidents and events.

The above utilization can be referred to as TR4 Identification of Traffic Bottlenecks and Monitoring.

Figure 1.5 shows a sample of the use case of analyzing congestion using a time-space diagram. The vertical axis is time, and the horizontal axis is distance. The redder the color, the lower the speed. Based on the visualization, when and where congestion starts and how far it extends can be determined.

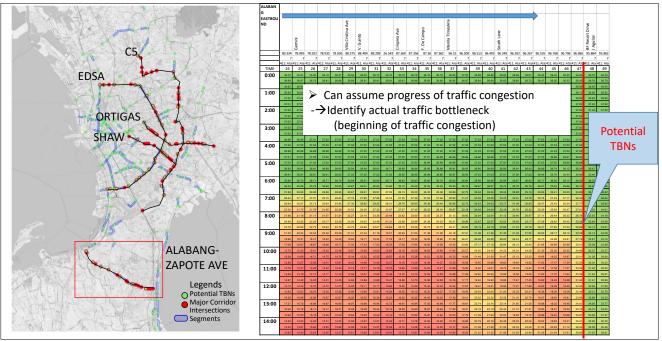




Figure 1.5: Sample of a Time-Space Diagram to Analyze Congestion

Figure 1.6 compares the travel speed data between March 2019 before the pandemic curtailed public mobility and March 2020 when Metro Manila was placed under ECQ. Travel speeds on EDSA in 2019 were low at less than 20km/h, but 2020 figures showed around 60km/h.

Using these diagrams, the situation before and after significant events/incidents can be compared and the impact on traffic flow can be analyzed. MMDA can use these when considering interventions before such events happen. In addition, the effectiveness and impact of traffic management interventions on traffic flow implemented in conjunction with the opening of new roads and railway infrastructures can be verified.

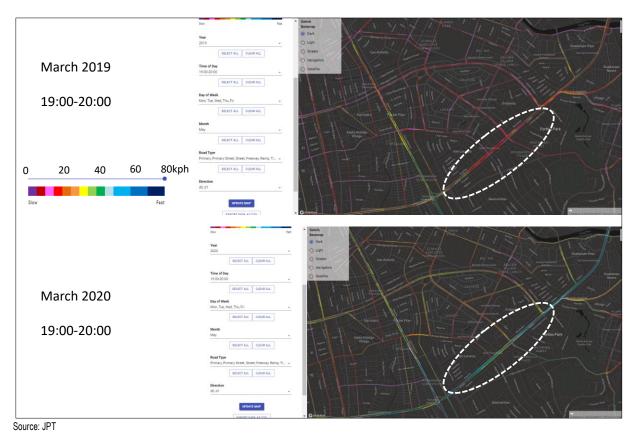


Figure 1.6: Travel Speeds on EDSA Before and During the Pandemic

2 DESIGN AND TECHNICAL DOCUMENTATION

2.1 Architecture of Platform

(1) Architecture Diagram

Figure 2.1 shows how data flows through the platform. The specific components are as follows:

- (a) Data Source: Waze-traffic data is fetched via an API request to the GeoRSS API.
- (b) **App Engine Cron Job:** makes an API request to Thinking Machines' internal Flask Web Service every two (2) minutes which orchestrates the fetching of Waze-traffic data and the automation of loading to a Google Cloud Storage bucket and BigQuery datasets.
- (c) **Raw Waze Dataset:** contains the tables for the raw Waze-traffic data i.e., irregularities, jams, and alerts.
- (d) **Dagster:** runs the road links speed calculation steps on the Waze-traffic data from the Raw Waze Dataset.
- (e) **Instance Schedule:** boots up the Compute Engine instance hosting the Dagster instance every first day of the month. Booting up the Compute Engine instance will run the road links speed calculation pipeline.
- (f) Processed Waze Dataset: contains the Big Query output tables processed from road links speed calculation executed by the Dagster instance; tables in this dataset are ready for consumption in the JICA Dashboard Web App.
- (g) **Cloud Run:** will host the Dashboard Web App which can query and display the processed Waze data from the Processed Waze Dataset in a map view.

| Open Data Sources | Google Cloud Platform | O Google Cloud Platform |
|------------------------|---|--|
| | Thinking Machines Waze Data Warehouse | JICA-MMDA Waze Data Warehouse |
| Waze Traffic-data | App Engine Data Landing Cloud Storage | Raw Waze Datasets BigQuery |
| | Cron Job (scheduled every 2 minutes) | |
| | App Engine | Boots Monthly Instance Schedule |
| → Denotes movement o | of data | Dagster ETL |
| Facilitates another re | source | Compute Engine |
| | | Ļ |
| | | Processed Waze Datasets BigQuery |
| | | + |
| | | JICA Dashboard Cloud Run |
| | | |

Source: JPT

Figure 2.1: Diagram of the Data Platform

(2) Google Cloud Platform

This travel speed database and dashboard used could service "Google Could Platform".

(a) A Suite of Cloud Computing Services that runs on the same infrastructure that Google uses internally for its end-user products (ex. Google Search, Gmail, and YouTube)

- (b) **Wide Range of Services:** Computing, Storage, Big Data, Machine Learning, Networking, Developer Tools, and Management tools
- (c) **Project Name:** MMDA-waze

(3) GCP Services

Listed in the chart below are the GCP services used for the project. Each of these services will be described in detail, and the role it plays in the project's overall architecture.

| Service | Description | Project Purpose |
|---|--|---|
| Cloud Storage | File storage web service for storing and accessing data on the GCP infrastructure | Host files generated by services within the Google Cloud Platform, audit logs, and Terraform backend |
| Big Query | Serverless data warehouse that enables scalable analysis over petabytes of data via ANSI SQL | Store raw Waze-traffic data, and run queries for the Waze Speed Calculation |
| Compute Engine | Scalable and configurable virtual machines | Run the Dagster Waze Speed Calculation pipeline monthly |
| Cloud Build | Serverless CI/CD platform for building, testing, and deploying software | Automate the building and pushing of the Dagster pipeline image to the Container Registry upon merging of change requests to the pipeline code in the GitHub repository |
| Cloud Identity and Access Management (IAM) | Identity management solution for accesses to GCP's resources | Control and limit access to the different services running on the Google Cloud Platform project |
| Container Registry | Repository for storing, managing, and accessing the GCP project's Docker images | Contain the images of the pipeline and dashboard code |
| Cloud Run | Serverless platform for developing and deploying highly scalable containerized applications | Hosts the container for the JICA dashboard web app |

Table 2.1: GCP Services

Source: JPT

(4) Cloud Storage (GCS)

Table 2.2: Cloud Storage used for the Project

| Bucket Name | Description | |
|------------------------------|---|--|
| *Artifacts.mmda-waze.appspot | Bucket used for storing Cloud Run builds artifacts | |
| MMDA-waze_cloudbuild | Bucket used by Cloud Run for staging build objects | |
| MMDA-waze-logsink | Bucket used for the GCP project logs | |
| MMDA-waze-terraform | Bucket for storing Terraform state, Terraform automates the | |
| | management of the GCP project's resources through code | |

Source: JPT

(5) Compute Engine (GCE)

Below is a list of all the GCE instances in this project and their respective purposes:

Table 2.3: GCE Instances in the Project

| VM Name | Purpose | |
|---------------------|---|--|
| Dagster-monthly | VM instance that hosts the monthly Waze Speed Calculation pipeline for production use, started every first day of the month and turned off at the last minute of the day. | |
| Dagster-monthly-dev | VM instance that hosts the Waze Speed Calculation pipeline for development use. | |

| VM Name | Purpose | | |
|------------------------|--|--|--|
| Dagster-historical | VM instance that hosts the historical Waze Speed | | |
| | Calculation pipeline for production use. | | |
| Dagster-historical-dev | VM instance that hosts the historical Waze Speed | | |
| | Calculation pipeline for development use. | | |

Source: JPT

(a) Instance Schedules

Below is a list of all the instance schedules responsible for scheduling when to turn on and off the GCE instances in the project:

| Instance Schedule Name | Purpose |
|--|---|
| Monthly-speed-calculation- schedule | Starts the dagster VM every 12:00 AM Manila Time Zone on the first day of the month, and stops at 11:59 PM the same day. |
| Daily-speed-calculation- schedule | Starts the dagster-dev VM every 12:00 AM Manila Time Zone every day, and stops it at 6:00 AM the same day. Can be disabled during the non-development time to save costs. |

Table 2.4: Instance Schedules

Source: JPT

(6) Access and Security (IAM): Users and Service Accounts

End-user access and application access through service accounts are managed through Cloud Identity and Access Management (Cloud IAM.) Each user, group of users, or service account is assigned a role(s) to determine the level of access to GCP resources. A role is a collection of permissions that is granted to the users and determines the level of access to GCP resources. Permissions cannot be assigned directly to an individual user or group of users. Roles, instead of permissions, are granted to the users.

(a) Service Accounts

To run code in GCP, service accounts are required and assigned to applications. Each application can have as many service accounts as needed to represent the different logical components.

Below is a table that details the service accounts, purpose, and assigned roles:

| Service Account Name | Purpose | Roles |
|------------------------------|---|--|
| waze-pipeline-service- | • Service account used by the Waze | BigQuery Data Editor |
| account@mmda- | Speed Calculation pipeline; also | BigQuery Job User |
| waze.iam.gserviceaccount.com | assigned to the Compute Engine instance hosting the pipeline | BigQuery Read Session User Secret Manager Secret Accessor |
| | | Storage Admin |
| waze-74407@appspot. | Service account for enabling the transfer | BigQuery Data Editor |
| gserviceaccount.com | of raw Waze-traffic data from Thinking | BigQuery Job User |
| | Machines' internal `waze-174407` GCP | |
| | project to the `mmda-waze` project | |
| mmda-waze-jica- | • Service account used by the JICA | BigQuery Data Viewer |
| dashboard@mmda- | Dashboard web app in the dev | BigQuery Job User |
| waze.iam.gserviceaccount.com | environment deployed on Cloud Run | BigQuery Read Session User |
| mmda-waze-jica-dashboard- | Service account used by the JICA | BigQuery Data Viewer |
| prod@mmda- | Dashboard web app in the production | BigQuery Job User |
| waze.iam.gserviceaccount.com | environment deployed on Cloud Run | BigQuery Read Session User |
| 218567230177@cloudbuild. | Service account used by Cloud Build | Cloud Build Service Account |
| gserviceaccount.com | when automating the building of the | |
| | pipeline image and pushing it to the | |

 Table 2.5:
 Service Account Details

| Service Account Name | Purpose | Roles |
|---|---|---|
| | Container Registry | |
| jica-waze-pipeline- bqup@mmda- waze.iam.gserviceaccount.com | Service account used by bqup for exporting the project's BigQuery structure and source code | BigQuery Metadata Viewer |
| terraform-service- account@mmda- waze.iam.gserviceaccount.com | Service account used for managing the project's GCP resources through Terraform | Cloud Build Editor Cloud SQL Admin Compute Admin Compute Network Admin Service Account Admin Service Account User Project IAM Admin Storage Object Admin |

Source: JPT

(7) Google Groups

Table 2.6: Google Groups Purposes

| Service Account Name | Purpose | Roles |
|--|--|---|
| mmda-waze- devs@thinkingmachin.es | Google Group for developers and maintainers of the project | Owner |
| jica-mmda-waze- clients@thinkingmachin.es | Provides view access to all the GCP Project resources to the stakeholders | Viewer |
| jica-mmda-waze-clients-bq- user@thinkingmachin.es | • Enables viewing of BigQuery data and metadata, and the usage of BigQuery jobs for analysis | BigQuery Data Viewer BigQuery Job User |

Source: JPT

(a) Networking

| Network | Subnetwork | Region | IP Address Ranges | Gateways |
|-----------------|----------------------------|-------------|-------------------|----------|
| Dagster-network | DAGSTER-network-subnetwork | us-central1 | 10.0.0/16 | 10.0.0.1 |

Source: JPT

(8) BigQuery

BigQuery is an enterprise data warehouse that enables super-fast SQL queries using the processing power of Google's infrastructure.

The BigQuery (BQ) Project Structure follows Thinking Machine's (TM) project structure standards for data warehouses. These standards ensure a consistent high-quality structure and process to manage the BQ tables and views in the project.

(a) Cloud Run

For hosting the JICA Dashboard web application we run services in Cloud Run. We have separate services for the phase 1 and phase 2 versions of the web application listed below:

Table 2.8: Services Run in Cloud Run

| Service Name | Description |
|---|--|
| mmda-waze-jica- dashboard-dev | Cloud Run service for the JICA dashboard web app for development purposes |
| mmda-waze-jica- dashboard-prod | Cloud Run service for the JICA dashboard web app for development |
| mmda-waze-jica- dashboard-phase-1-prod | Cloud Run service for the Phase 1 JICA dashboard web app for production use |

Source: JPT

2.2 Aggregation Method

This chapter discusses the most crucial variables and terminologies involved in the computations. Shown below, is a table of summary of each variable, their descriptions, and what each one looks like in the data warehouse. Furthermore, each variable, along with visual examples, is further expounded upon in the succeeding subchapter.

(1) Variables

| Variable | Description | Sample Data |
|----------------|--|---|
| Road Type | Numeric code for the type of road | 1 - street |
| | where the jam occurred | 17 - private road |
| Roadlink | <100m road segment splits | Lawton Ave _s0_i1_m0 |
| | | A. Mabini Ave _s0_i0_m2 |
| Freeflow Speed | speeds along roads when and where | • 25.84 |
| | there is no traffic (in m/s) | • 33.71 |
| Jammed Speed | average speed in a jam from Waze | • 20.81 |
| | data (in m/s) | • 29.56 |
| Direction | pertains to the direction of the jam | • d0 |
| | | • d1 |

 Table 2.9:
 Variables used in the Computations

Source: JPT

(a) Jams

Before defining the variables, it is crucial to define what a jam is as this is the main foundation of the calculations. According to Waze, a jam is recorded when the average speed among a certain number of cars on the road falls below 20% of the usual speed along that road. This "usual speed", or what we call free flow speed, is the average speed of a car traveling when there is no heavy traffic (e.g. speeds of cars early in the morning).

(b) Road Type

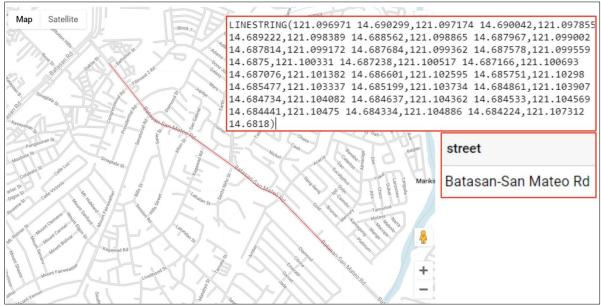
Road types are numerical values that help us categorize the kind of road being considered. Shown below are the current values from the Waze documentation. For analysts, knowing the type of road they are dealing with will help them to have more accurate estimates of speed and other metrics.

| _ |
|------------|
| Expressway |
| Class A1 |
| Class A2 |
| Class B |
| Class C |
| Class D |
| Others |
| |

Table 2.10: Road Type Classification

(c) Road Links

In Waze data, roads are lengths and lines defined by geographical coordinates. Roads are defined by linestrings, which are a connected series of line segments, often represented by a collection of longitude and latitude coordinates. The image below shows an example linestring, which, when transformed with geographic functions in the data warehouse, translates to the Batasan-San Mateo Road in Quezon City.



Source: JPT

Figure 2.2: Linestring Translation of Batasan-San Mateo

Road links are just smaller road segments with lengths less than 100m. The reason for splitting these roads into smaller segments is to further improve the accuracy and consistency of speed calculations on these roads, as jams are highly dependent on intersections. The way the team has split roads into road links involves two processes: the naming and the calculation processes.

(a) How Road Links were Named

Table 2.11: Naming of Road Links

| Steps | Road Link Names |
|---|--|
| 1, Starting with the original street name | Batasan-San Mateo Rd |
| 2, This is then differentiated from other streets also named 10th Ave | Batasan-San Mateo Rd_s0 |
| 3, Splits by intersections with other streets | Batasan-San Mateo Rd _s0_i0, Batasan-San Mateo Rd _s0_i1, etc. |
| 4, Split into <100m road links | Batasan-San Mateo Rd _s0_i0_m0, Batasan-San Mateo Rd_s0_i0_m1, etc. |
| Source: JPT | |

The first process is divided into four steps as shown in the table above. To further understand this, we take our previous linestring for example. We have a starting linestring for a road named Batasan-San Mateo Rd. This entire road length is further classified differently from those who have the same street name, resulting in naming conventions like Batasan-San Mateo Rd_s0 and Batasan-San Mateo Rd_s1 (Batasan-San Mateo Rd Street 0, Street 1). The third step further splits these unique streets by intersections, resulting in names like Batasan-San Mateo Rd_s0_i0 and Batasan-San Mateo Rd_s0_i1 (Batasan-San Mateo Rd Street 0 Intersection 0, Street 0 Intersection 1). Lastly, these are split into road link segments smaller than 100m, resulting in names like Batasan-San Mateo Rd_s0_i0_m1.

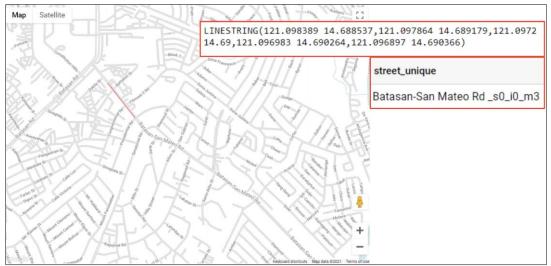
(b) How Road Links were Split

| Steps | | | | | | | |
|---|--|--|--|--|--|--|--|
| 1, Obtain the unique coordinates for each road in Waze from | | | | | | | |
| linestrings | | | | | | | |
| 2, Split the road into smaller segments based on its | | | | | | | |
| intersections with other roads | | | | | | | |
| 3, If there are any segments longer than 100m, split these into | | | | | | | |
| even smaller segments of length (original length)/100 each | | | | | | | |
| Source: JPT | | | | | | | |

Table 2.12: Splitting the Road Links

This second process is responsible for trimming the long linestrings into road link segments of less than 100m. For example, the raw linestring of Batasan-San Mateo Rd is more than 100m, thus, this will be continuously split using the steps as mentioned in the table until we satisfy our threshold.

Eventually, we arrive at segments that satisfy the conditions, as shown below.



Source: JPT

Figure 2.3: Trimmed Down Linestring of Batasan–San Mateo

Shown below is an example of how each linestring looks like in the data warehouse.

| street_sim | coords |
|-----------------------------|---|
| Aguho _s0_i5_m1 | LINESTRING(121.063758056115 14.6312519123159, 121.063757 14.631249 |
| Dona Elena _s0_i1_m0 | LINESTRING(120.991699 14.740061, 120.991877 14.739989, 120.991967 14 |
| 1: MacArthur Hwy _s0_i34_m5 | LINESTRING(120.957229879193 14.7173402723181, 120.957229 14.71734 |
| Martan _s0_i4_m0 | LINESTRING(121.085607 14.69826, 121.085658 14.698434, 121.085657 14. |
| Pio Pedrosa _s0_i0_m0 | LINESTRING(120.987509 14.428312, 120.987678 14.428427, 120.987744 14 |
| 38th _s0_i2_m0 | LINESTRING(121.058929 14.557434, 121.058883 14.557557, 121.058826 14 |
| Emerald _s0_i1_m1 | LINESTRING(121.032788079657 14.7085190162866, 121.032876 14.70850 |
| F. Manalo _s1_i20_m0 | LINESTRING(121.033038 14.599593, 121.033102 14.599696, 121.033198 14 |
| Katarungan _s1_i1_m1 | LINESTRING(121.090846291434 14.6978167413849, 121.090846 14.69781 |
| Don Mario _s0_i0_m0 | LINESTRING(121.080546 14.679002, 121.080502 14.678936, 121.080452 14 |
| Tulip _s0_i0_m0 | LINESTRING(121.011199 14.482859, 121.011091 14.482637, 121.01104 14.4 |
| Source: IPT | |

Source: JPT

Figure 2.4: Linetstring in Data Warehouse

(c) Freeflow Speed

One of the issues with Waze data is that it does not provide travel speeds in free-flow conditions, as Waze is primarily intended to display congested sections. To solve this issue, the travel speed during free flow is calculated from "jammed speeds", "delay travel time between free flow and jammed condition," and "jammed length" values in the Waze data. The specific calculation method is described below.

Free-flow speeds (in meters per second) are along roads when there is no traffic. Free-flow speed is a prerequisite to understanding the formula used for jammed speeds, as these are used to infer travel times along the unjammed parts of roads. This formula computes free-flow speeds:

 $\frac{length_{jam}}{\frac{length_{jam}}{speed_{jam}-0.1} - delay_{jam}}$

Where: length_jam = length of jam according to Waze (in meters) speed_jam = average travel speed along with the jam (in meters per second) delay_jam = difference between the in-jam delayed travel time and the ideal free-flow travel time (in seconds)

For any given date and road link, this is applied in the following manner:

- (i) Get the jams that occurred on the road link for that day and the past days;
- (ii) Compute the free-flow speed using the formula;
- (iii) Take the median free-flow speed among those jams.

Freeflow speeds (in meters per second) are the speeds along roads when there is no traffic. Freeflow speed is a prerequisite to understanding the formula that the team used for jammed speeds, as these are used to infer travel times along the unjammed parts of roads. Freeflow speeds were computed by this formula:

$$\frac{length_{jam}}{\frac{length_{jam}}{speed_{jam}-0.1} - delay_{jam}}$$

Where:

length_jam = length of jam according to Waze (in meters)
speed_jam = average travel speed along the jam (in meters per second)
delay_jam = difference between the in-jam delayed travel time and the
ideal free-flow travel time (in seconds)

For any given date and road link, this is applied in the following manner:

- (i) Get the jams that occurred on the road link for that day and the past days
- (ii) Compute the free-flow speed using the formula
- (iii) Take the median free-flow speed among those jams

(d) Jammed Speed

Jammed speed (in meters per second) is a metric that is provided by Waze data. It is the average speed of vehicles on a congested road. The jammed speed formula that the JPT

used was based on the inference from free-flowing speeds of vehicles on the road links. The formula for jammed speed is shown below.

 $\frac{(\Sigma length_{jam}) + (\Sigma length_{freeflow})}{(\Sigma traveltime_{jam}) + (\Sigma traveltime_{freeflow})}$

Where: length_jam = length of jam accdg. to Waze (in meters) length_freeflow = length of jam not occupied by length_jam (in seconds) traveltime_jam = length_jam / jam speed (in meters) traveltime_freeflow = length_freeflow / free-flow speed (in seconds)

(e) Direction

Direction pertains to the direction of a traffic flow on a road link. This is another important variable to be aware of, as shown in the final dashboard.

There are only two values for the road link directions: d0 and d1. Jams with d0 pertain to road links with traffic flows closer to either true East or true North or those that point towards Quadrant 1 of the XY plane. On the other hand, jams with d1 pertain to road links with traffic flows closer to either true West or true South or those that point towards Quadrant 3 of the XY plane.

| Table 2.13: | Definition of Directions |
|-------------|---------------------------------|
|-------------|---------------------------------|

| ITEM | In case of Double Link Road (eg. EDSA, C5, Ortigas, Quezon Ave…) | In case of NOT Double Link Road |
|------|---|---------------------------------|
| "d0" | East Bound / North Bound | Existing "d0" |
| "d1" | West Bound / South Bound | Existing "d1" |

Source: JPT

To further understand how direction is calculated, Figure 2.5 shows a specific example. If there exists a jam (the red arrow in the figure), and it's pointing towards Quadrant 1, leaning more towards the northern angle, following the conditions above, the jam direction is closer to the true North/true East rather than the true South/true West. Therefore, the direction of this jam is d0.

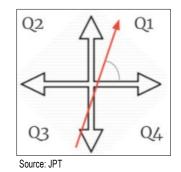


Figure 2.5: Setting Directions of Traffic Flows

This variable will help distinguish the speeds between two opposing traffic flows on the same road link.

(2) Buffer Zones

Buffer zones will be set up to handle changes in Waze Road Data due to inaccurate GPS by the app. This does not guarantee that the changing Waze road data will always be

captured, but it increases the change of capture. The buffer zones are still able to distinguish overlapping road data due to overpasses or flyovers.

The size of the buffer zone will depend on road type and size. The same buffer zone range will apply every month and year. If the coordinates of the road change per run and these are not captured by the buffer zones, they will not be captured by the data.

(3) Corridor Maps and Visualizations

The road links per corridor were developed by JPT.

The maps show alignments of circumferential and radial roads and can be queried on BigQuery GeoViz.

Query:

SELECT ST_GEOGFROMTEXT(coords) as linestring

FROM `mmda-waze.waze_lookups.202110_corridors_v2`

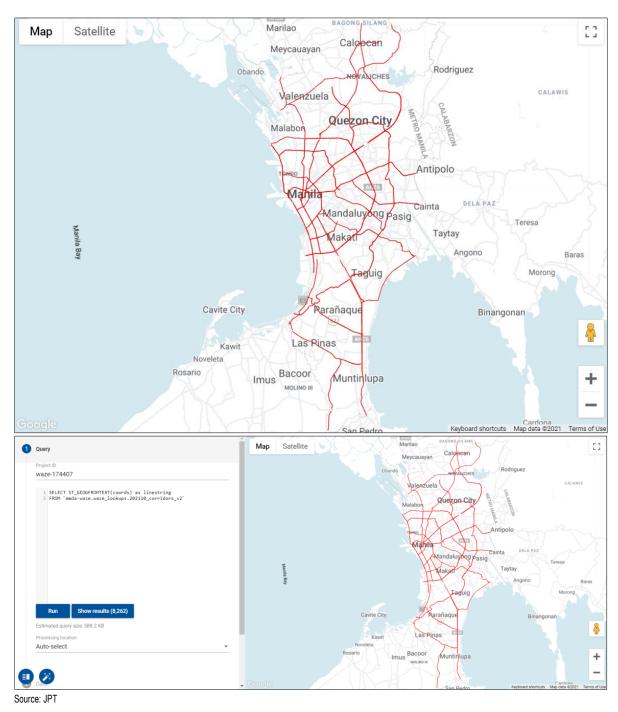


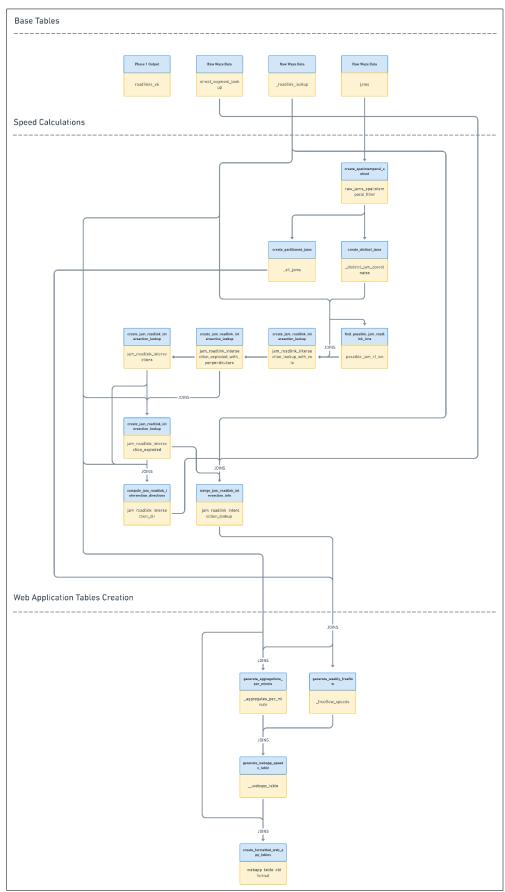
Figure 2.6: Alignments of Circumferential and Radial Roads in Metro Manila

2.3 Data

This section covers the data source used in the Waze Speed Calculation pipeline and the JICA Dashboard web app, BigQuery datasets, for storage of both raw and processed Waze-traffic data, frequency of data ingestion and processing, and the detailed flow of data from source to final tables produced.

(1) Data Flow

A better view of the flowchart can be seen in the Whimsical link here. This is the full data stream for the CTMP Project in the data warehouse. The blue boxes represent the pipeline tasks while the yellow boxes represent the output tables generated by that specific pipeline task. It gets raw data from Waze, stores it in the jams table, then undergoes a series of data transformations before we arrive at the final road link lookup table.



Source: JPT

Figure 2.7: Data Flowchart

(2) BigQuery Datasets

| Dataset Name | Details |
|-------------------------|--|
| waze_lookups | Dataset for the processed and aggregated Waze-traffic data in production use; tables sourced by the JICA Dashboard web application in the prod environment are stored here; this dataset is updated monthly |
| waze_lookoups_dev | Dataset for the processed and aggregated Waze-traffic data in development use; tables sourced by the JICA Dashboard web application in the dev environment are stored here; use this dataset when testing changes introduced to the pipeline code before deploying to production |
| waze_traffic | Dataset for the raw Waze-traffic data: jams, alerts, irregularities; this dataset is updated every 2 minutes; for production use |
| waze_traffic_historical | Dataset for the raw Waze-traffic data: jams, alerts, irregularities; a historical copy up to a certain date but not appended every 2 minutes unlike `waze_traffic` |
| phase_1_web_app | Dataset for the processed Waze data ready for dashboard consumption; for production use |

Table 2.14: Dataset Details

Source: JPT

(3) Data Dictionary and Data Processing

(a) Data Dictionary and Data Processing Sheet

Table 2.15: Data Dictionary and Data Processing Sheet

| Project Nam | e Dataset Name | Table Name | Fields | Value | Description | Notes | Shared/Internal |
|-------------|----------------|-----------------------|----------------------|------------|---|--|-----------------|
| mda-waze | waze_lookups | roadlinks_v6 | street_unique | STRING | Name string of the roadlink in <street_name></street_name> | Used for prod/live dashboards | Shared |
| | | | | | Linestring representation of the roadlink; | | |
| | | | | | contains the roadlink's coordinates that can be | | |
| | | | WKT | LINESTRING | visualized using certain geographic functions | Used for prod/live dashboards | Shared |
| | | | | | | Used for prod/live dashboards | |
| | | | | | Integer ID of the roadlink; unique identifier of | Osed for prouvive dashboards | |
| mda-waze | waze lookups | roadlink lookup | roadlink id | INTEGER | each roadlink | Used for prod/live dashboards | Shared |
| | | | | | Integer representation of the road type; | | |
| | | | | | refer to either the Waze-traffic spec or JICA's | | |
| | | | | | documentation; used for more accurate | | |
| | | | roadType | INTEGER | estimates of vehicle speeds on that road type | Used for prod/live dashboards | Shared |
| | | | | | | | |
| | | | street_sim | STRING | Formatted name string of the roadlink | Used for prod/live dashboards | Shared |
| | | | | | Linestring representation of the roadlink; | | |
| | | | | GEOGRAPH | | | |
| | | | coords | Y | visualized using certain geographic functions | Used for prod/live dashboards | Shared |
| | | | 000/00 | | Notanzoa asing ocitani goographic fullolions | coss for provine dasiboards | 0.00.00 |
| | | | angle | FLOAT | Angle of roadlink in degrees | Used for prod/live dashboards | Shared |
| | | | bg roadlink length | FLOAT | Length of the roadlink in meters | Used for prod/live dashboards | Shared |
| | | | bq_roauink_iengui | LOAT | Lenger of the foadilitik in meters | Osed for prouvive dashboards | Shareu |
| | | | | GEOGRAPH | Polygon representation of the roadlink with 6.5m | | |
| | | | buffered_6m | Y | buffers on each side | Used for prod/live dashboards | Shared |
| | | | | | | | |
| | | | | | Name string of the roadlink in | | |
| | | | | | <street_name>_s<i> format</i></street_name> | | |
| | | | | | where: | | |
| | | | | | street_name - refers to raw street name | | |
| nmda-waze | waze_lookups | street_segment_lookup | street | STRING | s <i> - ith roadlink with the same street name</i> | Used for prod/live dashboards | Shared |
| | | | | | Polygon/multilinestring representation of the | | |
| | | | | | street segment | | |
| | | | coords | STRING | coordinates in string | Used for prod/live dashboards | Shared |
| | | | | | The angle of the roadlink with respect to the | | |
| | | | bearing | STRING | horizontal X axis | Used for prod/live dashboards | Shared |
| | | | direction horizontal | STRING | Horizontal direction of the street E.g. E, W | Used for prod/live dashboards | Charad |
| | | | direction_nonzontai | STRING | Horizontal direction of the street E.g. E, W | Osed for prodvive dashboards | Shareu |
| | | | direction_vertical | STRING | Vertical direction of the street E.g. N, S | Used for prod/live dashboards | Shared |
| | | | | | | | |
| | | | direction_road | STRING | Direction of the road E.g. E, W, N, S | Used for prod/live dashboards | Shared |
| | | | | | | | |
| nmda-waze | waze_lookups | _freeflow_speeds | roadlink_id | INTEGER | Integer ID of the roadlink | Used for prod/live dashboards | Shared |
| | | | direction_jam | STRING | Direction of the jam E.g. N, S, E, W | Used for prod/live dashboards | Sharad |
| | | | unection_jam | GIRING | Direction of the jam E.g. N, O, E, W | used for prouvive dashboards | Shareu |
| | | | | INTEGER | Year when jam occured | Used for prod/live dashboards | Shared |
| | | | year | | | | |
| | | | year | INTEGEN | Integer representation of month when jam | | |
| | | | year | INTEGER | Integer representation of month when jam occured (e.g 0 = January, 1 = February, etc) | Used for prod/live dashboards | |
| | | | | | | Used for prod/live dashboards | |
| | | | | | occured (e.g 0 = January, 1 = February, etc) Number of vehicle samples that were added to | Used for prod/live dashboards | |
| | | | | INTEGER | occured (e.g 0 = January, 1 = February, etc) | Used for prod/live dashboards Used for prod/live dashboards | Shared |
| | | | month | INTEGER | occured (e.g 0 = January, 1 = February, etc) Number of vehicle samples that were added to get this average freeflow speed value in that | | Shared |

| Project Nam | ne Dataset Name | Table Name | Fields | Value | Description | Notes | Shared/Internal |
|-------------|-----------------|-----------------------------|-----------------------|---|---|-------------------------------|-----------------|
| mmda-waze | waze_lookups | _aggregates_per_minute | time | TIMESTAMP | Timestamp of jam recorded | Used for prod/live dashboards | Shared |
| | | | roadlink_id | INTEGER | Integer ID of the roadlink | Used for prod/live dashboards | Shared |
| | | | direction_jam | STRING | Direction of the jam captured by the roadlink | Used for prod/live dashboards | Shared |
| | | | | FLOAT | Length of the roadlink in meters | Used for prod/live dashboards | |
| | | | ixn_total_length | FLOAT | Total length of intersection in meters | Used for prod/live dashboards | |
| | | | | | Integer multiplier of how much the intersection | | |
| | | | ixn_length_multiplier | FLOAT | will grow based on aggregates | Used for prod/live dashboards | |
| | | | freeflow_speed | FLOAT | Speeds of the vehicles without traffic | Used for prod/live dashboards | |
| | | | jammed_time | FLOAT | Duration of jam in seconds | Used for prod/live dashboards | Shared |
| mmda-waze v | waze_lookups | webapp_table_ <date></date> | roadlink_id | INTEGER | Integer ID of the roadlink | Used for prod/live dashboards | Shared |
| | | | direction_jam | STRING | Direction of the jam E.g. N, S, E, W | Used for prod/live dashboards | Shared |
| | | | day | DATE | Date of when the jam has occured | Used for prod/live dashboards | Shared |
| | | | hour | INTEGER | Total number of hours that a jam occured on that roadlink in a specific timeframe | Used for prod/live dashboards | Shared |
| | | | | | Pertains to which minute time frame the jam was | | |
| | | | | | captured (segmented between 0 minutes, 20 minutes, and 40 minute time-windows between | | |
| | | | minute_bucket | INTEGER | full hours); Has unique values of 0, 20, 40 only | Used for prod/live dashboards | Shared |
| | | | ave_speed | FLOAT | average travel speed along the jam (in meters per second) | Used for prod/live dashboards | Shared |
| | | | | | Formatted ame string of the roadlink in | | |
| | | | | | <street_name>_s<i>_i<j>_m<k> format where:</k></j></i></street_name> | | |
| | | | | street_name - refers to raw street name s <i> - ith roadlink with the same street name</i> | | | |
| mmda-waze | waze_lookups | webapp_table_old_format | street unique | STRING | i <j> - jth intersection of the roadlink m<k> - kth <100 meter split of the roadlink</k></j> | Used for prod/live dashboards | Shared |
| | hazo_loonapo | | | FLOAT | freeflow speed of vehicles in that jam (meters per second) | Used for prod/live dashboards | |
| | | | speed | | | | |
| | | | time | INTEGER | | Used for prod/live dashboards | |
| | | | day | INTEGER | Integer value to day of the month Integer value of month of the year (e.g. 0 = | Used for prod/live dashboards | Shared |
| | | | month | INTEGER | January, 1 = February) | Used for prod/live dashboards | Shared |
| | | | year | INTEGER | Year of when the jam occured | Used for prod/live dashboards | Shared |
| | | | date | DATE | Timestamp of when the jam occured Integer representation of the road type of the | Used for prod/live dashboards | Shared |
| | | | | INTEGED | roadlink; refer to either the Waze-traffic spec or | | Objected |
| | | | roadtype | INTEGER | JICA's documentation Has only two values 0 and 1, which pertains to | Used for prod/live dashboards | Snared |
| | | | | | d0 and d1. | | |
| | | | | | d0 are for jams closer to the direction of either the true East or true North. | | |
| | | | direction | INTEGER | d1 for jams closer to the direction of either the true West or true South | Used for prod/live dashboards | Shared |
| | | | | | Formatted ame string of the roadlink in | | |
| | | | | | <pre>street_name>_s<i>_i<j>_m<k> format where:</k></j></i></pre> | | |
| | | | | | street_name - refers to raw street name | | |
| | | | | | s <i>- ith roadlink with the same street name i<j> - jth intersection of the roadlink</j></i> | | |
| mmda-waze | waze_lookups | _average_ff_per_r1_dir | street_unique | STRING | m <k> - kth <100 meter split of the roadlink</k> | Used for prod/live dashboards | |
| | | | roadlink_id | INTEGER | Integer ID of the roadlink Has only two values 0 and 1, which pertains to | Used for prod/live dashboards | Shared |
| | | | | | d0 and d1. | | |
| | | | | | d0 are for jams closer to the direction of either the true East or true North. | | |
| | | | di | INTEGER | d1 for jams closer to the direction of either the | llead for good (* 1997) | Objected |
| | | | | INTEGER | true West or true South | Used for prod/live dashboards | |
| | | | freeflow_speed | FLOAT | Calculated freeflow speed in meters per second Number of datapoints used to calculate the | | |
| | | | observations | INTEGER | average freeflow speed | Used for prod/live dashboards | Shared |

| Project Name | Datacot Namo | Table Name | Fields | Value | Description | Notos | Sharod/Intornal |
|--------------|---|-----------------------------|----------------|-----------|--|---|-----------------|
| Project Name | Dataset Name | | Fields | value | Description | Notes | Shared/Internal |
| | | | | | Alias from _average_ff_per_rl_dir | | |
| | | | | | If the value for the direction column above is 0, this refers to the freeflow speed average for that row's roadlink. | | |
| N/A | N/A | N/A | ff_d0 | INTEGER | Is the value of freeflow speeds that follow the direction of the roadlinks. Alias from _average_ff_per_rl_dir | Used for prod/live dashboards | Shared |
| | | | | | If the value for the direction column above is 1, this refers to the freeflow speed average for that row's roadlink. | | |
| | | | ff_d1 | INTEGER | Is the value of freeflow speeds that follow the opposite direction of the roadlinks. | Used for prod/live dashboards | Shared |
| | | | | | Alias from _average_ff_per_rl_dir | | |
| | | | | | If the value for the direction column above is 0, this refers to the total number of observations (under the observation column). | | |
| | | | freq_d0 | INTEGER | Total number of datapoints used to calculate ff_d0 values; more datapoints make the ff_d0 values much more significant and accurate | Used for prod/live dashboards | Shared |
| | | | | | | | |
| | | | | | Alias from _average_ff_per_rl_dir | | |
| | | | | | If the value for the direction column above is 1, this refers to the total number of observations (under the observation column). | | |
| | | | | | Total number of datapoints used to calculate | | |
| | | | freq_d1 | INTEGER | ff_d1 values; more datapoints make the ff_d1 values much more significant and accurate | Used for prod/live dashboards | Shared |
| | | | · • | | | | |
| | jica_2021_ <suffix< th=""><th>raw_jams_spatiotemporal_fil</th><th></th><th></th><th></th><th>Used for dev/testing only, intermediate table used for</th><th></th></suffix<> | raw_jams_spatiotemporal_fil | | | | Used for dev/testing only, intermediate table used for | |
| waze-174407 | > | ter | speed | FLOAT | Jam speed in meters per second | computations Used for dev/testing only, | Internal |
| | | | street | STRING | Name string of the street specific to that city | intermediate table used for computations | Internal |
| | | | Su CCL | SINING | rearrie suring or the street specific to that city | Used for dev/testing only, | mollia |
| | | | city | STRING | Name string of the city where the jam occurred | | Internal |
| | | | | | | Used for dev/testing only, intermediate table used for | |
| | | | length | INTEGER | Jam length in meters Integer representation of the road type; refer to either the Waze-traffic spec or JICA's | computations Used for dev/testing only, intermediate table used for | Internal |
| | | | roadType | INTEGER | documentation difference between the in-jam delayed travel | computations Used for dev/testing only, | Internal |
| | | | delay | INTEGER | time and the ideal freeflow travel time (in seconds) | intermediate table used for computations Used for dev/testing only, | Internal |
| | | | jamTime | TIMESTAMP | Time the jam occurred | intermediate table used for computations | Internal |
| | | | coords | STRING | Linestring representation of where the jam | Used for dev/testing only, intermediate table used for computations | Internal |
| | | | coords | STRING | occurred | | mellidi |
| waze-174407 | jica_2021_ <suffix ></suffix | _distinct_jam_coordinates | jam_id | INTEGER | Integer ID of the jam | Used for dev/testing only, intermediate table used for computations Used for dev/testing only, | Internal |
| | | | coords | STRING | Linestring representation of the jam coords in string | intermediate table used for | Internal |
| | | | | | Name string of the street where the jam | Used for dev/testing only, intermediate table used for | |
| | | | street | STRING | occurred | computations Used for dev/testing only, intermediate table used for | Internal |
| | | | roadType | INTEGER | Road type of the street where the jam occurred | computations Used for dev/testing only, | Internal |
| | | | num_jams | INTEGER | Number of times the jam occurred in the table | intermediate table used for computations Used for dev/testing only, | Internal |
| | | | bq_jam_length | FLOAT | Length of the jam linestring in meters | intermediate table used for | Internal |
| | | | | | | Used for dev/testing only, | |
| waze-174407 | jica_2021_ <suffix ></suffix | _all_jams | jam_id | INTEGER | Integer ID of the jam referenced in thedistinct_jam_coordinates | intermediate table used for | Internal |
| | | | time | | Start time of the jam | intermediate table used for computations | Internal |
| | | | | | | Used for dev/testing only, intermediate table used for | |
| | | | jammed_speed | FLOAT | Jammed speed in meters per second | computations Used for dev/testing only, | Internal |
| | | | freeflow_speed | FLOAT | Calculated freeflow speed in meters per second | intermediate table used for | Internal |
| | | | spood | | | | |
| waze-174407 | jica_2021_ <suffix ></suffix | possible_jam_rl_ixn | jam_id | INTEGER | Integer ID of the jam referenced in thedistinct_jam_coordinates | Used for dev/testing only, intermediate table used for computations Used for dev/testing only, | Internal |
| | | | atract ion- | OTDING | Name string of the street where the jam | intermediate table used for | Internal |
| | | | street_jam | STRING | occurred Formatted name string of the street where jam occurred | computations | Internal |
| | | | | | <street_jam>_s<i>_i<j>_m<k> format</k></j></i></street_jam> | | |
| | | | | | where: street_name - refers to street where jam | | |
| | | | | | occured s <i> - ith roadlink with the same street name</i> | Used for dev/testing only, | |
| | | | street_sim | STRING | i <j> - jth intersection of the roadlink m<k> - kth <100 meter split of the roadlink</k></j> | intermediate table used for computations | Internal |
| | | | | | · · · · · · · · · · · · · · · · · · · | | |

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| Project Name | Dataset Name | Table Name | Fields | Value | Description | Notes | Shared/Internal |
|--------------|---|------------------------------|--------------------------|----------|--|---|-----------------|
| | | | | | | Used for dev/testing only, | |
| | • | jam_roadlink_intersection_lo | , | | Integer ID of the jam referenced in the | intermediate table used for | |
| waze-174407 | > | okup_with_mls | jam_id | INTEGER | _distinct_jam_coordinates | computations | Internal |
| | | | | | Nome string of the street where the im- | Used for dev/testing only, | |
| | | | iom atroat | STRING | Name string of the street where the jam occurred | intermediate table used for computations | Internal |
| | | | jam_street | STRING | Formatted name string of the street where jam | computations | mema |
| | | | | | occurred | | |
| | | | | | | | |
| | | | | | <jam_street>_s<i>_i<j>_m<k> format</k></j></i></jam_street> | | |
| | | | | | where: | | |
| | | | | | street_name - refers to street where jam occured | | |
| | | | | | s <i> - ith roadlink with the same street name</i> | Used for dev/testing only, | |
| | | | | | i <j> - jth intersection of the roadlink</j> | intermediate table used for | |
| | | | street_sim | STRING | m <k> - kth <100 meter split of the roadlink</k> | computations | Internal |
| | | | | | | Used for dev/testing only, intermediate table used for | |
| | | | roadlink_id | INTEGER | Integer ID of the roadlink that captured the jam | computations | Internal |
| | | | rodulink_iu | INTEGER | integer 10 of the roadinik that captured the jam | Used for dev/testing only, | memai |
| | | | | GEOGRAPH | Linestring representation of the intersection | intermediate table used for | |
| | | | intersection | Y | within the roadlink | computations | Internal |
| | | | | | | Used for dev/testing only, | |
| | | | | | | intermediate table used for | |
| | | | rl_length | FLOAT | Roadlink length in meters | computations | Internal |
| | | | | | | Used for dev/testing only, intermediate table used for | |
| | | | ixn_length | FLOAT | Intersection length in meters | computations | Internal |
| | | | | | | | |
| | | jam_roadlink_intersection_e | | | | Used for dev/testing only, | |
| | | xploded_with_perpendicular | | | Integer ID of the jam referenced in the | intermediate table used for | |
| aze-174407 | > | S | jam_id | INTEGER | _distinct_jam_coordinates | computations | Internal |
| | | | | | | Used for dev/testing only, | |
| | | | roadlink_id | INTEGER | Integer ID of the roadlink that contured the ism | intermediate table used for computations | Internal |
| | | | | INTEGER | Integer ID of the roadlink that captured the jam | Used for dev/testing only, | memai |
| | | | | | Linestring representation of intersection | intermediate table used for | |
| | | | intersection | STRING | coordinates in string | computations | Internal |
| | | | | | | | |
| | lion 2024 | | | | | Used for dev/testing only, | |
| aze-174407 | jica_2021_ <suffix ></suffix | jam_roadlink_intersections | ixn_id | INTEGER | Integer ID of the intersection from the roadlink | intermediate table used for computations | Internal |
| d2e-1/440/ | > | jam_roadiink_intersections | IXI_IU | INTEGER | Integer 1D of the Intersection from the roadilitik | Used for dev/testing only, | memai |
| | | | | | Linestring representation of the intersection | intermediate table used for | |
| | | | intersection | STRING | coordinates | computations | Internal |
| | | | | | | Used for dev/testing only, | |
| | | | | | | intermediate table used for | |
| | | | ixn_length | FLOAT | Length of the intersection in meters | computations | Internal |
| | | | | | | Used for dev/testing only, intermediate table used for | |
| | | | angle | FLOAT | Angle of the intersection in degrees | computations | Internal |
| | | | | | Linestring coordinates of starting point of the | Used for dev/testing only, | |
| | | | | | intersection on the map; connect to endpoint to | intermediate table used for | |
| | | | ixn_firstpoint | STRING | draw intersection | computations | Internal |
| | | | | | Linestring coordinates of last point of the | Used for dev/testing only, | |
| | | | ive and aint | STRING | intersection on the map; connect to start point to | | Internal |
| | | | ixn_endpoint | STRING | draw intersection | computations | mernal |
| | | | | | | Used for dev/testing only, | |
| | jica_2021_ <suffix< td=""><td>jam_roadlink_intersection_di</td><td></td><td></td><td></td><td>intermediate table used for</td><td></td></suffix<> | jam_roadlink_intersection_di | | | | intermediate table used for | |
| aze-174407 | > | r | roadlink_id | INTEGER | Integer ID of the roadlink | computations | Internal |
| | | | | | | Used for dev/testing only, | |
| | | | ivo id | INTEGER | Integer ID of the intersection from the reIE-I | intermediate table used for computations | Internal |
| | | | ixn_id | INTEGER | Integer ID of the intersection from the roadlink | Used for dev/testing only, | merna |
| | | | | | Boolean value to dictate if jam flows with or | intermediate table used for | |
| | | | direction_flow | BOOLEAN | against predicted traffic direction | computations | Internal |
| | | | | | | | |
| | | | | | | Used for dev/testing only, | |
| aze-174407 | | _jam_roadlink_intersection_l | iom id | INTEGER | Integer ID of the jam | intermediate table used for computations | Internal |
| a20-1/440/ | > | ookup | jam_id | INTEGER | Integer ID of the jam | Used for dev/testing only, | memai |
| | | | | | | intermediate table used for | |
| | | | roadlink_id | INTEGER | Integer ID of the roadlink that captured the jam | computations | Internal |
| | | | | | | Used for dev/testing only, | |
| | | | capped_intersection_leng | | Length of the intersection in the roadlink in | intermediate table used for | |
| | | | th | FLOAT | meters | computations | Internal |
| | | | | | Rooloon value to distate if ison flows with | Used for dev/testing only, | |
| | | | direction_flow | BOOLEAN | Boolean value to dictate if jam flows with or against predicted traffic direction | intermediate table used for computations | Internal |
| | | | uncouon_now | DOOLEAIN | against predicted tranic direction | Used for dev/testing only, | memai |
| | | | | | | intermediate table used for | |
| | | | | | | | |

Source: JPT

(b) Computations Create Roadlinks by < 100m Lengths Lookup Table of jam-roadlink Intersections Merged_Table Overlay Unjammed Roadlinks and times With Freeflow Speeds

Source: JPT

Figure 2.8: Computation Flowchart

Details:

- Lookup Table is fixed on its location data across each run. (i.e. 150: Padre Burgos E _s0_i0_m0, primary roads will always have the same location coordinates) Based on 2018 to 2020 data.
- (ii) Merged tables can be compared historically because road names and road types are fixed per location data.

Steps:

- (i) Creation of < 100m road links based on unique road coordinates from Waze
- (ii) Determine all unique jam-road link intersections
- (iii) Determine the average speed per road link based on the speeds of the jams along them
- (iv) Estimate the free-flow speed per road link based on speeds and travel times along unjammed portions of the road links
- (v) Fill in free-flow speeds for road links and times that did not have jam data for a given road link.

(c) Speed and Merged Table

The Speed and Merged table are the resulting BigQuery table from the aggregated jammed speeds and free-flow speeds per road link. Initially, we use the jammed speeds to determine the average speed for a road link, however, in cases such that a road link does not have jam data, we estimate the free-flow speed for the road link based on speeds and travel times along its unjammed portions. We use the estimated free-flow speed to fill in the average speeds for road links that do not have jam data. The Speed and Merged table is the data source used by the JICA Dashboard Web application.

(4) Dagster

(a) **Dagster Instances**

| Description |
|--|
| VM instance that hosts the monthly Waze Speed |
| Calculation pipeline for production use. |
| VM instance that hosts the monthly Waze Speed |
| Calculation pipeline for development use. |
| VM instance that hosts the historical Waze Speed |
| Calculation pipeline for production use. |
| VM instance that hosts the historical Waze Speed |
| Calculation pipeline for development use. |
| |

Table 2.16: Dagster Instances

(b) Dagster Pipelines

There is a single dagster pipeline responsible for orchestrating the Waze Speed calculation and producing the final BigQuery tables for the Dashboard web app: waze_lookup_pipeline. The dagster instance image is deployed as a Docker container in the dagster Compute Engine instance. The waze_lookup_pipeline does not have any defined scheduler in code to orchestrate the project's objective monthly run; rather we let the Instance Schedule monthly-speed-calculation-schedule run the pipeline for us in 1-month intervals.

(c) VM: Dagster (Prod)

All output tables produced by the Waze Speed calculation pip fall under one dataset which is the waze_lookups dataset.

(d) Output Tables

| Pipeline | Dataset | Table |
|----------------------|--------------|---|
| waze_lookup_pipeline | waze_lookups | webapp_table_ <date></date> |
| | | webapp_table_old_format |
| | | aggeregates_per_minute |
| | | all_jams |
| | | distinct_jam_coordinates |
| | | free-flow_speeds |
| | | jam_roadlink_intersection_lookup |
| | | jam_roadlink_intersection_dir |
| | | jam_roadlink_intersection_exploded |
| | | jam_roadlink_intersection_lookup_with_mls |
| | | jam_roadlink_intersections |
| | | raw_jams_spatiotemporal_filter |

Table 2.17: Output Tables

Source: JPT

(e) **Pipeline Notifications**

Every month an email notification will be sent to stakeholders and maintainers of the project showing the results of the Waze Speed Calculation pipeline.

| Speed Calculation Pipeline Result up until July 2021: SUCCESS (External) Inbox x | | | 8 | Ø |
|--|-----------------------|---|---|---|
| mmda-waze@em9254.pipelines.thinkingmachin.es to gabgebgib, me ♥ | 8:23 AM (2 hours ago) | ☆ | ¢ | : |
| Speed Calculation Steps Results Breakdown: | | | | |
| Attach Unique Road Type To Roadlink Lookup: SUCCESS Compute Jam Roadlink Intersection Directions: SUCCESS Create Distinct Jams: SUCCESS Create Formatted Web App Roadlinks Tables: SUCCESS Create Formatted Web App Tables: SUCCESS Create Jam Roadlink Intersection Lookup: SUCCESS Create Partitioned Jams: SUCCESS Create Spatiotemporal Subset: SUCCESS Create Street Lookup: SUCCESS Create Street Lookup: SUCCESS Generate Aggregations Per Minute: SUCCESS Generate Webapp Speeds Table: SUCCESS Generate Webapp Speeds Table: SUCCESS Identify Street Segment Intersections: SUCCESS Map Overlapping Roadlinks: SUCCESS Map Overlapping Roadlinks: SUCCESS Split By Intersection: SUCCESS Split By Length: SUCCESS Update Street Lookup: SUCCESS | | | | |

Figure 2.9: Example of a Pipeline Notification

(f) Trigger a Manual Run

Should the clients, stakeholders, or maintainers of the project decide to run the Waze Speed Calculation pipeline manually, it can be done by starting/restarting the dagster VM/Compute Engine instance via the Google Cloud Console.

• Step 1

Look up or search "Compute Engine" in the Google Cloud Console search bar and click the first search result item: Compute Engine.

| ٩ | Compute Engine | × | ~ |
|------|--|---|---|
| PROD | UCTS & PAGES | | |
| | Compute Engine | | |
| ۲ | Migrate for Compute Engine Compute Engine | | |
| ۲ | Add VM Instance Compute Engine | | |
| | Committed use discounts Compute Engine | | |

Source: JPT

Figure 2.10: Google Cloud Console Search Bar

• Step 2

Locate the dagster item under the INSTANCES tab and click the More actions icon or the vertical three dots icon on the right side, click Start/Resume if the dagster item is currently stopped denoted by the Status column. If currently running and not stopped, click Stop instead and click Start/Resume again after stopping.

| \leftarrow | ightarrow C $ ightarrow$ conso | ole.cloud.google. | com /compute/insta | ances?project | =mmda-waze | | | ର 🕁 🖁 | 🕻 🛊 🕕 Update 🔅 |
|--------------|--------------------------------|---------------------------|---|----------------------|------------|----------------------------|----------------|--|-----------------------------|
| ≡ | Google Cloud Platform | 🕽 MMDA Waze 👻 | Q Com | pute Engine | | | | X ¥ | 5 0 2 i 🔒 |
| ۲ | Compute Engine | VM instances | CREATE INSTANCE | 📩 IMPORT VM | C REFRESH | ÷ | © OPERATIONS - | HELP ASSISTA | INT HIDE INFO PANEL 🗢 LEARN |
| Virtual | machines ^ | INSTANCES | INSTANCE SCHEDULE | | | | | dagster | |
| E | VM instances | • , | configurable virtual machines fo | or running workloads | on Google | | | PERMISSIONS | LABELS MONITORING |
| Ē | Instance templates | infrastructure. Learn mor | - | | | | | Edit or delete permis "Add Member" to gra | |
| 8 | Sole-tenant nodes | Tilter Enter prop | erty name or value | | | 0 | ± II | | ted permissions |
| = | Machine images | Status O | Name Cone Cone Cone Cone Cone Cone Cone Cone | Recommendations | In use by | Internal Con 10.0.0. SS | H 💌 🚦 | Show linen | leu permissions |
| 8 | TPUs | | central1- a | | | (<u>nic0</u>) | Start / | Resume | rty name or value 💡 💡 |
| % | Committed use discounts | □ • | dagster- us- | 🌻 Save \$23 / mo | 1 | | H 🔻 Stop | | Inheritance |
| Q | Migrate for Compute Engi | | dev central1- a | | | (nic0) | Susper | nd |) |
| | | | | | | | Docot | | Admin (1) |



The Waze Speed Calculation will now run.

(5) Types of Manual Triggers

 Table 2.18:
 Types of Manual Triggers

| VMs | Purpose | VM Details |
|--------------------|--|------------------------|
| dagster-monthly | Runs the Waze Speed Calculation pipeline on the previous month's raw Waze traffic data; scheduled to run every first day of the month but can be manually triggered as well | 1 vCPU, 3.75 GB memory |
| dagster-historical | Runs the Waze Speed Calculation pipeline on the raw Waze data from 2018 up until the last day of the previous month; manually triggered | 2 vCPUs, 13 GB memory |

Source: JPT

(6) Monthly Run

Manually triggering a monthly run is needed if the scheduled monthly run every first day of the month fails due to intermittent and unlikely reasons such as down services, or internet connectivity issues in the Compute Engine instance of the pipeline. If manual intervention from the maintainers of the project is needed to fix unforeseen issues to get the pipeline running again, the monthly run will have to be manually triggered after the issue has been resolved.

Table 2.19: How to Do Monthly Run Manually

| Issue | Details | Actions Required |
|----------------------------|--|--------------------------------|
| Speed Calculation Fails | Information on the failed task will be elaborated further on the email notification sent to stakeholders after the run has concluded. | Compute Engine Instance in the |

Source: JPT

(7) Full Run

Manually trigger a historical run is needed if the stakeholders decide to update the road links data used for the speed calculation from 2018 up until the current date.

| Issue | Details | Actions Required |
|---------------------------|---|---|
| Road links Data Change | The roadlinks data in the roadlinks_v6 BigQuery table is based on a file provided by the JICA stakeholders. Should the stakeholders decide to update the roadlinks data used on both the speed calculation and the dashboard web app, maintainers of the project should update the roadlinks_v6 and _roadlink_lookup table accordingly | Contact Thinking Machines and provide the updated roadlinks file. The maintainers of the project should manually update the roadlinks_v6 and _roadlinks_lookup BigQuery tables in the waze_lookup dataset. Other than the BigQuery tables mentioned, the geometries.json file in the JICA Dashboard Web App Github repository should be updated as well. After updating the roadlinks data, start/restart the dagster-historical Compute Engine Instance in the GCP UI to trigger the historical speed calculation. |

Table 2.20: How to Do Full Run Manually

Source: JPT

2.4 Dashboard

The Web App Dashboard is intended to visualize jams at a road link level.

| No | Button/Filter | Details |
|-----------|--|---|
| 1 | % of Time Below KPH | Only displays the roadlinks that meet the % occurrence |
| 2 | Speed | Only displays the roadlinks that are selected in the range |
| 3 | Worst Roadlinks Based on Percentage of Time | Narrows down the search to worst roadlinks in terms of jams/delays |
| 4 | Roadlinks with Speed Below KPH | Only displays the roadlinks that are selected in the range |
| 5 | Color Bar | Color symbols of how fast/slow a roadlink is. This is affected by the roadlink speed filter |
| 6 | Time of Day | (Only at the speed filters) Select from hourly times of day |
| 7 | Year | Select the year |
| 8 | Day of Week | Select the day of the week |
| 9 | Month | Select the month of the year |
| 10 | Road Type | Select the road type as determined by the JICA (previously determined by Waze data, but due to randomness of the raw data labeling, this was made consistent by JICA) |
| 11 | Direction | d0 - East Bound / North Bound d1 - West Bound / South Bound |
| 12 | Update Map | Displays the queried results |
| 13 | Export Data as CSV | Download as a csv file the data shown on the dashboard based on the filters selected |
| 14 | Clear all Filters | Restores all filters to default |
| Source: J | PT | |

 Table 2.21:
 Web App Dashboard Button Details

| | A dashboard for viewing traffic speed in Metro Manila. |
|--|--|
| | |
| % OF TIME BELOW 79 KPH SPEED | % OF TIME BELOW 79 KIPH SPEED |
| ercentage of Time Below 79 kph | Roadlinks with Speed Below 79 kph |
| 0% | |
| /orst Roadlinks Based on Percentage of Time | |
| how All | Slow Fa: |
| oadlinks with Speed Below 79 kph | Year |
| | 2019 |
| | |
| low Fast | Time of Day |
| | 19:00-20:00 |
| ear | SELECT ALL CLEAR ALL |
| ······································ | |
| ay of Week | Day of Week |
| fon, Tue, Wed, Thu, Fri | Mon, Tue, Wed, Thu, Fri |
| SELECT ALL CLEAR ALL | SELECT ALL CLEAR ALL |
| | |
| Ionth | Month Oct |
| <u> </u> | |
| SELECT ALL CLEAR ALL | SELECT ALL CLEAR ALL |
| Road Type | Road Type |
| Primary, Secondary, Primary Street, Street, Free 👻 | Primary, Secondary, Primary Street, Street, Free |
| SELECT ALL CLEAR ALL | SELECT ALL CLEAR ALL |
| | |
| | |
| Direction | Direction d0 |

Figure 2.12: Select Button / Filter in Dashboard

2.5 Access Management

(1) Updating Dashboard User Access

In order to add or remove emails with access to the Web App Dashboard, the developer must redeploy the mmda-waze-jica-dashboard-<environment> service in Cloud Run.

(a) Step 1

Look up or search "Cloud Run" in the Google Cloud Console search bar and click the first search result item: Cloud Run.

| Q Cloud Run | × ~ |
|-------------------------|-----|
| PRODUCTS & PAGES | |
| Cloud Run | |
| Sa Cloud Run for Anthos | |

Source: JPT

Figure 2.13: Cloud Run

(b) Step 2

Locate and click the Cloud Run service you want to redeploy; for example, the mmda-wazejica-dashboard-dev service.

| \equiv Google Cloud Platform * M | | | | | | |
|---|-----------------------------------|-------------|-----------------------|-----------|---------------|-----------------------|
| Cloud Run Services | + CREATE SER | VICE 🔚 M/ | ANAGE CUSTOM DOMAINS | Сору | DELETE | |
| Filter Filter services | | | | | | |
| 🗧 🌒 Name 个 | Req/sec <table-cell></table-cell> | Region | Authentication 😮 | Ingress 😧 | Last deployed | Deployed by |
| Mmda-waze-jica-dashboard-dev | 0 | us-central1 | Allow unauthenticated | All | Aug 19, 2021 | gab@thinkingmachin.es |
| 🔲 🔮 mmda-waze-jica-dashboard-prod | 0 | us-central1 | Allow unauthenticated | All | Aug 26, 2021 | gab@thinkingmachin.es |

Source: JPT

Figure 2.14: Selecting Cloud Run Service

(c) Step 3

After clicking the Cloud Run service of your choice; the user will be redirected to the Cloud Run Service details page; click the EDIT & DEPLOY NEW REVISION button.

| ≡ Goog | e Cloud Platf | orm 🔹 MMDA Waze | - | | Q Cloud Run | |
|---------|---------------|-----------------|---------------------|-------------------------|---|---|
|) Cloud | Run ← | Service details | 🖍 EDIT & DEI | PLOY NEW REVISION | 🔯 SET UP CONTINUOUS DEPLOYMENT | |
| 🔮 mm | nda-waze-jica | -dashboard-dev | Region: us-central1 | URL: <u>https://mmd</u> | a-waze-jica-dashboard-dev-zya4adr2eq-uc.a.run.app | Ū |
| METRICS | REVISIONS | LOGS TRIGGERS | DETAILS | YAML PER | RMISSIONS | |

Source: JPT

Figure 2.15: Edit and Deploy New Revision Button

(d) Step 4

In the Deploy revision page of the mmda-waze-jica-dashboard-<environment> service, click the VARIABLES AND SECRETS tab

| | ۹ (| Cloud Run |
|--|-----|-----------|
| Cloud Run - Deploy revision to mmda-waze-jica-dashboard-dev (us-central1) | | |
| Every change to the service configuration creates an immutable revision. A revision consists of a specific container image, along with other environment settings. | | |
| CONTAINER VARIABLES & SECRETS CONNECTIONS SECURITY | | |
| General | | |
| Container image URL * | | |
| gcr.io/mmda-waze/jica-dashboard SELECT | | |
| E.g. us-docker.pkg.dev/cloudrun/container/hello Should listen for HTTP requests on \$PORT and not rely on local state. <u>How to build a container?</u> Container port 8080 | | |
| Requests will be sent to the container on this port. We recommend listening on \$PORT instead of this specific number. | | |

Source: JPT

Figure 2.16: Variables and Secrets Tab

(e) Step 5

Locate the Environment variables section under the VARIABLES & SECRETS tab, and update the value of the EMAILS variable; either append a new email address separated by a comma sign, or remove an old email address.

| ≡ Google Clo | oud Platform | • MMDA Waze 👻 | | | ٩ | Cloud Run |
|--------------------|---|--|--------------------|-----------------------|---|-----------|
|) Cloud Run | Contraction Contractica Con | y revision to mmda-wa | ze-jica-dashbo | oard-dev (us-central1 |) | |
| , , | ervice configuration crea nage, along with other er | tes an immutable revision. A re wironment settings. | vision consists of | | | |
| CONTAINER | VARIABLES & SECRE | TS CONNECTIONS | SECURITY | | | |
| | | | | | | |
| Environment variab | bles | | | | | |
| Name | v | alue | | | | |
| REQUIRE_AUTH | | TRUE | | | | |
| EMAIL_DOMAINS | | thinkingmachin.es | | _ | | |
| EMAILS | | u@gmail.com.mypersonal@gr | nail.com 👕 | | | |

Source: JPT

Figure 2.17: Environment Variables

(f) Step 6

Click the DEPLOY button at the bottommost part of the Deploy revision screen.

| | s revision immediately ne traffic will be migrated to this revision, overriding all existing traffic splits, if any. |
|-------------|---|
| DEPLOY | CANCEL |
| Source: JPT | |

Figure 2.18: Deploy Button

(2) Updating Access to the Web App Cost Metrics

Other than controlling access to the Web App Dashboard service itself, we can also manage users who can view the web app cost metrics for monitoring query usages, quota, and billing.

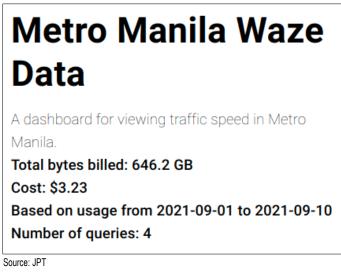


Figure 2.19: Screenshot of Cost Estimation in Dashboard

However, with the current implementation of the web app dashboard from phase one of the project, users with access to this view can only be updated via changes in the web app source code which requires assistance from Thinking Machines.

(3) Dashboard Year, Month, and Day Filters

The combination of values you select in the date filters will determine the roadlinks data to be displayed in the dashboard map view. Specifically, different combinations of filters will result in varying roadlink speeds average in the map view which is shown by the color of the roadlinks/line segments. Clicking the "UPDATE MAP" button in the dashboard computes the average speed of the roadlinks over the selected dates determined by the date filters.

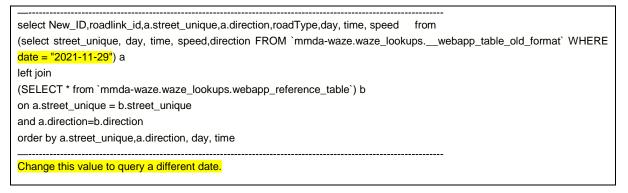
For example, selecting only Mondays from the month of September year 2021 will only compute the average roadlinks speeds over four (4) days or ninety-six (96) hours since there are only four Mondays in September 2021. In order to verify this, hovering over a displayed roadlink in the map view will show a pop-up displaying the following information with regards to the hovered-over roadlink: name, average speed, average speed in direction d0, average speed in direction d1, and percent of time below N-kph.

| Year 2021 • • • • • • • • • • • • • • • • • • • | | | Data Stree | Str | ₽ IIII | |
|--|---|----------------|------------------------|---|---------------|---------|
| SELECT ALL CLEAR ALL Day of Week Mon SELECT ALL CLEAR ALL Month Sep SELECT ALL CLEAR ALL Month Sep SELECT ALL CLEAR ALL Provide the time of the | Year | | | Teg I | Ser | |
| SELECT ALL CLEAR ALL Day of Week Mon SELECT ALL CLEAR ALL Month Sep SELECT ALL CLEAR ALL Month Sep SELECT ALL CLEAR ALL Provide the time of the | 2021 | - | ourdes Costillo Street | | | |
| Day of Week Mon SELECT ALL CLEAR ALL Month Sep SELECT ALL CLEAR ALL SELECT ALL CLEAR ALL Direction d0 VUPDATE MAP EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | SELECT ALL CLEAR ALL | _ | Luskol Street | Average speed: 14.00 | 61875 kph | |
| Mon - SELECT ALL CLEAR ALL Month Sep - SELECT ALL CLEAR ALL Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class ~ SELECT ALL CLEAR ALL Direction d0 - EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | Day of Week | | | d1 average speed: 13 | 3 71 knh | Bayan |
| SELECT ALL CLEAR ALL Month Sep SELECT ALL CLEAR ALL Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class * SELECT ALL CLEAR ALL Direction d0 VPDATE MAP EXPORT DATA AS CSV EXPORT DATA AS CSV | | | -N-Kan | Below 80 kph for 1009 (96 out of 96 hours) | % of the time | |
| Sep SELECT ALL CLEAR ALL Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 VUPDATE MAP EXPORT DATA AS CSV EXPORT DATA AS CSV | Non | | | | | |
| Sep SELECT ALL CLEAR ALL Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 VUPDATE MAP EXPORT DATA AS CSV EXPORT DATA AS CSV | SELECT ALL CLEAR ALL | 10 | | | Hone - | |
| Sep SELECT ALL CLEAR ALL Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 VUPDATE MAP EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | | | sto Istin | Bus | X n's ci | - |
| Sep Sep Set Control of the second s | Month | | 1 2 2 | anan. | | Te casi |
| SELECT ALL CLEAR ALL Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class * SELECT ALL CLEAR ALL Direction d0 * UPDATE MAP EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | | 9 ³ | S S Ice Crede | Store | | T. |
| Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL Direction d0 UPDATE MAP EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | 3ep | <u> </u> | | | | |
| 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 UPDATE MAP EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | | | | | | |
| 1: Expressway, 2: Class A1, 3: Class A2, 4: Class ~ SELECT ALL CLEAR ALL Direction d0 UPDATE MAP EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | SELECT ALL CLEAR ALL | | | | | |
| d0 UPDATE MAP EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | | | | | | |
| UPDATE MAP EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class | | | | | |
| EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL | * | | | | |
| EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction | ···· • | | | | |
| EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction | | | | | |
| EXPORT SPACE TIME TABLE DATA AS CSV | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction | | | | | |
| EXPORT SPACE TIME TABLE DATA AS CSV | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 | * | | | | |
| | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 | * | | | | |
| | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 UPDATE MAP | *** | | | | |
| CLEAR ALL FILTERS | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 UPDATE MAP EXPORT DATA AS CSV | * | | | | |
| CLEAR ALL FILTERS | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 UPDATE MAP EXPORT DATA AS CSV | ••• • | | | | |
| | Road Type 1: Expressway, 2: Class A1, 3: Class A2, 4: Class SELECT ALL CLEAR ALL Direction d0 UPDATE MAP EXPORT DATA AS CSV EXPORT SPACE TIME TABLE DATA AS CSV | * | | | | |

Source: JPT

Figure 2.20: Screenshot of Year, Month, and Day Filter in Dashboard

(4) Querying for Merged Tables



2.6 Known Limitations

These are all the known issues. There may be more issues not yet found.

(1) Slow Dashboard Load Times

Slow loading times may be due to the individual user's internet connectivity, or hardware limitations

Slow loading times may also be due to Cloud Run's "cold start". If the service is not used for an unspecified amount of time, Google terminates the web app dashboard. Using the web app again after it has been terminated requires the Cloud Run instance to re-download the web app dashboard requirements (docker image) and start it again. Increasing the minimum instances to make a warm start would increase resource costs unnecessarily.

(2) Waze Data Limitations

(a) Waze GPS Data Changes Every Run

Challenge:

- The Waze road data (marked by the red lines) is not the same on every run.
- This will not line up with the road links data set by JPT in Road links v6.
- If the road data is not captured at all, the data will assume it is free-flowing.



Figure 2.21: Example of Waze GPS Data which Does Not Match Road Links

Solution:

• Buffer zones (marked by the blue highlights) will be created that will detect any Waze road data in the buffer zones like a map matching.

Implications:

- There is a higher chance the Waze road data will be captured.
- The buffer zones are still able to distinguish overlapping road data due to overpasses or fly-overs.
- The buffer zones may inadvertently capture road traffic from other roads that are overlapping or intersecting. This can understate or overstate traffic speed data.

(b) Some Road Links Do Not Have Any Jams Data

- Red lines represent all jams from 2020-05 to 2021-07
- Cyan highlights represent road links without any data (e.g. village, military area, etc.)
- 5,000 out of 59,000 road links do not have jam data



Figure 2.22: Example of Road Links which Has No Waze Data

(c) When Waze Updates their Underlying Roadmap Location

Challenge:

- Waze updated its underlying map from the 2018 map which road links v6 is based on.
- This is a special case that cannot be handled by widening the buffer of the road links v6 since the roads are in completely different locations.

Implication:

• Certain road links will not be captured because the Road links v6 location is wrong



Figure 2.23: Example of New Waze Road Links

(d) Road Links based on U-turns Cannot Be Captured

Challenge:

• The methodology for dropping irrelevant intersections is based on the angle between the endpoints of the road link and the intersection.

Implication:

• There is a possibility that the jams of U-turns will not be attributed to the U-turn road link.



Figure 2.24: Example of a U-turn which Cannot Be Captured

(e) Waze Road Data can Shift and Might Not Be Consistent from Run to Run

Challenge:

- The Waze road data (marked by the red lines) is not the same in every run. This does not line up with the road links data set by JICA in Road links v6.
- If the road data is not captured at all, the data will assume it is free-flowing.



Figure 2.25: Example of Inconsistent Waze Data

Solution:

• Buffer zones (marked by the blue highlights) will be created that will detect any Waze road data.

Implication:

- There is a higher chance that the Waze road data will be captured.
- The buffer zones are still able to distinguish overlapping road data due to overpasses or fly-overs.
- The buffer zones may inadvertently capture road traffic from other roads that are overlapping or intersecting. This can understate or overstate traffic speed data.
- (f) Increasing the Buffer Zone Size May Make It Harder to Differentiate the Overlapping and Intersecting Roads

Challenge:

- Overlapping roads can affect the captured speed data of the roads below and/or above.
- Perpendicular roads may affect the speed of the main roads

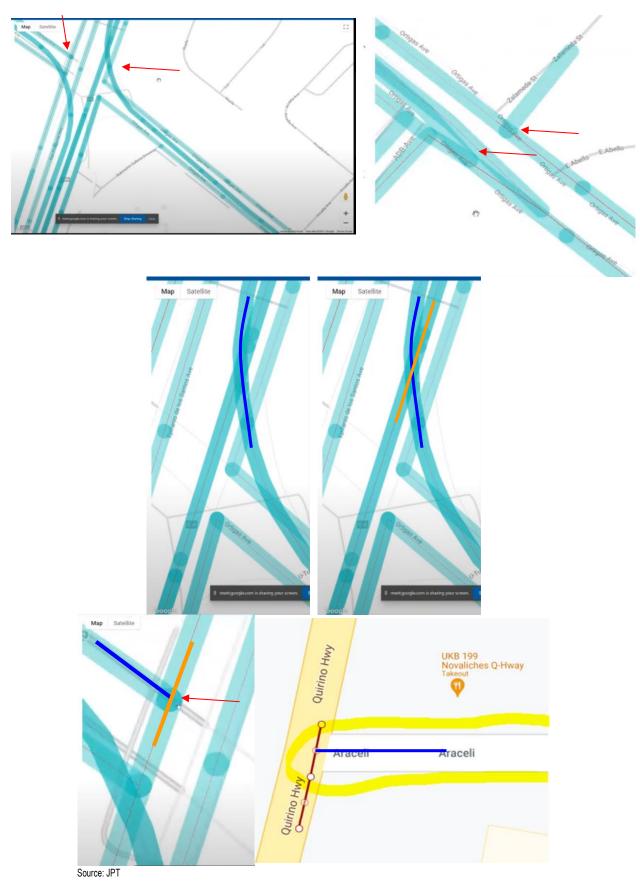


Figure 2.26: Example of Problem Due to Increasing Buffer Size

Solution:

- Create a code wherein the data will not be captured by the road if the angle of two intersecting and overlapping lines is more than 20 degrees.
- This is how we remove roads that are not part of the original road.
- (g) New Traffic Areas and New Roads will Not Be Captured. This Appears as Red Lines Without Buffer Zones

Challenge:

- New road data that comes in for streets will not be captured in methodology 2 because road links v6 are fixed.
- This happens when Waze captures new traffic data in areas it did not capture before (i.e., 2018, 2019).
- This is unique to methodology 2 because it is based on road links v6.

Implication

• New road links will not be properly captured.



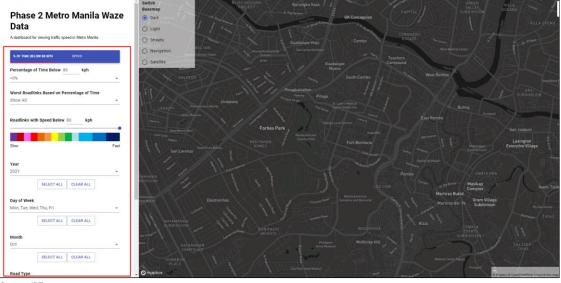
Source: JPT

Figure 2.27: Example of New Waze Data on Road Links Not Captured Before

3 USER MANUAL

3.1 Instructions

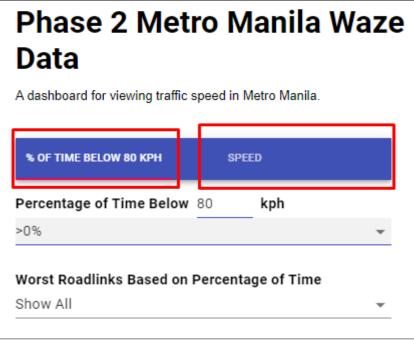
- (a) Go to the Dashboard at this link: https://mmda-waze-jica-dashboard-prod-zya4adr2equc.a.run.app/
- (b) Select the different filters to the left of the Dashboard to change the results shown on the screen.



Source: JPT

Figure 3.1: Waze Data Dashboard

(c) Switch between % of Time below KPH filters and speed filters by clicking on the respective columns.



Source: JPT

Figure 3.2: Data Set Type

(d) Select a filter by clicking on the drop-down button.

| % OF TIME BELOW 80 KPH | S | PEED | |
|--------------------------|----|------|---|
| Percentage of Time Below | 80 | kph | |
| >0% | | | - |

| % OF TIME BELOW 80 KPH | SPEE | D | |
|--------------------------|-------------|-----|---|
| Percentage of Time Below | w 80 | kph | |
| >0% | | | |
| >10% | | | |
| >20% | | | |
| >30% | | | |
| >40% | | | |
| >50% | | | |
| >60% | | | |
| >70% | | | |
| >80% | | | |
| >90% | | | |
| 2021 | | | Ŧ |

Figure 3.3: Percentage of Time Below the Speed

(e) Drag Roadlinks with a speed bar to change the values or directly input the values.

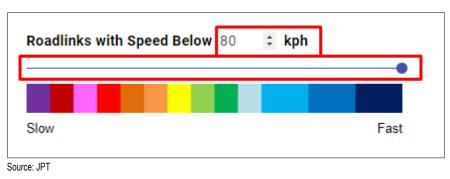


Figure 3.4: Speed Range

- (f) The different colors shown on the map will correspond to the speed of the roadlink.
- (g) For some filters, you will be able to 'Select All' the values. This will filter to all the values.

You can also 'Clear All' to unselect all the values.

| 2021 | | |
|--------------|---------------------------------------|---------|
| | SELECT ALL CLEAR ALL | |
| Day of Wee | k | |
| Mon, Tue, V | /ed, Thu, Fri | - |
| | SELECT ALL CLEAR ALL | |
| Month Oct | | - |
| | SELECT ALL CLEAR ALL | |
| Road Type | | |
| Primary, Pri | mary Street, Street, Freeway, Ramp, T | rails 🤜 |
| | SELECT ALL CLEAR ALL | |

Figure 3.5: Selecting Year, Day, Month, and Road Type

(h) When you have selected the necessary filters, click 'Update Map' to apply the filters on the Map.



Figure 3.6: Update Map Button

 To download the data of the filters selected on the dashboard, click 'Export Data as CSV'.



Figure 3.7: Export Data As CSV Button

(j) Click on the 'Clear all filters' button to reset all filters back to the default values.



Figure 3.8: Clear All Filters Button

(k) You can adjust the Dashboard visual by changing the 'Switch Basemap'.



Figure 3.9: Base Map Options

(I) For certain key users, the cost associated with the dashboard will be visible.

Metro Manila Waze Data

A dashboard for viewing traffic speed in Metro Manila. Total bytes billed: 646.2 GB

Cost: \$3.23

Based on usage from 2021-09-01 to 2021-09-10 Number of queries: 4

Source: JPT

Figure 3.10: Cost Summary

- (m) For more details on the Dashboard and the back-end, refer to the Design and Technical Documentation.
- (n) For more details on the data refer to the Data Dictionary and Processing Documentation.

| | Data | |
|--|-------------|--|
| dashboard for viewing traffic speed in Metro N | Manila. | A dashboard for viewing traffic speed in Metro Manila. |
| % OF TIME BELOW 79 KPH SPEED | | % OF TIME BELOW 79 KPH SPEED |
| ercentage of Time Below 79 kph | _ | Deadlinks with One of Delaw 70 with |
|)% | | Roadlinks with Speed Below 79 kph |
| orst Roadlinks Based on Percentage of | Time | |
| now All | | Slow F |
| oadlinks with Speed Below 79 kp | h | Year |
| | | 2019 |
| ow | Fast | Time of Devi |
| | | Time of Day 19:00-20:00 |
| ear 019 | | SELECT ALL CLEAR ALL |
| 112 | | |
| ay of Week | | Day of Week |
| on, Tue, Wed, Thu, Fri | - | Mon, Tue, Wed, Thu, Fri |
| SELECT ALL CLEAR ALL | | SELECT ALL CLEAR ALL |
| | · | Month |
| l onth ct | - | Oct |
| SELECT ALL CLEAR ALL |] | SELECT ALL CLEAR ALL |
| Road Type | | Road Type |
| Primary, Secondary, Primary Street, Str | eet, Free 👻 | Primary, Secondary, Primary Street, Street, Free |
| SELECT ALL CLEAR AL | L | SELECT ALL CLEAR ALL |
| | | Direction |
| Direction | | |



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE PROJECT FOR COMPREHENSIVE TRAFFIC MANAGEMENT PLAN FOR METRO MANILA

TECHNICAL REPORT NO. 4 IDENTIFICATION OF TRAFFIC BOTTLENECKS AND MONITORING

November 2022

ALMEC CORPORATION ORIENTAL CONSULTANTS GLOBAL CO., LTD. TRANSPORTATION RESEARCH INSTITUTE CO., LTD.

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ABBREVIATIONS

| CSV | comma-separated values |
|------|---|
| CTMP | Comprehensive Traffic Management Plan |
| DPWH | Department of Public Works and Highways |
| EDSA | Epifanio delos Santos Avenue |
| JICA | Japan International Cooperation Agency |
| JPT | JICA Project Team |
| LGU | local government unit |
| LOC | level of congestion |
| LOS | level of service |
| MMDA | Metropolitan Manila Development Authority |
| NCR | National Capital Region |
| TBN | traffic bottleneck |
| WKT | well-known text |

1 INTRODUCTION

1.1 Objectives

The first activity in identifying traffic bottlenecks (TBNs) and understanding the prepandemic traffic situation in Metro Manila is administering questionnaire surveys by MMDA and the 17 NCR LGUs in 2019. Based on the results of the first questionnaire survey, MMDA identified 102 bottlenecks, while the LGUs listed 187 locations, or a total of 289 TBNs, including road segments. However, it should be noted that these bottlenecks were identified subjectively.

For this reason, the objectives of this chapter are to define traffic bottlenecks and identify the major traffic bottlenecks in Metro Manila. By identifying the bottlenecks, the expected outcomes are as follows:

- (i) Common understanding among the MMDA and related parties about the trend of traffic congestion in Metro Manila;
- (ii) Clear definition of traffic bottlenecks for Metro Manila based on quantitative analysis;
- (iii) Longlist of traffic bottlenecks in Metro Manila; and
- (iv) Strengthened capacity for identifying traffic bottlenecks using a data-driven methodology.

1.2 Overall Approach

The overall approach to identifying bottlenecks is shown in Figure 1.1. The identified bottlenecks by MMDA and the LGUs were first screened using the Waze travel speed data. TBNs based on Waze travel speed data that were not yet identified by the MMDA and LGUs were added to the potential longlist while TBNs initially determined were retained.

In the second screening, the JPT prepared a datasheet for data collection which will be used for site observation by the traffic enforcers. Then, the TBNs will be classified into intersections, road segments, and areas according to the site conditions. Also, the typology will be made depending on the causes of congestion. Through these steps, the longlist of major TBNs will be finalized.

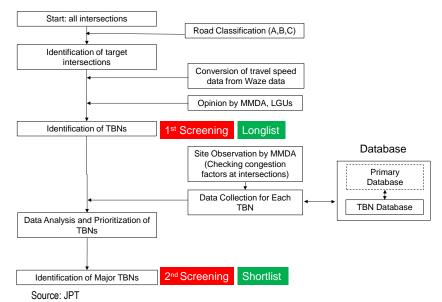


Figure 1.1: Workflow for Longlisting Major Traffic Bottlenecks

2 DEFINITION OF TRAFFIC CONGESTION AND TRAFFIC BOTTLENECKS

2.1 Basic Traffic Engineering Knowledge of Traffic Congestion

Before defining traffic congestion and bottlenecks, the basic traffic engineering knowledge is described in this section for a better common understanding. Traffic congestion is a phenomenon caused by a pile-up of traffic demands which cannot be accommodated in the network. Meanwhile, a bottleneck is a point in the target area where traffic capacity is the lowest. It commonly becomes the starting point of traffic congestion. Figure 2.1 illustrates the concept of traffic congestion and traffic bottleneck. Traffic flow forms a queue at the upstream section of a bottleneck when traffic demand exceeds the traffic capacity of that bottleneck.

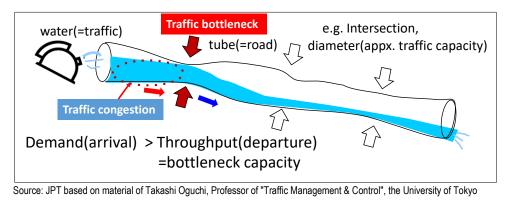


Figure 2.1: Concept of Traffic Congestion and Traffic Bottleneck

The graph in Figure 2.2 shows the relationship among traffic demand, traffic capacity, and queue length. The horizontal line in the graph represents time, while the vertical line in the first graph is traffic volume. The vertical line in the second graph represents queue length. Traffic congestion starts when traffic demand (traffic volume) exceeds the traffic capacity. When traffic demand exceeds the capacity, traffic congestion continues, and the queue lengthens. Since excess traffic demand accumulates, the longest queue is observed when the excess demand disappears. When traffic demand is lower than capacity, the vehicle queue shortens. Then, when the number of vehicles stuck in traffic congestion is handled, traffic congestion eases.

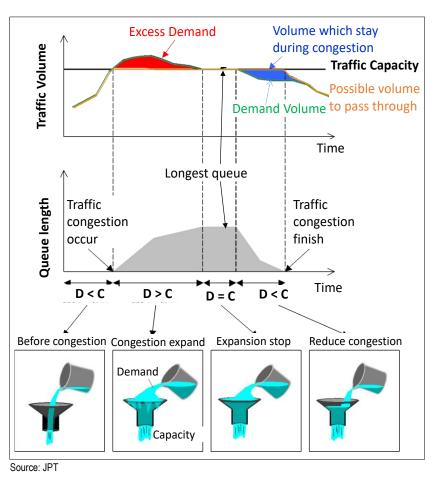


Figure 2.2: Relationship among Traffic Demand, Capacity, and Queue Length

There are two conditions when a point or a segment becomes a traffic bottleneck, as illustrated in Figure 2.3. The first is when traffic demand exceeds traffic capacity (excess demand over capacity) due to concentrated traffic caused by narrow road segments, for instance, thereby resulting in traffic congestion. In this case, improvements, such as road widening, grade separation with a flyover, or connection of missing links, are required. The second condition is when the original road capacity is reduced caused of obstructions, such as on-street parking and PUV terminals, resulting in traffic congestion even though traffic demand does not exceed the original traffic capacity. In this case, traffic management measures, such as enforcing parking regulations, are required.

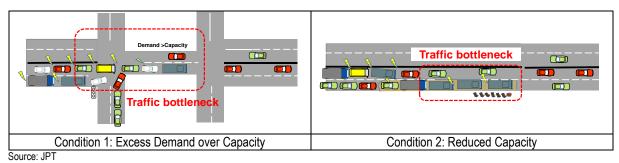


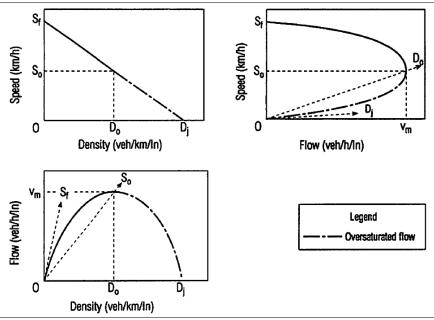
Figure 2.3: Conditions of Bottlenecks Resulting in Congestion

From a traffic engineering perspective, traffic flow is defined by three (3) parameters, i.e., flow, density, and speed, as shown in Table 2.1.

| Parameter | Definition | |
|---------------------------|---|--|
| Flow (traffic volume) Q | the traffic volume or number of vehicles that have passed a certain point | |
| Density k in [vehicle/km] | the number of vehicles that exist in the unit length of road | |
| Speed v in [km/h] | the mean speed of vehicles | |
| | | |

| Table 2.1: | Three Parameters of | Traffic Flow |
|------------|---------------------|--------------|
|------------|---------------------|--------------|

These parameters are interrelated, as shown in Figure 2.4. The maximum traffic capacity of a given section is determined when the traffic flow rate is at its maximum (Q-Max). When the density is greater than that, it becomes a congested flow area where the speed decreases. While it is possible to measure traffic flow rates at individual intersections, speed can also be used as an indicator of traffic conditions and an identifier of a bottleneck. On the other hand, since daily traffic capacity can be reproduced from traffic volume estimates, macro analysis can be utilized to determine the traffic demand.



Source: Highway Capacity Manual 2000.

Figure 2.4: Conditions of Bottlenecks Resulting in Congestion

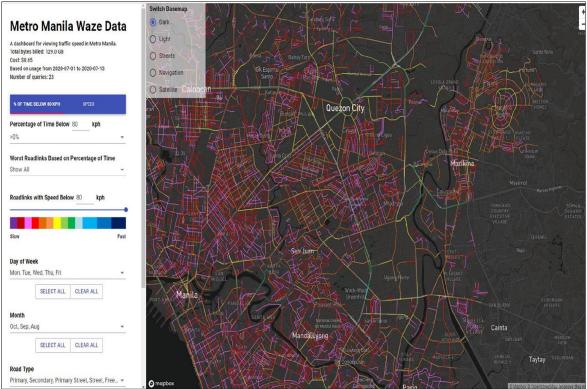
2.2 Definition of Common Criteria of Traffic Congestion and Bottlenecks

(1) Aggregation and Development of Waze Travel Speed Data

Under the Connected Citizens Program, MMDA can obtain travel speed data from Waze, a navigation company. Such data can provide a bird's eye view of the entire Metro Manila. In this CTMP Project, the Waze travel speed data in 2019 was collected and aggregated per 100-meter link. A dashboard web system was developed to visualize the data for any given time, day of the week, month, and by road class. By using this travel speed data from Waze, the traffic situation in Metro Manila was analyzed, and the common criteria for traffic bottlenecks were considered.

(2) Target Intersections

For the identification of TBNs where effective traffic management should be applied, roads were first classified by function, i.e., A, B, C, and D, as shown in Table 2.2. Based on the proposed network classification, target intersections were selected. These are composed of A-A roads, A-B roads, A-C roads, and B-B roads, as shown in Table 2.3. The number of target intersections has a total of 751, and the locations are shown in Figure 2.6.



Source: JPT

Figure 2.5: Developed Dashboard for Travel Speed Data from Waze

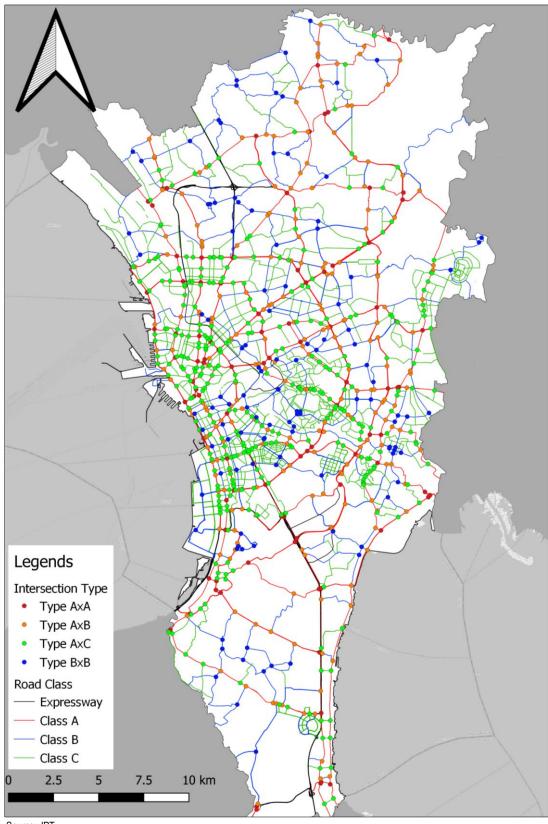
| Table 2.2: | Road Classification for Traffic Management Planning |
|------------|---|
|------------|---|

| Road Classification | Definition/Function | Responsibility for Construction | Responsibility for TM |
|------------------------|---|------------------------------------|--------------------------|
| Expressway | A major road with a median strip, access control and a curb shoulder. Toll fee needed. | DPWH, Private | DPWH, Private |
| Class A | A major road that mainly connects cities, excludes expressways. Refers to the radial and circumferential roads. | DPWH, Private | MMDA, Private |

| Road Classification | Definition/Function | Responsibility for Construction | Responsibility for TM |
|------------------------|--|------------------------------------|--------------------------|
| Class B | A road that complements Class A roads. An access road to major roads or facilities. | LGUs, Private | MMDA, LGUs, Private |
| Class C | A road that complements Class B roads, connecting roads in residential subdivisions, and adjacent barangays within a city. | LGUs, Private | LGUs, Private |
| Class D | The least important road. An access road to facilities within a city. A living road that give priority to pedestrians. | LGUs, Private | LGUs, Private |

| Class of Intersection | | No. of Intersections |
|-------------------------------|-------------------|----------------------|
| 1 | Class A x Class A | 95 |
| 2 | Class A x Class B | 224 |
| 3 | Class A x Class C | 321 |
| 4 | Class B x Class B | 111 |
| Target Intersections in total | | 751 |
| (Others) | | (>10,000) |
| Source: JPT | | • |

Source: JPT

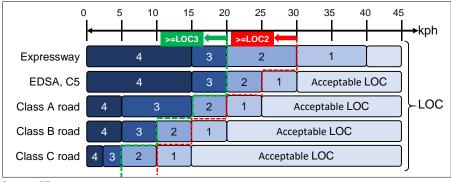


Source: JPT

Figure 2.6: Target Intersections as Potential Traffic Bottlenecks

2.3 Definition of Bottlenecks

The level of service (LOS) is commonly used in traffic analysis to qualitatively examine traffic conditions and travel services. According to the Highway Capacity Manual, LOS is a qualitative measure describing operational conditions within a traffic stream based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. By referring to the LOS, the JPT proposed a new indicator named level of congestion (LOC) to identify traffic bottlenecks. LOCs are determined by travel speed, i.e., when travel speed is low, the LOC is high. Acceptable travel speeds differ depending on the road classification and function. Different thresholds of LOC were proposed for each road class, as shown in Figure 2.7. For Epifanio de los Santos Avenue (EDSA) and Circumferential Road 5 (C-5), which are classified as Class A roads, access roads connecting to them are relatively few compared to other Class A roads. Road users expect higher travel speeds when using them, so a different threshold from that of Class A roads was applied to EDSA and C-5. In determining the LOC of an intersection, the travel speed of inflow traffic on each leg of the intersection was used as a basis.



Source: JPT

Figure 2.7: Level of Congestion by Road Class

Based on the new indicator, LOC, the target intersections were evaluated (Figure 2.8). An intersection's LOC was determined using the 2019 average travel speed data obtained from Waze, which covers weekdays from 6:00AM to 8:00PM, for inflow traffic on each leg of an intersection. An intersection was regarded as a TBN when its LOC in at least one direction is 3 or more.

In summary, a TBN is defined as "an intersection/point whose inflow traffic in at least one direction has an LOC of 3 or more." Based on this definition, the 751 target intersections were narrowed down to 164 TBNs (Table 2.4 and Figure 2.9).

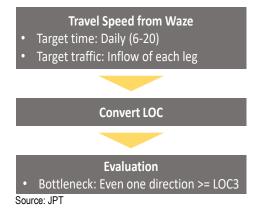
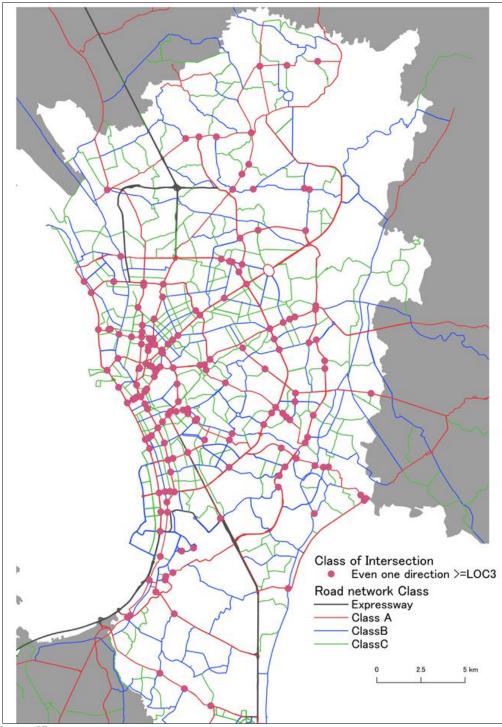


Figure 2.8: Flow of Identifying TBNs

| Class | No. of Intersections | |
|-------|-------------------------|---|
| 01055 | Target | TBN (LOC = >3) |
| AxA | 95 | 50 |
| AxB | 224 | 58 |
| AxC | 321 | 50 |
| ВxВ | 111 | 6 |
| Total | 751 | 164 (33%) |
| | A x B A x C B x B | Class Target A x A 95 A x B 224 A x C 321 B x B 111 |

 Table 2.4:
 Number of Traffic Bottlenecks Based on Waze Data



Source: JPT

Figure 2.9: Traffic Bottlenecks based on LOC >=3

(1) Checking and Adding of TBNs Identified by MMDA and LGUs

As mentioned earlier, questionnaire surveys were distributed to MMDA offices and 17 LGUs in Metro Manila in 2019 to identify traffic bottlenecks. In the process, MMDA and the LGUs subjectively identified traffic bottlenecks. Table 2.5 breaks down the target intersections into those identified by MMDA and the LGUs in the questionnaire surveys. The 109 intersections identified by MMDA and LGUs are included in the 751 target intersections. Furthermore, the bottlenecks identified by MMDA and LGUs include 10 non-intersections such as U-turn slots or merging points.

| Class of Intersection | | Number of Intersections/TBNs | | |
|-----------------------|--------------|------------------------------|-------------|--|
| Class OI | Intersection | Target | MMDA + LGUs | |
| 1 | AxA | 95 | 36 | |
| 2 | AxB | 224 | 41 | |
| 3 | AxC | 321 | 30 | |
| 4 | BxB | 111 | 2 | |
| Total | | 751 | 109 | |
| Line | | - | 15 | |

| Table 2.5 | Breakdown of Target Intersections by Government Office |
|-----------|--|
| | Breakaown of farget intercectione by Covernite of the |

Source: JPT

Next, the 164 TBNs identified based on Waze travel speed data, and 109 TBNs from MMDA and LGUs were compared to sort out overlapping points, as summarized in Table 2.6 and shown in Figure 2.10. Out of the 109 TBNs identified by both MMDA and LGUs, 64 overlap with those identified based on Waze travel speed data, while 45 locations do not overlap. Since the 45 locations of non-overlapping TBNs are possible TBNs, they were added into TBNs as well.

Table 2.6: TBNs based on LOC and Government Office

| Intersection | Initially Identified TBN | | No. of Overlapping | No. of Non-ov | erlapping TBNs | |
|--------------|--------------------------|---------------------|---------------------------------|------------------------------|----------------|------------|
| Туре | Total | TBN with >= LOC3 | TBN Identified by MMDA + LGU | TBNs (>=LOC3 & MMDA + LGU | >= LOC3 | MMDA + LGU |
| AxA | 61 | 50 | 36 | 25 | 25 | 11 |
| AxB | 75 | 58 | 41 | 24 | 34 | 17 |
| AxC | 66 | 50 | 30 | 14 | 36 | 16 |
| BxB | 7 | 6 | 2 | 1 | 5 | 1 |
| Total | 209 | 164 | 109 | 64 | 100 | 45 |

Source: JPT.

In conclusion, the total number of TBNs is 209 points, 164 TBNs were identified using Waze travel speed data and 109 TBNs were determined by the MMDA/LGUs. An overlap of 64 TBNs were existing on the list of both MMDA/LGU and LOC based method.

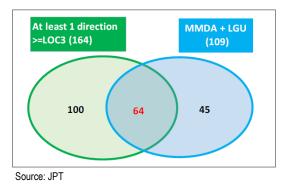


Figure 2.10: TBNs Identified based on LOC and Government Office

Of the 209 bottlenecks identified based on travel speed and observation by MMDA and LGU counterparts, 42 locations were deemed as serious bottlenecks facing severe congestion. They are shown in Figure 2.11.

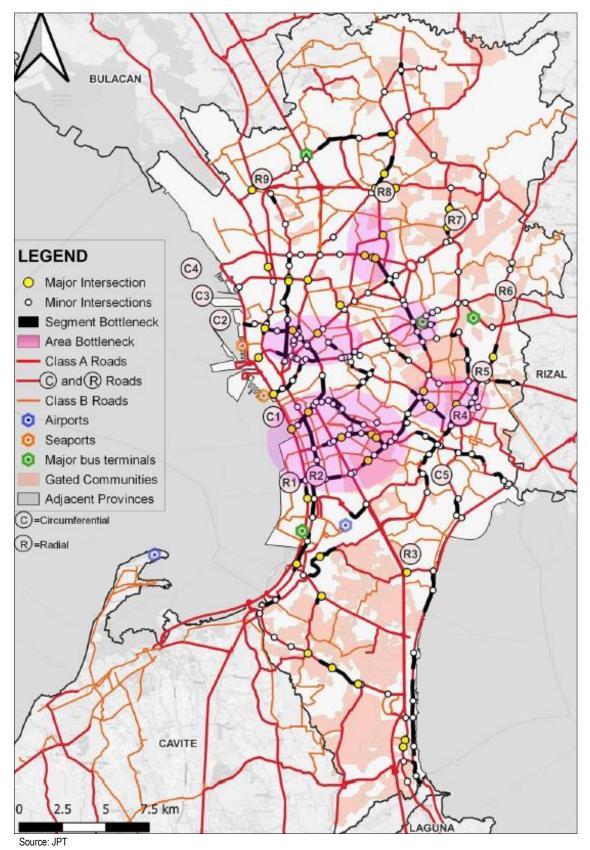


Figure 2.11: Location of Identified TBNs

3 SHARED UNDERSTANDING OF TRAFFIC CONGESTION AND BOTTLENECKS

3.1 Traffic Situation in Metro Manila

Figure 3.1 illustrates the traffic situation in Metro Manila before the COVID-19 pandemic. This was based on Waze travel speed data. As observed in the figure, a single bottleneck at an intersection extends to the segments along the corridor until the surrounding area as congestion becomes more severe.

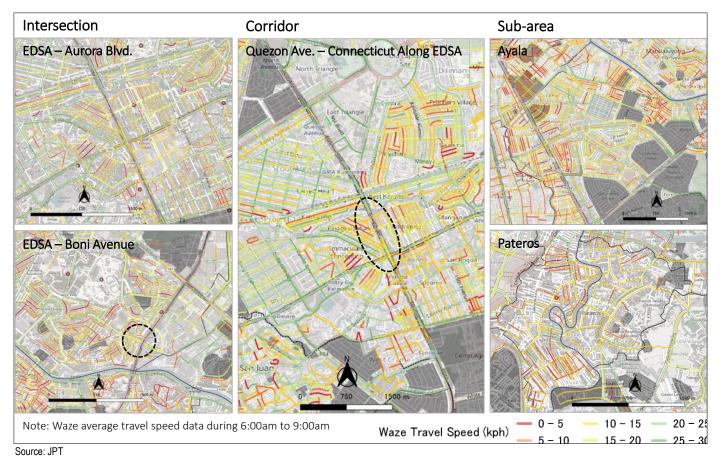


Figure 3.1: Pre-pandemic Traffic Situation in Metro Manila based on Waze Data

3.2 Traffic Conditions in TBNs

As mentioned earlier, the TBNs were identified using two approaches: by LOC based on Waze travel speed data and by questionnaire surveys administered by MMDA and the LGUs. This section spells out the traffic condition.

(1) Overlapping Points (Class A x Class A)

Among the TBNs identified by MMDA and the LGUs, those that were judged as TBNs with LOCs of greater than 3 and are overlapping with Waze travel speed data were included in the TBNs. Table 3.1 shows the detailed information about selected overlapping points regarding their traffic condition. These points are found to be low-speed sections at least in the inflow direction of a major road.

| EDSA–Shaw Boulevard | Lacson Ave.–Laong Laan St. |
|---|--|
| Mandaluyong | Manila |
| | |
| AxA | AxA |
| TBN identified by MMDA | TBN identified by LGUs |
| TBN identified by LOC (>= LOC3) | TBN identified by LOC (>= LOC3) |
| D1: 15.2km/h: LOC3 (EDSA) D2: 8.9km/h: LOC3 (Class A) D3: 16.0km/h: LOC3 (EDSA) D4: 10.5km/h: LOC3 (Class A) | D1: 11.8km/h: LOC3 (Class A) D2: - D3: 10.5km/h: LOC3 (Class A) D4: 23.8km/h: LOC1 (Class A) |
| | Mandaluyong Image: Second s |

Table 3.1: Traffic Conditions in Overlapping AxA Bottlenecks

Source: JPT

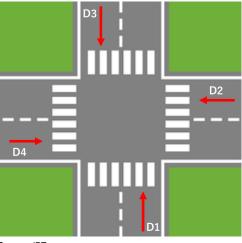


Figure 3.2: Leg Numbering System

(2) Non-overlapping Points (Class A x Class A)

Among the TBNs identified by MMDA or the LGUs, those that did not fall under LOC 3 to 4 criteria were added to the TBNs as well. Table 3.2 describes the detailed information regarding representative non-overlapping points with their traffic conditions. Most of the non-overlapping TBNs are located along Class A roads, such as, MacArthur Hwy., EDSA, Commonwealth Ave., Ortigas Ave., and Alabang-Zapote Rd. Large variation between travel speed data from 6:00am to 8:00pm from these road sections may be the reason why the average travel speed data resulted to LOC values lower than 3.

| Intersection Name | EDSA-MacArthur Highway | Quirino Highway–Commonwealth Avenue |
|------------------------------------|--|---|
| Location | Caloocan | Quezon City |
| Мар | | 1 28.1 26.7 20.5 00 0 <td< th=""></td<> |
| Class | AxA | AxA |
| MMDA or LGU | TBN identified by MMDA and LGUs | TBN identified by LGUs |
| LOC | Not TBN identified by LOC (>= LOC3) | Not TBN identified by LOC (>= LOC3) |
| LOC of Each Inflow Direction | D2: 21.6km/h: LOC2 (EDSA) R1_3: 32.2km/h: LOC0 (EDSA) R2_1: 29.2km/h: LOC0 (Class A) | D4: 26.7km/h: LOC0 (Class A) D2: 21.6km/h: LOC1 (Class A) D3: - |
| Source: IDT | D1: 18.0km/h: LOC2 (Class A) | D1: 36.5km/h: LOC0 (Class A) |

| | Traffic Conditions in New supplements a AvA Dattlements |
|------------|---|
| Table 3.2: | Traffic Conditions in Non-overlapping AxA Bottlenecks |

Source: JPT

(3) Non-intersections along Class A Roads

The U-turn slots and merging points which MMDA or the LGUs identified as traffic bottlenecks are located on Class A roads, as shown in Table 3.3. These segments should be checked and added to the TBNs, as well.

| Name | EDSA, Santolan Crame U-turn slot | EDSA SM North Annex - U-turn Slot Corregidor – U-turn Slot |
|-------------|----------------------------------|---|
| Мар | | |
| Class | A | A |
| MMDA or LGU | TBN identified by MMDA | TBN identified by MMDA |

 Table 3.3:
 Non-intersections along Class A Roads

3.3 Classification of Traffic Bottlenecks

Classifying the identified TBNs will create appropriate measures against traffic congestion. For instance, if several TBNs are on the same road and adjacent to each other, grouping them would suggest a holistic solution that would be more effective to the entire corridor. As mentioned earlier, there are two conditions when a point or a section becomes a TBN: excess demand over capacity and reduced capacity. Moreover, the severity and direction of traffic congestion or the queue length may differ depending on site conditions. Therefore, classifying bottlenecks would be essential to make localized measures in tackling congestion.

1) Typology of Traffic Bottlenecks

To determine the major TBNs from the 209 identified TBNs, they were categorized according to intersection type, the severity of congestion, structure and signal type, number of crossing conflicts and legs, and implementation possibility (Table 3.4).

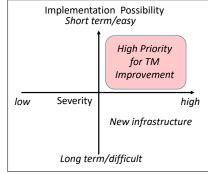
| Category | Туроlоду |
|-------------------------------|--|
| Intersection Type | ✓ Major Corridor: Class A x Class A, B, C |
| | ✓ Minor Corridor: Class B x Class B |
| Severity of Congestion | ✓ High congestion level (LOC>=3) |
| | ✓ Long queue length in each leg |
| Structure and Signal Type | Signalized or non-signalized |
| | ✓ At-grade or Segregated (Elevated) |
| Crossing Conflict/No. of Legs | Many conflict locations |
| Implementation Immediately | ✓ Short-term / Easy implementation |
| | Long term / Difficult implementation |

Table 3.4: Traffic Bottleneck Categories

Source: JPT

High priority was given to intersections comprising at least one Class A road. Structure and signal type identify signalized and non-signalized intersections, as well as at-grade and segregated (grade-separated) intersections. The number of crossing conflicts in, and legs of, an intersection determines the time to turn to other directions and the probability of a road crash. The more crossing conflicts there are, the higher the probability of being stuck in traffic or causing road crashes, especially if an intersection is non-signalized. Implementation possibility is also considered since priority TBNs need immediate action. Long-term plans may be difficult to execute, since they might require a higher budget, new infrastructures, and land acquisition. Major, or high-priority, TBNs fall under the high severity / short-term implementation criteria, as shown in Figure 3.3.

Meanwhile, the severity of congestion is based on two factors: level of congestion (LOC) and queue length. For LOC, LOC A refers to the initial TBNs selected by MMDA and LGUs. LOC B to D are dependent on the number of approaches or directions with an LOC of 3 or 4 a TBN has.



Source: JPT

Figure 3.3: Criteria for Major TBNs

Table 3.5: Severity of LOC

| | Severity of LOC |
|-------------|-----------------------------|
| А | Selected by MMDA/LGUs |
| В | =1 Direction has >= LOC3 |
| С | >=2 Directions have >= LOC3 |
| D | All Directions have >= LOC3 |
| Source: JPT | |

Queue length relies on the site observation done in 2021 by MMDA traffic enforcers in the 209 TBNs. In the questionnaire they accomplished, they estimated the queue length per approach of each TBN, indicating "01" for the longest queue and "04" for no queue or less than 100-m queue length. Queue Length 1 means that at least two approaches have moderate queue lengths, while Queue Length 6 means at least one direction has over 500m queue length.

| Table 3.6: | Severity of Queue Length |
|------------|--------------------------|
| | |

| Severity of Queue Length | | |
|--------------------------|--------------------|--|
| 1 | >=2 Direction = 03 | |
| 2 | All Direction = 03 | |
| 3 | =1 Direction = 02 | |
| 4 | >=2 Direction = 02 | |
| 5 | All Direction = 02 | |
| 6 | >=1 Direction = 01 | |
| Source: JF | т | |

Where queue length: 01 Heavy: over 500m 02 Moderate: over 300m to 500m 03 Light: over 100m to 300m 04 No Queue or <100m

Source: JP1

Table 3.7 classifies the long-listed TBNs by intersection type, signalization, and structure. It shows that: (i) 164 (78%) of the 209 long-listed TBNs satisfy the LOC criteria; (ii) 92 (44%) are non-signalized intersections, implying the need for signalization to manage traffic; and (iii) 175 (84%) are at-grade TBNs, implying that traffic congestion can be mitigated by improving at-grade intersections.

| Int. Type | >=LOC3 | Identified by MMDA/LGUs | Non-signalized | At-grade | Segregated | | |
|-----------|--------|----------------------------|----------------|----------|------------|----|--|
| AxA | 50 | 11 | 26 | 35 | 39 | 22 | |
| AxB | 58 | 17 | 30 | 45 | 66 | 9 | |
| AxC | 50 | 16 | 35 | 31 | 64 | 2 | |
| BxB | 6 | 1 | 1 | 6 | 6 | 1 | |
| Subtotal | 164 | 45 | 92 | 117 | 175 | 34 | |
| Total | | 209 | 209 | | 209 | | |

Table 3.7: Long-listed Intersection Bottlenecks by Type

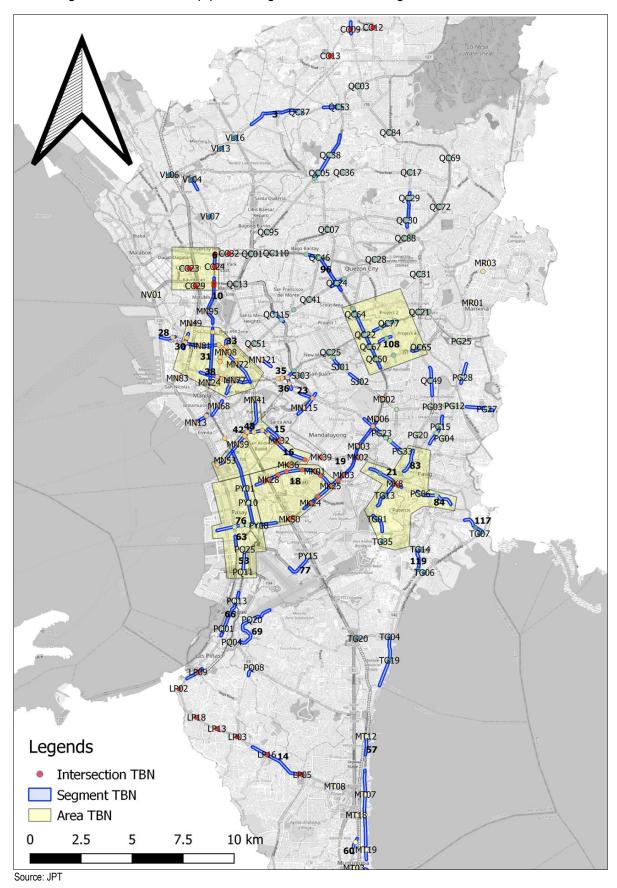


Figure 3.4 shows a map presenting the intersection, segment, and area TBNs.

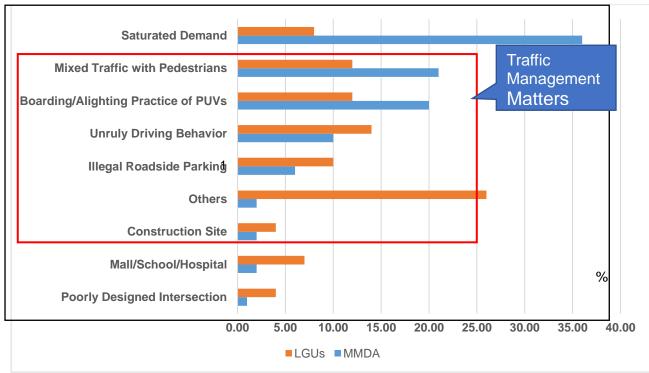


4 Causes and Factors of Traffic Congestion

4.1 Congestion Causes according to MMDA and LGUs

Based on the results of the questionnaire surveys conducted among MMDA and LGU CPTs, the major causes of traffic congestion, accounting for 35% for MMDA and 43% for LGUs are: PUJs stopping at intersections, non-compliance with driver rules, and illegal parking, as shown in Figure 4.1.

The questionnaire survey results showed that there are some differences in the causes of traffic congestion as perceived by MMDA and LGU counterparts. The LGU counterparts did not consider excess demand as a top cause. This could be explained by the fact that their jurisdiction mainly covers local roads which have less traffic volume than major roads. Second, the causes identified by MMDA counterparts are attributed to the traffic bottlenecks on major roads, whereas those by LGU counterparts can be associated with traffic bottlenecks on local streets.



¹ "Others" include manual overriding of traffic signals, obstruction by illegal vendors, and poor signal phase timing. Source: Questionnaires conducted among MMDA and LGU CPTs.

Figure 4.1: Traffic Congestion Causes Identified by MMDA and LGUs

4.2 Factors of Congestion

Factors affecting traffic congestion in Metro Manila were grouped based on local traffic and physical characteristics, among other aspects, as shown in Table 4.1. Based on these, the JPT analyzed each bottleneck from the traffic engineering point of view.

(a) Road Infrastructure: In particular, number of lanes (lack of number of lanes, insufficient road width); intersection layout (improper geometric layout, inadequate corner cutting, and improper location of road facilities [pavement markings]); road alignment (sharp curve, gradient change point [sag point], steep slope); tunnels/underpasses (entrance of underpasses). (b) Traffic Control and Regulations: In particular, signal timing (inadequate traffic control with/without traffic signal); poor visibility of traffic signals; left-turning or oncoming vehicles (no left-turn lane, insufficient left-turn lane length, conflict between a left-turning car and an oncoming car); right-turning vehicles (right-turning vehicles blocking those going straight ahead, improper stop line position, improper channelization); and traffic signs (improper traffic sign or installation location). However, it should be noted that for intersections where traffic enforcers intervene, it is difficult to verify whether the signal control was appropriate relative to the traffic conditions since there are no records.

| | Aspect | Factor of Congestion | | | | | |
|-----------------|--------------------------|---|--|--|--|--|--|
| | Number of Lanes | Lack of number of lanes | | | | | |
| | Number of Lanes | Insufficient road width | | | | | |
| | | Wrong geometric intersection layout | | | | | |
| | Intersection Layout | Inappropriate for center point of intersection | | | | | |
| Road | Intersection Layout | Inadequate corner cutting | | | | | |
| Infrastructure | | Improper location of road facilities (road markings) | | | | | |
| | | Sharp curve | | | | | |
| | Road Alignment | Gradient change point (sag point) | | | | | |
| | | Steep slope | | | | | |
| | Tunnels, Underpass | Entrance of underpass | | | | | |
| | | Inadequate traffic control (in case of no traffic signal) | | | | | |
| | Signal Timing | Inadequate traffic signal control (in case of with traffic signal) | | | | | |
| | | Poor visibility of traffic signal | | | | | |
| Traffic Control | Left-turning or oncoming | No left-turn lane | | | | | |
| and | Vehicles | Insufficient left-turn lane length | | | | | |
| Regulation | Venicies | Conflict between a left-turning car and an oncoming car | | | | | |
| | | Right-turning vehicles blocking vehicles proceeding straight ahead | | | | | |
| | Right-turning Vehicles | Improper stop line position | | | | | |
| | | Improper channelization | | | | | |
| | Traffic Sign | Improper traffic sign or installation location | | | | | |
| | | Speed reduction due to large vehicle | | | | | |
| Traffic | Conflict by Specific | Motorcycle is obstructed by other modes | | | | | |
| Characteristic | Traffic | Bike is obstructed by other modes | | | | | |
| | | Inadequate pedestrian facilities | | | | | |
| | Railway Crossing | Stopping traffic at railway crossing | | | | | |
| | | Difference in cross-sectional configuration between the bridge and | | | | | |
| | Bridge Section | general sections | | | | | |
| Environment | | Concentration of traffic on bridges | | | | | |
| of Roadside | Traffic Flow from/to | Traffic flow in/out at driveway along roadside shop | | | | | |
| and | Roadside Land Use, | Traffic flow in/out from intersections and narrow streets | | | | | |
| Intersection | Connecting Streets, etc. | Traffic flow in/out from IC at expressway | | | | | |
| interecetion | | Speed reduction due to PUV stop | | | | | |
| | PUJ, PUB | Speed reduction due to PUJ stop | | | | | |
| | | Lane reduction with dedicated bus and priority lanes | | | | | |
| | On-street Parking | Obstruction of travel by on-street parking | | | | | |
| | Exceeding | Excess traffic capacity at intersections | | | | | |
| | Capacity | Excess traffic capacity at non-intersections | | | | | |
| Traffic | | Concentration of traffic at a specific time | | | | | |
| Demand | | Concentration of traffic on roadside facilities at specific times and | | | | | |
| 20.10110 | Concentrated Traffic | periods | | | | | |
| | | Concentration of traffic during specific periods during events or | | | | | |
| | | incidents | | | | | |
| Others | Construction Work | Lane blockage due to construction | | | | | |
| | Clogging of Downstream | Clogging with congestion | | | | | |

| Table 4.1: | Factors | of | Congestion |
|------------|---------|----|------------|
|------------|---------|----|------------|

- (c) **Traffic Characteristics:** In particular, disturbance by specific traffic (reduced speed due to large vehicle, motorcycle obstructed by other modes, bike obstructed by other modes, inadequate pedestrian facilities).
- (d) Environment of Roadside and Intersections: In particular, railway crossing (stopping traffic at railway crossing); bridge section (difference in cross-sectional configuration between the bridge and approach sections, concentration of traffic on bridges); traffic flow from/to roadside land use, connecting streets, etc. (traffic flow in/out at driveway along roadside shop, traffic flow in/out from intersections and narrow streets, traffic flow in/out from IC at expressway); PUJs/PUBs (reduced speed due to PUV stop, lane reduction with dedicated bus and priority lanes); on-street parking (travel obstructed by on-street parking).
- (e) **Traffic Demand:** In particular, exceeding capacity (excess traffic demand at intersections, excess demand at non-intersections); concentrated traffic (at specific times, on roadside facilities at specific times and periods, or during events or incidents).
- (f) **Others:** In particular, construction work (lane blockage due to construction); clogging downstream.

Based on traffic enforcers' observation, data and information about congestion and its causes for each identified bottleneck were collated into datasheets, as shown in Table 4.2.

The accuracy and consistency of these data were checked by photos taken at the site. Meanwhile, basic information, such as the intersection type (class, signalized, etc.), road inventory (number of lanes, road width, etc.), traffic count data from MMDA, and travel speed data from Waze, was also collected and shown in another datasheet (Table 4.3).

Method of data collection for each Datasheet can be referred to Appendix.

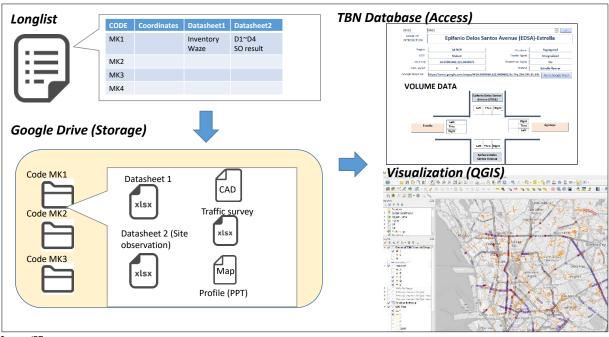
For this CTMP Project, the above-mentioned data helped in determining the intersection type of the bottlenecks and the countermeasures for each factor of congestion. For easy handling and access on demand, this intersection bottleneck database is stored in cloud servers. Microsoft Access can be used to navigate the database. Using a GIS application, the data can be visualized to see the location of intersection bottlenecks in Metro Manila. Together with other databases which the CTMP Project developed, analyzing the traffic situation in the metropolis and choosing TM measures have become more efficient and science-based (Figure 4.2). More detailed information can be referred to Technical Report 08_Manual on Traffic Bottleneck Database.

| | | | | Congestion Situation | | | | | | |
|--------------------|----------------------------|-----------------------|---------------|--|-------------------|---------------|----------------|----|-----|--|
| | Appro (tow | | | Vehicle Queue Length Spill over from intersection | ¹ Spil | l ove inte | r to u rsec | • | ear | |
| D1 | Taft South | 02 M | oderate : ove | or 300m to 500m Yes | | | No | | | |
| D2 | Taft North | <mark>02 M</mark> | oderate : ove | r 300m to 500m No | | No | | | | |
| D3 | A. Arnaiz W | est <mark>None</mark> | | Yes | | | No | | | |
| D4 | A. Arnaiz Ea | ast 02 M | oderate : ove | er 300m to 500m Yes | | | No | | | |
| D5 | | | | | | | | | | |
| | | | C | hecklist for Factor of Congestion (intersection) | | | | | | |
| 1:STF | RONGLY AGE | REE, 2:AGREE, 3 | 3:DISAGRE | E | | | | | | |
| Fa | actor item | Checkpo | oint | Factor of Congestion | D1 | D2 | D3 | D4 | D | |
| | | Number of | lanes | Lack of number of lanes | 1 | 3 | 1 | 1 | | |
| | Deed | Number of | lanes | Insufficient road width | 2 | 3 | 2 | 2 | | |
| inf | Road rastructure | | | Wrong geometric intersection layout | 3 | 1 | 3 | 3 | | |
| | | Intersection | layout | Inadequate corner cutting | 1 | 2 | 1 | 1 | | |
| | | | | Improper location of road facilities (road markings) | 2 | 3 | 2 | 2 | | |
| | | Cignaltin | ala a | Inadequate of traffic signal control | 1 | 1 | 1 | 1 | | |
| | | Signal tin | ning | Bad visibility of traffic signal | 1 | 2 | 1 | 1 | | |
| | | | | No left-turn lane | 1 | 1 | 1 | 1 | | |
| Traffic regulation | | Right-turning or | • | Insufficient left-turn lane length | 1 | 2 | 1 | 1 | | |
| | | vehicle | es | | 1 | 3 | 1 | 1 | | |
| | | | | Conflict between a left-turning car and an oncoming straight c | ar | 3 | | | | |
| | | | | Right-turning vehicles blocking vehicles proceeding straight ahead | 1 | 1 | 1 | 1 | | |
| | | Left-turning v | vehicles | | 1 | 2 | 1 | 1 | ┢ | |
| | | | | Improper stop line position Improper channelization | 1 | 3 | 1 | 1 | - | |
| | | | | Speed reduction due to large vehicle | 1 | 1 | 1 | 1 | - | |
| | | | | Obstruction by motorcycles | 1 | 2 | 1 | 1 | _ | |
| Trat | ffic situation | Large vel | hicle | Obstruction by hiotocycles | 1 | 2 | 1 | 1 | _ | |
| | | | | Obstruction by pedestrian | 1 | 2 | 1 | 1 | _ | |
| | | Railway Cr | occina | Stopping traffic at railway crossing | 1 | 2 | 1 | 1 | _ | |
| | | | - | Traffic flow in/out from intersections and narrow streets | 1 | 1 | 1 | 1 | - | |
| | | Driveway from shop | | | 1 | 2 | 1 | 1 | - | |
| | vironment of adside and | 00p | | Traffic flow in/out from IC at expressway Speed reduction due to PUV stop | 1 | 3 | 1 | 1 | - | |
| | tersection | | 11/ | | 1 | 1 | 1 | 1 | _ | |
| | | PUJ, PU | 50 | Speed reduction due to PUJ stop Lane reduction with dedicated bus and priority lanes | 1 | 2 | 2 | 1 | _ | |
| | | On street p | orking | Obstruction of travel by on-street parking | 1 | 2 1 | 2 | 1 | - | |
| | | On-street p | arking | Excess traffic capacity at intersections | 1 | 1 | 3 1 | 1 | - | |
| | | Over capa | acity | Excess traffic capacity at intersections | 1 | 2 | 2 | 1 | _ | |
| | | | | | 1 | 2 | 2 | 1 | - | |
| Trat | ffic Demand | | | Concentration of traffic at specific time Concentration of traffic on roadside facilities at specific times | and | | | | F | |
| | | Concentrate | d traffic | periods | 1 | 1 | 1 | 1 | | |
| | | | | Concentration of traffic during specific periods during events of incidents | or 1 | 2 | 1 | 1 | | |
| | | Construc | tion | Lane blockage due to construction | 1 | 1 | 1 | 1 | | |
| | Others | Clogging of do | wnstream | Clogging with congestion of downstream | 1 | 2 | 1 | 1 | | |
| | | Free Com (if any | | Due to traffic accident, tenporaly congestion occurs | | | | | | |

Table 4.2: Sample of Datasheet 2: Results of Site Observation

| | Table 4 | able 4.3: Sample of Datasheet 1: Basic Data and Information about Intersection TBNs | | | | | | | | |
|------|---------|---|--|--------------------|-----------|--|--|--|--|--|
| | | | | Common Information | | | | | | |
| CODE | E PY04 | 4 | | | Sheet No. | | | | | |

| CODE | PYO | | | 1 | | 1 | | | | | | Sheet N | ю. | | | | |
|-------------------------------|----------------------------|--------|----------------|-------------------|------------|-------------|-------------------------------|-------------------------|--|-----------------------|-----------|------------|--|----------|-------------|-------------------------|--|
| REGIO | N 14 M | NCR | | CITY | | Pasay | | | | | | | | | | | |
| Name of Interse | | EDS | A-Taft | Ave. | | | | | | Administ (Main Roa | | | | | | MMDA | |
| Latitud (Center of | e / Longit Intersection | ude | | | | | | 14.5375177, 121.0007001 | | | | | | | | | |
| Interse | ction Typ | be | | | AxB | | | Structur | e | | | | | | 01 At-grade | | |
| Signaliz | alization 01 Signalized | | | | | | | Pedestr | ian Signal | 1 | | | | | | 00 No | |
| Station | | | | 01 Yes | | Name of | Station | | | | | | | 1 | Т | aft | |
| | ting Layo | out (C | AD) | | U | RL | | https:// | drive.goos | ale.com/dr | ive/folde | rs/10G20 | i opt77AfXlil | ENatE(| | ztzfYY5Z1?usp=sharing | |
| Photo | | 1 | | Date | | 2021/3/16 | 3 | | ime | 8:0 | | | | _ | | vXTT281C10b2ajQuFtLb | |
| | Map /IID | | - | Juic | I | 2021/ 5/ 10 | , | • | | | | | | | | .,19.03z?hl=ja | |
| Google | Map (UR | | | | | | | | | | ie.com/r | Taps/@1 | 4.3370334, | ,121.00 | 005601 | .,19.052?III= <u>Ja</u> | |
| | 1 | | | 1 | | | | Layo | out (Invent | tory) | | | | | | | |
| | Арр | proac | h | Dedlerated | Len- | No. of | | Right- | 1 | Deallerated | | oad Wid | | Right | - | Data Source | |
| | (to | oward | d) | Dedicated Left | Throug | Through | Dedicat ed Right | Throug | Total | Dedicated Left | Throug | Through | Dedicated Right | - | Total | Data Source | |
| D1 | EDSA W | /est | | 1 | - 0 | 4 | - | - 1 | 6 | | L 0.0 | 14.0 | - | 3.5 | 21 | 03 DPWH Atlas | |
| D2 | EDSA E | | | 0 | | | 1 | 0 | | | 0.0 | 13.6 | | 0.0 | 17 | | |
| D3 | Taft Nor | | | | | 3 | | | 3 | | 0.0 | | | 0.0 | 7 | 03 DPWH Atlas | |
| D3 | Taft Sou | | | | | 3 | | | 3 | | | | | | | | |
| | Tan Sou | Ith | | | | 3 | | | 3 | | | | | | 6.8 | | |
| D5 | | | | | | | | | | | | | | | | 03 DPWH Atlas | |
| | | | | | | - | | Tra | affic Volur | ne | | | | | | | |
| Date of Traffic Volume Survey | | | | | | | | | | Wedr | iesday, N | larch 06, | 2019 | | | | |
| Peak Time | | | | | Fro | m | | 08:00 | :00 AM | | - | То | | | 09:00:00 AM | | |
| | | | Approach Class | | Class Peak | | k Hour Traffic Volu (PCUs) | | Total | PUB | PUJ | PUV | PUT% | | | | |
| | | oward | | | Left | Through | Right | Total | Volume | | | | | | | | |
| D1 | EDSA W | /est | | A | 255 | 3,840 | 13 | 4,108 | 4,096 | 135 | 471 | 299 | 22.1% | | | | |
| D2 | EDSA Ea | ast | | A | 0 | 3,163 | 332 | 3,495 | 3,627 | 81 | 527 | 279 | 24.5% | | | | |
| D3 | Taft Nor | th | | A | 345 | 30 | 456 | 831 | 917 | 0 | 176 | 56 | 25.3% | | | | |
| D4 | Taft Sou | ıth | | A | 12 | 25 | 134 | 171 | 203 | 0 | 44 | 6 | 24.6% | | | | |
| D5 | | | | | | | | | | | | | #DIV/0! | | | | |
| Traffic ' | Volume S | Surve | ev Data | (Excel) | I | I | I | https://o | drive.goog | le.com/driv | /e/folder | s/1gOSU | II9MSJXEto | UkKal | hlMina | Rxcj6Mt6f?usp=sharing | |
| | | | | \ | | | Tr | | | | | | | <u> </u> | | <u> </u> | |
| Source | | | | | | | | | el Speed from Waze, LOC 2019/ Weekday / Daily(6-20)/ Inflow | | | | | | | | |
| oouroe | | proac | | Class | In/Out | | Km/h | LOC | | 2010/ 11 | | July (0 20 | <i>,</i> ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | | | | |
| D1 | EDSA W | | -, | A | Inflow | | 13.7 | 4 | | | | | | | | | |
| D2 | EDSA E | | | A | Inflow | | 15.1 | 3 | | | | | | | | | |
| D3 | Taft Nor | | | A | Inflow | | 13.4 | 3 | | | | | | | | | |
| D3 D4 | | | | A | | | 0.0 | | | | | | | | | | |
| | Taft Sou | iun | | ~ | Inflow | | 0.0 | 0 | No Data | | | | | | | | |
| D5 | | | | | Inflow | | | | | | | | | | _ | | |
| | EDSA W | | | A | Outflow | | 17.6 | 3 | | | | | | | | | |
| D2_0 | EDSA Ea | | | A | Outflow | | 22.5 | 2 | | | | | | | | | |
| D3_0 | Taft Nor | th | | A | Outflow | | 0.0 | 0 | No Data | | | | | | | | |
| D4_0 | Taft Sou | ıth | | A | Outflow | | 19.8 | 2 | | | | | | | | | |
| D5_0 | | | | | Outflow | | | | | | | | | | | | |
| | | | | | | | | 5 | Signal Data | a | | | | | | | |
| Signal I | Phase Da | Ita | | | | | | URL | | | | | | | | | |
| CCTV E | | | | | | | | URL | | | | | | | | | |
| Source: | | | | | | | | UNL | | | | | | | | | |
| Source: " | 171 | | | | | | | | | | | | | | | | |

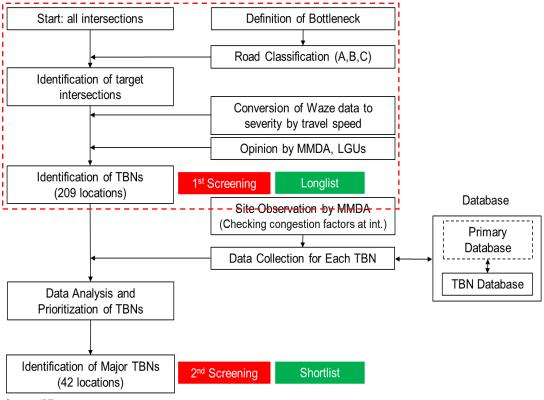


Source: JPT

Figure 4.2: Conceptual Diagram of the Intersection Bottleneck Database

5 MANUAL ON IDENTIFYING TBNS USING WAZE TRAVEL SPEED DATA

The first steps in identifying traffic bottlenecks involve defining the road classification, identifying target intersections (AxA, AxB, AxC, and BxB intersections), converting waze travel speed data from csv file to a map, and applying LOC criteria for intersection, segment, and area TBNs. MMDA and LGUs may also add problematic intersections based on their engineering judgement.



Source: JPT

Figure 5.1: Workflow in Identifying Traffic Bottlenecks

5.1 Road Classification

The JPT, MMDA, and LGU counterpart team defined each road class based on functionality. They specified which roads or establishments each road class connects. Moreover, expressways and major arterial roads provide the most mobility or ability to move, while local streets gives more access given more possible routes.

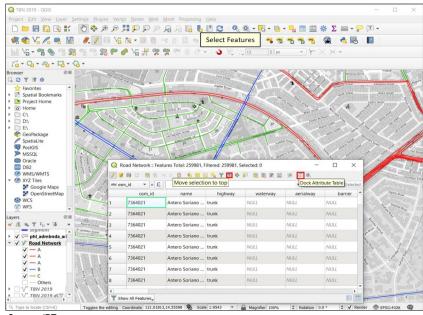
| Road Classifica | tion | Definition | Function |
|-----------------------------------|------|--|----------|
| Expressway and Major Arterials | A | Controlled access or limited access road with access ramps, lane dividers, etc., for high-speed traffic. Affect basic urban space & land use. Backbone serving major traffic flow in Metro Manila such as R1-R10 and C1-C6, and those with the same function as an integrated network. | Mobility |
| Minor Arterials | В | Provides access to international airports and ports and other major traffic-generating sources. Articulate primary road network. Provide major traffic flow with alternate routes. Affect basic urban space & land use. | |
| Major Collectors | с | Connect major traffic-generating sources of LGU to Primary roads. Connect Barangay centers with LGU/City Hall. Serve main traffic within LGUs. | |
| Minor Collectors | D | Connect barangay with other barangays. Road that connects main socio-economic activity facilities/areas such as schools, hospitals, markets, etc. for the residents in LGUs and provides good access to primary/secondary roads. Roads that serve main traffic circulation within LGUs. | |
| Local Streets | E | Roads that complete destination trips, connected to other roads but do not belong to the classes above. Living roads that prioritize pedestrians. Roads that mostly serve intra-barangay traffic, gated villages, etc. | Acces |

| Table 5.1: | Road | Classification | Description |
|------------|------|----------------|-------------|
|------------|------|----------------|-------------|

Source: JPT

The following steps show how to edit the road classification of links from the Road Network database.

(a) Open the attribute table and click "Dock Attribute Table" and "Move selection to top".



Source: JPT

Figure 5.2: Road Network Attribute Table

- (b) Select the links that need to be updated.
- (c) Select "NewRC" field and type the new value.
 - 1 = Expressway (black)
 - 2,3 = A (red)
 - 4 = B (blue)
 - 5 = C (green)
 - 9 = Others (grey)

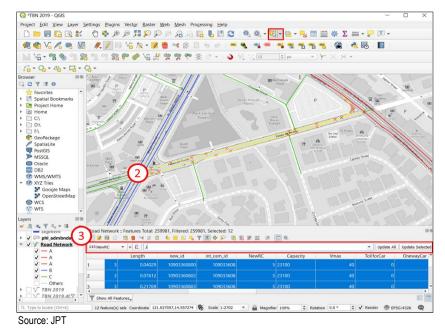


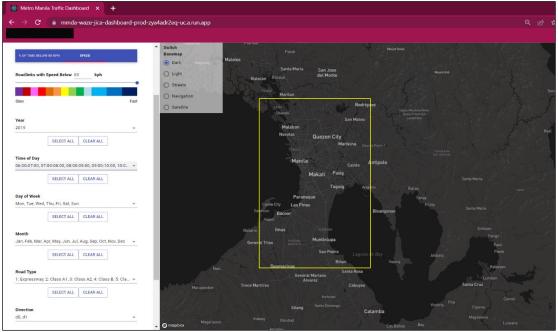
Figure 5.3: Updating Road Links

And click the "Update Selected". The link will change it's color depending on the new assigned class.

5.2 Waze Data Dashboard

This section explains the elements found in the Waze Data Dashboard, as well as how to export network and space-time table data.

- (a) Access Metro Manila Waze Data dashboard by going to https://mmda-waze-jicadashboard-prod-zya4adr2eq-uc.a.run.app/.
- (b) Zoom the map such that whole Metro Manila can be seen in the screen.



Source: JPT

Figure 5.4: Waze Data Dashboard

- (c) Set the filters to the left of the dashboard to change the results shown in the map or export the needed data.
 - Switch the analysis method to "Speed."
 - Select 80kph. The colors shown in the map will correspond to the speed of the road link.
 - For some filters, you will be able to "Select All" the values. This will average the data called by the filter. You can also "Clear All" to unselect the values.

For the traffic bottleneck identification in CTMP, ALL day of week, month, road type, and direction were selected for the year 2019. Time of day values were from 6:00 am to 8:00 pm.

Filtered values related to time of day, day of week, and month may be changed in future studies depending on the scope the strategies/plans to be implemented.

- Road links with a likely cardinal direction of either East or North will show up under the "d0" filter, while those that are either West or South will show up under "d1."

| · → C 🔒 mmda-waze-jica-dashboard- | prod-zya4adr2eq-uc.a.r | un.app | | |
|---|------------------------|-----------|--|--------------------------------------|
| | | | rtanuet | |
| % OF TIME BELOW 80 KPH SPEED | 3.1 _{ap} | Malo | | |
| Roadlinks with Speed B low 80 kph | 3.2 | Hagonoy | Santa Maria San Jo Bulacan Bocaue del Mor | |
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| Slow Fa | st O Satellite | | Carl Carlos Carlos | Rodrigue |
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| 2019 | | | Malabon | |
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| Time of Day | 0 - 5 | | Manila | Cainta An |
| 06:00-07:00, 07:00-08:00, 08:00-09:00, 09:00-10:00, 10:0 • | 5 - 10 | | Makati | Pasig |
| SELECT ALL CLEAR ALL | 10 - 15 | | | aguig Angono |
| Day of Week Mon, Tue, Wed, Thu, Fri, Sat, Sun | 15 - 20 | | Paranaque Cavite City Las Pinas | |
| SELECT ALL CLEAR ALL | 20 - 25 | | Dalahican Kawit | E |
| Month | 25 - 30 | | Rosario Imus ALABANG | |
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| SELECT ALL CLEAR ALL | 35 - 40 | | San Pe | |
| Road Type | 40 - 45 | | Dasmarinas | Biñan Santa Rosa |
| 1: Expressway, 2: Class A1, 3: Class A2, 4: Class B, 5: Cla 🔹 | 45 - 50 | | General Mariano Alvarez Trece Martires | Cabuyao |
| SELECT ALL CLEAR ALL | 50 - 60 | | | (2 A 2 7 A |
| Direction | 60 - 70 | | Silang Santo Dom | ingo Calai |
| d0, d1 3.4 | 70 - 80 | | | |

Figure 5.5: Components of the Waze Data Dashboard

(d) Show updated map or export needed data.

- When needed filters are selected, click "Update Map" to apply the filters on the map.
- Export road network attribute by clicking "Export data as CSV." The attribute contains street name, average speed, road type, and well-known text (WKT) among others. WKT is important in plotting the links in a GIS software.
- Export space-time for circumferential and radial roads by clicking "Export
- Space Time Table Data as CSV."

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| Direction d0, d1 UPDATE MAP | 4.1 | | | Lastria |
| EXPORT DATA AS CSV | 4.2 | Rosari | o Imus | 344 AR |
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Figure 5.6: Exporting Data from Waze Data

5.3 Creating Level of Congestion Map

From the exported network data, the comma-separated values (CSV) file can be converted into a map. The following steps show how to compute for the level of congestion and to present the links in the map.

(a) Paste the exported "Waze Network data" in the template provided. The template will determine road class based on the Level of Congestion (LOC) speed criteria set by the JICA project team. LOC of d1 and d0 shall be automatically computed by using the average speed (speed_d0, speed_d1) and road class (LOCClass) of each link.

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| _s2_i0_m0 | 23.7634 23.78456099 23.742170 | 52 8758 | 8758 | 100 11: Others | LINESTRIN | | 3 | 0 | 0 | C5 | 0 1 | 5 15 | 20 20 | 25 25 30 | 30 | |
| _s2_i0_m1 | 23.7634 23.78456099 23.742170 | 52 8758 | 8758 | 100 11: Others | LINESTRIN | | 3 | 0 | 0 | Exp | 0 1 | 5 15 | 20 20 | 30 30 40 | 40 | |
| EDSA / Ortigas Flyover N _s0_i0_m0 | 46.3993 46.39925135 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | EDSA | EDSA | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m1 | 50.9375 50.93748573 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | EDSA | EDSA | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m2 | 46.1203 50.69823133 41.542310 | 27 8758 | 8758 | 100 2: Class A1 | LINESTRIN | EDSA | EDSA | 0 | 0 | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m3 | 50.6982 50.69823133 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | EDSA | EDSA | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m4 | 50.4835 50.48350232 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | EDSA | EDSA | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m5 | 50.4868 50.48684365 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_10_m6 | 50.4655 50.46546929 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | EDSA | EDSA | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m7 | 50.5712 50.57122859 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s1_i0_m0 | 44.6215 50.57396361 38.66913 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | 0 | | | | | | | |
| EDSA / Ortigas Flyover N _s1_i0_m1 | 52.7411 50.46893773 55.013244 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | 0 | | | | | | | |
| EDSA / Ortigas Flyover N _s1_i0_m2 | 51.2734 50.48684365 52.05998: | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | 0 | | | | | | | |
| EDSA / Ortigas Flyover N _s1_i0_m3 | 54.1065 50.48684365 57.726070 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | 0 | | | | | | | |
| EDSA / Ortigas Flyover S _s0_i0_m0 | 36.8671 34.31300601 39.421230 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | 0 | | | | | | | |
| EDSA / Ortigas Flyover S _s0_i0_m1 | 43.7492 43.74924 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | | 0 | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m0 | 25.1433 25.13054693 25.155993 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 1 | 1 | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m1 | 43.7299 32.61163584 54.848179 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | 0 | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m2 | 21.701 32.60559565 10.796463 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | 4 | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m3 | 45.1266 32.60559565 57.647649 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | 0 | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m4 | 32.6001 32.60012484 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m5 | 44.5164 32.62184898 56.410976 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | 0 | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m6 | 32.6195 32.6194584 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m7 | 32.6385 32.63854076 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m8 | 32.6258 32.62577034 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 0 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m9 | 32.4942 26.40410139 38.58437 | | 8758 | 100 2: Class A1 | LINESTRIN | | EDSA | 1 | 0 | | | | | | | |
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Figure 5.7: Waze Data Converter

(b) Save the file as "2019 Waze Travel Speed Data LOC Converter V1.csv".

| 2019 Waze Travel Speed Data LOC Converter V1 | | | | | | |
|--|---------------|--|--|--|--|--|
| CSV (Comma delimited) (*.csv) | ▼ Save | | | | | |
| More options | | | | | | |
| Name 1 | Date modified | | | | | |

Source: JPT

Figure 5.8: Save As File Type

(c) Open "2019 Waze Travel Speed Data LOC Converter V1.csv" and Delete the Level of Congestion (LOC) speed criteria.

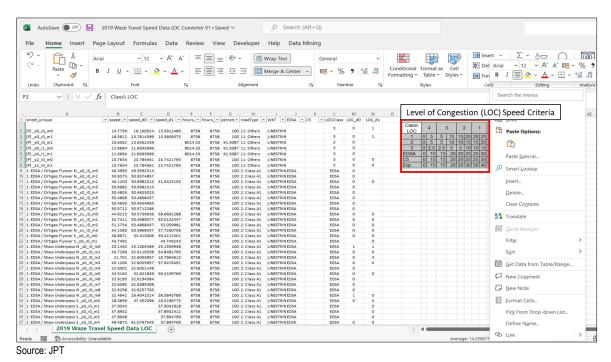
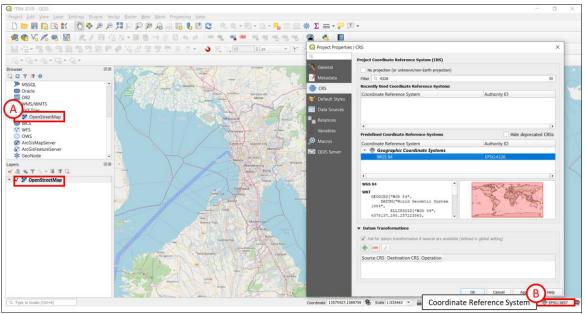


Figure 5.9: Level of Congestion Speed Criteria

- (d) Open QGIS and create a new .qgz file.
- (e) A: Drag "OpenStreetMap" from Browser to Layers. B: Set Coordinate Reference System to "EPSG:4326".



Source: JPT

Figure 5.10: Coordinate Reference System

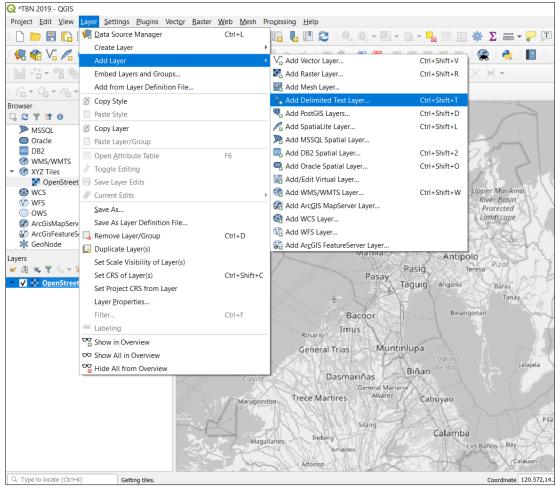
(f) Right click OpenStreetMap (OSM) and click "Properties". Set Grayscale to "By Lightness" and "Apply".

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Source: JPT

Figure 5.11: Map Set to Grayscale

(g) Import Waze travel speed data by clicking on "Layer" -> "Add Layer" -> "Add Delimited Text Layer".



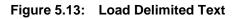
Source: JPT

Figure 5.12: Add Delimited Text Layer

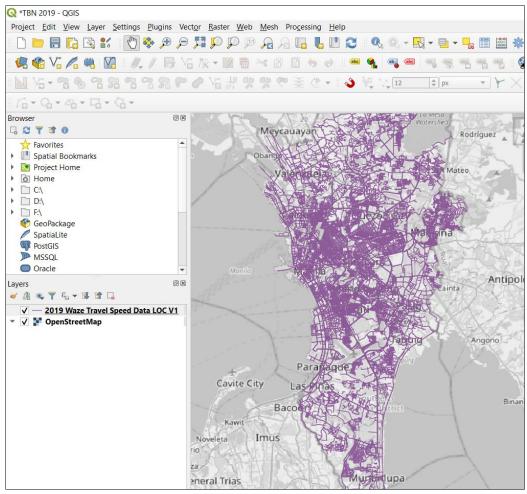
(h) Load "2019 Waze Travel Speed Data LOC V1". Geometry field will automatically detect the WKT column of the csv file. Select "Detect" for Geometry type. Press "Add".

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| | | 4 [P]_s0_i1_m0 | 21.66936988 | | | 8014.333333 | 8758 | 91.50871584 | | | | |
| | | 5 [P]_s0_i1_m1 | 21.66936988 | | | 8014.333333 | 8758 | 91.50871584 | | E Martin | | |
| | | 6 [P]_s2_i0_m0 | 23.76336876 | | 23.74217652 | | 8758 | 100 | | 100 | | |
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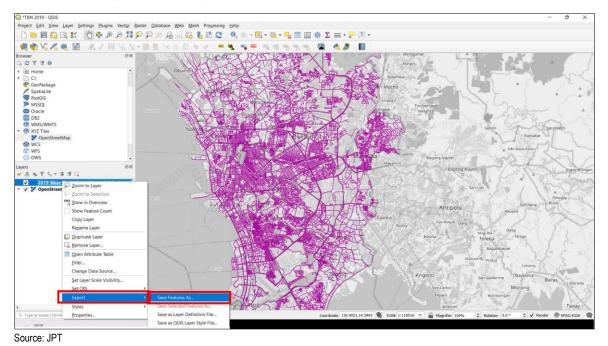


(i) In this updated map, the links are not yet categorized.



Source: JPT

Figure 5.14: LOC Road Network



- Right click the layer. Click "Export." Click "Save Features As"



- Set Format to "ESRI Shapefile" and save the shape file in a folder as "TBN 2019".

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Source: JPT

Figure 5.16: LOC Map as Shape File

(j) 10. Right click "TBN 2019" and click "Open Attribute Table". Click "Dock Attribute Table".

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| 6-9-8-6-6- | | 3 [P] _s0_i0_m2 | 23.6562259300 | 23.6562259300 | NULL | 8014.33333299 | 8758 | 91.5087158399 | 11: Others | NULL | NULL | 3 |
| owser @8 | TR | 4 [P] _s0_i1_m0 | 21.6693698800 | 21.6693698800 | NULL | 8014.33333299 | 8758 | 91.5087158399 | 11: Others | NULL | NULL | 3 |
| C T I O | 1 | 5 [P] _s0_i1_m1 | 21.6693698800 | 21.6693698800 | NULL | 8014.33333299 | 8758 | 91.5087158399 | 11: Others | NULL | NULL | 3 |
| ☆ Favorites I Spatial Bookmarks | -25 | 6 [P]_s2_i0_m0 | 23.7633687599 | 23.7845609899 | 23.7421765200 | 8758.00000000 | 8758 | 100.000000000 | 11: Others | NULL | NULL | 3 |
| Project Home | X | 7 [P] _s2_i0_m1 | 23.7633687599 | 23.7845609899 | 23.7421765200 | 8758.00000000 | 8758 | 100.000000000 | 11: Others | NULL | NULL | 3 |
| | / | 8 1: EDSA / Ortig | 46.3992513500 | 46.3992513500 | NULL | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| D DA | | 9 1: EDSA / Ortig | 50.9374857299 | 50.9374857299 | NULL | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| 😵 GeoPackage 🖉 SpatiaLite | | 10 1: EDSA / Ortig | 46.1202708000 | 50.6982313299 | 41.5423102700 | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| PostGIS MSSQL | | 11 1: EDSA / Ortig | 50.6982313299 | 50.6982313299 | NULL | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| MSSQL Oracle | 4 | 12 1: EDSA / Ortig | 50.4835023199 | 50.4835023199 | NULL | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| yers 🛞 🛛 | Mani | 13 1: EDSA / Ortig | 50.4868436499 | 50.4868436499 | NULL | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| /ी क २ ६ २ छ जे दि ✓ — <u>TBN 2019</u> | gar - | 14 1: EDSA / Ortig. | 50.4654692900 | 50.4654692900 | NULL | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| - 2019 Waze Travel Speed Data LOC V1 | 1 | 15 1: EDSA / Ortig | 50.5712285899 | 50.5712285899 | NULL | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| V PropenStreetMap | | 16 1: EDSA / Ortig | | 50.5739636100 | | | | 100.000000000 | | EDSA | NULL | EDSA |
| | 1 | 17 1: EDSA / Ortig. | 52,7410912300 | 50.4689377300 | 55.0132447200 | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| | + | 18 1: EDSA / Ortig | 51.2734123299 | | | | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| | Cavite | 19 1: EDSA / Ortig | 54.1064571100 | 50.4868436499 | 57.7260705699 | 8758.00000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDSA |
| | H. | | 36.8671180600 | | | | | 100.000000000 | | EDSA | NULL | EDSA |
| | Kawit | 21 1: EDSA / Ortig | | | 43.7492429799 | | | 100.000000000 | | EDSA | NULL | EDSA |
| No | oveleta | | 25.1432703400 | | | | | 100.000000000 | | EDSA | NULL | EDSA |
| 23 | 2734 | | 43.7299076700 | | | | | 100.000000000 | | EDSA | NULL | EDSA |
| ene: | eral Trias | | 21.7010284899 | | | | | 100.000000000 | | EDSA | NULL | EDSA |
| 12 | 10001 | 4 | | | | | | | | | | |
| Q. Type to locate (Ctrl+K) | AND: | 1: EDSA / Shaw . | 21.7010284899 | 32.6055956499 | 10.7964613200 | 8/58.0000000 | 8758 | 100.000000000 | 2: Class A1 | EDSA | NULL | EDS |

Figure 5.17: LOC Map Attribute Table

(k) A: Right click "TBN 2019" and click "Properties". B: On the lower left, click "Style" and load "LOCClass". Legends for different road classes will show on the map in different colors.

| | | | - TBN 2019 | 🛥 🍓 🙉 🛲 🔤 📼 | @ e | 2 | | | × | | |
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| Project Home O Home | | 🚥 Labels | 1- | Value Legend 1 1 | Load style | from file | Organize • New fol | der | | ⊫ • | |
| | | 3D View | × | 2 2 3 3 | | 🗸 🗞 Laye | er - * | Name | | Date modified | T |
| GeoPackage | | Fields | × × × | CS CS EDSA EDSA Exp Exp | Categories | ✓ 🎸 Symi ✓ 🔗 3D S | 51 | CCClass | | 27/05/2022 1:31 pn | n C |
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| V — EDSA V — Exp | / 1 | 🔲 🗧 🍞 Metadata 🥜 | 5 | | | | | | | | |
| ☐ — 2019 Waze Travel Speed | Data LOC VI | [P]_s0 Legend | Save | 1 Style Style | | | | | | | |
| | 3 | (P) st | 10.000 | r as Default ore Default | | | | ~ < | | | |
| | 4 | 02_ [4] D2_ [9] | Add | | | Load Style | File n | ame: LOCClass | | QGIS Layer Style File, SLI | D File (' |
| | 3 | 11.24 | Rena | ame Current | | | | | | | |

Source: JPT

Figure 5.18: LOC Map Load Style

(I) Links classified as EDSA and C5 should be sense-checked in the map because the formula in the excel file has limitations on detecting those links.

Uncheck 1, 2, 3, and Exp from "TBN 2019" layer. Uncheck also the 2019 Waze Travel Speed Data LOC Converter V1. Links that does not belong to EDSA and C5 should be re-classified.

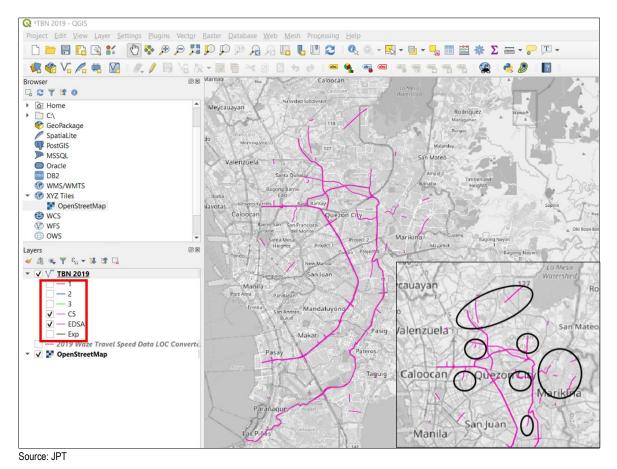


Figure 5.19: Raw Data on C5 and EDSA links

(m) A: Use "Select Features" and select links outside EDSA and C5. B: Select links. C: Click "Move Selection to Top".

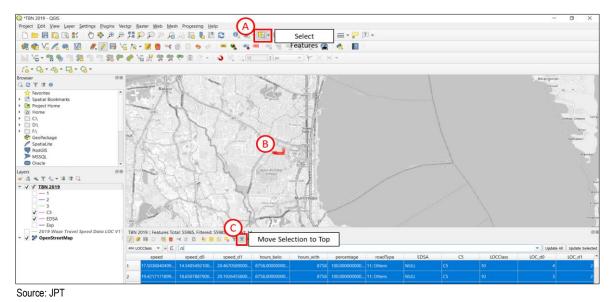
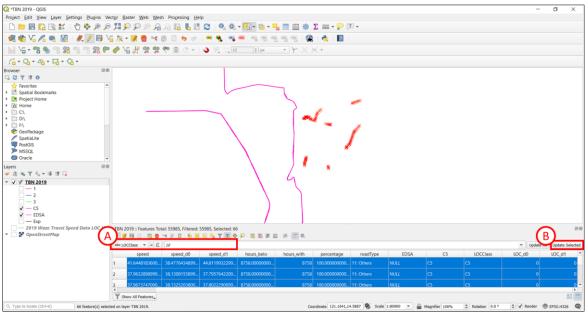


Figure 5.20: Cleaning EDSA and C5 Data

(n) To change the LOCClass, selected links should be marked first. Label the links outside EDSA and C5 with a different number by selecting LOCClass. A: Type any number besides 1 to 3. For instance, "10". B: And Click "Update Selected".



Source: JPT

Figure 5.21: Reclassifying Links

(o) Export TBN 2019 as .csv file and label it as "2019 Waze Travel Speed Data LOC Converter V2".

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| | 1 41.6448183600 38.4776434899 | | 8758 100.00000000 1 | Geometry type | Automatic | * | |
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| | 2 37.9632898999 38.1308155899 | 37.7957642200 8758.00000000 | 8758 100.00000000 1 | | | | - |
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| | Show All Features | | | | | | 12 |

Source: JPT

Figure 5.22: Exporting Cleaned LOC Map

In this example, 2019 Waze Travel Speed Data LOC Converter V2 have links with "LOCClass=10". These links were previously automatically classified as EDSA or C5 in the excel file and were labeled "10" in QGIS attribute table.

These links should be re-classified as either 1, 2, 3, or Exp (based on the road type column).

The Project for Comprehensive Traffic Management Plan for Metro Manila TECHNICAL REPORT NO. 4: IDENTIFICATION OF TRAFFIC BOTTLENECKS AND MONITORING

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| _ | EDSA N Exit _s0_i0_m0 | | 38.58129 | speed_ | 8758 | 8758 | | : Class A2 El | | | 10 | 000_00 | |
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| | EDSA S Entry/Quezon City s0 i0 m0 | | 13.72656 | | 8758 | 8758 | | Class A2 El | | | 10 | 4 | |
| | EDSA S Entry/Quezon City s0 i0 m1 | | 13.72656 | | 8758 | 8758 | | Class A2 El | | | 10 | 4 | |
| 1: | EDSA S Entry/Quezon City _s0_i0_m2 | 10.78691 | 10.78691 | | 8758 | 8758 | 100 3 | : Class A2 El | DSA | | 10 | 4 | |
| 1: | EDSA S Entry/Quezon City_s1_i0_m0 | 19.04341 | 19.04341 | | 8758 | 8758 | 100 3 | Class A2 El | DSA | | 10 | 3 | |
| 1: | EDSA S Entry/Quezon City _s1_i0_m1 | 19.04341 | 19.04341 | | 8758 | 8758 | 100 3 | Class A2 El | DSA | | 10 | 3 | |
| 1: | EDSA S Entry/Quezon City _s1_i0_m2 | 19.04341 | 19.04341 | | 8758 | 8758 | 100 3 | : Class A2 El | DSA | | 10 | 3 | |
| 3 11 | : C. P. Garcia S Entry _s3_i0_m0 | 12.7354 | | 12.7354 | 5831 | 8758 | 66.57913 3 | : Class A2 | | C5 | 10 | | 4 |
| 7 12 | 0: Roxas/EDSA Flyover N _s0_i0_m0 | 46.33874 | 46.33874 | | 8758 | 8758 | 100 3 | : Class A2 El | DSA | | 10 | 0 | |
| | 0: Roxas/EDSA Flyover N _s0_i0_m1 | 48.88715 | 48.88715 | | 8758 | 8758 | 100 3 | : Class A2 El | DSA | | 10 | 0 | |
| | 0: Roxas/EDSA Flyover N _s0_i0_m2 | | 48.88715 | | 8758 | 8758 | | : Class A2 El | | | 10 | 0 | |
| | 0: Roxas/EDSA Flyover N _s0_i0_m3 | | 48.88529 | | 8758 | 8758 | | : Class A2 El | | | 10 | 0 | |
| | 0: Roxas/EDSA Flyover N _s0_i0_m4 | 49.0203 | | | 8758 | 8758 | | : Class A2 El | | | 10 | 0 | |
| | 0: Roxas/EDSA Flyover N _s0_i0_m5 | | 49.37052 | | 8758 | 8758 | | : Class A2 El | | | 10 | 0 | |
| | 0: Roxas/EDSA Flyover S _s0_i0_m0 | | 54.84137 | | 8758 | 8758 | | : Class A2 El | | | 10 | 0 | - |
| | 0: Roxas/EDSA Flyover S _s0_i0_m1 | 48.42552 | | 48.42552 | 8758 | 8758 | | Class A2 El | | | 10 | | 0 |
| | 0: Roxas/EDSA Flyover S _s0_i0_m2 | 48.42416 | | 48.42416 | 8758 | 8758 | | Class A2 El | | | 10 | | 0 |
| | 0: Roxas/EDSA Flyover S _s0_i0_m3 0: Roxas/EDSA Flyover S _s0_i0_m4 | 48.42359 48.42485 | | 48.42359 48.42485 | 8758 8758 | 8758 8758 | | : Class A2 El : Class A2 El | | | 10 10 | | |
| | 0: Roxas/EDSA Flyover S_s0_10_m4 | | 38.08963 | | 8758 | 8758 | | : Class A2 El : Class A2 El | | | 10 | 0 | 0 |
| | 8: Mindanao Ave N s0 i0 m0 | | 33.11339 | 55.11551 | 8758 | 8758 | | : Class A2 El | U JA | C5 | 10 | 0 | |
| | 8: Mindanao Ave N _s0_i0_m1 | | 33.11339 | | 8758 | 8758 | | : Class A2 | | C5 | 10 | 0 | |
| | 8: Mindanao Ave N _s0_i0_m2 | | 33.11572 | | 8758 | 8758 | | : Class A2 | | C5 | 10 | 0 | |
| | 8: Mindanao Ave N s0 i0 m3 | 33.1159 | | | 8758 | 8758 | | : Class A2 | | C5 | 10 | 0 | |
| | 2019 Waze Travel Speed Da | | | | | | | | | | | | |

Figure 5.23: Attribute Table as CSV

(p) Make a duplicate of "2019 Waze Travel Speed Data LOC Converter" and rename it to "2019 WTSD V2". Use Vlookup function for LOCClass column from "2019 Waze Travel Speed Data LOCV2".

| File Home Insert Page Layo | ut Formula | as Data | Review Vi | ew Deve | loper | Help Data Mini | ng | | | | | | | | | | | | 🖓 Cor |
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| | | | | | | percen v roadType | WKT V EDSA | CS | LOCClass | 06_00 | LOC_d1 | 0 | | G II | | | | | |
| P] _s0_i0_m0 | 14.7759 | 16.16052404 | 13.3912486 | 8758 | 8758 | 100 11: Others | LINESTRIN | | 3 | 0 | 1 | | Class\ LOC | 4 | 3 | 2 | 1 | 0 | |
| P]_s0_i0_m1 | 18.5812 | 23.78143992 | 13.38093749 | 8758 | 8758 | 100 11: Others | LINESTRIN | | 3 | 0 | 1 | | 1 | 0 5 | | | 20 20 2 | | |
|]_s0_i0_m2 | | 23.65622593 | | 8014.33 | 8758 | 91.5087 11: Others | LINESTRIN | | 3 | 0 | | | 2 | 0 5 | | | 15 15 2 | | |
|]_s0_i1_m0 | 21.6694 | 21.66936988 | | 8014.33 | 8758 | 91.5087 11: Others | LINESTRIN | | 3 | 0 | | | 3 | | | | 10 10 1 | | |
|]_s0_i1_m1 | 21.6694 | 21.66936988 | | 8014.33 | 8758 | 91.5087 11: Others | LINESTRIN | | 3 | 0 | | | EDSA | 0 15 | | | 25 25 3 | | |
|]_s2_i0_m0 | 23.7634 | 23.78456099 | 23.74217652 | 8758 | 8758 | 100 11: Others | LINESTRIN | | 3 | 0 | 0 | | C5 | 0 15 | | | 25 25 3 | | |
| 2]_s2_i0_m1 | 23.7634 | 23.78456099 | 23.74217652 | 8758 | 8758 | 100 11: Others | LINESTRIN | | 3 | 0 | 0 | | Exp | 0 15 | 15 | 20 20 3 | 30 30 4 | 0 40 | |
| EDSA / Ortigas Flyover N _s0_i0_m0 | 46.3993 | 46.39925135 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m1 | 50.9375 | 50.93748573 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m2 | 46.1203 | 50.69823133 | 41.54231027 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m3 | 50.6982 | 50.69823133 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m4 | 50.4835 | 50.48350232 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m5 | 50.4868 | 50.48684365 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m6 | 50.4655 | 50.46546929 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | LUSA | 0 | | | | | | | | | |
| EDSA / Ortigas Flyover N _s0_i0_m7 | 50.5712 | 50.57122859 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | | | | | | | | | |
| EDSA / Ortigas Flyover N _s1_i0_m0 | 44.6215 | 50.57396361 | 38.6691288 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s1_i0_m1 | | 50.46893773 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s1_i0_m2 | | 50.48684365 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | 0 | | | | | | | | |
| EDSA / Ortigas Flyover N _s1_i0_m3 | | 50.48684365 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | 0 | | | | | | | | |
| EDSA / Ortigas Flyover S _s0_i0_m0 | | 34.31300601 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | 0 | | | | | | | | |
| EDSA / Ortigas Flyover S _s0_i0_m1 | 43.7492 | | 43.74924298 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | | 0 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m0 | | 25.13054693 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 1 | 1 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m1 | | 32.61163584 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | 0 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m2 | | 32.60559565 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | 4 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m3 | | 32.60559565 | 57.64764909 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | 0 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m4 | | 32.60012484 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m5 | | 32.62184898 | 56.41097692 | 8758 | 8758 | 100 2: Class A1 | LINESTRINEDSA | | EDSA | 0 | 0 | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m6 | 32.6195 | 32.6194584 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m7 | | 32.63854076 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 0 | | | | | | | | | |
| EDSA / Shaw Underpass N _s0_i0_m8 | 32.6258 | 32.62577034 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | EDSA | 20 | | | | | | | | | |

Figure 5.24: VLOOKUP Formula

(q) Filter "LOCClass" = 10 and #N/A.

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| [P] s0 i0 m2 | | 23.65622593 | 15.58095749 | 8014.33 | 8758 | | , sgrt Largest to smallest | | 0 | 1 | 2 | | 5 | | 10 15 | | | | | |
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| [P]_s2_i0_m0 | | | 23.74217652 | 8758 | 8758 | 100 11: 0 | Clear Filter From "LOCClass" | | 0 | 0 | Exp | | | | | | | | | |
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| 1: EDSA / Ortigas Flyover N _s0_i0_m0 | | 46.39925135 | | 8758 | 8758 | 100 2: Cl | | > | | | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover N _s0_i0_m1 | | 50.93748573 | | 8758 | 8758 | 100 2: Cl | | | 0 | | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover N _s0_i0_m2 | | | 41.54231027 | 8758 | 8758 | | Number <u>Filters</u> | 2 | 0 | 0 | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover N _s0_i0_m3 | | 50.69823133 | | 8758 | 8758 8758 | 100 2: Cl. | Search | 0 | 0 | | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover N _s0_i0_m4 | | 50.48350232 | | | | 100 2: Cl. | | ~ | 0 | | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover N _s0_i0_m5 | | 50.48684365 50.46546929 | | 8758 8758 | 8758 8758 | 100 2: Cl. 100 2: Cl. | (Select All) | | 0 | | | | | | | | | | | |
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| 1: EDSA / Ortigas Flyover N _s0_i0_m7 | | 50.57122859 | 20.000000 | 8758 | 8758 | 100 2: Cl. | 2 | | 0 | 0 | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover N _s1_i0_m0 | | 50.57396361 | | 8758 | 8758 | 100 2: Cl. | 3 | | 0 | 0 | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover N _s1_i0_m1 | | 50.46893773 | | 8758 | 8758 8758 | 100 2: Cl. 100 2: Cl. | 1 0 | | 0 | 0 | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover N _s1_i0_m2 | | 50.48684365 | | | | | □ c5 | | 0 | 0 | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover N _s1_i0_m3 | | 50.48684365 | | 8758 8758 | 8758 8758 | 100 2: Cl. 100 2: Cl. | EDSA | | 0 | 0 | | | | | | | | | | |
| 1: EDSA / Ortigas Flyover S _s0_i0_m0 1: EDSA / Ortigas Flyover S _s0_i0_m1 | 43,7492 | 34.31300601 | 43.74924298 | 8758 | 8758 | 100 2: Cl | Exp | | 0 | 0 | | | | | | | | | | |
| 1: EDSA / Ortigas Piyover S_SU_I0_m1 1: EDSA / Shaw Underpass N_s0_I0_m0 | | 25.13054693 | | 8758 | 8758 | 100 2: Cl | ⊡ exp ⊠ #N/A | | | 1 | | | | | | | | | | |
| 1: EDSA / Shaw Underpass N _s0_i0_m0 | | 32.61163584 | | 8758 | 8758 | 100 2: Cl | E WIN/A | | 0 | 0 | | | | | | | | | | |
| 1: EDSA / Shaw Underpass N _SO_IO_m1 1: EDSA / Shaw Underpass N _sO_IO m2 | | 32.60559565 | | 8758 | 8758 | 100 2: Cl | | | 0 | 4 | | | | | | | | | | |
| 1: EDSA / Shaw Underpass N _s0_i0_m2 1: EDSA / Shaw Underpass N _s0_i0_m3 | | 32.60559565 | | 8758 | 8758 | 100 2: Cl | ОК | Cancel | 0 | 4 | | | | | | | | | | |
| 1: EDSA / Shaw Underpass N _50_10_mS | | 32.60012484 | 57.04704303 | 8758 | 8758 | 100 2: Cl | UK | Cancel | 0 | | | | | | | | | | | |
| 1: EDSA / Shaw Underpass N _s0_i0_m4 1: EDSA / Shaw Underpass N _s0_i0_m5 | | 32.62184898 | 56 41097692 | 8758 | 8758 | 100 2: Class A | 1 LINESTRINEDSA | EDSA | 0 | 0 | | | | | | | | | | |
| 1: EDSA / Shaw Underpass N _s0_i0_m5 | | 32.6194584 | 30.41037032 | 8758 | 8758 | 100 2: Class A | | EDSA | 0 | | | | | | | | | | | |
| 1: EDSA / Shaw Underpass N _s0_i0_m0 | | 32.63854076 | | 8758 | 8758 | 100 2: Class A | | EDSA | 0 | | | | | | | | | | | |
| 1: EDSA / Shaw Underpass N s0 i0 m8 | | 32.62577034 | | 8758 | 8758 | 100 2: Class A | | EDSA | 0 | | | | | | | | | | | |
| 2019 Waze Travel Speed | | (+) | | 07.00 | 07.50 | AUD 2. CIdSS A | | Loveri | 4 | | | 1.1 | - | | | _ | | | | |

Figure 5.25: Filtering Reclassified Links

(r) LOCClass = 10 should be changed to the default "LOCClass" value based on "roadType". Copy the formula and select the cell along "roadType" (Column H).

| 💶 AutoSaver 🔘 🐏 🔚 2019 WTSD V | | | | | | | | | | | | | | | | | 6 - | Ø | |
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| $1155 \checkmark \times \checkmark f_{\rm X} = {\rm F}({\rm H}15) $ | 5="2: Clas | s A1",1,IF(H1 | 55="3: Class / | 2",1,IF(H1 | 55="4: C | lass B",2,IF(H155=" | 5: Class C",3,IF(H1 | 55="6: C | ass D",3,IF(H1 | 55="1: Ex | pressw | ay","Exp",IF(H155=' | '11: Othe | ers",3,"")) |))))) | | | | 1 |
| A | в | С | D | ε | F | G H | 1 1 | К | E E | м | N | O P | QR | S T | UV | W X Y | Z AA | AB | AC |
| | | | | | | | * WKT * EDSA | * C5 | LOCCI | | | * | | | | | | | |
| 5 1: EDSA N _s1_i12_m4 | | | 42.0702493 | 8758 | 8758 | 100 2: Class A1 | | | 1 | 0 | 0 | | | | | | | | |
| 6 1: EDSA N _s1_i13_m0 | | 33,44342163 | 29.47755788 | 8758 | 8758 | 100 2: Class A1 | | | 1 | 0 | 0 | | | | | | | | |
| 1: EDSA N _s1_i13_m1 | 33.4839 | 33.48385895 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | 1 | 0 | Г | | | 20-2-11 | | | | | _ |
| 1: EDSA N _s1_i13_m2 | 36.827 | 33.48779858 | 40.16625333 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | 1 | 0 | 0 | =IF(H155="2 | : Clas | s A1". | 1.IF(H | 155 = | "3: Class | | |
| 1: EDSA N _s1_i14_m0 | 36.8951 | 33.49609576 | 40.29406295 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | 1 | 0 | 0 | | | 0.000 | | | | | |
| 1: EDSA N _s1_i15_m0 | 35.7405 | 33,66729124 | 37.81362678 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | 1 | 0 | 0 | A2",1,IF(H15 | 5 = 4 | : Clas | s B",2, | ,IF(H1 ! | 55 = 5:0 | lass | - 1 |
| 1: EDSA N _s1_i15_m1 | 33.6673 | 33.66729124 | | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | 1 | 0 | | C".3.IF(H155 | -" | Class | וו כ ייח | | -"1. | | |
| 1: EDSA N_s1_i15_m2 | 31.2262 | 33.66729124 | 28.78503387 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | 1 | 0 | 0 | C ,5,17(115 | - 0. | CIASS | ו, כ, ט | L(UT2: | D – 1 . | | |
| 1: EDSA S_s1_i7_m0 | 14.5503 | | 14.55026376 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN EDSA | | 1 | | 3 | Expressway | "Fyn | " IF(H | 155 =' | 11.0 | thers" 3 | ""))))) | 11 |
| 1: EDSA S Entry/Quezon City s0 i0 m0 | 13.7266 | 13.72656086 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 3 | | Expressivay | , LAP | ,n (n | 100 - | 11.0 | uners ,s, | , ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,, | " |
| 1: EDSA S Entry/Quezon City s0 i0 m1 | 13.7266 | 13.72656086 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 3 | | | | | | | | | - 1 |
| 1: EDSA S Entry/Quezon City s0 i0 m2 | 10.7869 | 10.78691368 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 3 | | Mater HITE | | | | | | | - 1 |
| 1: EDSA S Entry/Quezon City s1 i0 m0 | 19.0434 | 19.04341326 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 2 | | Note: H155 | value | will a | epena | on th | e row. | | - 1 |
| 1: EDSA S Entry/Quezon City s1 i0 m1 | 19.0434 | 19.04341326 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 2 | | | | | | | 1. | | |
| 1: EDSA S Entry/Quezon City s1 i0 m2 | 19.0434 | 19.04341326 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 2 | | | | | | | | | |
| 6 11: C. P. Garcia 5 s0 i8 m10 | 42.3118 | | 42.31183604 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | C5 | 1 | | 0 | | | | | | | | |
| 11: C. P. Garcia S _s0_18_m11 | 43.0319 | | 43.03190721 | 8758 | 8758 | 100 2: Class A1 | LINESTRIN | CS | 1 | | 0 | | | | | | | | |
| 11: Pres C.P. Garcia Ave S Svc Rd s1 i0 m0 | 32.0786 | | 32.07859371 | 8014 | 8758 | 91.5049 3: Class A2 | LINESTRIN | CS | 1 1 | | 0 | | | | | | | | |
| 120: Roxas/EDSA Flyover N _s0_i0_m0 | 46.3387 | 46.33873754 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 0 | | | | | | | | | |
| 120: Roxas/EDSA Flyover N s0 i0 m1 | 48.8872 | 48.88715003 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 0 | | | | | | | | | |
| 120: Roxas/EDSA Flyover N _s0 i0 m3 | 48.8853 | 48.88528698 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 0 | | | | | | | | | |
| 120: Roxas/EDSA Flyover N s0 i0 m4 | 49.0203 | 49.02029801 | | 8758 | 8758 | 100 3: Class A2 | LINESTRIN EDSA | | 1 | 0 | | | | | | | | | |
| 120: Roxas/EDSA Flyover N s0 i0 m5 | | 49.37051991 | 49.27665677 | 8758 | 8758 | 100 3: Class A2 | | | 1 | 0 | 0 | | | | | | | | |
| 120: Roxas/EDSA Flyover S s0 10 m0 | | 54.84137436 | | 8758 | 8758 | 100 3: Class A2 | | | 1 | 0 | 2 | | | | | | | | |
| 120: Roxas/EDSA Flyover S s0 i0 m1 | 48.4255 | | 48.42552181 | 8758 | 8758 | 100 3: Class A2 | | | 1 | | 0 | | | | | | | | |
| 120: Roxas/EDSA Flyover S s0 i0 m2 | 48.4242 | | 48.42415924 | 8758 | 8758 | 100 3: Class A2 | | | 1 | | 0 | | | | | | | | |
| 120: Roxas/EDSA Flyover S s0 i0 m4 | 48.4249 | | 48.42485309 | 8758 | 8758 | 100 3: Class A2 | | | 1 | | 0 | | | | | | | | |
| 120: Roxas/EDSA Flyover S s0 10 m5 | | 38.08962929 | | 8758 | 8758 | 100 3: Class A2 | | | 1 | 0 | 0 | | | | | | | | |
| 128: Mindanao Ave N_s0_i0_m0 | | 33.11338776 | | 8758 | 8758 | 100 3: Class A2 | | C5 | 1 | 0 | | | | | | | | | |
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| | 33,1134 | 33.11338776 | | | | | | | | | | | | | | | | | |
| 128: Mindanao Ave N _50_10_m0 128: Mindanao Ave N _50_10_m1 128: Mindanao Ave N _50_10 m2 | | 33.11338776 33.11572277 | | 8758 8758 | 8758 8758 | 100 3: Class A2 100 3: Class A2 | | C5 | 1 | 0 | | | | | | | | | |

Source: JPT

Figure 5.26: Finalizing Road Class of Unclassified Links

(s) A: Save the new version as .csv file. B: Delete the Level of Congestion (LOC) speed criteria and click save.

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Figure 5.27: Deleting LOC Criteria on CSV File

(t) Load the new version of Waze Travel Speed Data. Click "Layer" -> "Add Layer" -> "Add Delimited Text Layer". Select the .csv file.

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Figure 5.28: Adding Delimited Text File of Sense Checked Data

(u) Convert the map to .shp file. Right click on the Waze travel speed data and click "Export" -> "Save Feature as". Set Format to "ESRI Shapefile" and save the shape file in a folder.

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Figure 5.29: Append to Layer

(v) Select "Style" and load "LOCClass".

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Figure 5.30: Load LOC Class Style

Below is a map showing the road classification with different LOC criteria.

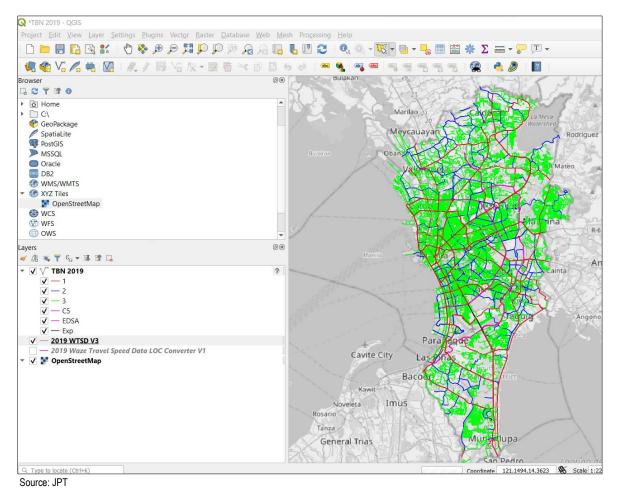


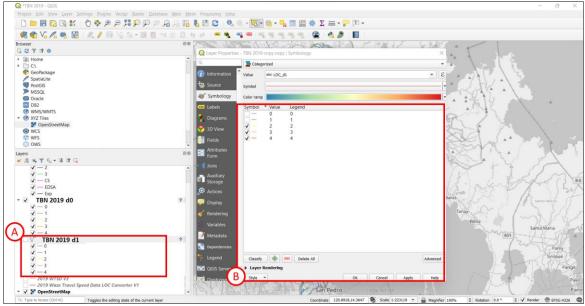
Figure 5.31: Road Classification of the LOC Map

(w) A: Duplicate the updated "TBN 2019" and rename as "TBN 2019 d0". B: Load "LOC Map d0" style.

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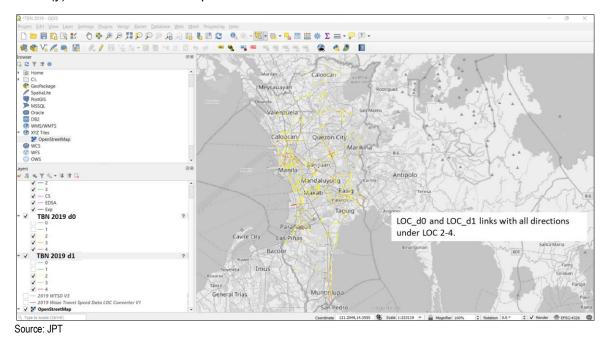
Figure 5.32: Load LOC Map d0

(x) A: Duplicate the updated "TBN 2019" and rename as "TBN 2019 d1". B: Load "LOC Map d1" style.



Source: JPT

Figure 5.33: Load TBN 2019 d1 Style



(y) Filter "TBN 2019" duplicates based on desired values.

Figure 5.34: Road Network Under LOC 2 to 4

(z) To be able to prioritize intersections along major roads, "LOCClass" should be further filtered into Class A and B. A: Open properties of "TBN 2019 d0" and select "Source".
 B: Click "Query Builder". C: Type "LOCClass" IN ('1','2','C5','EDSA') and press "OK".

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Figure 5.35: Filtering Class A to Class B Road Links for d1

 To be able to prioritize intersections along major roads, "LOCClass" should be further filtered into Class A and B. A: Open properties of "TBN 2019 d1" duplicates and select "Source". B: Click "Query Builder". C: Type "LOCClass" IN ('1','2','C5','EDSA') and press "OK".

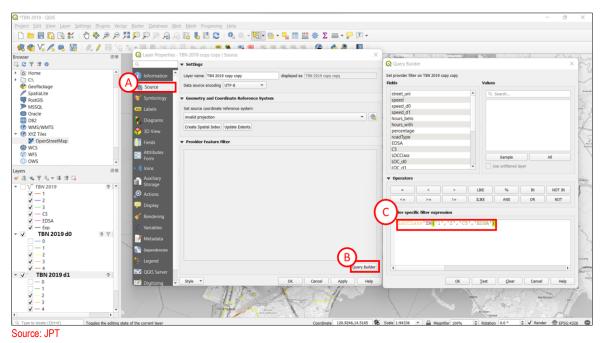


Figure 5.36: Filtering Class A to Class B Road Links for d0

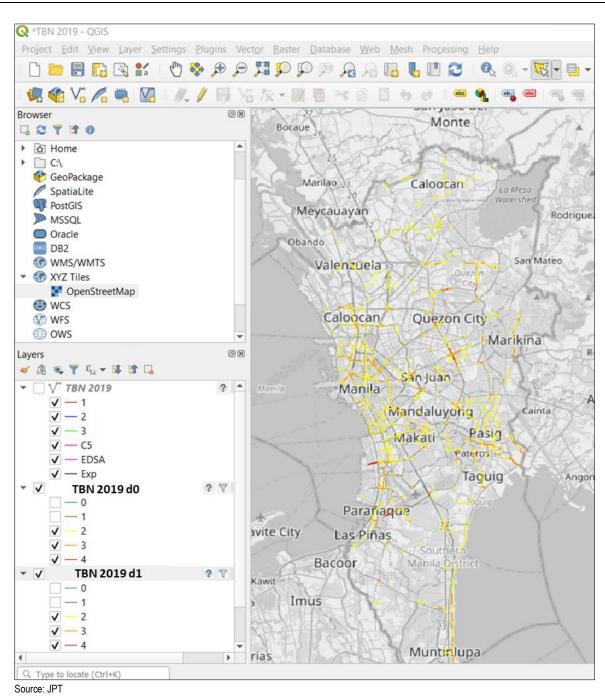


Figure 5.37: Class A and B Road Network Under LOC 2 to 4

5.4 Identification of Traffic Bottlenecks

(1) Intersection

The intersections with at least one inflow link categorized as LOC 3 to 4 are considered as "Traffic Bottlenecks (TBN)." Moreover, the 17 LGUs and MMDA determined intersection traffic bottlenecks by considering road classification and traffic conditions during peak hours. The following steps describes how to add an intersection based on the criteria mentioned above and how to add for other fields for the database.

(a) Click "Layer" -> "Create Layer" -> "New Shape Layer."

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Figure 5.38: Creating an Intersection TBN Layer

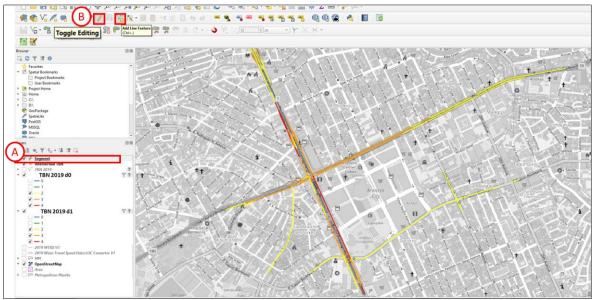
(b) A: Locate where you want to save the new shape layer by filling-out the file name. Save file name as "Intersection TBN" B: Add an filed or column by typing "Code" below "New Field", select data type, and click "Add to Field List". Repeat Step B and add "LGU" and "IntType".

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Source: JPT



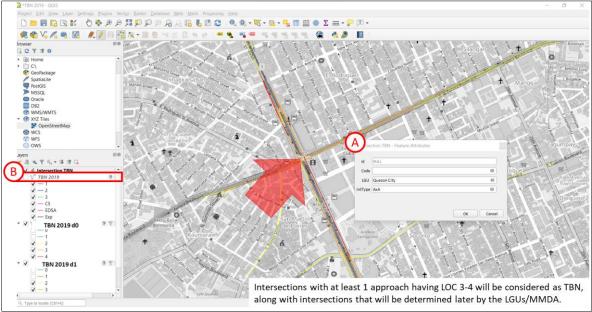
(c) A: Select "Intersection TBN". B: Click "Toggle Editing" and then "Add Point Feature".



Source: JPT

Figure 5.40: Toggle Editing

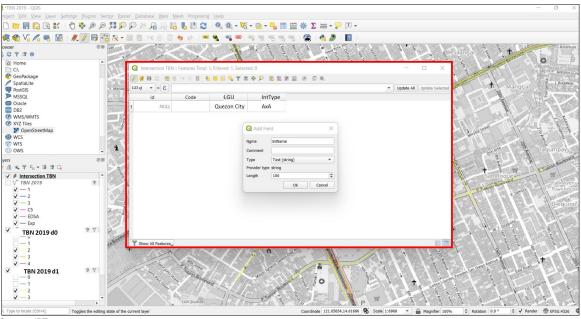
(d) A: Select intersection TBN on the map based on LOC criteria and LGU-MMDA recommendations. Then, input the LGU on the pop-up tab that will appear. B: Select "TBN 2019" and unselect "TBN 2019 d0 and TBN 2019 d1" to determine the "IntType".



Source: JPT

Figure 5.41: Creating a Point

- (e) After creating all the points/intersections, name the codes by Intersection LGU (A-Z), then Intersection Type (AxA BxB). Example: QC22.
- (f) Add other fields by right-clicking "Intersection TBN", selecting "Attribute table", clicking "New field", typing the Name of the field or column and selecting the field Type. Save and click "Toggle editing mode" to lock the changes.



Source: JPT

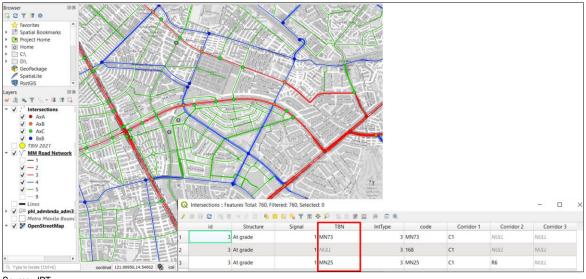
Figure 5.42: Intersection TBN Attribute Table

The following are other fields to add after data collection:

- Intersection Name (IntName), Text
- LGU, Text
- Intersection Type (IntType), Text (i.e. AxA, AxB, AxC, BxB)

- Structure, Text (i.e. At-grade/Segregated)
- Number of Legs (Legs), Whole Number
- X Coordinate (X), Decimal
- Y Coordinate (Y), Decimal
- Segment TBN, Whole Number
- Area TBN, Text
- PUV Stop, Whole Number (i.e. 1-Yes, 0-No)
- Corridor, Text (e.g. C4, C5, R10)
- Signal, Whole Number (i.e. 1-Yes, 0-No)
- Signal Type, Whole Number
 - 1 At-grade, Unsignalized
 - 2 Segregated, Unsignalized
 - 3 At-grade, Signalized
 - 4 Segregated, Signalized
- Crossing Conflict (Crossing), Whole Number
- Merging (Crossing), Whole Number
- Diverging (Crossing), Whole Number
- AutoCAD, Whole Number (i.e. 1-Yes, 0-No)
- Volume Count, Whole Number (i.e. 1-Yes, 0-No)

The JPT has predetermined intersections (target intersections) under AxA, AxB, AxC, and BxB class. These points may be used as a base data for TBN maps. The "TBN" field requires the code of the intersection. Both points and fields may be added to this shape file.



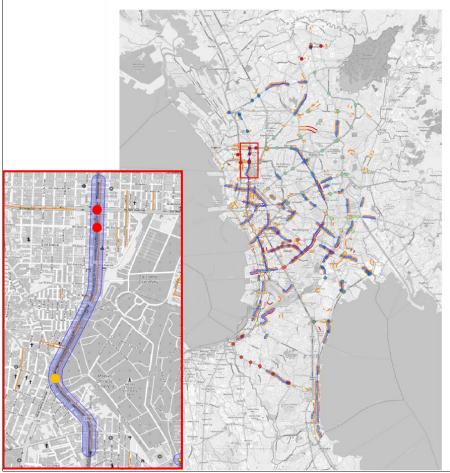
Source: JPT

Figure 5.43: Target Intersections

(2) Segment

A segment TBN is a road segment with at least one (1) intersection TBN that overlaps with links having LOC 3 to 4. The length of the segment is identified by the continues links with

LOC 3 to 4 on either side of the road. LOC 3 to 4 links disconnected by less than 100-meter distance shall still be considered as part of the segment. And, segment TBN should have a length equal to or more than 500 meters.



Source: JPT



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Figure 5.45: Creating a Segment TBN Layer

(b) A: Locate where you want to save the new shape layer by filling-out the "File Name". B: Add an attribute or column by typing desired name, select data type, and click "Add to Field List".

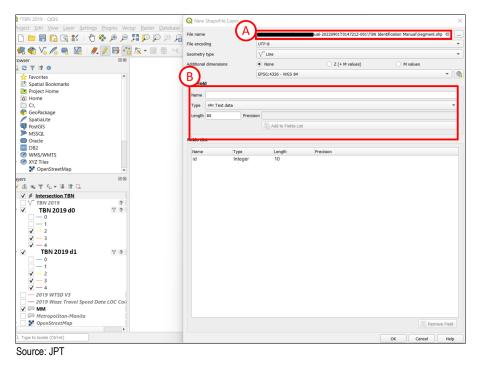
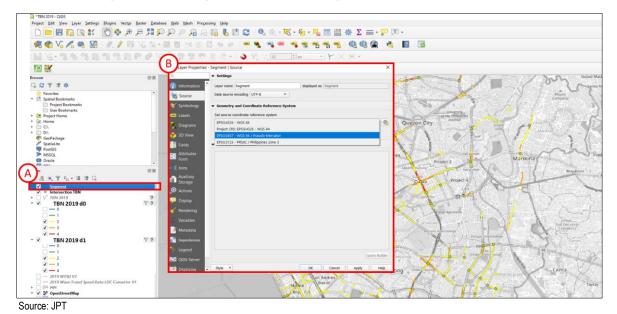


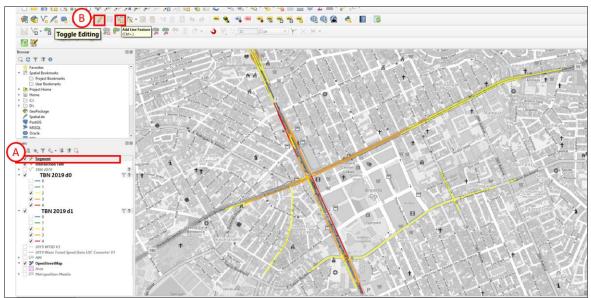
Figure 5.46: Saving Line Shape File



(c) A: Right click the Segment layer. B: Change the source of the layer to EPSG:3857

Figure 5.47: Setting Coordinate System of Segment TBN

(d) A: Select "Segment TBN". B: Click "Toggle Editing" and then "Add Line Feature".



Source: JPT

Figure 5.48: Toggle Editing

(e) Trace the segment based on the given criteria and right-click. Fill-out necessary information. Add other fields by right-clicking "Segment", selecting "Attribute table", clicking "New field", typing the Name of the field or column and selecting the field Type.

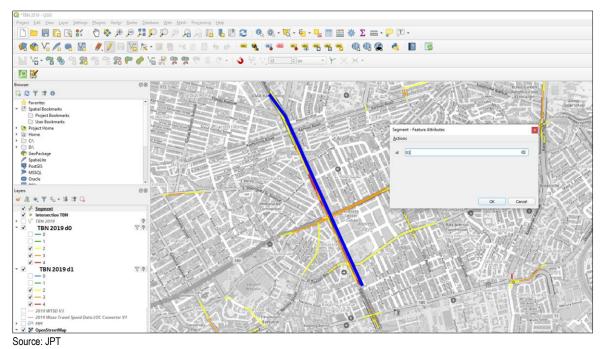
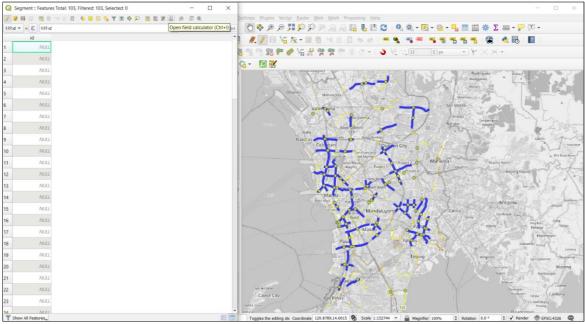


Figure 5.49: Creating Line for Segment TBN

(f) Open attribute table -> Click "Toggle editing mode" -> "Open filed calculator".



Source: JPT

Figure 5.50: Attribute Table of Segment TBN

(g) A: Type "Length" beside Output field name -> Select "Decimal" from Output field type > Double click or type "\$length" under "Geometry". B: Open attribute table -> Click
 "Toggle editing mode" -> Double click on the "Length" field to sort from smallest to biggest -> Highlight the lengths less than 500 m -> Click "Delete" and save.

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Source: JPT

Figure 5.51: Computing for Segment TBN Length

(h) Name segments from North to South. Click "Dock Attribute Table" -> Click "Move selection to top" -> Select the Segment from North to South and type Segment number on "id" field.

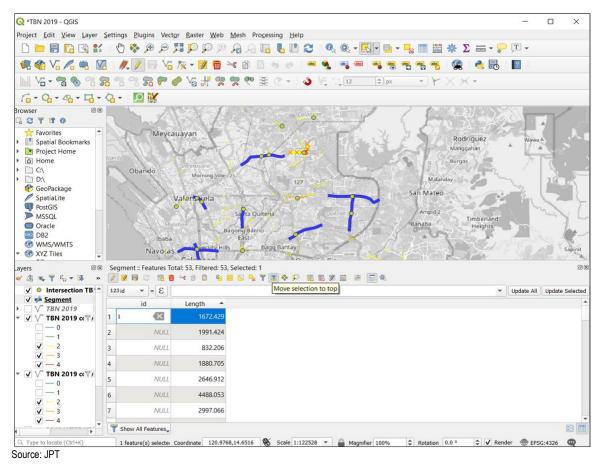


Figure 5.52: Naming Segment TBNs

Add other fields by right-clicking "Segment", selecting "Attribute table", clicking "New field", typing the Name of the field or column and selecting the field Type. Save and click "Toggle editing mode" to lock the changes.

Other fields to be added include:

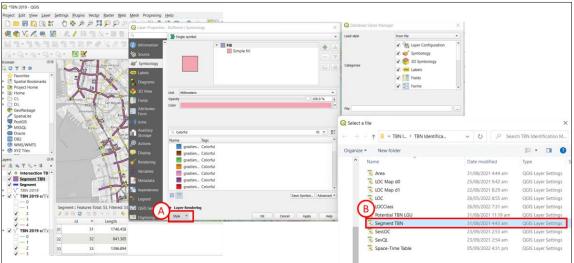
- Road Name (RdName), Text
- Road Class (RdClass), Text (i.e. A, B, C, Others)
- (i) To create a buffer, A: select "Segment", B: click "Vector" -> "Geoprocessing Tools" -> "Buffer". C: Select the layer "Segment TBN" and change "Distance = 50 meters" -> Go to "Buffered" -> Select "Save to File" -> Name it as Segment TBN -> Click "Run".

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Source: JPT

Figure 5.53: Creating a Buffer for Segment TBN

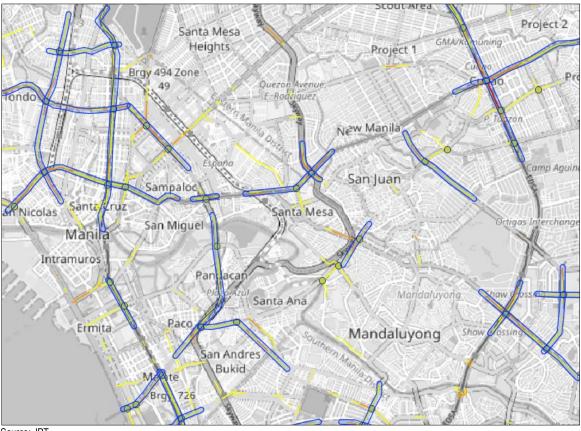
(j) hange the symbology of the buffer by opening the "Properties" and A: clicking "Style".B: Select "Segment TBN".



Source: JPT

Figure 5.54: Load Segment TBN Style

The map below shows the buffered segment TBNs (blue lines) that groups the intersection TBNs (yellow points).



Source: JPT

Figure 5.55: Intersection and Segment TBNs with LOC Map

(3) Area

Area TBN further groups the segment and intersection TBNs for future project implementation. Saturated regions of the map with LOC 3 to 4 links, and intersection and segment TBNs comprise this TBN. It should be noted that relationship, distance, and local ordinances between intersection and segment TBNs should be considered in grouping them. The steps below show how to create a polygon for area TBNs.

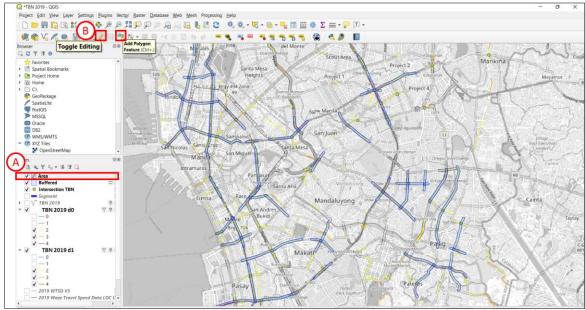
(a) A: Click "Layer" -> "Create Layer" -> "New Shape Layer." B: Locate where you want to save the new shape layer by filling-out the "File Name". C: Add an attribute or column by typing desired name, select data type, and click "Add to Field List".

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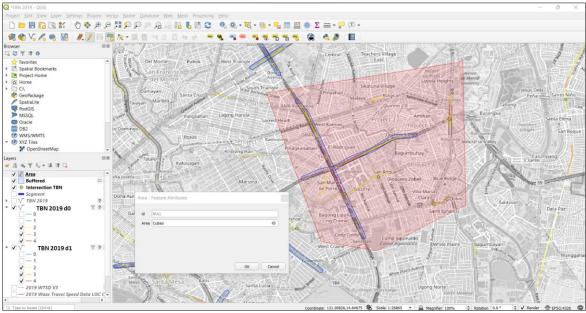
(b) A: Select "Area". B: Click "Toggle Editing" and then "Add Polygon Feature".



Source: JPT

Figure 5.57: Toggle Editing

(c) Draw a polygon following the criteria for area and fill-out information in the pop-up box that will appear. Add other fields by right-clicking "Area", selecting "Attribute table", clicking "New field", typing the Name of the field or column and selecting the field Type.



Source: JPT

Figure 5.58: Adding Area TBN Data

APPENDIX

Method of Data Collection and Longlist



The Project for Comprehensive Traffic Management Plan for Metro Manila



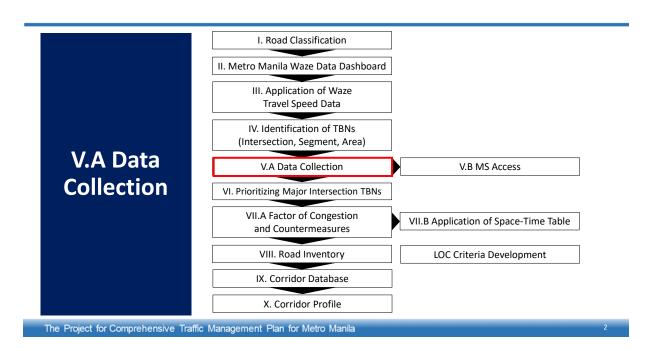
Data Collection

CTMP Database Training

September 2022

JICA Project Team

The Project for Comprehensive Traffic Management Plan for Metro Manila



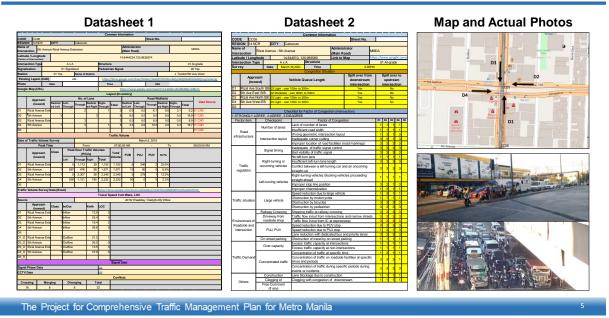
VI.A. DATA COLLECTION

OUTLINE

- 1. Datasheet Information
- 2. Datasheet 1
 - a. Contents
 - b. Common Information
 - c. Layout Inventory
 - d. Traffic Volume
- 3. Datasheet 2
 - a. Contents
 - b. Site Survey
 - i. Objectives
 - ii. Ideal Workflow
 - iii. Methodology
 - iv. Summary
- 4. Longlist

The Project for Comprehensive Traffic Management Plan for Metro Manila

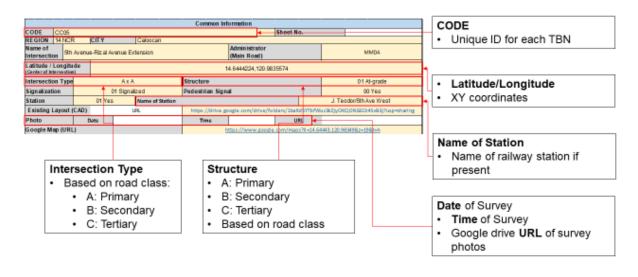
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| Road Width | | | | | Peek Box | e Traffic Ve | Sume 1 | | | <u> </u> | - | Calculation and |
| Road Width | | | approace (forward) | | | (PCUs) | | Total | PUB PW | PW - | en l | |
| | - | | | | | oun mont | Total | | | | | |
| | | 01 | Red Averue Strategics | | 1 1 1 | 10 3 | 1,152 | 1.521 | 6 2 | | 0.9% | |
| | _ | 20 | Din Akonuo Piaul Avenue | | | 4/0 5/ | | 234 | 3 2 | | 0.9% | |
| Traffia Data | 1 | 04 | Sh Annun | | - | 101 18 | - | 3,232 | 10 | | 2.7% | |
| Traffic Data | | 05 | | | | | | | | | | |
| Traffic count per approach | | TIARS | Volume 3474 | ey Della (Ko | Certi | | | | | Notes, 1740 | STOR PATHONNY | uitheld_ |
| | | Source | | | _ | | Travel 6 | p++6 ftp | 2015/Washit | - Charlest Ma | il de la | |
| Traffic counter per PUV type | - | | Approach | Ciaree | NOut | Kimh | 100 | | 3518- WWW.D | e i unito de | - TTOP | |
| | | | (toward) | | 1 May | | | | | | | |
| Waze Speed data and LOC | | 50 | Real Avenue Str. Avenue | | 1 How | | | | | | | |
| | | 00 | Pizal Avenue | - | infor | 19 | | - | | | | |
| | | 04 | Mh Amrun | | lider | 28 | 8 8 | | | | | |
| | | 08 | | | | | | | | | | |
| | 7 | 0.0 | Pizel Averue | 100 | 1 Outlos 1 Outlos | 21 | 1 1 | | | | | |
| Additional Information | | 00.0 | Rical Avenue | - | *Outlos | 38 | | | | | | |
| Traffic Circal and COT/ data (drive links) | | 04,0 | Sh Aerus | - | Dullas | | | - | | | | |
| Traffic Signal and CCTV data (drive links) | | 04,0 | | - | | _ | | | | | | |
| No. of conflicts | | | · | - | <u> </u> | | - | | | | | |
| · NO. OF CONTINUES | | Bighar OCTVI | Phase Data | | | | - | _ | | _ | | |
| | - L | COL | 049 | | | | - | Confi | - the | | | |
| | | 010 | naing B | Inging | Diwide | 1 1 | lotai | | | | | |
| The Project for Comprehensive Traffic Management Plan for Metro | Manila | 1 | 16 | 1 | 1 | | 12 | | _ | _ | | |

2.b. DATASHEET 1: Common Information



The Project for Comprehensive Traffic Management Plan for Metro Manila

| | | | | | | La | iyout (l | nventory | | | | | | | |
|-------------------------|-------------------|--------------------|---------------------|---|---|-------------------|----------|--------------------|-------|---------|---------------------|-------------------|-------------------------------------|--|--|
| | Approach | | | No. o | f Lane | | | | | Road V | Midth(m) | | | | |
| | | Dedicat ed Left | Left- Through | Through | Dedicat ed Right | Right- Through | Total | Dedicat ed Left | | Through | Dedicat ed Right | Right- Through | Total | Data Source | |
| D1 | Rizal Avenue Exte | | | 2 | | 1 | | 3 0. | 0 0. | 6.1 | 0.0 | 3.1 | 9.2 | 01 CAD | |
| D2 | 5th Avenue | 3 | | | 3 | 1 | | 6 9. | 5 0.0 | 0.0 | 9.5 | 0.0 | 18.9 | 01 CAD | |
| D3 | Rizal Avenue Exte | | | 3 | | | | 3 0. | 0 0. | 8.9 | 0.0 | 0.0 | 8.9 | 01 CAD | |
| D4 | 5th Avenue | 1 | | 3 | | 1 | | 5 3. | 3 0. | 0 10.0 | 0.0 | 3.3 | 16.7 | 01 CAD | |
| D5 | | | | | | | | | | | | | | 01 CAD | |
| | | | | | | | | | - + | | | | | • | |
| pproac Road appro | name per | | • If d n d | lo. per novem there ledicat novem lirections "thro | ient is no ted ient in, cou | int | • | Carria appro | | width | per | | data 01 02 str 03 04 | CAD Assumption from eet view DPWH Atlas Inventory Survey Others | |
| ne Proie | et for Compreh | ensive | Traffic | Manaos | ement | Plan fo | Metro | o Manila | | | | | | | |

2.c. DATASHEET 1: Layout (Inventory)

2.d. DATASHEET 1: Traffic Volume

| | | | | _ | | | | lume | | | | | | | | _ | | | | | | |
|--------|----------------------|-----------|------|----------------|-------|-----------|-------------|---|---|--|--|--|--|---|---|---|--|--|--|--|---|--|
| ate o | f Traffic Volume : | | | | | | | | March | 18, 2019 | | | | | _ | | Date | a of | Troff | | unt Surv | vov |
| | Peak Tir | ne | | | am | | 07:00 | 00 AM | | - | To | | 080 | MA 00:00 | | | Date | e 01 | ITall | | unit Surv | vey |
| | Approach (toward) | Class | Peak | Hour Tr (PC | | imes | Total | PUB | PUJ | PUV | PUTS | | | | | | | | | | | |
| | (coware) | | Let | Through | Right | Total | volume | | | | | | | | | | | | | | | |
| 1 | Rizal Avenue Exte | 1 | 0 | 1,113 | 39 | 1,152 | 1,152 | 6 | 246 | 2 | 22.0% | | | | | | | | | | | |
| 2 | Sth Avenue | 1 | 997 | 476 | 98 | 1,571 | 1,571 | 19 | 90 | 0 | 6.9% | | | | | | | | | | | |
| 3 | Rizial Avenue Exte | 1 | 0 | 2,307 | 38 | 2,345 | 2,345 | 3 | 278 | 1 | 12.0% | | | | [| | | | | _ | | |
| 4 | Sth Avenue | 1 | 926 | 1,121 | 185 | 2,232 | 2,232 | 50 | 0 | 0 | 22% | | | | | | | | | | | |
| 6 | | <u> </u> | | | | | | | | | | | | | | | | | | | | |
| raffic | Volume Survey | Data (Exc | 201 | | | https://d | rive.google | e.com/driv | re/u/a/tol | iden/170 | IdT15v55ERP | METRANN | i gfotffm N | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | LOCA | | | C.3 ROAD | | | WENUE | | _ | | _ | | | | |
| | | | | | | | | | TION: OF SURI | | C.3 ROAD | | | VENUE | | | | | | | | |
| Do | ak Time | | | | | | 7 | DATE | OF SUR | VEY: | FRIDAY, MA | RCH 08, | 2019 | | | | | | | Α. | Α. | |
| | ak Time | | | | | |] | | OF SUR | VEY: | | | 2019 | | MABINI AV | E. | A. B0 | NIFACIO | AVE. | A. MABINI | A. BONIFACIO | |
| - | Get the h | | | | | |] | DATE FR | OF SUR | VEY: I | FRIDAY, MA | GTH | 2019 AVE. | A. | MABINI AV | | | A. | AVE. | | | Tota |
| - | Get the h | | | | | | | DATE FR | OF SUR | VEY: I | FRIDAY, MA | 6TH | 2019 AVE. | A. | | | | | | MABINI | BONIFACIO | Tota |
| - | | | | | | | | FRI Time (| OF SURI OM 0 61 01 Day - 0700 | 4TH 4TH TH AVE 2 1153 | FRIDAY, MA | GTH 6TH 4TH AVE 5 | AVE. | A. | 8 80125ACIO 8 908 | 4TH AVE. 9 172 | 4TH AVE. | A MARINA 2017 11 4492 | GTH AVE. | MABINI U-TURN 7a 521 | U-TURN 10a | |
| - | Get the h | | | | | | | DATE FR/ Time (0600 | OF SURI OM 0 6* 0f Day - 0700 - 0800 | 4TH 4TH TH AVE 2 1153 1113 | FRIDAY, MA AVE. BONFACIO 3 46 39 | 6TH 4TH AVE 5 1802 2307 | A MARNA A MARNA AVE 6 60 38 | A. 6TH AVE. 7 152 185 | 8 8012FACIO 8 903 1121 | 4TH AVE 9 172 185 | 4TH AVE. 10 653 829 | A MARINI 11 449 476 | етн Але. 12 50 98 | MABINI U-TURN 7a 521 741 | BONIFACIO U-TURN 10a 125 168 | 73 |
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2.d. DATASHEET 1: Traffic Volume

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| Ciete o | A Traffic Volume Peak Tá | | _ | Ŧ | Ren | _ | _ | _ | 07.00 | 00.44 | , | Marc | sh 8, 20 | 15 | T | 00 AM | |
| | Approach | Class | | tak Hou | PCUs | | | | Total | PU | Т | ۳W | PUN | | _ | | |
| | (toward) | | Left | | nigh (Rg | gint | Tek | | lolume | - | • | rw | 1.00 | <u>~</u> | _ | Vo | lume per approach and per |
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| <u>D4</u> | Rical Avenue Exe Sh. Avenue | | F | | 27 | 38 188 | 2. | | 2,346 | \vdash | 3 | 21 | | | 225 | | |
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| The Proj | ject for (| Com | pre | her | ารเข | е | In | atho | c N | 1an | nag | en | nen | it P | 'lar | Manila | Traffic Count Survey Results 10 |
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| Basic | Inform | natio | or | 1 | | | | | | | | | | | | | apreach Spill over 10 Spill ov |
| Cod | le/ID | | | | | | | | | | | | | | | D1 Basi | Ale South SE EI Light : eler 100m to 300m. Yes No |
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| | iotaro t | arrea | | | | | | | 7 1 1 | <u> </u> | | | | | | 1.STRONO Pectrolia | LYAOPEE 2AOPEE 3005A0FEE m Oneleoint Pacter of Comparition III III III III III |
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| Traf | ze Spe | ed (| da | ta a | and | d L | .Ó | bC | | | | | | | | Otes | Concentrated traffic <u>times and particle</u> Concentration of traffic during specific periods during events or incident <u>Construction</u> Lane blockage due to construction <u>1 1 1 1</u> |

3.b. DATASHEET 2: Site Survey (Objectives)

Objectives :

- To grasp the traffic situation for each potential Traffic Bottlenecks (TBNs)
- > To find the factor/cause of traffic congestion at each TBNs

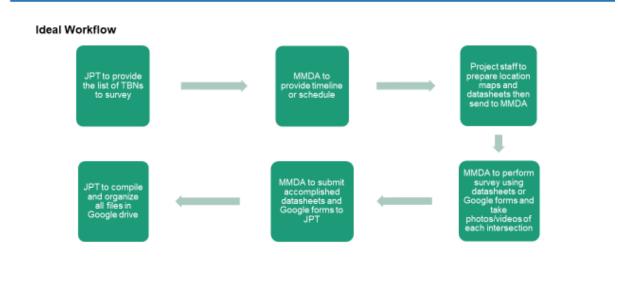


- Based on the site observation and data, countermeasures against traffic congestion will be initially considered and incorporated into CTMP
- MMDA can do the series of activities by themselves sustainably

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3.b. DATASHEET 2: Site Survey (Ideal Workflow)



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Trial Sites

Two trial sites were considered before the actual survey.

This will help identify possible problems and concerns to address them accordingly.

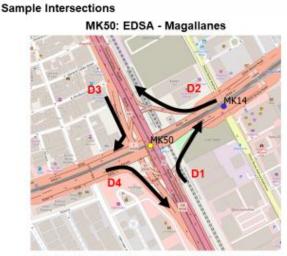
There are many complicated intersections in Metro Manila that JPT would like to investigate. The project team will provide each map with corresponding direction labels.



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3.b. DATASHEET 2: Site Survey (Methodology)



For D1 and D2, surveyors need to observe from MRT Magallanes footbridge.

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Location: • Makati City Remarks:

· Elevated intersection

Since it is difficult to consider the solution at elevated intersections such as flyover and underpass, focus on the merging points, especially at-grade.

Sample Intersections



Location:

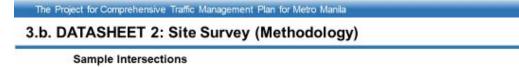
City of Manila

Remarks:

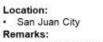
- 6-legged intersection
- Consider only the specified directions for the survey (higher class roads)

16

17



SJ02: Ortigas Avenue – Wilson

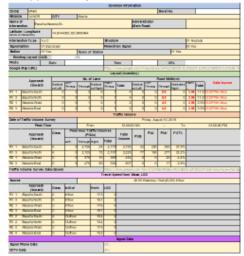


 Presence of service road
 Maybe service road may be considered for D3 only

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Datasheet 1: Desk Work

Prepared by project staff → Bring on the site to support survey



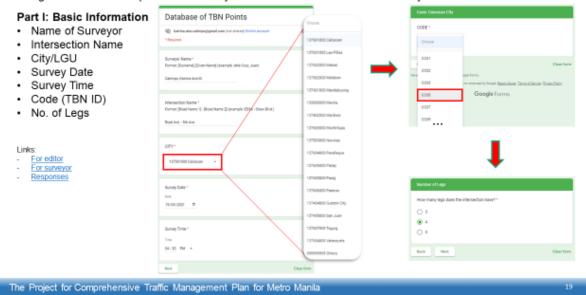
Data sheet for intersection



18

The Project for Comprehensive Traffic Management Plan for Metro Manila 3.b. DATASHEET 2: Site Survey (Methodology)

A Google form was developed to be used by the traffic enforcers for the site survey.



A Google form was developed to be used by the traffic enforcers for the site survey. D1 Spill-over from DOWNSTREAM Intersection No Lane: in case of one way (appointe direction only) Part II: Congestion Situation 341 0.14 Queue Length 01 Queue Length* O No Lane · Spill-over from downstream intersection D1 Spill-over to UPSTREAM intersection 1 Spill-over to upstream 0 144 intersection No No O No Lana Links: For editor For surveyor D4 Ш Responses 0 01 Heavy : Over 500m 8 02 Medium : Over 300m to 500m 03 Light : Over 100m to 300m O Nere The Project for Comprehensive Traffic Management Plan for Metro Manila

3.b. DATASHEET 2: Site Survey (Methodology)

3.b. DATASHEET 2: Site Survey (Methodology)

| A Google form was developed to Part III: Factor of Congestion | be used by | the tra | iffic en | forcers | for the s | ite survey. | | | - Ec | or editor or surveyor esponses |
|--|---|-------------------|----------|----------|-----------|--|------------------|-------|----------|--------------------------------------|
| decided for further of Congression (for 4 legs) (11 Decision 0 Lines in case of one may (opposite direction only) | Read Infrastructure | e - | | | | Traffic Regulation | * STRONOLY AGPEE | AGNEE | DISAOPEE | NoLane |
| huide for Lanes | ⇒ | STRONGLY ASREE | AOPEE | DISAGREE | No Lane | Inadequate of traffic signal control | 0 | 0 | 0 | 0 |
| D3 | Lack of number of lanes | 0 | 0 | 0 | 0 | Ded visibility of traffic signal | 0 | 0 | 0 | 0 |
| ↓ ; | Insufficient road width | 0 | 0 | 0 | 0 | No left-turn lane | 0 | 0 | 0 | 0 |
| | Wrong geometrie intersection layout | 0 | 0 | 0 | 0 | Insufficient left- turn lane length | 0 | 0 | 0 | 0 |
| | tradequate corner cutting | 0 | 0 | 0 | 0 | Conflict between a left-turning car and an oncoming straight car | 0 | 0 | 0 | 0 |
| <u>⊶</u> ≡ | Improper location of road facilities (road markings) | 0 | 0 | 0 | 0 | Rightsurving whicles blocking weliates proceeding straight ahead | 0 | 0 | 0 | 0 |
| | | | | | | Improper stop Ine position | 0 | 0 | 0 | 0 |
| | | | | | | Improper channelization | 0 | 0 | 0 | 0 |

The Project for Comprehensive Traffic Management Plan for Metro Manila

A Google form was developed to be used by the traffic enforcers for the site survey.

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|--|---------------------------------|--------|----------|---------|--|--------------------|-------|----------|---------|---|---|---------------|-------|---------------|-----------|
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| ipeed reduction due to trucks | 0 | 0 | 0 | 0 | Strapping traffic at calvary | 0 | 0 | 0 | 0 | | capacity at intersections | 0 | 0 | 0 | 0 |
| Obstruction by natorcacles | 0 | 0 | 0 | 0 | erosting | ~ | 0 | <i></i> | 0 | | capacity at non- intersections | 0 | 0 | 0 | 0 |
| Obstruction by Sicycles | 0 | 0 | 0 | 0 | Traffic flow in/out from intersections and narrow streets | 0 | 0 | 0 | 0 | ⇒ | Cincellation of Toffic at specific time | 0 | 0 | 0 | 0 |
| Obstruction by pedeotrian | 0 | 0 | 0 | 0 | Traffic flow in/out from IC at expressivay | 0 | 0 | 0 | 0 | | Concertration of traffic on reachine facilities all specific times and periods | 0 | 0 | 0 | 0 |
| art III. | Facto | r of C | ongest | tion | Speed reduction due to PUE stop | 0 | 0 | 0 | 0 | | Concertration of Taffic Guing specific periods | | 0 | | |
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| ure m. | | | | | Rpeed reduction due to PUJ stop | 0 | 0 | 0 | 0 | | during contribution includentia | | | | |
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| Links: - <u>For ed</u> - <u>For su</u> | litor rvevor | | | | due to PUU stop Lane reduction with dedicated bus and priority lanes Obstruction of transil by on- | _ | _ | - | - | | during events or | Sliowogy | • | DEMOREE | Relate |
| Links: - For ed - For su | litor rvevor | | | | due to PUU stop Lane reduction with dedicated bus and priority lanes Obstruction of | 0 | 0 | 0 | 0 | | during exerts or incidents | STRONGE | • | otanimes O | |
| Links: - For ed - For su - Respo | <u>litor</u> rvevor rrses | | - | | due to PLU stop Leve reduction with dedicated has and priority leves Obstruction of Taxwell by on- struct parking | 0 | 0 | 0 | 0 | | Coher issues * | STRONGEY | | | TOLINE |
| Links: - <u>For ed</u> - <u>For su</u> - <u>Respo</u> | itor rvevor vrses | | - | | due to PUU stop Lane reduction with dedicated bus and priority lanes Obstruction of transil by on- | 0 | 0 | 0 | 0 | | dang events or incidents Other Issues * Lare timinage Larts Disproving Disproving | STRONGO C. | 0 | 0 | NLAN O |

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3.b. DATASHEET 2: Site Survey (Methodology)

Example: EDSA-Taft (Based on MMDA's survey)



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D1 Direction

From where is the start of congestion? Upstream or downstream of the target TBN?

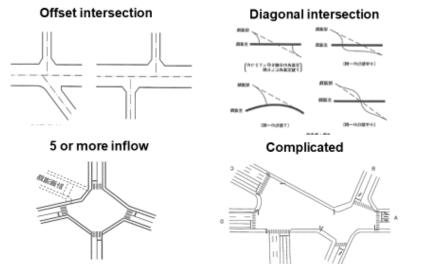
| Spill-over from DOWNSTREAM intersection | Even when the traffic signal towards the direction of travel becomes green, vehicle cannot move due to "spill- over" situation. | |
|--|---|----|
| Spill-over to UPSTREAM intersection | D1 Spill-over from DOWINSTREAM Intersection * | |
| | D1Spill-over to UPSTREAM intersection * Yes No No Lane | |
| The Project for Comprehensive Traffic Management Plan for Metro Manila | | 24 |

3.b. DATASHEET 2: Site Survey (Methodology)

As much as possible, "strongly agree" or " disagree" should be selected. "Agree" is only for the factors with less effect on congestion.

| And | Road Infrastructure * | Always full? | | Very narro | w? |
|---|---|-----------------|-------|------------|----------|
| | 5 | AN ADDEE | ADICE | DISAGREE | Ale Lane |
| and the second second second | 1att of turber of | 0 | 1 | 0 | |
| CONTRACTOR OF | Insufficient toad | 0/ | ۲ | 0 | |
| | Wrong pacewire intersection layout | 6 | ۲ | 0 | |
| | Instanceurse corner Curting | | ۲ | | |
| | improper location of read facilities (read reachings) | | ۲ | | |
| acing D1 from intersection | | | | | |
| | | | | | |

Wrong geometric layout → Many conflicts occur which lead to traffic jams



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3.b. DATASHEET 2: Site Survey (Methodology)

Improper road facilities

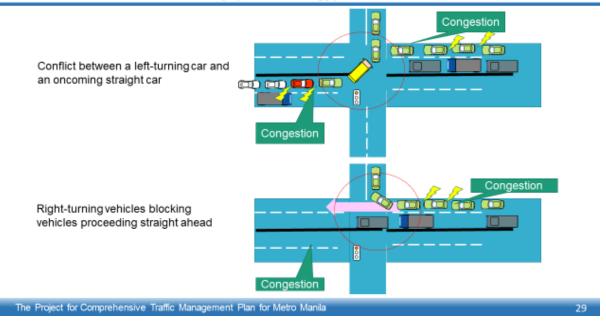
- No road marking (No transit guideline, No stop line ,etc)
- No sign



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3.b. DATASHEET 2: Site Survey (Methodology) As much as possible, "strongly agree" or " disagree" should Is the signal phase adequate Can drivers see signal be selected. "Agree" is only for the factors with less effect clearly? Location, light for the traffic on congestion. condition flow? No Lane ۲ Red ri ۲ No left furn land ۲ antis ۲ Conflict bet View: Facing D1 from intersection work of mim Improper plop time position ۲ Improper chanterization ۲ Prohibited left turn from southbound? Next page The Project for Comprehensive Traffic Management Plan for Metro Manila 28

3.b. DATASHEET 2: Site Survey (Methodology)



٠

Improper channelization Insufficient or too much channelization The Project for Comprehensive Traffic Management Plan for Metro Manila

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3.b. DATASHEET 2: Site Survey (Methodology)

As much as possible, answer "strongly agree" or " disagree".



| affic Etuation * | | | | |
|--|----------------|-------|----------|--------|
| | STRONGLY AGREE | AGREE | DISAGREE | NoLere |
| ipent reduction due a large vehicle | | ۲ | | |
| Toritraction by instancycles | | ۲ | | |
| Sorbuction by Acycles | | ۲ | | |
| Davitruction by sedesthian | | ۲ | | |

View: Facing D1 from intersection



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| | STRONGLY AGREE | 40868 | 21545855 | No Late |
|--|----------------|-------|----------|---------|
| Ropping traffic at aliviey crossing | | | ۲ | |
| Patfic fiew initiat tars intersections and namow streets | | ۲ | | |
| hattic here kivitud here IC at elementary | | | ۲ | |
| Speed reduction due to PUV stop | 0 | ۲ | | |
| iperd reduction due Is PGJ stop | | ۲ | | |
| Lane reduction with bottcated loss and priority tanks | 0 | ۲ | | |
| Destruction of travel | | ۲ | | |

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3.b. DATASHEET 2: Site Survey (Methodology)

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The Project for Comprehensive Traffic Management Plan for Metro Manila

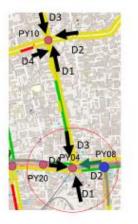
34

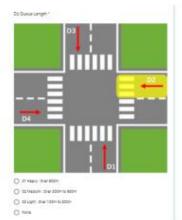
3.b. DATASHEET 2: Site Survey (Methodology)



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3.b. DATASHEET 2: Site Survey (Methodology)





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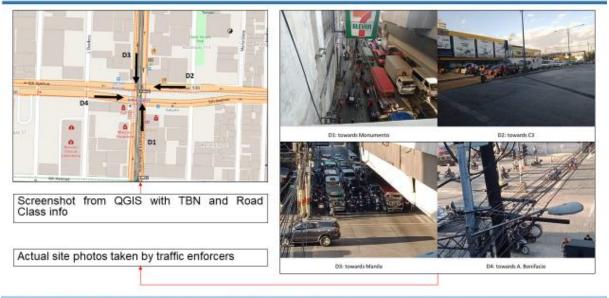
37

3.b. DATASHEET 2: Site Survey (Methodology)

Output : Based on the answer from google form, project staff convert it to the datasheet

| Consistent Information CODE MN43 Sheet No. | | | | | Checklist for Factor of Congestion (Intersection) | | | | | | | |
|--|-------------|--|---------------------------------------|--------------|---|----------------|-------------------|---------------------------|--|------|-----------|-----|
| | | | 1.STRONOLY AGREE, 2.AGREE, 3.DISAGREE | | | | | | | | | |
| REGION | 14 NCR | CIT | Y Mania | | | | Factor item | Checkpoint | Factor of Congestion | 10.3 | 10.36 | 135 |
| Name of | - | ñe-Nace | | | Administrator | | | Number of lanes | Lack of number of lanes | | | |
| Intersection | E POR | me-Mace | de OL | | Main Road) | | Road | HOTOR OTHER | Insufficient road width | | | |
| Latitude / Lo | a na ituda | | | | | | intractucture | | Wrong geometric intersection | | | |
| Cathle of Inter- | | 14.6144959.120.5595464 Link to Map Trips // Web Books Intersection Myour Indequate co Process local | Inadequate corner outling | | | _ | | | | | | |
| | | | | | | | | | Improper location of road facilities | | | |
| Intersection | туре | | AxC | | , | 01 At-grade | | Signal timing | Inadequate of traffic signal control | _ | | 4 |
| Survey | | Dete | | Time | | | | and a much | Red visibility of traffic signal | | | |
| | | | - | | | | | Right-turning or | No left-turn lane | | | |
| | | | Congest | ion 5 Buatio | | | Traffic | oncoming vehicles | Insufficient left-turn lane length | | _ | |
| | Approact | | | | Spilloverfr | | negulation/ | or some of the solution | Conflict between a left-turning car | | | |
| | (In ward) | | Vehicle Quer | ue Length | | | | | Right-turning vehicles blocking | | | |
| | | · . | | | intersection | a intersection | | Left-turning vehicles | Improper stop line position | | | |
| 81_1 A.8 | Sonifacio S | louth | | | | | | | Improper channelization | _ | | |
| 81_2 A.6 | Ronitacio N | iorth | | | | | | | Speed reduction due to large | _ | | _ |
| - | | | | | _ | _ | Traffic situation | Large vehicle | Obstruction by motorcycles | | | |
| R2_1 110 | h Ave. Wei | 12 | | | | | | Carlie carries | Obstruction by bigy des | _ | | |
| 82_2 | | | | | | | | | Obstruction by pedie trian | _ | | _ |
| - | | | | | | | | Railway Grossing | Stopping traffic at railway crossing | - | | _ |
| | | | | | | | Province and and | | Traffic flow initial from Traffic flow initial from IC at | _ | | 4 |
| | | | | | | | Environment of | shop | | - | | - |
| | | | | | | | Roads ide and | | Speed reduction due to PUV stop | - | | - |
| | | | | | | | intersection. | PUU PUV | Speed reduction due to FUJ stop | - | | - |
| | | | | | | | | | Lane reduction with dedicated bus | _ | | _ |
| | | | | | | | | On-street parking | Obstruction of travel by on-street | - | | _ |
| | | | | | | | | _ | Excess traffic capacity at intersections | | | |
| | | | | | | | | Over opporty | Excess traffic capacity at ron- intersections | | | |
| | | | | | | | Traffic Denand | | Concentration of traffic at specific Snee | | \square | ٦ |
| | | | | | | | | Concentrated traffic | facilities at specific times and periods | | | |
| | | | | | | | | | specific periods during events or incidents | | | |
| | | | | | | | | Construction | Lane blockage due to construction | | | |
| | | | | | | | | Clogging of downsiteem | Clogging with congestion of downstream | | | |
| | | | | | | | Others | Pres Comment (f any) | | | | |

LOCATION MAP AND ACTUAL SITE PHOTOS



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3.b. DATASHEET 2: Site Survey (Methodology)

Strengths

· Real-time and actual situation is considered.

Weaknesses

· The data collected is qualitative, which means it can vary depending on the surveyor.

Opportunities

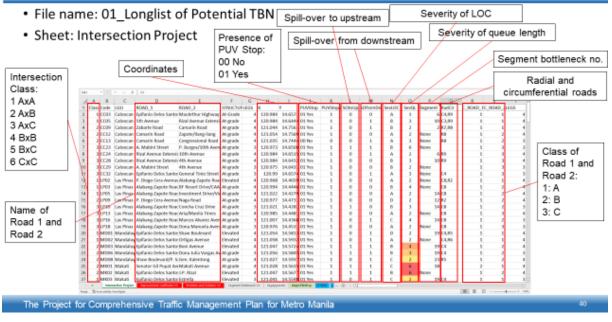
The traffic enforcers know the traffic situation well.

Threats

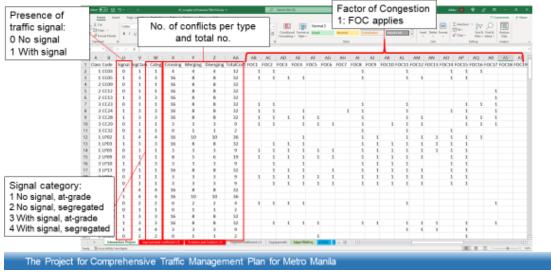
- COVID-19 travel restrictions affect the traffic situation, especially PUV operations.
- · Special events during the time of survey may cause variations from the actual situation.

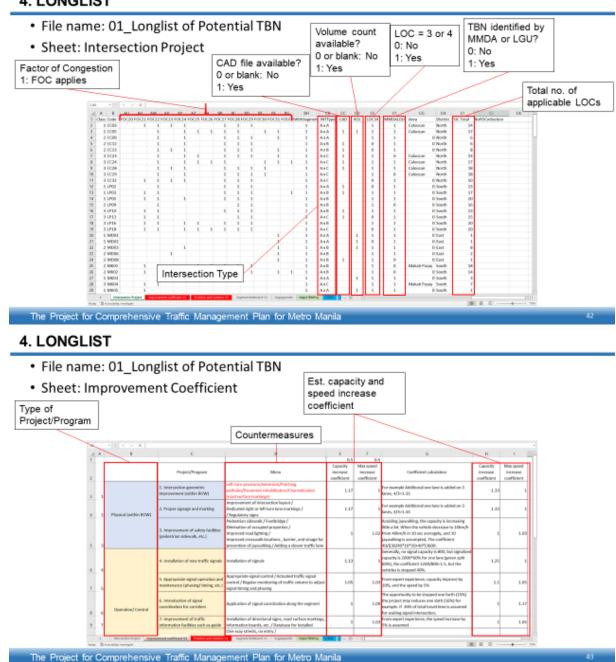
The subjectivity of the information will be supplemented by road inventory data.

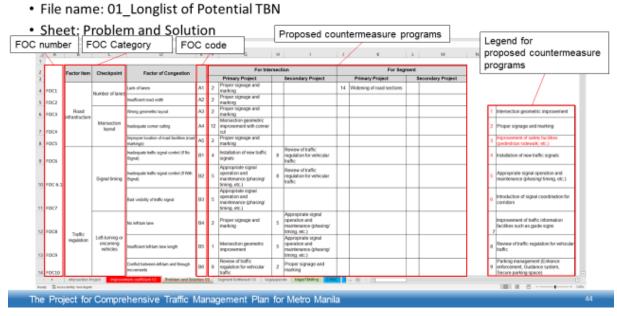
The Project for Comprehensive Traffic Management Plan for Metro Manila

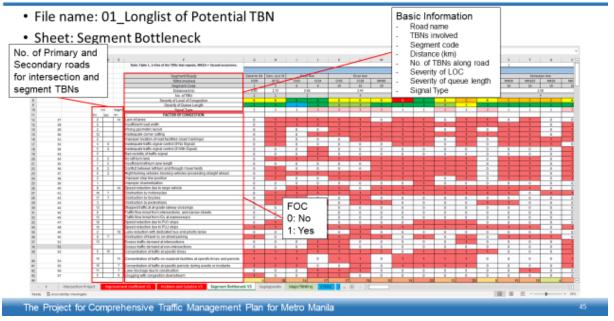


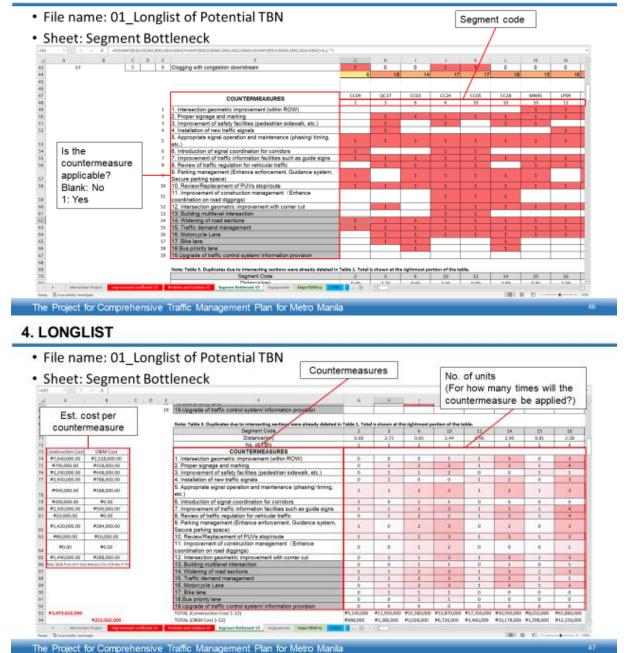
- File name: 01_Longlist of Potential TBN
- · Sheet: Intersection Project





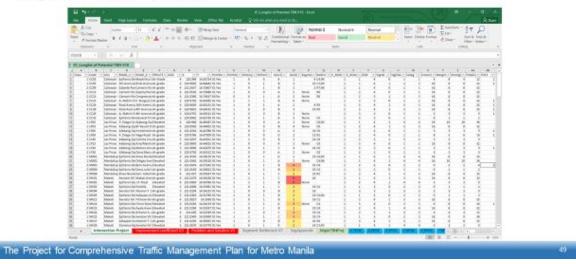






| | heet: | Segme | | leneck | / | - | | | (For | of units | nany tin | | |
|---|----------------------------|---|------------------------|--|----------------------------------|------------|-----------------------|----------------|--------------------------|-------------|--------------|------------|-------------|
| | Δ | | ¢ 0 <u>F</u> | linear t | 1 | 0. | - H . () | | cou | ntermea | asure t | e app | ied?) |
| Î | Ect o | ost per | 1.0 | 19 Upgrade of traffic control system/ information prove | ion . | | | | | 1 | 1 | | 1 1 |
| | | 1000 C | | Note: Table 1. Daplicates due to intersecting sections were als | | | and the second second | | and the second states of | | / | | |
| | counten | measure | | Segment Cote | area a second and a second and a | | 1 | in represent p | 10 | 12 | 14 | 15 | 16 |
| | | | | Distance(kgr) | | 1.65 | 2.23 | 0.45 | 2,64 | to | 2.90 | 0.81 | 2.50 |
| | | | | No. of TEN | | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 4 |
| | instruction Cost | OBM Cest | 1 7 | COUNTERMEASURES | | | | 1.10.11 | 1.1 | 100 | | 1.22 | |
| | 7,840,000.00 | P1,528,000.00 | | 1. Intersection geometric improvement (within ROW) | | D | 0 | - 10 | 1 | 1 | 7.3 | 1.0 | 3 |
| 1 | #790,000.00 | P158,000.00 | | 2. Proper signage and marking | | Ð | -1 | - 2 | | 1 | 1.0 | - 3 | 4 |
| | 2 240,000 00 | P648,000.00 | | 3. Improvement of safety facilities (padestrian sidewaik | G 610.) | D | - 1 | 1 | :2 | 0 | . 10 | 1 | 1 |
| | 1,940,000.05 | P768,000.00 | | 4. Installation of new treffic signals | | 0 | . 1 | . 0 | 0 | 1 | . 1 | - 0 | .1 |
| | P340,000.00 | P188,000.00 | | Appropriate signal operation and maintenance (phase etc.) | ing/sming, | 1 | 1 | | - 1 | 1 | 1. | - 3 | 1 |
| 1 | \$200,000.88 | #0.00 | | 6. Introduction of signal coordination for corridors | | . 1 | | 1.1 | + | 0 | | | <u></u> |
| | 2,500,000.00 | P500,000,00 | | 7. Improvement of treffic information facilities such as g | zuide signs | 1 | 1 | -2 | 3 | 1 | 1.3 | 1 | 4 |
| | P30,000.00 | #0.00 | | 8. Review of traffic regulation for vehicular traffic | | D | - 1 | 2 | 2 | - 1 | 13 | 4 | 4 |
| | 1,420,000.00 | P284,000.00 | | Parking management (Enhance enforcement, Guidar Secure parking space) | nce system, | 1 | • | 2 | 3 | 0 | 2 | | - 1 |
| | P68,000.00 | #16,000.00 | | 10. Review/Replacement of PUVs stophoute | | - 1 | -1 | . 2 | 13 | 1 | 1.3 | | 3 |
| | P0.00 | #0.00 | | Improvement of construction management (Enhan coordination on road diggings) | 69 | D | | - 1 | 2 | 0 | D | | -1 |
| | P1,440,008.08 | P258,000.00 | | 12. Intersection geometric improvement with corner cut | t | Ð | | 1 | 12 | 1 | - 13 | 1 | 100 |
| | e bes hon sets bet | Reprint for pick list 4 fee | | 13. Building multilevel intersection | (U) | 0 | - 0 | . 5 | 1 | 0 | 1 | | 1 |
| | | | | 14 Widening of road sections | | 1 | 1 | 2 | 3 | 1 | 13 | 1 | - 3 |
| | | | | 15. Traffic demand management 16. Motorcycle Lane | | 1 | 1 | 3 | 3 | 1 | 3 | 3 | 1 |
| | | | | 17. Bite lane | | 0 | - 1 | | 3 | 0 | 0 | | 0 |
| | | | | 18 Bus priority late | | D | | 1 | 1 | 0 | 0 | | 9 |
| | | | | 19 Upgrade of treffic control system/ information provis | uion . | p | | | ů. | Ó | Ú. | | |
| k | 1,073,630,090 | | | TOTAL Construction Cost 3-121 | | P3.140.000 | 911,950,000 | P15.383,000 | P33.870,000 | P17,350,000 | #50,958,000 | #8,010,000 | P61.880.000 |
| | | #213.562.000 | | 10TAL KOMM Cast 1-L31 | | 9908,000 | 92,366,000 | P3.028.000 | P6.725.000 | | \$10,178.000 | P1.598.000 | P12.355.000 |
| | +.) emplacits | - rolad | ent coefficient on the | And the second s | CHINA COMPANY | | | | | | | | |
| | T-Assessed to be add | and the second se | | | | - | | | | | 1001 0 | - El | |
| í | and a second second second | and the second second | | Traffic Management Plan for Metr | | | | | | | | | |

• The list of bottlenecks, including the survey data, will be compiled into the longlist for further analysis.



Relevant links

- Google form for surveyor: <u>https://forms.gle/tScWTX3qVjMNsbT99</u>
- Form responses: <u>https://docs.google.com/spreadsheets/d/1GFASy_doBBX46gDqH7elKWNrXH</u> <u>iu_jp189xlANc6QPU/edit?usp=sharing</u>
- Google form for editor: <u>https://docs.google.com/forms/d/1kYLftyUJSaf1T3P6pQIBMNssMEII6x--</u> <u>cI2S4UMRjCs/edit</u>

The Project for Comprehensive Traffic Management Plan for Metro Manila

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

THE PROJECT FOR COMPREHENSIVE TRAFFIC MANAGEMENT PLAN FOR METRO MANILA

TECHNICAL REPORT NO. 5 INTERSECTION CAPACITY ANALYSIS

November 2022

ALMEC CORPORATION ORIENTAL CONSULTANTS GLOBAL CO., LTD. TRANSPORTATION RESEARCH INSTITUTE CO., LTD.

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ABBREVIATIONS

| CTMP | Comprehensive Traffic Management Plan |
|------|---|
| G/C | green/cycle |
| JICA | Japan International Cooperation Agency |
| JPT | JICA Project Team |
| MMDA | Metropolitan Manila Development Authority |
| RTOR | right-turn on red |
| TCU | through car unit |
| V/S | volume/saturation |

1 USER'S GUIDE FOR SPREADSHEET CAPACITY ANALYSIS TEMPLATES

1.1 Introduction

Three (3) spreadsheet templates have been developed to facilitate capacity analyses of signalized and non-signalized intersections.

This user's guide describes the basic operations of the templates concerning the initialization and data entry, and critical assumptions and analytical procedures from which the templates are constructed. The users are assumed to have an adequate working knowledge of personal computers and the Microsoft Excel spreadsheet program. It is also assumed that the users are sufficiently familiar with traffic engineering terminology and understand the theoretical bases of intersection capacity analysis to properly interpret the results.

Because traffic, roadway, and control factors can sometimes produce a very complicated situation as far as capacity analysis is concerned, it is imperative that the user understands the basic assumptions and equations which have been used in constructing the templates. In particular, when an analysis involves shared left/through lanes and/or overlap phasing, an assessment should be made to determine if the methodology remains applicable. Sometimes, it may be necessary to alter the input data to "trick the system" into producing a better result. This cannot be done without a thorough understanding of the methodology.

1.2 The Templates

The first template, named "Intersection Turning Movement Survey – Conversion to TCUs," is for converting intersection turning movement counts into Through Car Unit (TCU) which can then be input into the capacity analysis templates.

The second template, named "Intersection Capacity Analysis - Planning Method," is for evaluating future intersections, geometric improvements, and signal warrants, and in various planning and preliminary engineering studies which do not warrant a detailed analysis of signal operations.

The third template, named "Intersection Capacity Analysis - Operations Method," is for the detailed evaluation of intersection operations, particularly in evaluating the effectiveness of existing signal control, developing timing plans, comparing alternative phasing plans, and final intersection design.

Both planning and operations methods require traffic volumes and intersection lane configuration as basic input. The main difference is that the user must specify signal phasing and timing in the operations method while such input data is not required for the planning method.

1.3 A Few Words of Caution

The templates are not perfect in the sense that there are unusual circumstances that would render the assumptions and the various parameters embedded in the templates inaccurate or invalid. The user should always review the input data and the results carefully before drawing conclusions. There is no substitute for sound engineering judgment, and one must take care not to fall into the "GIGO" trap¹.

A macro command to initialize the input data cells is incorporated into the templates. When the template is opened, a warning message regarding the use of macros may be displayed. Select "Enable Macros" to continue. Alternatively, macros can be disabled, and the template can be initialized manually when used for other intersections.

The templates have been designed to avoid accidental alteration of the internal logic, and all cells are protected except the cells where data input is done by the user. If you try to input data into a protected cell, a warning message is displayed. Press the "Cancel" button in the dialogue box to terminate the operation. Do not remove the protection unless you know exactly what you are doing.

Where input of a value data (including zero) is required, entering a label (including blank spaces) may result in errors in related cells. Therefore, one must not use the space bar to blank out a numerical entry; enter a zero (0) instead.

¹ "GIGO" is an acronym used at IBM, back in the Stone Age of computers, and it stands for "Garbage In – Garbage Out" – in other words, the quality of the finished product will not be better than the quality of the input.

1.4 From Start to Finish

The file names of the three templates are "TM_CONV_MMDA.xlsm," "Capa_PL_MMDA.xlsm," and "Capa_OP_MMDA.xlsm." The "xlsm" file format indicates that macro is embedded in the template and its use is explained below. These and any filled-in templates can be retrieved for editing or to start a new analysis.

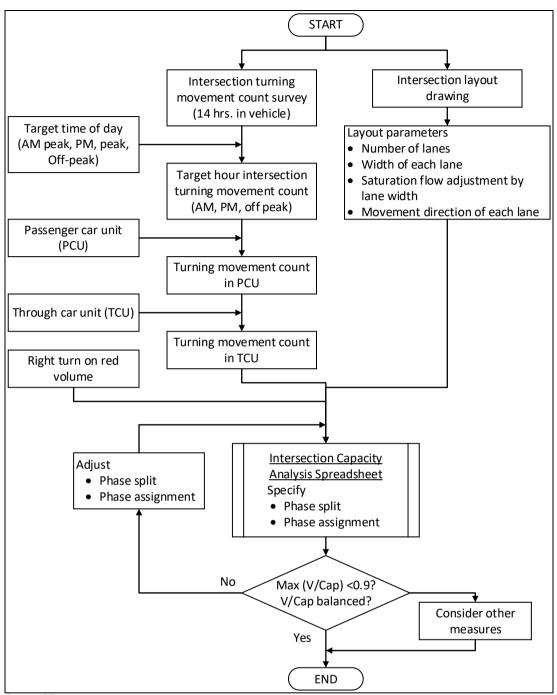
To start a new analysis from a previously filled-in template, press the "Shift," "Ctrl" and "I" keys simultaneously. This will initialize all input data cells except for a few locations where default values are supplied but can still be changed by the user as they are not protected.

The initialized template shows zero blanks in numerical cells and "XXXXX" in label cells. In addition, the initial texts in cells intended for inputs are colored blue to help distinguish which cells are intended for data entry. Note that time should be entered as a label and unnecessary zeroes may be erased as desired. For example, when left-turn movement is prohibited, a blank entry in the left-turn volume cell may be less ambiguous than a zero entry.

Follow standard Excel procedures to print and store data sheets. Default print ranges and margins have been pre-defined but, again, they can be changed if necessary.

Since data entry requires little effort, saving a datasheet to a file is not critical if a hard copy is retained, especially if one is kept in the traffic count folder. This would avoid the trouble of keeping track of the files. Otherwise, a file-naming scheme should be devised and followed to avoid confusion and make file identification and retrieval easier. As a suggestion, one might use "T" for the first digit to indicate that it is a turning movement survey file, "P" for the planning method, and "O" for the operations method. The next three digits could be the intersection number and the last four digits could be "_01A" to indicate the first count or analysis of 2022. The file name should appear on each spreadsheet at the upper right-hand corner following the title "FN:."

The workflow of intersection capacity analysis is shown in Figure 1.1.



Source: JPT

Figure 1.1: Intersection Capacity Analysis Process Flow

2 TURNING MOVEMENT SURVEY TEMPLATE

This template is set up to process turning movement counts for a period on a separate worksheet. The upper part of the template identifies the location and the time period. The next section shows the through car units (TCU) used by the Template. The TCU converts the traffic count of different types of vehicles in different movement directions into equivalent car units. Below the TCU units are spaces for entering volume counts by classification and movement. Total vehicles and the equivalent TCUs for each movement are computed automatically.

The turning movement diagrams at the bottom are plotted automatically using the total vehicle and TCU figures in the date entry table.

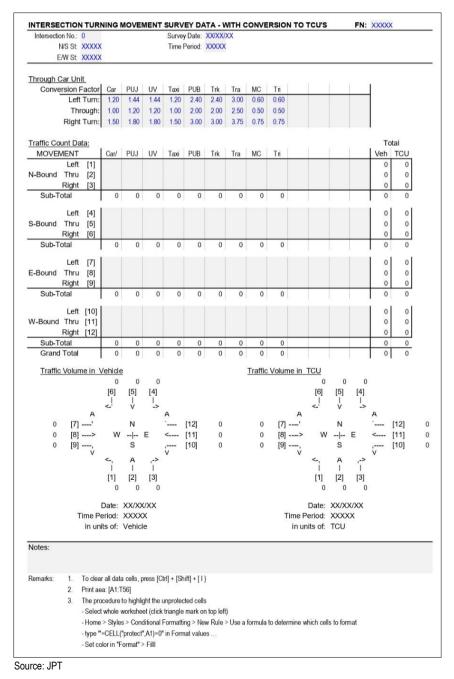


Figure 2.1: Intersection Turning Movement Survey – Conversion to TCUs

2.1 Street Orientation

To avoid confusion, it is necessary to designate one of the two intersecting streets as northsouth street and the other one as an east-west street. The two street names should be entered separately in the designated cells. Also, each of the movements is numbered 1 to 12 for uniformity. The movement numbers are shown in the table and the plots (Figure 2.1). After all the data are entered, the plots should be visually checked to spot any abnormalities.

2.2 **Conversion Factors**

Conversion factor converts the traffic count of different vehicle types and movement direction into the equivalent traffic volume of passenger cars through movement. There are 9 vehicle types used by MMDA for classified traffic count surveys and three (3) factors for three (3) movements (left turn, through, and right turn). Thus, a total of 27 factors are defined.

Large vehicles are less maneuverable than small vehicles and less efficient in terms of intersection operation. Passenger car equivalent converts the volume count of different vehicle types into that of a passenger car. The unit for the converted count is called the passenger car unit or PCU.

Likewise, turning vehicles (left and right turns) normally take more time than through movement to pass through an intersection as they have to reduce the speed. Effective traffic count is thus higher than the actual count, or conversely, intersection capacity is reduced by turning vehicles. Through car equivalent adjusts the effective traffic volume into through car unit.

The classification, applicable vehicle type, and default conversion factor are set in Table 2.1. These factors are not protected and not initialized, and one can alter the factors, if necessary. It is recommended however to set the standard factors and apply these factors consistently.

| Left turn | Through | Right turn |
|-----------|---|---|
| 1.20 | 1.00 | 1.50 |
| 1.44 | 1.20 | 1.80 |
| 1.44 | 1.20 | 1.80 |
| 1.20 | 1.00 | 1.50 |
| 2.40 | 2.00 | 3.00 |
| 2.40 | 2.00 | 3.00 |
| 3.00 | 2.50 | 3.75 |
| 0.60 | 0.50 | 0.75 |
| 0.60 | 0.50 | 0.75 |
| | 1.20 1.44 1.44 1.20 2.40 2.40 3.00 0.60 | 1.20 1.00 1.44 1.20 1.44 1.20 1.44 1.20 1.20 1.00 2.40 2.00 2.40 2.00 3.00 2.50 0.60 0.50 |

Table 2.1: Vehicle Type Conversion Factor

Source: JPT

2.3 Notes

Three rows of the template following the heading "Notes:" are unprotected. They may be used to document any observations or comments which apply to the data.

3 CAPACITY ANALYSIS TEMPLATE – PLANNING METHOD

This template is organized into four sections. The upper portion identifies the location, period of study, and assumed saturation flow rate. This is followed by a turning movement diagram and a lane configuration diagram. These are the main data entry sections. The next section is the analysis section which computes saturation flows and volume/saturation flow ratios (V/S), selects critical movements, and sums up the critical V/S values. All of these are done automatically. The last section, under the heading of "Notes:" allows the user to enter any remarks or comments which are appropriate or necessary to clarify either the input data or the results.

| N ' [12] 0 0.00 '-> < 0.00 ' E < [11] 0 0.00 > <- 0.00 'S , [10] 0 0.00 > <- 0.00 V WB 0.00 , -> <- <- 0.00 A ,-> <- <- 0.00 A ,-> 0.00 A ,-> 0.00 0.00 | | Project: Int. No.: N/S St.: | Int. Co | de | | Date: | presenting: mm/dd/yyyy | | | | | (TCU) | per | P | | Analyst mm/dd/ | |
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| ea: [A1:S52] apacity is calculated proportional to lane width with the formla: ocedure to highlight the unprotected cells | | | | | | 2.81 | | 9 - 19 - 19 | 5 | | | | | | | | |
| ea: [A1:S52] apacity is calculated proportional to lane width with the formla: ocedure to highlight the unprotected cells t whole worksheet (click triangle mark on top left) | | | | | | | - | | e > Use a | a tormula | a to dete | rmine w | nich cel | is to forr | nat | | |
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Source: JPT

Figure 3.1: Intersection Capacity Analysis - Planning Method

3.1 Units

Both the saturation flow rate and the volumes should normally be entered in units of TCU (through car unit) per hour. However, this is entirely up to the user as long as they are consistent.

Lane widths must be in units of meters, with a maximum of two digits following the decimal point.

3.2 Right-Turn on Red (RTOR)

Where a right-turn on a red signal is permitted, a reduction in the right-turn volume should be considered. The user must estimate and enter these RTOR volumes in spaces provided in the volume diagram. In general, if there is a separate right-turn lane with adequate length, all of the right-turn vehicles may be treated as RTOR vehicles. On the other extreme where the right-turn volume is very small and there is no right-turn lane or right-turn island, no RTOR should be assumed.

Another consideration to be made is the interference with the through traffic from the crossing road. If right-turning traffic has to merge with the through traffic of the crossing road, the former must give way to the through traffic resulting in the reduction of the volume that can make a right turn on red. On the other hand, if there is an exclusive lane for right-turning traffic on the exit, there would be no interference with the through traffic on the crossing road.

Usually, 10 to 20 percent of right-turn vehicles can be assumed to be RTOR.

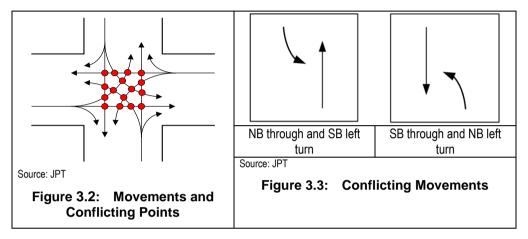
3.3 Saturation Flow Rate (S)

A default value of 1950 TCU per 3.0 meters of pavement width is provided in the template based on TEC's current practice. This can be modified to any value by the user. The program calculates the saturation ratio of lanes proportionally using this value.

3.4 Conflicting and Critical Movements

The planning method of capacity analysis is formulated mainly based on "Conflicting Movements" and "Critical Movements." The concept is explained below:

For a typical 4-legged intersection, there are twelve (12) movements (northbound left, northbound through, northbound right, etc.). Some of the movements can move concurrently (e.g. through movements on the same street) while some are conflicting (e.g. northbound through and southbound left-turn) and must move during different times of the signal cycle. Thus, signal timing is controlled by conflicting movements.



For any two-way street, there are mainly two sets of conflicting movements. Take a northsouth street, for example, the northbound through and the southbound left-turn form a set of conflicting movements (Figure 3.3) while the southbound through and northbound leftturn form the other set. One of these two sets of conflicting movements is critical that it will require more green time than the other. In some cases, left-turn movement can become critical because left-turns from one direction also conflict with right-turns from the other direction. Nevertheless, the concept is the same.

The amount of time required to process the critical conflicting movements in each cycle must be less than the cycle length if the intersection is to be free of congestion. The lower the G/C ratio of the critical conflicting movements, the better the intersection operation.

Since the amount of green time required is proportional to the number of vehicles and inversely proportional to the saturation flow rate, the required G/C of all critical movements is proportional to the sum of V/S of all critical movements where S is the saturation flow rate. The sum of V/S of the critical conflicting movements is therefore a good indicator of an intersection's level of saturation and is defined as the saturation factor "Y".

3.5 The "Y" Value

The planning method begins by computing V/S for all movements. The next step is summing up the V/S values for all possible combinations of conflicting movements. Finally, the combination of conflicting movements which yields the highest total V/S value is chosen.

Because the assumed saturation flow rate is achievable only under ideal conditions and because inter-green loss time and specific signal timing are not considered in the planning method, it is extremely important to understand that the computed "Y" value is not equivalent to volume/capacity ratio or even close to it. For a signal to operate without significant congestion, the "Y" value should be less than 0.75. Severe congestion should be expected if the "Y" value reaches 0.85. Typically, the results of planning analysis are interpreted qualitatively as follows:

| Range of Y Value | Interpretation |
|------------------|----------------|
| < 0.75 | below capacity |
| 0.75 to 0.85 | near capacity |
| > 0.85 | over capacity |
| Source: JPT | |

Table 3.1: "Y" Value and Traffic Condition

Comparing "Y" values in a quantitative way should be avoided especially for different locations and when the value differential is relatively small. For example, one should not quickly conclude that location "A" is better than location "B" because the "Y" values are 0.65 and 0.70 respectively. Similarly, it may be erroneous to conclude that scheme "A" is better than scheme "B" because the former has a "Y" value of 0.76 while the latter has a "Y" value of 0.78.

3.6 Shared Lane

Saturation flow rates under shared lane conditions are extremely complicated as explained in Section 4 of this user's guide. For the planning method application, minimum V/S values are computed assuming the shared lane is actually used exclusively by the movement. When a movement uses exclusive lanes only, the minimum V/S is its actual V/S. When a shared lane is involved, a movement group (e.g. right/through as a group) V/S is computed. The group V/S is then used in lieu of the V/S for the specific movement. However, this is modified in two respects:

- (a) When the minimum V/S is greater than the group average, the minimum dictates the V/S value because the shared lane is, in reality, operating as an exclusive lane. When this is found to be the case, the user must modify the lane configuration, i.e., change the shared lane to the exclusive lane, and redo the analysis.
- (b) When right turns are made from a shared lane only, the V/S for the right turn is computed as if the shared lane is an exclusive right-turn lane. This is reasonably accurate as right-turn vehicles will accumulate in the shared lane while through vehicles will shy away from the lane.

3.7 Shared Left-Right Lane and Single-Lane Approach

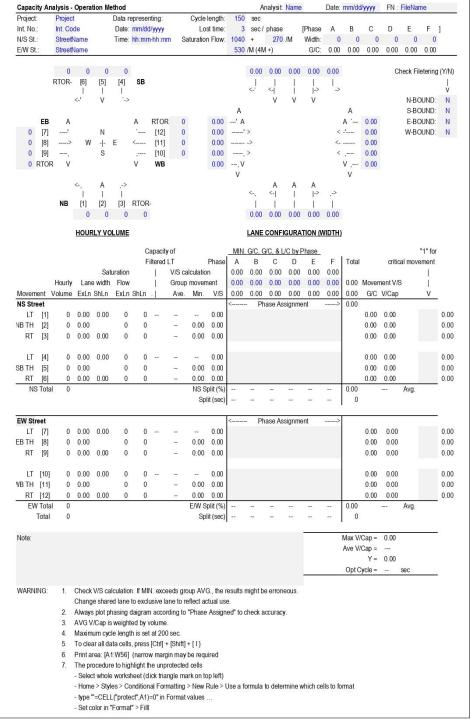
Where left and right-turns share a single-lane, either the left-turns or the right-turns must be treated as through traffic in order to fit into the template layout. If there is no opposing traffic, as at T intersections, either way, will work correctly. If there is opposing through traffic, the left-turns should be treated as through traffic.

For a single-lane approach, the single lane should be treated as a shared right-through lane. The template will automatically adjust the through volume to include the left-turn traffic.

4 CAPACITY ANALYSIS TEMPLATE – OPERATIONS METHOD

The organization of this template is similar to the planning method template, i.e., starting with a location and basic parameter section, followed by volume and lane configuration diagrams and an analysis section, and finally a "Notes" section.

Location, time, volume, and lane configuration data are entered exactly the same as with the planning template, but additional input data are required. Cycle length and lost time are self-explanatory. The others are discussed below.



Source: JPT

Figure 4.1: Intersection Capacity Analysis - Operations Method

4.1 Saturation Flow Rate

Saturation flow rates of protected movements under the operations method vary depending on the lane width. A base rate of 530 TCUs per meter is used for a lane width of 4 meters or wider. For lane widths between 2.5 and 4 meters, the following equation is used:

S = 1040 + 270 * W where W is the lane width in meters.

Thus, for a single 3-meter and double 3-meter lanes, the saturation flow rates are 1,850 TCUs and 3,180 TCUs respectively. The reduction in per meter rate for wider pavement is necessary to reflect uneven lane distribution of vehicles.

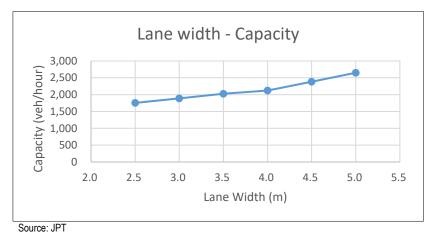


Figure 4.2: Lane Width vs. Capacity

Saturation flow rate and left-turn capacity under filtered left-turn conditions are described in Sections 4.8 and 4.9.

4.2 Number of Phases

Signal phases are indicated in the template as "A" ... "F". The number of phases is limited to 6 (A to F).

4.3 Minimum G/C for Pedestrian

Where a pedestrian crosswalk is provided, the Green/Cycle (G/C) ratio must be long enough to allow pedestrians to walk across the street safely. This G/C ratio is a function of cycle length and length of pedestrian crossing or width of the carriageway. Enter the pedestrian crossing length for each applicable phase following the heading "Width." The template computes the minimum G/C and transfers the data into the main analysis section under the heading "Min. G/C, G/C, L/C by Phase" for easy comparison with the actual G/C assigned to each phase.

Minimum G/C for pedestrians is based on a constant "Walk" period of 7 seconds and a flashing "Don't Walk" period which is required to walk from the departing curb face to within 1.5 meters of the curb face on the opposite side (It is normally assumed that pedestrians can finish the last 1.5 meters during the inter-green interval). A walking speed of 1.3 meters per second is assumed.

4.4 Filtering

Where left-turn movement is made through filtering (i.e., without a protected phase), it must be indicated by a "Y" under the heading "Check Filtering (Y/N)." The template is not designed to handle overlapping protective-permissive type phasing. In such cases, a conservative approach would be to ignore the permissive phase, i.e., assume left turns are made in the protected phase only. Based on the experience in the Philippines, the sequence of the protective-permissive left turn is not recommended as left-turning vehicles do not yield to opposing through traffic when the phase changes from protected to permissive.

4.5 G/C and L/C

The second and third rows of data cells under the headings of "Min. G/C, G/C …" and "Ph.A Ph.B …" display the actual Green/Cycle ratio assigned to each phase and the Lost Time/Cycle (L/C) ratio computed according to the previously specified lost time and cycle length. The assigned G/C (split) must be entered by the user. The total column is provided to ensure that the assigned G/C and the computed L/C total to one (1.00).

The computed V/S (Volume/Saturation Flow) values under the heading "Movement V/S" provide clues as to what initial G/C values should be tested. To achieve a V/Cap (Volume/Capacity) ratio of less than one, G/C must be greater than V/S for any movement.

By altering the G/C values (split) and the phase assignment, which is described in the next section, the user can find a combination that will produce the smallest V/Cap, a balanced V/Cap among the several movements, or the smallest average V/Cap for all movements. The ability to test different phasing and timing plans quickly is the main advantage of using the template; it does not automatically search for an optimum plan for the user.

4.6 Phase Assigned

The phasing plan is specified by the user under the heading "Phase Assignment" by entering a "1" in the appropriate cell of the movement-phase matrix. For example, a "1" in the upper-left corner cell indicates that a northbound left turn is assigned to Phase A and, conversely, a "0" or blank in this cell indicates that a northbound left-turn is not allowed in Phase A.

4.7 Volume/Capacity Ratio

To provide as much information to the user as possible, V/Cap is computed separately for each movement as well as for each direction and for the entire intersection. A timing plan which produces the lowest maximum V/Cap does not always produce the lowest average V/Cap. It is up to the user to decide which is the best measure to use in selecting the final design. For each movement, V/Cap is computed from:

$$V/Cap = \{V/S\}/\{G/C\}$$

Capacity of Filtered Left-turn Movement 4.8

The capacity of left-turn lanes under permissive left-turn conditions (i.e., filtering) is very difficult to estimate as many factors are involved, including volume level of opposing flow, the proportion of left-turning vehicles, amount of green time allocated to the movement, and lane configuration.

While manual procedures using various charts and tables may produce more accurate results, the benefits are often offset by human errors due to misunderstanding and complexity of the procedures. To overcome the problem in conducting capacity analysis, a somewhat simplified methodology has been developed to allow automatic calculation in the spreadsheet implementation of capacity analysis for signalized intersections.

(a) Capacity of Exclusive Left-turn Lane

Maximum left-turn volumes vary depending on the volume of opposing traffic, G/C ratio, and the number of approach lanes that the left-turning vehicles must travel across. The relationship is depicted in graphic format in Figures 2.1 to 2.3 of "Manual for the Design and Layout of Traffic Signals in the Philippines." Although the relationship is non-linear, a linear approximation is considered satisfactory within typical ranges of volume and G/C ratio. This linear approximation can be expressed as:

 $M(I) = 150 + \{1000-V(o)\}/2 - \{0.5-G/C\}*800 - \{60^{*}(N(o)-1)\}$

| where, | M(I) | = | Maximum volume (capacity) of left-turn lane, |
|--------|-----------|---------|--|
| | V(o) | = | Volume (Vehicle/Hour) of opposing traffic, |
| | G/C | = | Green over Cycle ratio (split), and |
| | N(o) | = | Number of lanes in the opposing direction. |
| | ation car | he simp | lified as: |

The equation can be simplified as:

M(I) = 310 - V(o)/2 + G/C*800 - 60*N(o)

Since pavement width is used throughout the spread-sheet application and M(I) has a minimum of 120 Vehicle/Hour, it is computed in the spreadsheet according to the following equation:

MAX(120,310-V(o)/2+G/C*800-(60*W(o)/3)) or,

MAX(120,310-V(o)/2+G/C*800-20*W(o))

where W(o) is the pavement width of the opposing direction and W(o)/3 is used to approximate the number of lanes.

Note that M(I) is not the saturation flow rate; it is the capacity of the left-turn lane for the given G/C. For this special condition, the normal V/S calculation is not carried out for the left-turn movement. The left-turn capacity is obtained as discussed above and V/Cap ratio for the left-turn movement is determined directly instead of from {V/S}/{G/C}.

(b) Capacity of Left-turns from Shared Lane

Where left turns are made from a shared through/left lane, the left-turn capacity would be expected to be less than what is determined from the above equation due to interference of through traffic in the shared lane. However, this reduction should be negligible except when the adjacent exclusive through lanes are heavily congested and the opposing through traffic is light. Under such conditions, a simultaneous left/through phasing would most likely be better which will provide a protected left turn without reducing the capacity. Consequently, the above formulation for the capacity of an exclusive left-turn lane is also applied to cases where left-turn filtering is made from a shared left-through lane.

4.9 Saturation Flow Rate of Through Movement from Shared Lane

Where left-turns are filtered and are made from a shared left-through lane, the shared lane can be used by through traffic for a portion of the available green time when the lane is not obstructed by left-turning vehicles. This unobstructed green time varies depending on the degree of saturation of the left-turn movement. The maximum volume of through traffic per hour of green time which could make use of the shared lane (Saturation flow rate of through movement) may be estimated from the following:

$$Q(ts) = \{1 - V(I)/M(I)\}^*Q(t)$$

where, Q(ts) = Saturation flow rate of through traffic in the shared lane,

V(I) = Volume of left-turns in the shared lane,

Q(t) = Saturation flow rate of through traffic in exclusive through lane,

and

M(I) is as determined above.

4.10 Minimum and Group V/S

As explained in the planning method application, it is necessary to compute and compare minimum and group V/S values to ensure that a shared lane is not functioning as an exclusive lane. However, in the cases involving left-turn filtering, computing group V/S values for the left-turn and the through movements is no longer necessary because the saturation flow rates already reflect the filtering condition as described in Sections 4.8 and 4.9.

4.11 Optimum Cycle Length

Optimum cycle length is calculated using Webster's equation. To obtain this value, the user must identify the critical movements by entering a "1" in the spaces provided. Currently, the maximum cycle length is set at 200 seconds. If the template shows 200 seconds as the optimum cycle length, it indicates that the intersection is saturated and cannot process all demands resulting in the queue.

Webster's equation is expressed as follows:

$$Co = \frac{1.5L+5}{1-\sum(\frac{V}{\varsigma})}$$

Where:

Co = Optimum cycle length (sec)

L = Sum of the lost time for all phases, usually taken as the sum of the inter-green periods (sec)

V/S = Ratio of the design flow rate to the saturation flow rate for the critical movement in each phase

If there is no overlap phasing, the critical movement for each phase is the movement that has the largest V/S value of all movements in that phase. If overlap phasing is used, however, the number of critical movements may be less than the number of phases and a movement with a large V/S value may not be critical if it can move in more than one phase. In the example below, movement A is not critical because the sum of the V/S values for movements B and C is greater than the sum for movements A and D. Furthermore, only movements B and C should be identified as critical even though there are three phases.

 Table 4.1:
 Overlapping Phase

| Movement | Phase | V/S |
|-------------|-------|-----|
| A | 1+2 | .35 |
| В | 1 | .15 |
| С | 2+3 | .32 |
| D | 3 | .10 |
| Source: JPT | | |

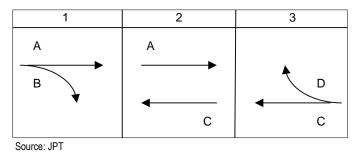


Figure 4.3: Traffic Phases