

## CHAPTER 3 SUPPLEMENTARY TRAFFIC SURVEY

### 3.1 REVIEW OF EXISTING TRANSPORT MASTER PLANS

#### 3.1.1 PDTU/RMRJ 2005

(1) Summary of the Study

The objective of this study is to evaluate future alternatives of urban transport infrastructure development in the Metropolitan Region of Rio de Janeiro (*Região Metropolitana do Rio de Janeiro: RMRJ*). In this study, the current traffic characteristics and transport demand were clarified and an economic-environmental benefit analysis of the proposed investments was conducted.

(2) Contents

The contents of the PDTU/RMRJ 2005 Study are shown in Table 3-1 below. It should be noted that Report No. 13 was used as the base reference for the modeling tasks and for clarifying the traffic/transport issues described in this report.

**Table 3-1 Contents of PDTU/RMRJ 2005**

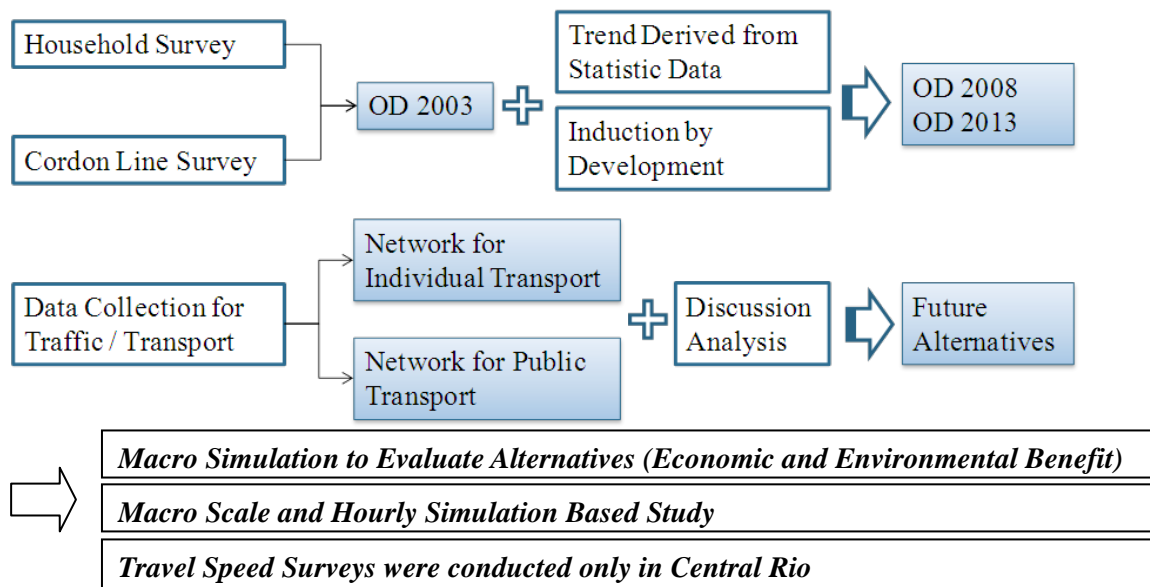
Report No.	Title
1	Work Plan
2	Analysis of Existing Studies and Plans
3	Questionnaires and Survey Plan
4	Compatibility with Existing Software
5	Progress of Network Preparation, Diagnostic and Origin-Destination (O-D) Survey
6	Network and Diagnostic (Finalized in Report No. 10)
7	Survey on Cordon Lines
8	Origin-Destination (O-D) Survey
9	O-D Matrices Design
10	Final Network and Diagnostic (Final Version)
11	Model Calibration
12	System Development
<b><u>13</u></b>	<b><u>Final Master Plan (Contents: Demand Forecast, Scenario Setting, Evaluation)</u></b>

→ **Reference for Modeling**

Source: JICA Study Team

(3) Methodology and Survey

According to Report No. 13, the methodology and survey structure of the PDTU/RMRJ 2005 were organized as shown in Figure 3-1 below.



Source: JICA Study Team

**Figure 3-1 Structure of the Study**

(4) Application in this Project

The PDTU/RMRJ 2005 Study was applied for the following:

- Clarification of current demand characteristics;
- Determination of sites and routes for the detailed traffic survey;
- Reference for the travel demand forecast methodology; and
- Reference for the evaluation unit (e.g., value of time).

### 3.1.2 PDTU/RMRJ 2011

#### (1) Summary of the Study

The objective of this study is to update the PDTU/RMRJ 2005 by reevaluating its results and preparing new proposals to address the traffic growth in the next ten years. The movement of both people and goods, and the demand for hosting the World Cup in 2014 and the Olympic Games in 2016 will be considered. This study is ongoing and will be concluded by 2013.

#### (2) Contents

The contents of the PDTU/RMRJ 2011 are shown in Table 3-2 below. At this moment, Report Nos. 2, 3, 4, and 11 has been finished.

**Table 3-2 Contents of PDTU/RMRJ 2011**

Report No.	Title
1	INFORMATION
2	<u>ZONING AND SAMPLING PLAN</u>
3	<u>UPDATE OF PDTU DATABASE</u>
4	<u>ANALYSIS OF LAND USE</u>
5	CURRENT NETWORK CALIBRATION
6	TRANSPORT PLANNING AND ACTION PLAN
7	HARDWARE, SOFTWARE, AND SYSTEM AVAILABILITY
8	ASSESSMENT OF PDTU UPDATE
9	TRAINING
10	DEVELOPMENT OF BASIC DESIGN OF MODAL INTEGRATION FOR RAIL TERMINAL
11	<u>REPORTING OF CARGO TRANSPORT</u>

*Progress*

*Progress*

Source: JICA Study Team

#### (3) Progress

##### 1) Zoning and Sampling Plan

Zoning was reconsidered due to the land use changes in the past ten years. The numbers of traffic analysis zones were increased from about 400 to about 700. However, the OD database for this new zoning system is still being developed.

2) Update of the PDTU Database

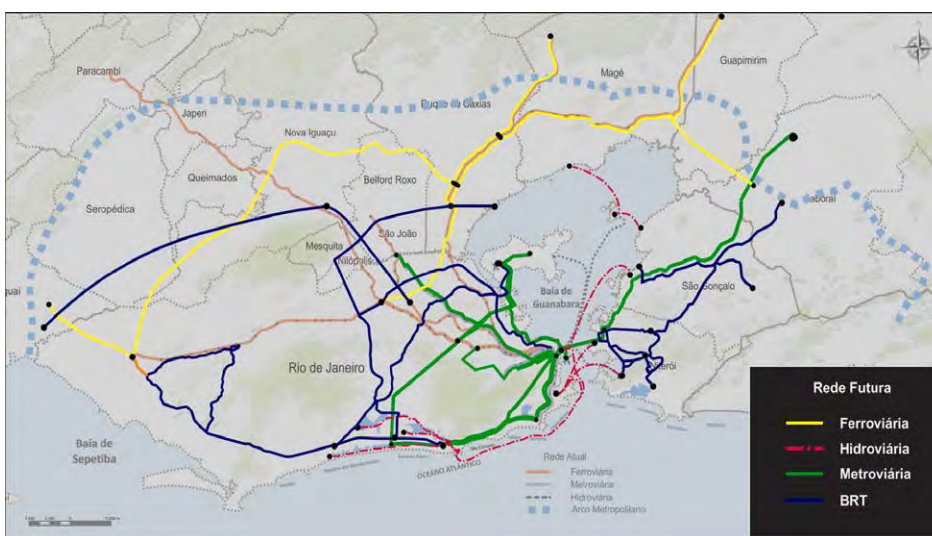
Network and travel demand data were updated by using passenger data from public transport operators. As for future network alternatives, two cases, namely, minimum development in 2016 and reasonable development in 2021, are being proposed as shown in Figure 3-2. In the 2016 case, only projects under construction and authorized by the government are included. On the other hand, in the 2021 case, projects were chosen considering the following five points:

- a) Avoid excessive overlap of supply;
- b) Consider potential demand;
- c) Network consolidation (radial-transverse);
- d) Integration with other corridors; and
- e) No carbon emission.

2016 = Minimum



2021 = Proposed Network



Source: JICA Study Team

Figure 3-2 Future Network Proposal in the PDTU/RMRJ 2011

3) Analysis of Land Use

The review of current land use and future land use forecast has been completed. This task is being validated at the moment.

4) Reporting of Cargo Transport

Survey of cargo demand has been conducted and the OD data for in-bound and out-bound for the city of Rio de Janeiro was developed. However, the OD data inside the city is still being developed.

(4) Application in this Project

The PDTU/RMRJ 2011 was used as the reference of the future network concept adopted in this report.

### 3.1.3 Rio 2016 Transport Strategy

(1) Summary of the Study

The objective of this plan is to build a transport strategy to accommodate the demand in the coming Rio 2016 Olympic Games. In this plan, the vision, major concepts, and key initiatives which will guide the planning and delivery of the olympic and paralympic transport services are provided.

(2) Contents

The contents of the Rio 2016 Transport Strategy are shown in Table 3-3 below. Report Nos. 4, 5, and 7 were used as reference for the modeling tasks in this report.

**Table 3-3 Contents of Rio 2016 Transport Strategy**

Report No.	Title
1	Introduction
2	Transport Strategy
3	Transport Governance
4	<b>Transport Investments and Legacy</b>
5	<b>Games Route Network and Traffic Management Measures</b>
6	Olympic Games Family Transport
7	<b>Spectator and Workforce Transport</b>
8	Venue Transport Plan
9	Special Operations
10	Transition from Planning to Delivery
11	Paralympic Games Transport

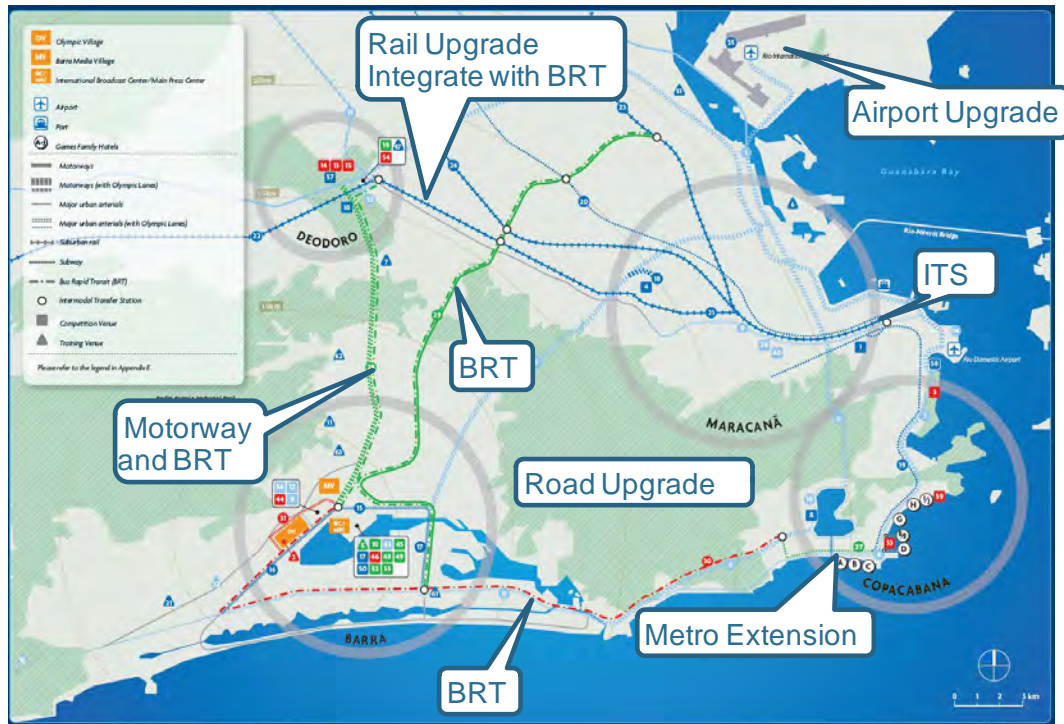
*Reference  
for  
Modeling*

Source: JICA Study Team

(3) Strategy Overview

1) Transport Investments and Legacy

In this report, the legacy of the Olympic Games will be considered in the 2016 future network by adding it to the PDTU 2011 scenario. The main legacy is shown in Figure 3-3.



Source: Rio 2016 Transportation Strategy

**Figure 3-3 Planned Infrastructure for Rio 2016**

2) Games Route Network and Traffic Management Measures

For the Olympic Games family transport, dedicated lanes called Olympic Lane are being planned as shown in Figure 3-4 below.



Source: Rio 2016 Transportation Strategy

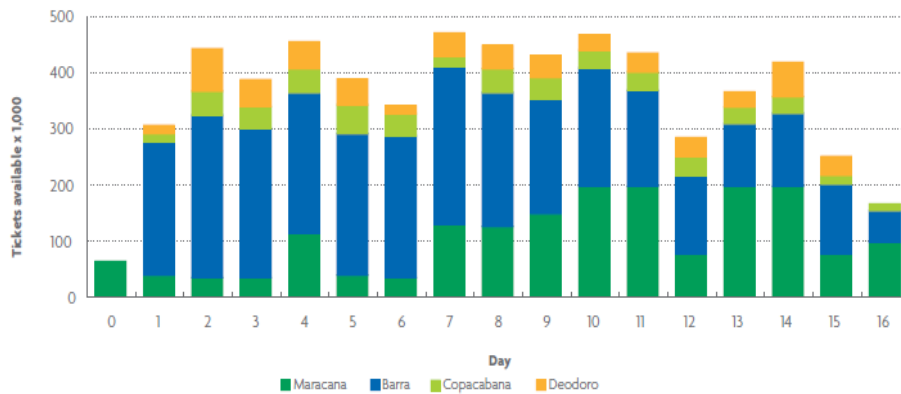
**Figure 3-4 Olympic Lane for Rio 2016**

In addition, traffic measures such as plate restriction are being considered in order to reduce the background traffic. Also, the transfer of school holidays from July to August and provision of incentives for simultaneous holidays will be planned. Through these traffic measures, it is expected that normal traffic are reduced by up to 30% during the Olympic Games. Thus, for demand estimation, this report will assume that some of these traffic measures will be implemented.

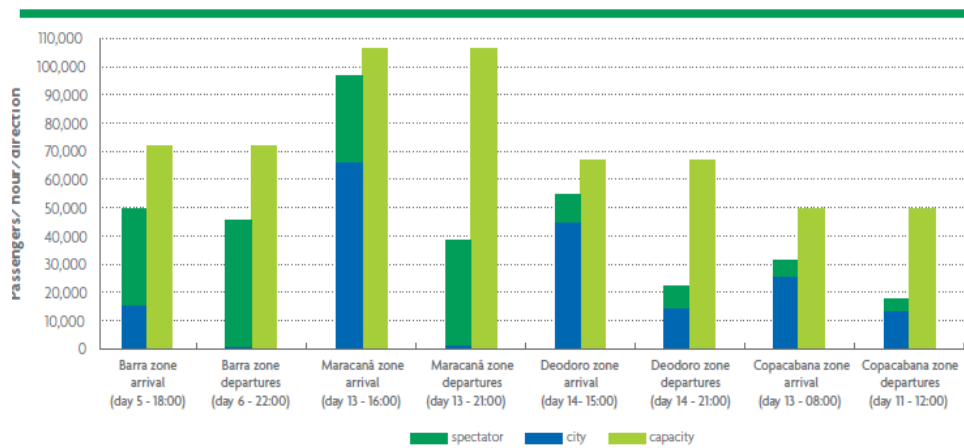
3) Spectator and Workforce Transport

The spectator demand is estimated for each game day. In addition, hourly demand is estimated and compared with the public transport capacity as shown in Figure 3-5 below. These numbers were considered in the modeling for the Olympic scenario.

[Daily Demand]



[Maximum Hourly Demand and Capacity (Public Transport)]



Source: Rio 2016 Transportation Strategy

Figure 3-5 Spectator Demand for Rio 2016



(4) Application in this Project

The Rio 2016 Transport Strategy was applied for the following:

- Assumption of the 2016 future network including the legacy of the Olympic Games;
- Assumption of the Olympic spectator demand and traffic measure for modeling the Olympic scenario:
  - Spectator Demand Peak: Departure from Barra Zone at 22:00 on Day 6 (The day when the finals of judo, swimming, and gymnastics are held); and
  - Demand/Capacity Peak: Departure from Maracana Zone at 16:00 on Day 13 (The day when the finals of track and field and football are held); and
- Assumption of public transport operation in the Olympic Games.

### 3.1.4 Update of the Strategic Transport Plan for the Olympic and Paralympic Games 2016

(1) Summary of the Study

The objective of this study is to update the strategic transport plan for the Olympics in Rio 2016. This study is now being conducted by the city of Rio de Janeiro, which is in charge of traffic operation. In this study, the Olympic demand data for traffic simulation and analysis is developed through traffic count survey and socioeconomic study.

(2) Contents

The contents of the whole study are shown in Table 3-4 below. Note that this study is still ongoing. Hence, it is necessary to understand the concept of this study so far.

**Table 3-4 Contents of Rio 2016 Transport Strategy Update**

Report No.	Title
Step 1	Work Plan
<b>Step 2</b>	<b>Update of Information and Model Preparation</b>
<b>Step 3</b>	<b>Matrices Design</b>
Step 4	Simulation Results and Proposal of Strategies

Source: JICA Study Team

(3) Progress

1) Update of Information and Model Preparation

In this step, traffic count survey and socioeconomic data analysis were conducted. The survey was used to project demand data from 2003 to 2011. The socioeconomic analysis was used to estimate the future background demand in 2016.

2) Matrices Design

In this step, traffic and transport demand is estimated considering future traffic growth forecast, the Olympic spectators demand, and traffic measures.

(4) Application in this Project

This study was used for the following:

- Validation of current traffic assignment; and
- Assumption of Olympic demand.

## 3.2 SUPPLEMENTARY TRAFFIC SURVEY

### 3.2.1 Objectives and Survey Methodology

#### (1) Objectives

The objectives of the supplementary traffic survey are: 1) to obtain the latest data on the roadway transport situation in Rio de Janeiro, 2) to analyze the transport characteristics through the survey data, and 3) to provide basic data for the traffic demand forecast. To achieve these objectives, the following surveys were conducted:

- 1) Traffic Count Survey;
- 2) Travel Time Survey;
- 3) Existing Traffic Count Data Analysis; and
- 4) CCTV Image Processing.

#### (2) Methodology

##### 1) Traffic Count Survey

##### i) Outline

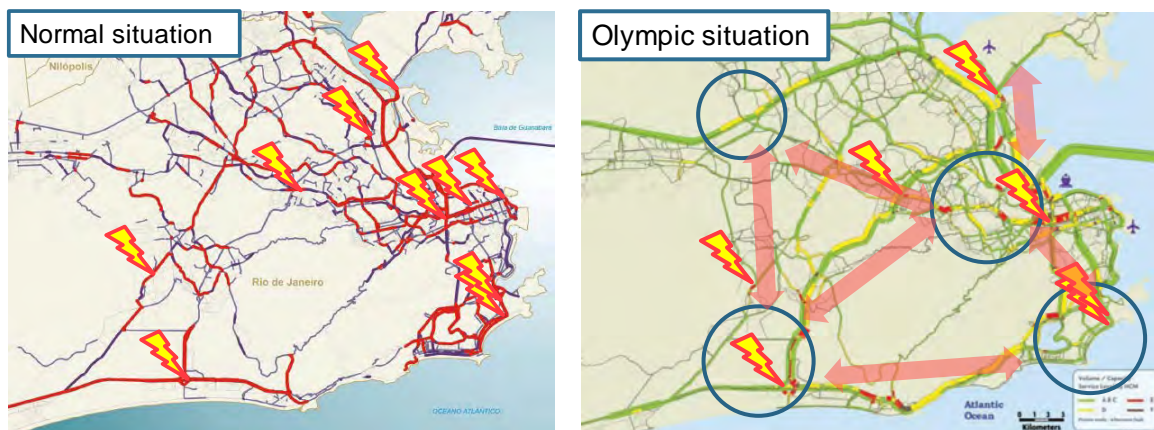
Traffic count data was obtained by counting vehicles manually at the roadside. The methodology of the survey is described as follows:

- > Weekday on 7 August 2012 (Tuesday) and weekend on 5 August 2012 (Sunday);
- > Traffic volume is summed by vehicle type every 15 minutes;
- > 15 hours including morning and evening peak hours (from 6 a.m. to 9 p.m.);
- > Traffic volume for each movement at signalized intersections;
- > Traffic volume for each direction at junctions and cross sections; and
- > Categories of vehicle type are:
  - a) Car (Passenger car, pickup truck)
  - b) Taxi
  - c) Van
  - d) Bus
  - e) Truck (Light truck , 2-axle truck, 3-axle truck, truck with 4 or more axles).

##### ii) Survey Location

The survey locations were determined considering the information available in the PDTU/RMRJ 2005 and Rio 2016 Transportation Strategy as shown on the next page. From the PDTU/RMRJ 2005 Study, locations with a high volume to capacity (V/C) ratio based on the results of the traffic modeling were chosen as the survey locations. Similarly, from the Rio 2016 Study, locations on the main routes for the Olympic Games were chosen.

The survey sites and their survey durations are shown in the next pages. Appendix 7 contains the detailed traffic count data.



Source: JICA Study Team

Figure 3-6 Comparison between Survey Locations and PDTU/Rio 2016

Table 3-5 Survey Stations List

No.	Location	Duration	Type	August	
				7	5
1	Av. Presidente Vargas – Av. Rio Branco	15 hours	Junction	O	
2	Av. Presidente Vargas – R. Primeiro de Marco	15 hours	Junction	O	
3	Av. Presidente Vargas – R. Bento Ribeiro	15 hours	Junction	O	
4	Av. Presidente Vargas – Praca da Republica	15 hours	Junction	O	
5	Av. Nossa Senhora de Copacabana – Av. Princesa Isabel	15 hours	Junction	O	
6	Av. Barata Ribeiro – Av. Princesa Isabel	15 hours	Junction	O	
7	Av. Presidente Vargas – Av. Francisco Bicalho (North, South, East, West)	15 hours	Intersection	O	O
8	Est. do Galeao – Linha Vermelha (North, South, East)	15 hours	Intersection	O	O
9	Av. das Americas – Av. Ayrton Senna (North, East, West)	15 hours	Intersection	O	O
10	Av. Brasil	15 hours	Cross section	O	O
11	R. Goias and Av. Amaro Cavalcanti	15 hours	Cross section	O	
12	Estr. dos Bandeirantes	15 hours	Cross section	O	
Total				12	4
				16	

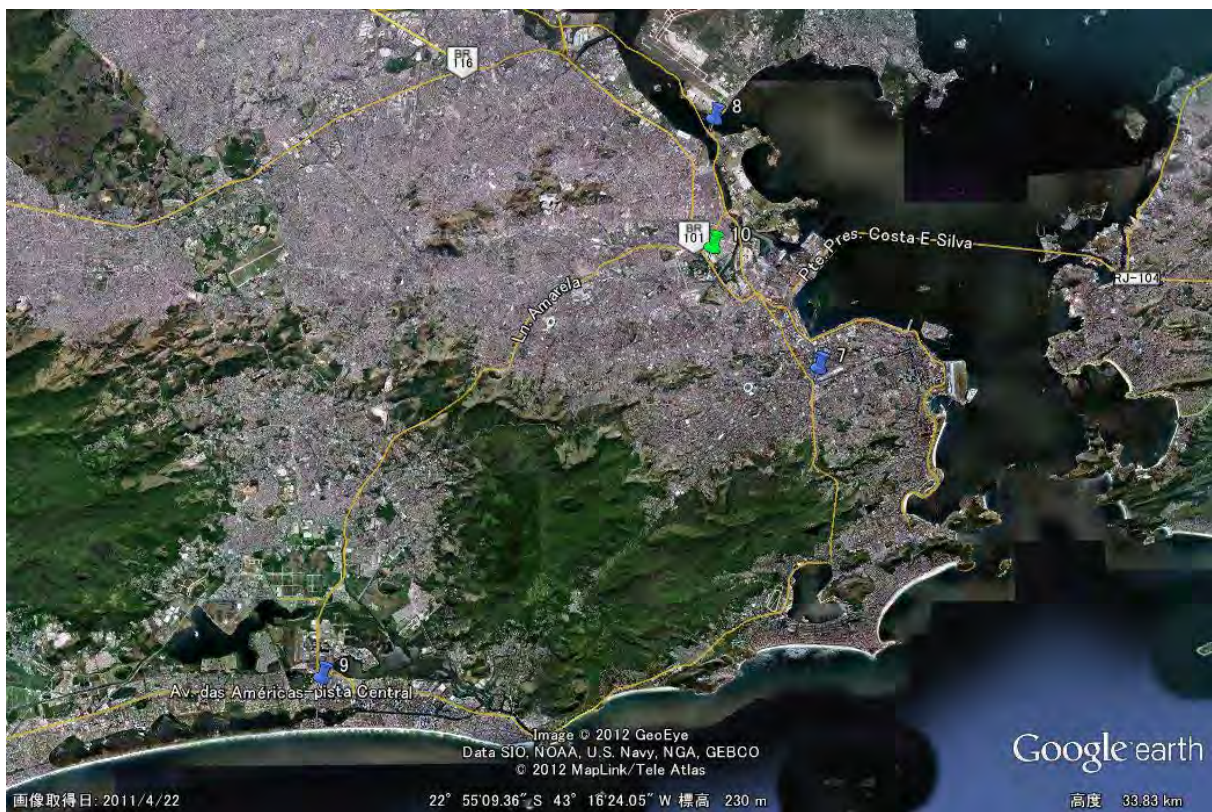
Note: 15 hours from 06:00 to 21:00

Source: JICA Study Team

[Weekday: 7 August 2012]



[Weekend: 5 August 2012]



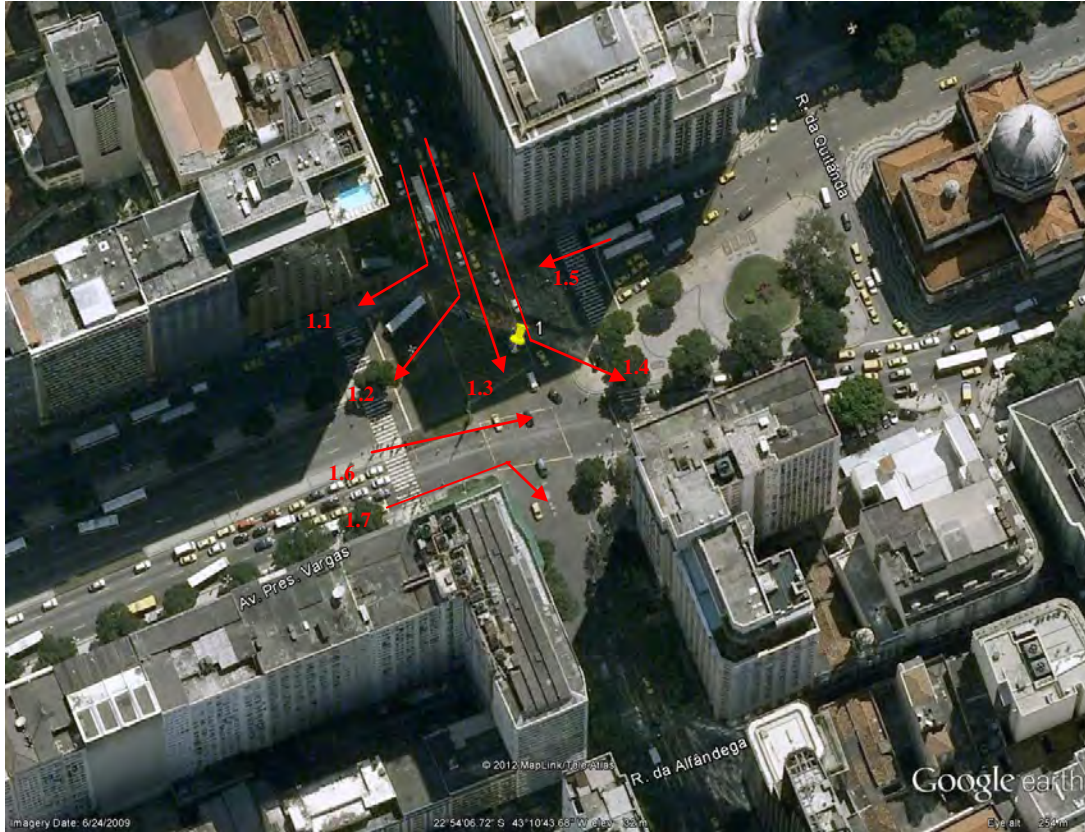
Source: JICA Study Team

Figure 3-7 Location Map of Survey Stations

iii) Survey Point

The counting layouts are shown in the following Figures 3-8 to 3-14.

1. Av. Presidente Vargas – Av. Rio Branco (7 August 2012)



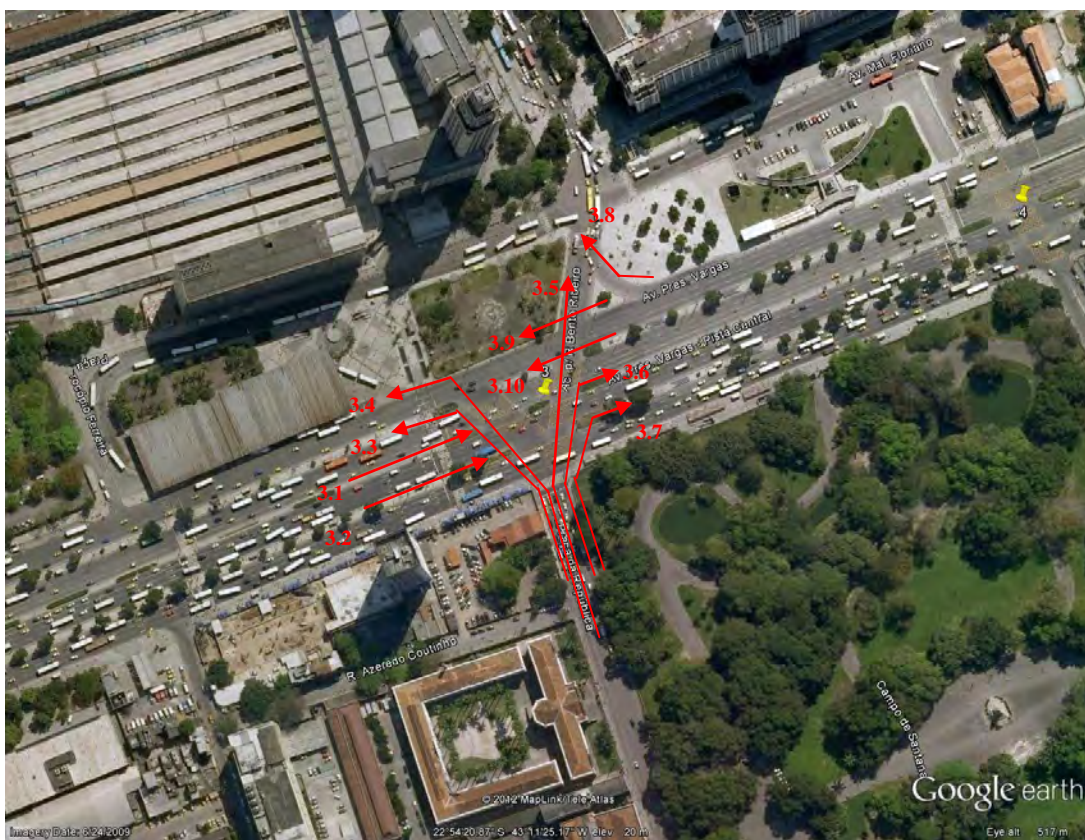
Source: JICA Study Team

Figure 3-8 Counting Layout at Location 1

2. Av. Presidente Vargas – R. Primeiro de Marco (7 August 2012)



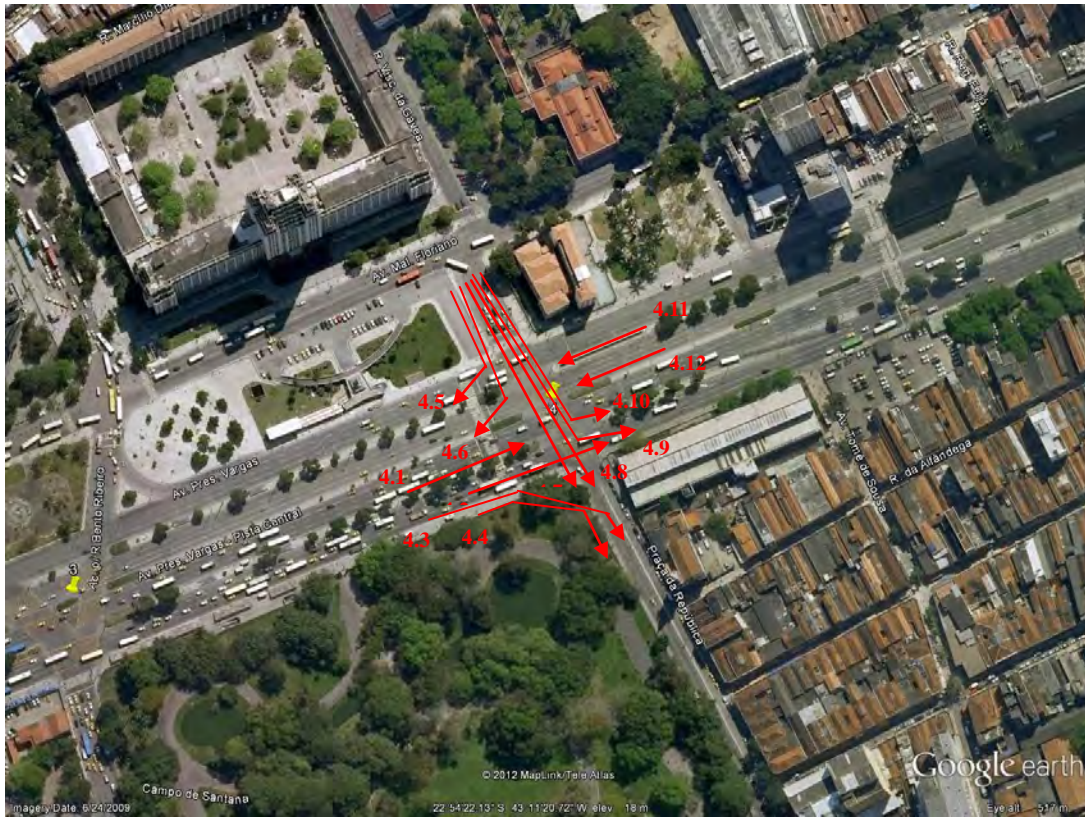
3. Av. Presidente Vargas – R. Bento Ribeiro (7 August 2012)



Source: JICA Study Team

Figure 3-9 Counting Layout at Locations 2 and 3

4. Av. Presidente Vargas – Praça da República (7 August 2012)



5. Av. Nossa Senhora de Copacabana – Av. Princesa Isabel (7 August 2012)



Source: JICA Study Team

Figure 3-10 Counting Layout at Locations 4 and 5



6. Av. Barata Ribeiro – Av. Princesa Isabel (7 August 2012)



7. Av. Presidente Vargas – Av. Francisco Bicalho (North, South, East, West) (5 and 7 August 2012)



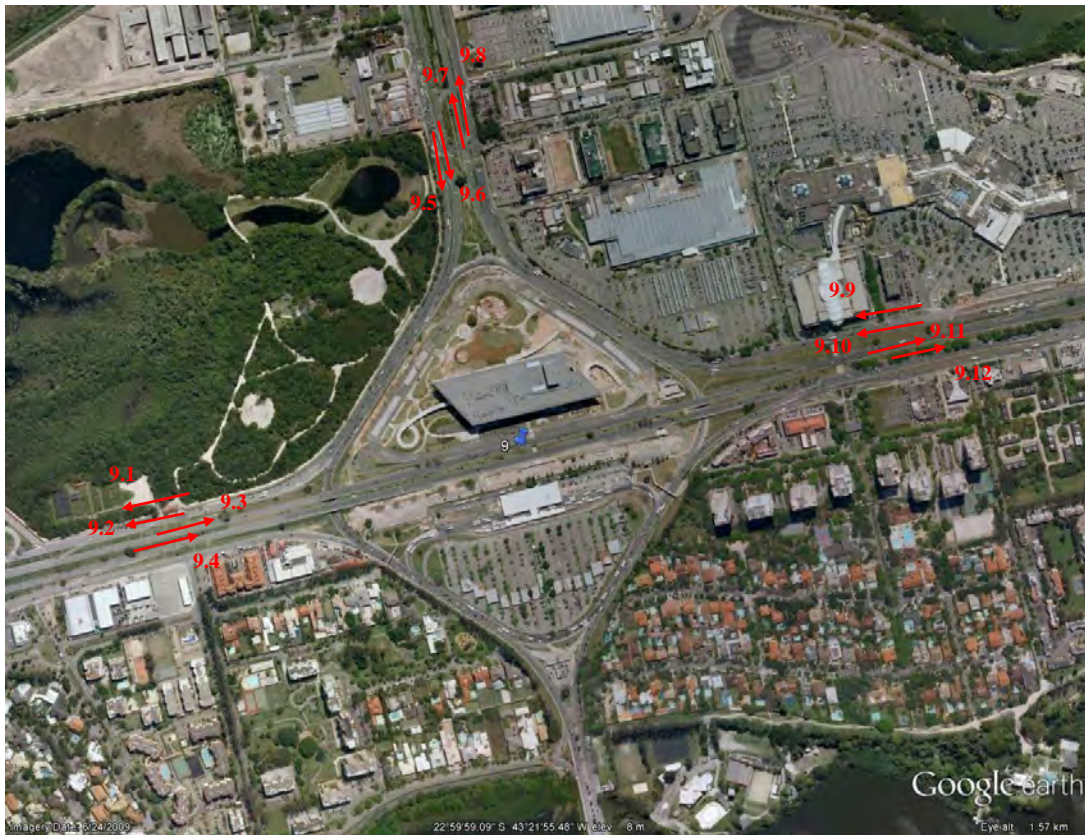
Source: JICA Study Team

Figure 3-11 Counting Layout at Locations 6 and 7

8. Est. do Galeao – Linha Vermelha (North, South, East) (5 and 7 August 2012)



9. Av. das Americas - Av. Ayrton Senna (North, East, West) (5 and 7 August 2012)



Source: JICA Study Team

Figure 3-12 Counting Layout at Locations 8 and 9

10. Av. Brasil (passarela 06) (5 and 7 August 2012)



11. R. Goiás and Av. Amaro Cavalcanti (7 August 2012)



Source: JICA Study Team

Figure 3-13 Counting Layout at Locations 10 and 11

12. Estr. dos Bandeirantes (7 August 2012)



Source: JICA Study Team

Figure 3-14 Counting Layout at Location 12

2) Travel Time Survey

i) **Outline**

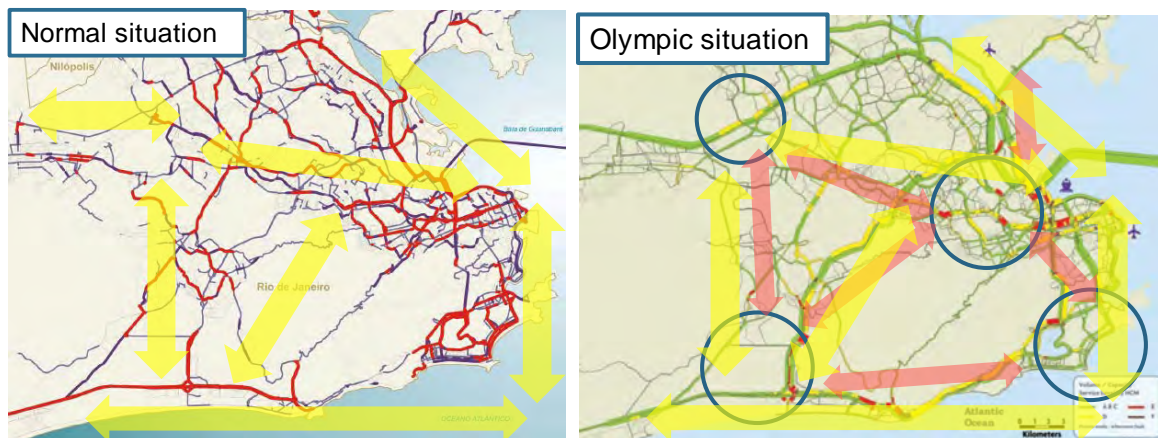
Travel time data was obtained by driving through the survey routes using a GPS device. The methodology of the survey is described as follows:

- > Weekday on 7 August 2012 (Tuesday) and weekend on 5 August 2012 (Sunday);
- > 30 vehicles (15 pairs = 15 routes \* 2 directions); and
- > 6 times a day (3 round trips); Starting time of each trip is as follows:
  - 1st round trip: Peak in the morning, i.e., 7 a.m. and 8 a.m.
  - 2nd round trip: Off-peak, i.e., 11 a.m. and 2 p.m.
  - 3rd round trip: Peak in the evening, i.e., 5 p.m. and 6 p.m.

ii) **Survey Routes**

The survey routes were determined considering the information available in the PDTU/RMRJ 2005 and Rio 2016 Transportation Strategy as shown in Figure 3-15 below. From the PDTU/RMRJ 2005 Study, the routes with high volume of assigned traffic based on the traffic modeling result were chosen as the survey routes. In addition, the main routes for the Olympic Games were also chosen from the Rio 2016 Study.

The survey routes and their lengths are shown in Table 3-6. Appendix 7 contains the detailed travel time data, timetable and route on this survey.



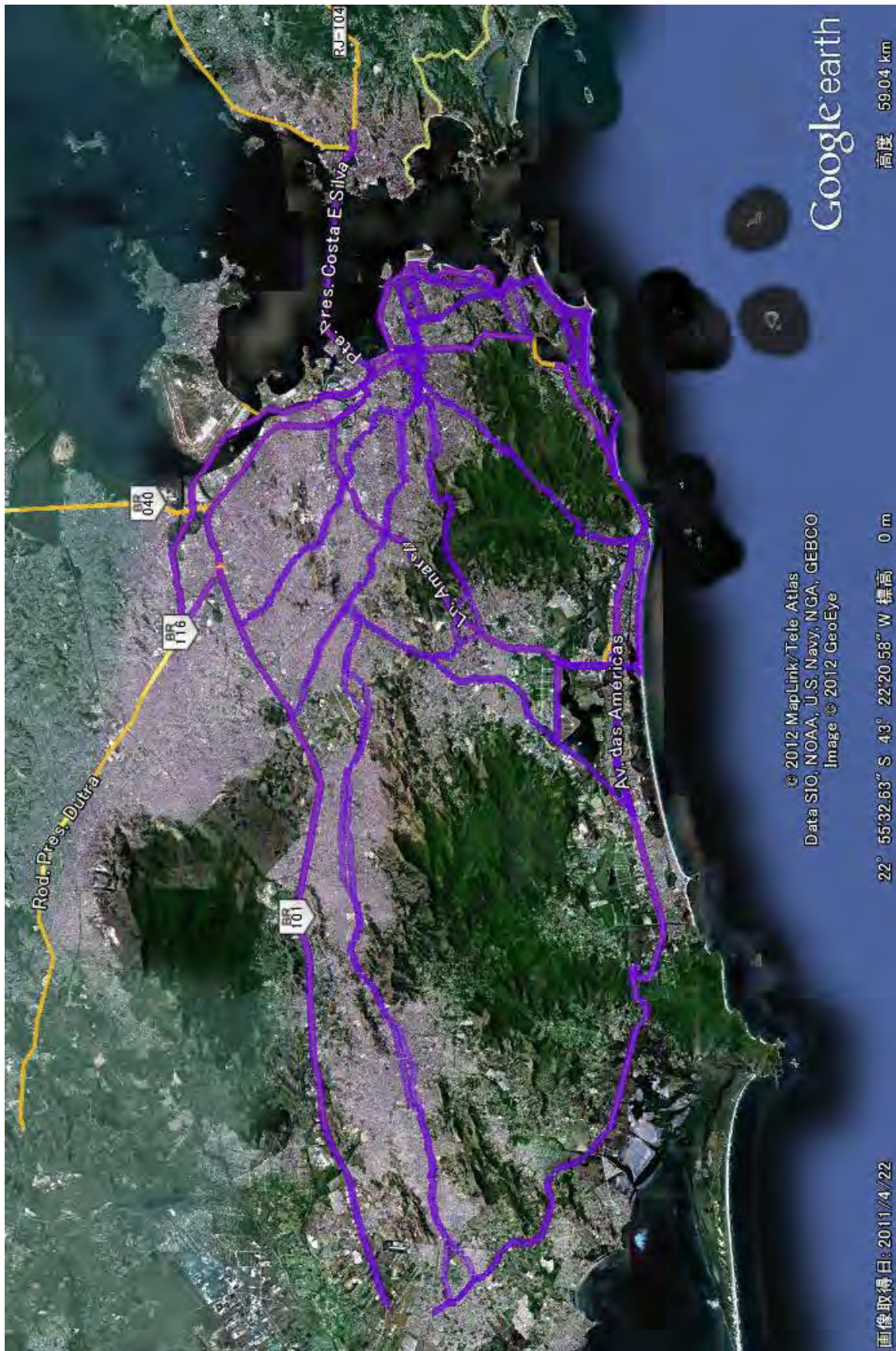
Source: JICA Study Team

**Figure 3-15 Location Comparison between Survey Routes and PDTU/Rio 2016**

**Table 3-6 Survey Routes List**

Route	Direction	Start	Goal	Main Road	Distance (km)
1	1-1	Cidade da Musica	Palácio das Exposições	Linha Amarela, Rio-Niteroi	30
	1-2	Palácio das Exposições	Cidade da Musica		31
2	2-1	Cidade da Musica	Av. das Americas / Estr. Da Matriz	Av. das Americas	27
	2-2	Av. das Americas / Estr. Da Matriz	Cidade da Musica		28
3	3-1	Av. da Brasil / Rod. Rio-santos	Av. da Brasil / Rod. Pres. Dutra	Av. Brasil	40
	3-2	Av. da Brasil / Rod. Pres. Dutra	Av. da Brasil / Rod. Rio-santos		39
4	4-1	Av. Cesario de Melo / Av. Maria Teresa	Estr. Int. Magalhães / R. Dominges Lopes	Av. de Santa Cruz	25
	4-2	Estr. Int. Magalhães / R. Dominges Lopes	Av. Cesario de Melo / Av. Maria Teresa		25
5	5-1	R. Dominges Lopes / R. Joao Vicente	Av. Salvador Allende / Av. das Americas	Av. Salvador Allende, Av. Nelson Cardoso	19
	5-2	Av. Salvador Allende / Av. das Americas	R. Dominges Lopes / R. Joao Vicente		20
6	6-1	Barra Square Shoppin Center	Av. Atlantica / Av. Prca. Isabel	Av. das Americas, Estr. Lagoa Barra	21
	6-2	Av. Atlantica / Av. Prca. Isabel	Barra Square Shoppin Center		22
7	7-1	Av. Lucio Costa / Av. Ayrton Senna	R. Francisco Otaviano / Av. Atlantica	Av. Ayrton Senna, Av. Sernambetiba	21
	7-2	R. Joaquim Nabuco / Av. Atlantica	Av. Lucio Costa / Av. Ayrton Senna		22
8	8-1	Around Maracana Stadium	Pte. Nova / Av. Amando Lombardi	Estr. Velha Tijuca	17
	8-2	Pte. Velha / Av. Amando Lombardi	Around Maracana Stadium		17
9	9-1	Av. Geremário Dantas / Ln. Amarela	Around Maracana Stadium	Av. Menezes Cortes	15
	9-2	Around Maracana Stadium	Av. Geremário Dantas / Ln. Amarela		15
10	10-1	Av. Brasil / Rod. Pres. Dutra	Av. Brasil / Rod. Pres. Dutra	Av. Brasil, Linha Vermelha	35
	10-2	Av. Brasil / Rod. Pres. Dutra	Av. Brasil / Rod. Pres. Dutra		31
11	11-1	Av. Ataulfo de Paiva / R. Visc. de Albuquerque	Vevd. da Perimetral / Av. Brasil	Av. Ns. de Copacabana, Av. Gen. Justo	21
	11-2	Vevd. da Perimetral / Av. Brasil	Av. Gen. San Martin / R. Visc. de Albuquerque		20
12	12-1	Around Praça Marcos Tamoio, 02.06.008 E.M. Pedro Ernesto	Around Praça Marcos Tamoio, 02.06.008 E.M. Pedro Ernesto	Vevd. Eng. Freyssinet, Vevd. Eng. Noronha	15
	12-2	Around Praça Marcos Tamoio, 02.06.008 E.M. Pedro Ernesto	Around Praça Marcos Tamoio, 02.06.008 E.M. Pedro Ernesto		18
13	13-1	Around Largo Alm Indio do Brasil	Av. Alm. Barroso / Av. Pres. Antonio Carlos	Av. Pres. Vargas, R. Primeiro Marco, Av. Republica do Chille, R. do Catete	14
	13-2	Av. Alm. Barroso / Av. Pres. Antonio Carlos	Around Largo Alm Indio do Brasil		13
14	14-1	Around Maracana Stadium	Deodoro Station	R. Joao Vicente, Av. Amaro Cavalcanti	19
	14-2	Deodoro Station	Around Maracana Stadium		21
15	15-1	Around Maracana Stadium	Praca Dez de Novembro	Av. Pst. Martin Luther King Junior	17
	15-2	Praca Dez de Novembro	Around Maracana Stadium		18

Source: JICA Study Team



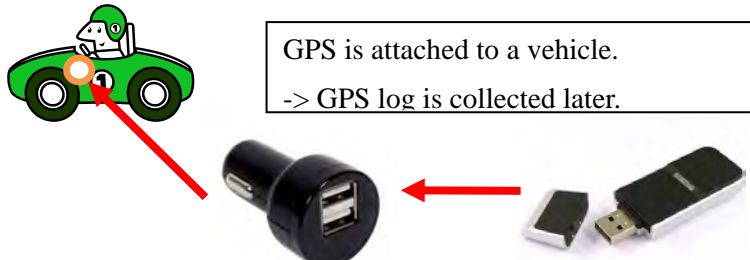
Source: JICA Study Team

Figure 3-16 Location Map of Survey Routes

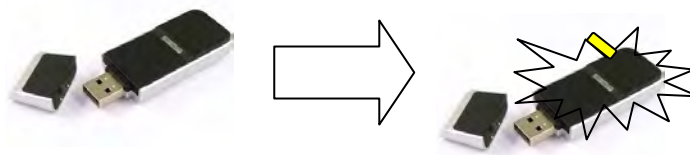
**iii) Survey Method**

The instructions for the travel time survey are shown in Figure 3-17 below.

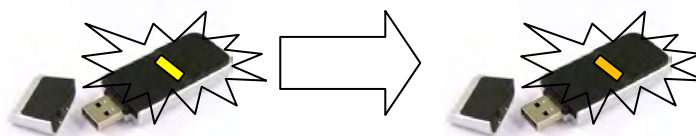
(1) Attach the GPS dongle (cigarette lighter port).



(2) Turn on the engine (electricity is automatically supplied to the GPS).



(3) Wait for about 30 seconds (GPS may catch the signal).



Blinking when signal is captured

(4) Start driving according to the timetable (GPS log is stored in the dongle).



(5) After finishing each driving, turn off the GPS (otherwise, the log will keep storing).



Note:

Wait until starting time of the next trip anywhere, if there is enough time until then.

Start next trip immediately if the current trip does not finish before the starting time of the next trip.

Source: JICA Study Team

**Figure 3-17 Instructions for Travel Time Survey**



3) Existing Traffic Count Data Analysis

**i) Summary**

The existing traffic count data were provided by CET-Rio and SMTR and analyzed by the JICA Study Team. The traffic volume data from CET-Rio was counted hourly by pneumatic (tube) detectors. Meanwhile, the traffic volume data from SMTR was surveyed manually every 15 minutes. The methodology of the analysis is described as follows:

[CET-Rio]

- > 297 data collection points
- > from May 2011
- > Vehicle types were not classified
- > Day, night, whole day and peak characteristics, and weekday and weekend characteristics

[SMTR]

- > 33 survey points
- > Survey was conducted in September 2011
- > Vehicle types were classified
- > Peak hour characteristics and vehicle type characteristics
- > Number of passengers in buses and vans were also observed

**ii) Survey Locations**

The data collection and survey points are shown in the following Tables 3-7 and 3-8, and Figures 3-18 and 3-19.

[CET-Rio]

**Table 3-7 Data Collection Points List Provided by CET-Rio**

No.	Point	Towards
1	Av. Oswaldo Cruz, próximo a Praça Nicaragua	Botafogo
2	Praia Botafogo, próximo a Praça Marinha Brasil	Centro
3	Av. Rui Barbosa, próximo ao Instituto Fernandes Figueira	
4	Av. Vieira Souto, próximo ao nº 460	Copacabana
5	Av. Vieira Souto, próximo ao nº 158	Leblon
6	Av. Vieira Souto, próximo ao nº 164	Copacabana
7	Rua Voluntarios da Patria, próximo ao nº 324	
8	Rua Real Grandeza, próximo ao nº 139	
9	Av. Maracana, próximo ao nº 970	Tijuca
10	Av. Maracana, próximo ao nº 970	Centro
11	Av. Atlantica, próximo ao nº 3056	Ipanema
12	Av. Atlantica, próximo ao nº 3056	Leme
13	Av. Atlantica, próximo ao nº 2266	Ipanema
14	Av. Atlantica, próximo ao nº 2302	Leme
15	Praia Botafogo, próximo ao nº 210 e Rua Farani	
16	Rua Barata Ribeiro, próximo ao nº 370 e Siqueira Campos	
17	Rua Siqueira Campos, próximo ao nº 85 e Barata Ribeiro	
18	Rua Farani, próximo ao canteiro central da Praia Botafogo	
19	Rua Pereira Nunes, próximo ao nº 17 e a Av. Maracana	
20	Rua Goias, próximo ao nº 124	
21	Rua Cirne Maia, próximo ao nº 31	
22	Av. Delfin Moreira, próximo ao nº 820	Niemeyer
23	Av. Delfin Moreira, próximo ao nº 900	Ipanema
24	Av. N. S. de Copacabana, próximo ao nº 956	
25	Rua Bolivar, próximo ao nº 45	
26	Rua Mario Ribeiro, próximo a Av. Rodrigo Otavio	
27	Av. Pe Leonel França, próximo a Rua Visc de Albuquerque	
28	Av. Rodrigo Otavio, próximo a Praça Sibelius	
29	Av. Rodrigo Otavio, próximo a Rua Artur Artu Araripe	
30	Rua Visconde de Albuquerque, próximo ao nº 1228	
31	Rua Dias da Cruz, próximo ao nº 827	
32	Av. Gal San Martin, próximo a Av. Borges de Medeiros	
33	Av. Borges de Medeiros, próximo ao nº 179	
34	Av. Gal San Martin, próximo ao nº 1159	
35	Av. Lineu de Paula Machado, próximo ao nº 720	
36	Rua Pacheco Leao, próximo ao nº 38	Gavea
37	Rua J. Botanico, próximo ao nº 746 Leao	Gavea
38	Rua J. Botanico, próximo a Rua Gal Garzon	J.Botanico
39	Rua Barao da Torre, próximo ao nº 408	
40	Rua Maria Quiteria, próximo ao nº 74	
41	Av. Nossa Sra de Copacabana, próximo ao nº 574A	
42	Rua Siqueira Campos, próximo ao nº 53	
43	Rua Visc de Silva, próximo ao nº 146	Humaita
44	Rua Joao Paulo I, próximo a Rua do Matoso e Dr Satamini	
45	Rua Dias da Cruz, próximo ao nº358	Eng Dentro
46	Rua Dias da Cruz, próximo ao nº384	Meier
47	Campo de Sao Cristovao, próximo a Rua Escobar	
48	Rua Escobar, próximo ao nº 84 e a Rua Santos Lima	
49	Av. Pedro II, próximo a Rua Figueira de Melo	Quinta
50	Av. Pedro II, próximo ao nº 219	Av. Franc. Bicalho
51	Rua Figueira de Melo x Av. Pedro II	
52	Av. Atlantica, próximo ao nº 2616	Ipanema
53	Av. Atlantica, próximo ao nº 2616	Leme
54	Rua Sao Francisco Xavier, próximo a Praca Maracana	
55	Av. Heitor Beltrao, próximo a Rua Marques de Valenca	
56	Rua Uruguai, próximo ao nº 380 e a Rua Conde de Bonfim	
57	Rua Conde de Bonfim, próximo ao nº 690	Usina
58	Rua Conde de Bonfim, próximo ao nº 719	Saens Pena
59	Estrada Furnas, próximo ao nº 1275	Itanhanga

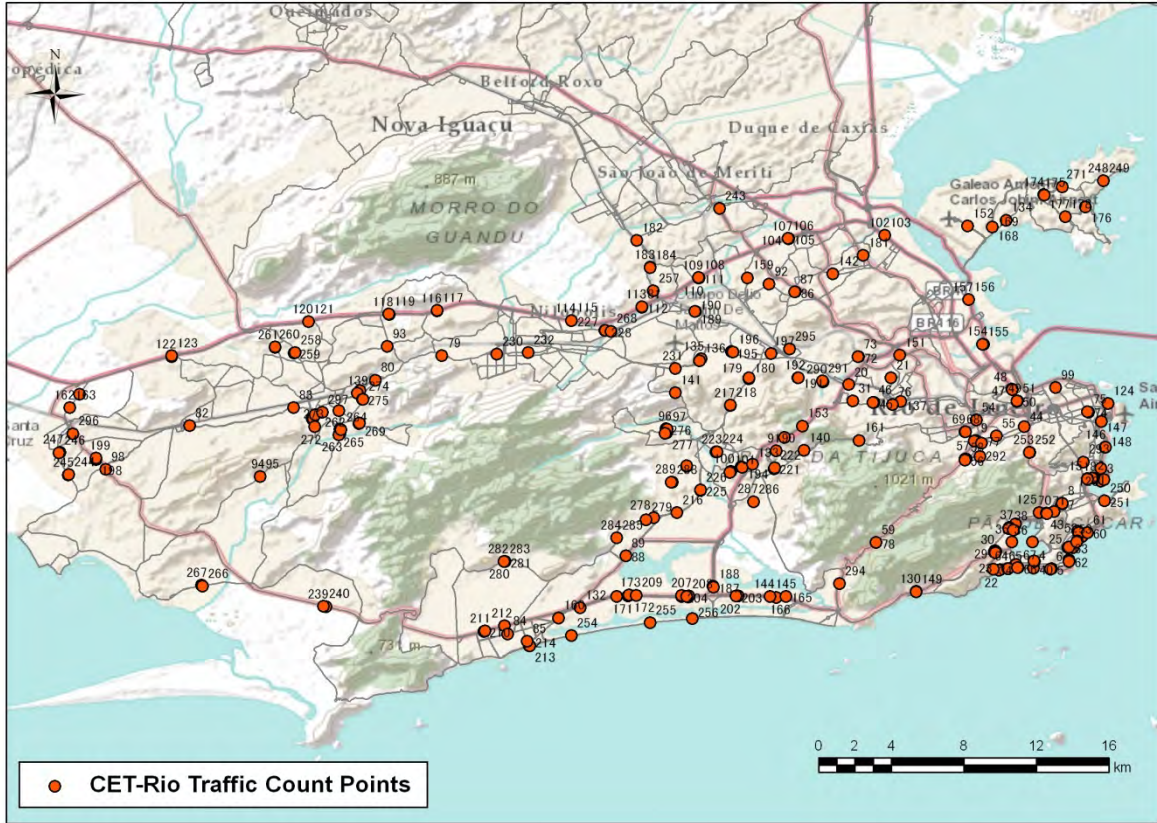
60	Av. Atlântica, próximo ao nº 1936	Leme
61	Av. Atlântica, próximo ao nº 1936	Ipanema
62	Av. Atlântica, próximo ao nº 3846	Ipanema
63	Av. Atlântica, próximo ao nº 3880	Leme
64	Av. Delfim Moreira, próximo ao nº 426	Niemeyer
65	Av. Delfim Moreira, próximo ao nº 426	Ipanema
66	Av. Vieira Souto, próximo ao nº 718	Leblon
67	Av. Vieira Souto, próximo ao nº 718	Arpoador
68	Rua Maxwell, próximo ao nº 145 e a Rua Gonzaga Bastos	
69	Rua Gonzaga Bastos, próximo ao nº 271 e a Rua Maxwell	
70	Rua Humaita, próximo ao nº 244	Jardim Botânico
71	Rua Humaita, próximo ao nº 229	Botafogo
72	Av. D. Helder Camara, próximo ao nº 6742	Cascadura
73	Av. D. Helder Camara, próximo ao nº 6742	Pilares
74	Av. Rep. do Paraguai	Pca Tiradentes
75	Av. Rep. do Paraguai	Lapa
76	Rua Hermengarda, próximo ao nº 478 e Rua Thompsom Flores	
77	Rua Conde de Bonfim, próximo ao nº 370	Usina
78	Estrada Furnas, próximo ao nº 1275	Alto Boa Vista
79	Av. Santa Cruz, próximo ao nº 8.264	Campo Grande
80	Av. Santa Cruz em frente nº 12.242	Campo Grande
81	Av. Brasil, Alca acesso Estrada Engenho Novo	Centro
82	Av. Cesario de Melo, próximo ao nº 13.604	Campo Grande
83	Av. Cesario de Melo, próximo ao nº 4.408	Bangu
84	Av. Genaro de Carvalho, próximo ao nº 2.332	Barra da Tijuca
85	Av. Gláucio Gil, próximo a Av. Hermes de Lima	Praia
86	Av. Monsenhor Felix, próximo a Rua Turiana	Irajá
87	Av. Monsenhor Felix, próximo a Rua Turiana	Madureira
88	Av. Salvador Allende, próximo a portao 3	Av. Ayrton Senna
89	Av. Salvador Allende, próximo a portao 3	Recreio
90	Estrada do Pau Ferro, próximo ao nº 893	Linha Amarela
91	Estrada do Pau Ferro, próximo ao nº 893	Est. do Guanumbi
92	Estrada Barro Vermelho, próximo nº 1468	Colégio
93	Estrada da Posse, próximo nº 1.168	Av. Brasil
94	Estrada do Magarca, próximo ao nº 1781	Av. das Américas
95	Estrada do Magarca, próximo ao nº 1781	Est. do Monteiro
96	Estrada dos Mananciais, próximo ao nº 1.132	Est. do Engenho Velho
97	Estrada dos Mananciais, próximo ao nº 1.132	Est. da Soca
98	Estrada da Pedra, próximo ao nº 178	Santa Cruz
99	Rua Rivadavia Correia, próximo ao nº 163	Av. Rodrigues Alves
100	Rua Retiro dos Artistas, próximo ao nº 1.420	Retiro dos Artistas
101	Rua Retiro dos Artistas, próximo ao nº 1.420	R. Edgard Werneck
102	Av. Brasil, km 12,8	Pista Central Sentido Santa Cruz
103	Av. Brasil, km 12,8	Pista Lateral Sentido Santa Cruz
104	Av. Brasil, km 18,8	Pista Central Sentido Centro
105	Av. Brasil, km 18,8	Pista Central Sentido Santa Cruz
106	Av. Brasil, km 18,8	Pista Lateral Sentido Santa Cruz
107	Av. Brasil, km 18,8	Pista Lateral Sentido Centro
108	Av. Brasil, km 24,3	Pista Lateral Sentido Santa Cruz
109	Av. Brasil, km 24,3	Pista Lateral Sentido Centro
110	Av. Brasil, km 24,3	Pista Central Sentido Centro
111	Av. Brasil, km 24,3	Pista Central Sentido Santa Cruz
112	Av. Brasil, km 28,0	Centro
113	Av. Brasil, km 28,0	Santa Cruz
114	Av. Brasil, km 30,4	Centro
115	Av. Brasil, km 30,4	Santa Cruz
116	Av. Brasil, km 35,3	Centro
117	Av. Brasil, km 35,3	Santa Cruz
118	Av. Brasil, km 40	Centro
119	Av. Brasil, km 40	Santa Cruz
120	Av. Brasil, km 45	Centro
121	Av. Brasil, km 45	Santa Cruz
122	Av. Brasil, km 54,4	Centro

123	Av. Brasil, km 54,4	Santa Cruz
124	Av. Pres. Kubitschek	Aterro
125	Túnel Rebouças	Lagoa
126	Infante Dom Henrique, km 2,7	Zona Sul
127	Av. Rui Barbosa, próximo ao n° 566	Centro
128	Praia do Flamengo	Botafogo
129	Av. Borges de Medeiros próximo ao n° 2.225	Centro
130	Auto Estrada Lagoa-Barra	Barra
131	Av. das Américas, próximo 7.380	Central - Recreio
132	Av. das Américas, próximo 12.141	Central - Centro
133	Linha Amarela, km 14 - Fx -1	Barra
134	Estrada do Galeão, proximo ao n° 4.100	Ilha
135	Av. Jambeiro, próximo ao n° 620	V.Valqueire
136	Av. Jambeiro, próximo ao n° 815	V.Valqueire
137	Rua Arquias Cordeiro, próximo ao n° 112	Engenho Novo
138	Rua Arthur Rios, próximo ao n° 692	
139	Rua Arthur Rios, próximo ao n° 929	BANGU
140	Estrada dos Tres Rios, próximo ao n° 2.702	Jacarepaguá
141	Estrada do Catonho, próximo ao n° 977	Jacarepaguá
142	Av. Bras de Pina, em frente ao n° 1345	Penha
143	Av. Epitáfio Pessoa	Leblon
144	Av. das Américas, próximo ao n° 2.901	Central - Centro
145	Av. das Américas, próximo ao n° 2901	Recreio
146	Infante Dom Henrique, km 1	Centro
147	Infante Dom Henrique, km 1	Zona Sul
148	Infante Dom Henrique, km 2,7	Centro
149	Auto Estrada Lagoa Barra	Centro
150	Av. Borges de Medeiros, próximo ao n° 2225	Leblon
151	Av. Dom Helder Camara, próximo ao n° 4.242	Abolição
152	Av. 20 de Janeiro	Aeroporto
153	Linha Amarela, km 5,6	Fundão
154	Linha Vermelha, km 3	Dutra
155	Linha Vermelha, km 3,5	Centro
156	Linha Vermelha, km 5,5	Centro
157	Linha Vermelha, km 5,5	Ilha
158	Linha Amarela, km 12,2	Barra
159	Av. dos Italianos, próximo ao n° 933	Acari
160	Av. Alfredo B. Silveira, próximo ao n° 1.270	Recreio
161	Av. Menezes Cortes, km 5,4	Jacarepaguá
162	Decaminada, 420	Av.Brasil-
163	Decaminada, 420	Guaratiba-
164	Américas, 2603	Lateral-Centro
165	Américas, 2603	Central-Centro
166	Américas, 2603	Lateral-Recreio
167	Américas, 2603	Central-Recreio
168	Estrada Canárias, 318	Ilha-
169	Estrada Canárias, 318	Centro-
170	Américas, 9650	Lateral-Centro
171	Américas, 9650	Central-Centro
172	Américas, 9650	Lateral-Recreio
173	Américas, 9650	Central-Recreio
174	Paulo e Silva, 400	Jd.Guanabara
175	Paulo e Silva, 400	Moneró
176	Estrada Cacuia, 1386	Cocotá
177	Estrada Galeão, 646	Jd.Carioca
178	Estrada Galeão, 671	Jd.Zumbi
179	Candido Benício, 1154	Campinho
180	Candido Benício, 1154	Praça Seca
181	Bento Cardoso, 835	Parada Lucas
182	Mal. Alencastro, 4277	Nilópolis
183	Mal. Alencastro, 2417	Ricardo Alb
184	Mal. Alencastro, 2417	Anchieta
185	Ayrton Senna, 1850	Lateral-Barra

186	Ayrton Senna, 1850	Central-Barra
187	Ayrton Senna, 1850	Central-JPA
188	Ayrton Senna, 1850	Lateral-JPA
189	João Vicente, 1775	Deodoro
190	João Vicente, 1775	Bento Ribeiro
191	Clarimundo de Melo, 906	Encantado
192	Clarimundo de Melo, 906	Cascadura
193	Geremário Dantas, 1052	Freguesia
194	Geremário Dantas, 1052	Tanque
195	Estrada Int. Magalhães, 635	Campinho
196	Estrada Int. Magalhães, 610	Sulacap
197	Padre Manso, 109	Madureira
198	Felipe Cardoso, 802	P. Guaratiba
199	Felipe Cardoso, 777	Av. Brasil
200	Américas, 3979	Central-Centro
201	Américas, 4200	Central-Recreio
202	Américas, 4093	Central-Centro
203	Américas, 4430	Central-Recreio
204	Américas, 6700	Central-Centro
205	Américas, 6700	Central-Recreio
206	Américas, 7607	Lateral-Barra
207	Américas, 6800	Lateral-Recreio
208	Américas, 7700	Central-Centro
209	Américas, 7700	Central-Recreio
210	Américas, 18365	Barra
211	Américas, 17250	Recreio
212	Américas, 16100	Recreio
213	Lucio Costa, 16400	Barra
214	Lucio Costa, 16400	Pontal
215	Estrada Bandeirantes	Curicica
216	Estrada Bandeirantes, 4259	Taquara
217	Candido Benício, 2973	Campinho
218	Candido Benício, 2973	Tanque
219	André Rocha, 2630	Curicica
220	André Rocha, 2630	Taquara
221	Estrada Tres Rios, 876	Grajaú
222	Estrada Geminiano Góis, 331	JPA
223	Estrada Tindiba, 1103	Pechincha
224	Estrada Tindiba, 1103	Taquara
225	Estrada Bandeirantes, 2512	Taquara
226	Estrada Bandeirantes, 2512	Curicica
227	Estrada Água Branca, 421	Deodoro
228	Estrada Água Branca, 372	Bangu
229	Av. Sta. Cruz	Campo Grande
230	Rua da Feira, 748	Bangu
231	Estrada Japoré, 957	Realengo
232	Francisco Real, 1279	Campo Grande
233	Estrada Monteiro, 206	Cantagalo
234	Estrada Monteiro, 225	Campo Grande
235	Baicuru, 44	Campo Grande
236	Estrada Cabuçu, 765	Rio da Prata
237	Estrada Cabuçu, 615	Campo Grande
238	Augusto Vasconc, 964	Campo Grande
239	Américas, 28705	Guaratiba
240	Américas, 28705	Grota Funda
241	Decaminada, 1800	Av. Brasil
242	Decaminada, 1800	Guaratiba
243	Av. Martin Luther King Jr. e.f. nº 13.738	Pavuna
244	Av. Areia Branca , em frente ao nº 1.628	Santa Cruz
245	Av. Areia Branca , em frente ao nº 1.628	Sepetiba
246	Av. Areia Branca, em frente ao nº 178	Estr. de Sepitiba
247	Av. Areia Branca, em frente ao nº 178	R. Álvaro Alberto
248	Av. Paranapuã, em frente ao nº 174	Tauá

249	Av. Paranapuã, em frente ao nº 174	Praça Calcuta
250	Av. Pasteur, em frente ao nº 350	Praia Vermelha
251	Av. Pasteur, em frente ao nº 350	Praia de Botafogo
252	Av. Paulo de Frontin, próximo ao nº 742	Túnel Rebouças
253	Av. Paulo de Frontin, próximo ao nº 763	Rio Comprido
254	Av. Sernambetiba, próximo ao semáforo nº 7627	Recreio
255	Av. Sernambetiba, próximo ao semáforo nº 7631	Recreio
256	Av. Sernambetiba, próximo ao semáforo nº 7635	Recreio
257	Estrada Marechal Alencastro, próximo Trav. Heckel de Assis	NILOPOLIS
258	Estrada Rio - São Paulo, próximo ao nº 1.278	Av. Brasil
259	Estrada Rio - São Paulo, próximo ao nº 1.278	Estr. Rio do A
260	Estrada Santa Maria, em frente ao nº 1380	Estr. do Tingui
261	Estrada Santa Maria, em frente ao nº 1380	Estr. do Campinho
262	Estrada da Cachamorra, em frente ao nº 371	Estr. do Cabuçu
263	Estrada da Cachamorra, em frente ao nº 371	Estr. do Mato Alto
264	Estrada da Cachamorra, em frente ao nº 716	Bangu
265	Estrada da Cachamorra, em frente ao nº 716	Barra da Tijuca
266	Estrada da Matriz, próximo ao nº 2.440	Campo Grande
267	Estrada da Matriz, próximo ao nº 2.440	Pedra de Guaratiba
268	Estrada da Água Branca, 77	Madureira
269	Estrada do Cabuçu, próximo ao nº 1.975	Estr. do Pré
270	Estrada do Cabuçu, próximo ao nº 1.975	Estr. do Viegas
271	Estrada do Dendê, em frente ao nº 1.056	Tubiacanga
272	Estrada do Monteiro, proximo ao nº 420	Barra da Tijuca
273	Estrada do Monteiro, proximo ao nº 420	Centro de Campo Grande
274	Estrada do Pré, em frente ao nº 1.079	Bangu
275	Estrada do Pré, em frente ao nº 1.079	Barra da Tijuca
276	Estrada do Rio Grande, próximo ao nº 4.306	Taquara
277	Estrada do Rio Grande, próximo ao nº 4.306	Pau da Fome
278	Estrada dos Bandeirantes, em frente ao nº 5.900	Vargem Grande
279	Estrada dos Bandeirantes, em frente ao nº 6.101	Curicica
280	Estrada dos Bandeirantes, próximo ao nº 14.789	Grota Funda
281	Estrada dos Bandeirantes, próximo ao nº 14.789	Taquara
282	Estrada dos Bandeirantes, próximo ao nº 16.293	Grota Funda
283	Estrada dos Bandeirantes, próximo ao nº 16.293	Taquara
284	Estrada dos Bandeirantes, próximo ao nº 8100	BARRA
285	Estrada dos Bandeirantes, próximo ao nº 8100	JACAREPAGUA
286	Estrada ten. Cel. Muniz de Aragão, em frente ao nº 898	Jacarépagua
287	Estrada ten. Cel. Muniz de Aragão, em frente ao nº 898	Taquara
288	Rua André Rocha, em frente ao nº 3.605	Curicica
289	Rua André Rocha, em frente ao nº 3.605	Taguara
290	Rua Assis Carneiro, em frente ao nº 375	Estação Piedade
291	Rua Assis Carneiro, em frente ao nº 375	Rua Clarimundo de Melo
292	Rua Bom Pastor, em frente ao nº 207	Prç Saens Peña
293	Rua Conde de Baependi, próximo ao nº 141	Largo do Machado
294	Rua Dom Rosalvo Costa Rego, em frente ao nº 146	Recreio
295	Rua Itamarati, próximo à Rua Cândida Bastos	Madureira
296	Rua Lucindo Passos, próximo ao nº 32	Felipe Cardoso
297	Rua Olinda Elis, em frente ao nº 111	Av. Cesário de Melo

Source: JICA Study Team



Source: JICA Study Team

Figure 3-18 Data Collection Points Map Provided by CET-Rio

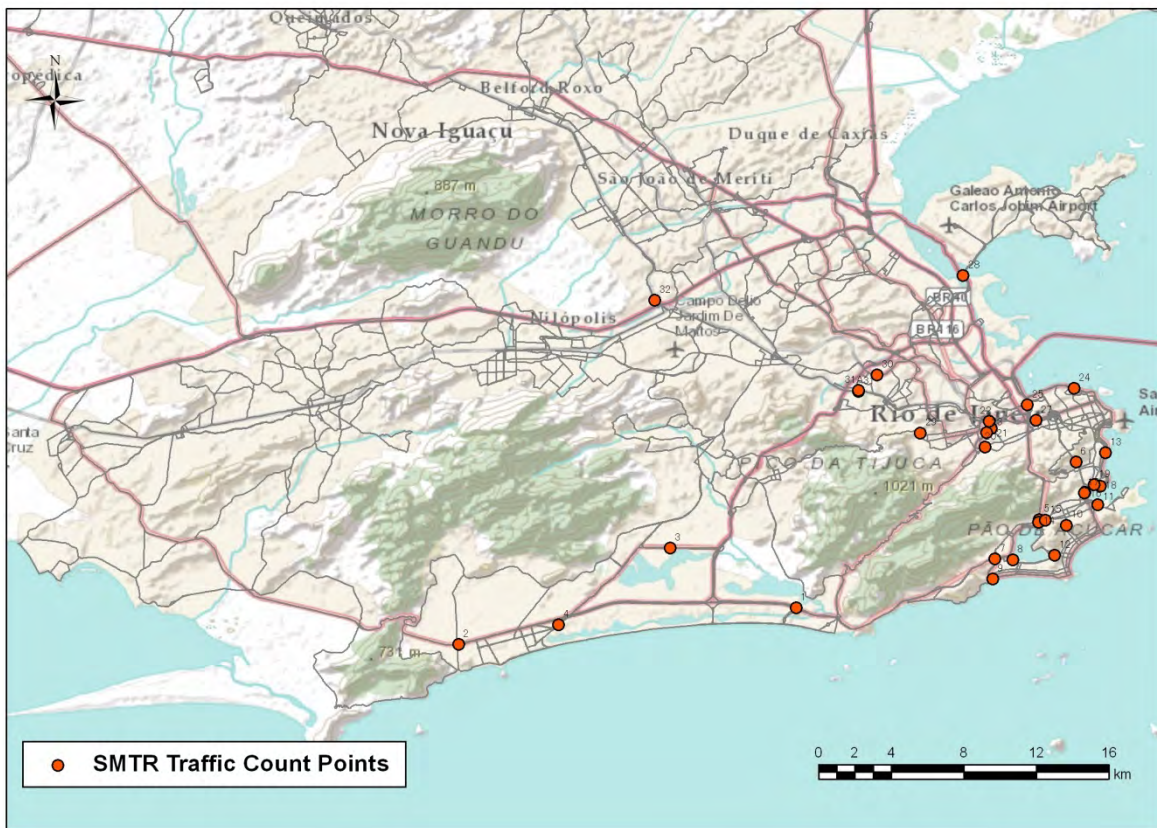
[SMTR]

**Table 3-8 List of Data Collection Points Provided by SMTR**

Post	Local	Volumetric Count	
		Date	Duration
1	Av. Das Americas Leste	21/09/2011	16:00- 19:59
2	Av. Das Americas Oeste	21/09/2011	16:00- 19:59
3	Av. Abelardo Bueno	21/09/2011	16:00- 19:59
4	Av. Alfredo Baltazar da Silveira	22/09/2011	06:00- 09:59
5	Tunel Reboucas	20/09/2011	16:00- 19:59
6	Tunel Santa Barbara	28/09/2011	06:00- 19:59
7	Praca Sibelius	20/09/2011	06:00- 09:59
8	Av. Borges de Medeiros	20/09/2011	06:00- 09:59
9	Av. Delfim Moreira	20/09/2011	06:00- 09:59
10	Tunel Alaor Prata (Tunel Velho)	21/09e22/09/2011	06:00- 09:59
11	Av. Venceslau Bras	21/09/2011	06:00- 09:59
12	Av. Henrique Dodswort (Corte Cantagalo)	21/09/2011	06:00- 09:59
13	Aterrodo Flamengo	26/09/2011	06:00- 09:59
14	Jardim Botanico	27/09/2011	06:00- 19:59
15	Rua Humaita	23/09/2011	06:00- 09:59
16	Av. Nacoes Unidas	26/09/2011	06:00- 19:59
17	Praia do Botafogo/Flamengo	26/09/2011	06:00- 19:59
18	Av. Rui Barbosa	27/09/2011	06:00- 19:59
19	Av. Oswaldo Cruz	27/09/2011	06:00- 19:59
20	Rua Conde de Bonfim	30/09/2011	06:00- 19:59
21	Av. Maracana	29/09/2011	06:00- 19:59
22	Radial Oeste, em frente ao Maracana	28/09/2011	06:00- 19:59
23	Av. Sao Francisco Xavier alt. Maracana	29/09/2011	06:00- 19:59
24	Perimetral/Av. Rodrigues Alves	03/10/2011	06:00- 19:59
25	Av. Francisco Bicalho altura Leopoldina	03/10/2011	06:00- 19:59
26	Linha Vermelha (São Cristóvão)		06:00- 19:59
27	Av. Pres Vargas	29/09/2011	06:00- 09:59
28	Av. Pres Joao Goular (acesso Ilha)	27/09/2011	06:00- 19:59
29	Av. Meneses Cortes	30/09/2011	06:00- 09:59
30	Av. Dom Helder	23/09/2011	06:00- 19:59
31	Av. Amaro Cavalcanti, em frente Engenho	03/10/2011	06:00- 19:59
31A	Av. Arquias Cordeiro	03/10/2011	06:00- 19:59
32	Av. Marechal Alencastro	30/09/2011	

Source: JICA Study Team





Source: JICA Study Team

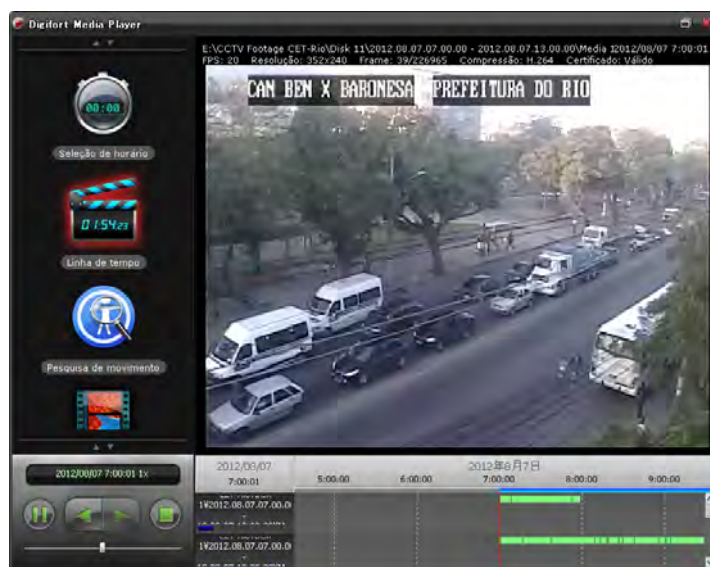
Figure 3-19 Data Collection Points Map Provided by SMTR

4) CCTV Image Processing

i) Outline

The CCTV video log was provided by CET-Rio as shown in Figure 3-20 below. Through image processing, traffic volume can be reduced at any time interval. In this survey, traffic volume was counted as follows:

- > Every 5 minutes
- > Weekday morning (7:00 – 9:00) and weekday evening (17:00 – 18:00)

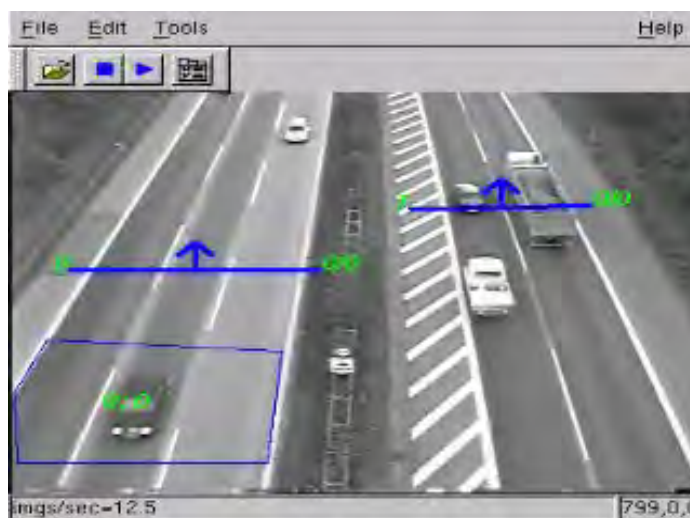


Source: JICA Study Team

Figure 3-20 CCTV Data Provided by CET-Rio

ii) Image Processing Method

Image processing was conducted through the Vitracom Siteview software developed by KOZO KEIKAKU ENGINEERING, Inc. The image data processing was implemented in cooperation with Chiba University from Japan, which provided the results to the JICA Study Team.










Source: JICA Study Team

Figure 3-21 Sample Image of Vitracom Siteview

iii) Survey Location

The locations and sample images of CCTV data are shown in Table 3-9 below.

Table 3-9 CCTV Locations for Image Processing

No.	Image	Remarks
291		Specific Period One direction
351		Two directions
378		Two files One way
401		One way
498		Two directions Two files
540		Vertical and horizontal
546		One direction

Source: JICA Study Team



Source: JICA Study Team

Figure 3-22 CCTV Location Map for Image Processing

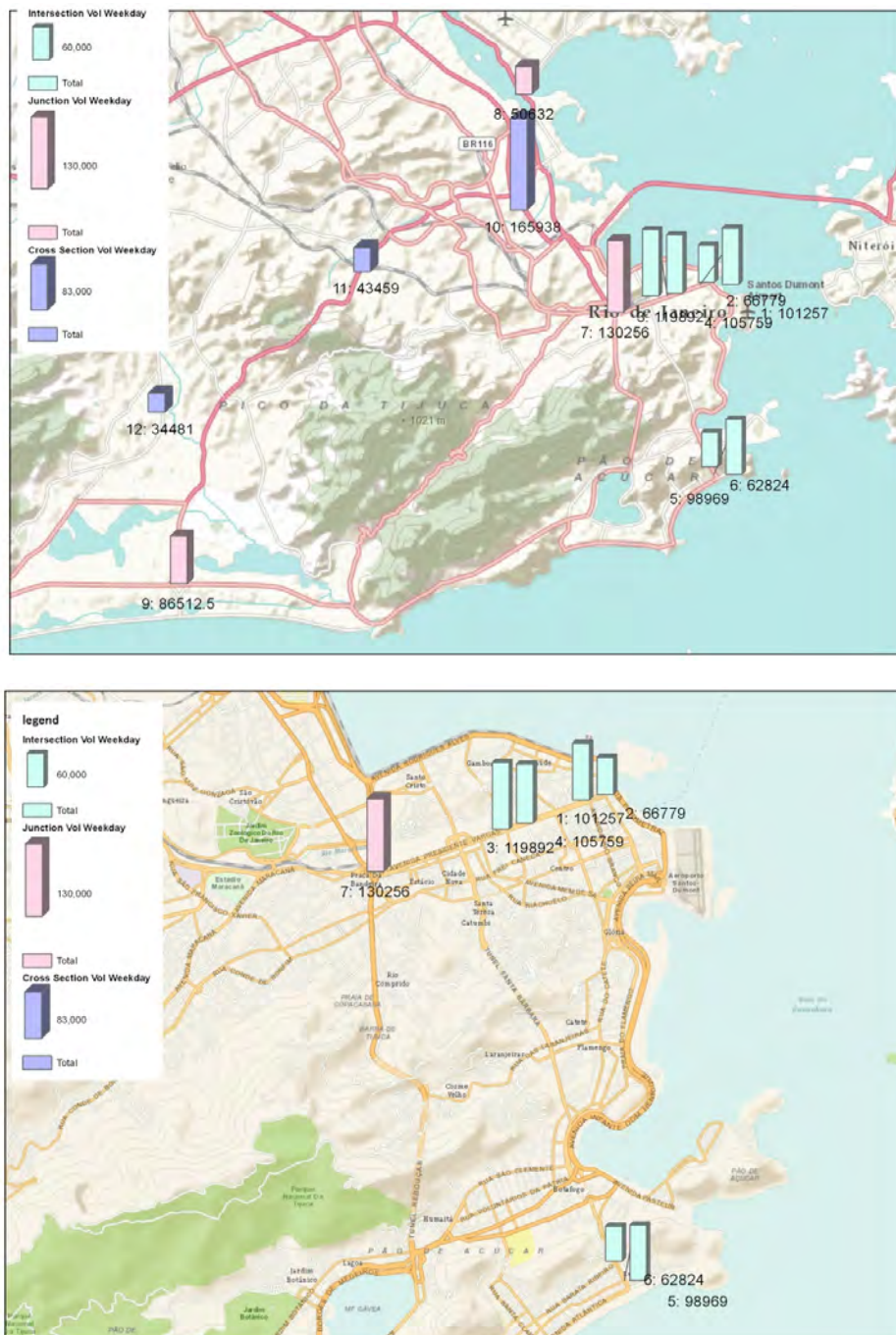
### 3.2.2 Survey Result

(1) Traffic Count Survey

1) Total Flow

[Weekday]

The total approaching traffic flow in each survey location is shown in Figure 3-23 below. The results show that it is necessary to control more than 100,000 vehicles per day during weekdays at the main intersections and junctions in the central area of Rio de Janeiro.



Source: JICA Study Team

Figure 3-23 Total Flow per day at Each Point (Weekday)

[Weekend]

During the weekend, the traffic volume is reduced to 60-70% of the weekday volume.



Source: JICA Study Team

**Figure 3-24 Total Flow per Day at Each Point (Weekend)**

Detail traffic movement on each survey locations are shown in Appendix 7.

2) Share of Vehicle Types

[Weekday]

In the downtown area such as Centro and Copacabana, the modal shares of car, taxi, and bus during weekdays are 50%, 20%, and 20%, respectively. In other locations, the share of car is higher. In Centro and Copacabana areas, electronic road pricing (ERP) for cars and better control of taxi and bus arrival/departure times should be considered.

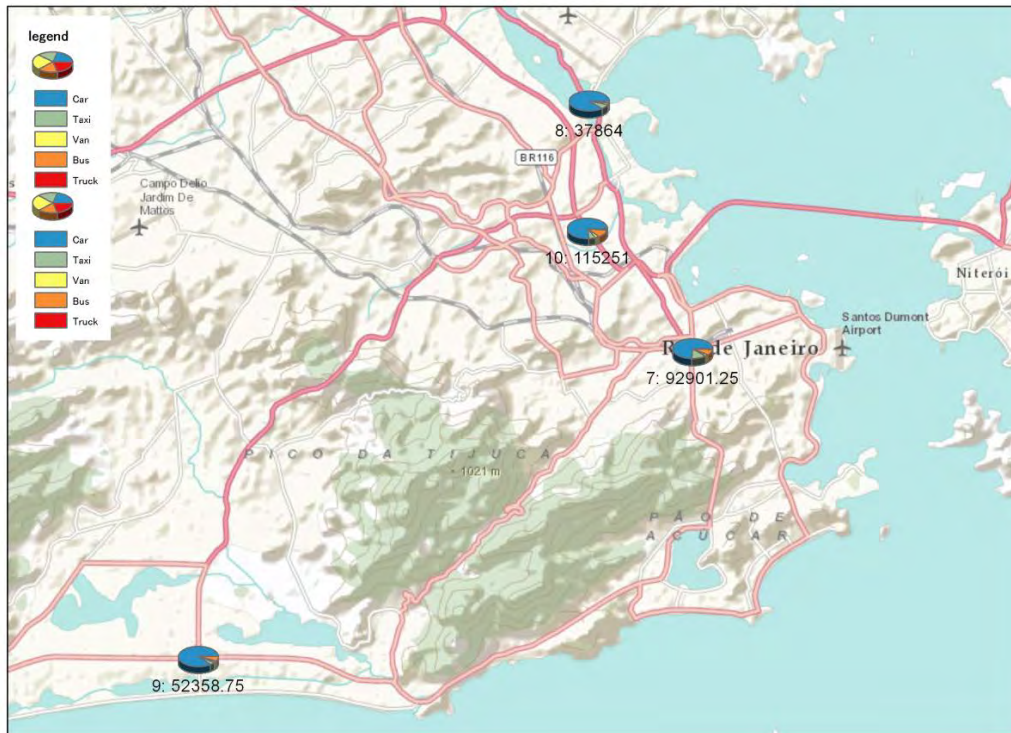


Source: JICA Study Team

Figure 3-25 Share of Vehicle Types per Day at Each Point (Weekday)

[Weekend]

During weekends, the share of vehicle types is almost the same as that during weekdays.



Source: JICA Study Team

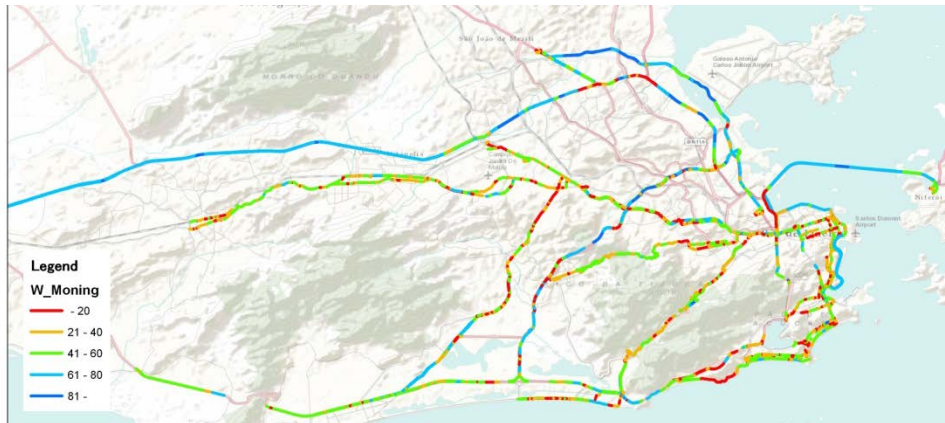
Figure 3-26 Share of Vehicle Types per Day at Each Point (Weekend)

- (2) Travel Time Survey
  - 1) Travel Speed in Each Link

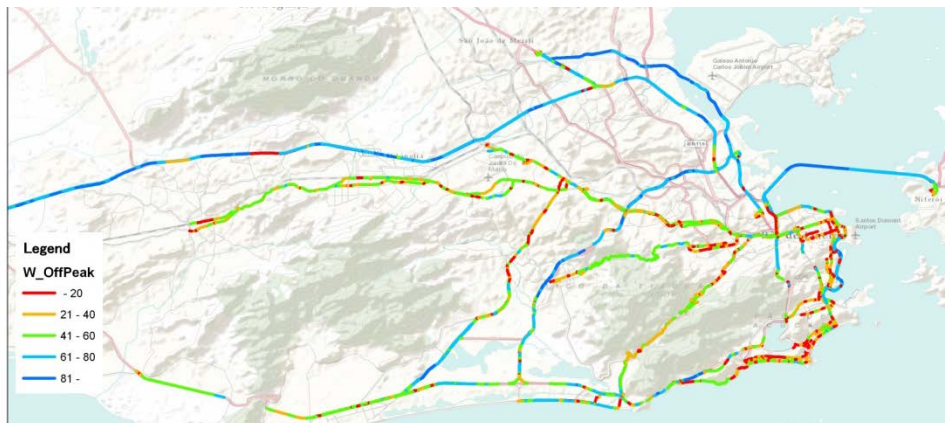
[Weekday, Whole Survey Area]

During the morning and evening peaks, low-speed links were observed as shown in Figure 3-27 below. The result of Travel speed in Rio central area and average travel speed by each area are shown in Appendix 7.

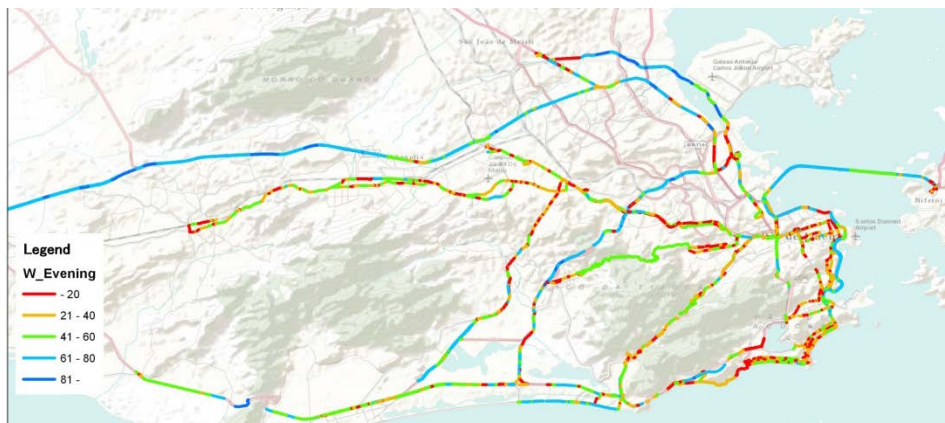
Morning Peak (7:00 – 9:00 a.m.)



Off-peak (11:00 a.m. and 2 p.m.)



Evening Peak (5:00 – 7:00 p.m.)



Source: JICA Study Team

Figure 3-27 Travel Speed in Each Link



[Weekend, Whole Survey Area]

Travel speeds during the weekend were much higher than during the weekday as shown in Figure 3-28 below. Continuously congested sections were not observed. Only congestion points (bottlenecks) could be visualized.

Morning Peak (7:00 – 9:00 a.m.)



Off-peak (11:00 a.m. and 2:00 p.m.)



Evening Peak (5:00 – 7:00 p.m.)



Source: JICA Study Team

Figure 3-28 Travel Speed in Each Link

2) Congestion Points

i) Congestion Road

After calculating the average speeds in each road of the study network, the 20 lowest-speed roads were selected as shown in Figure 3-29 below. These roads will be considered in formulating the intelligent transport system (ITS) master plan.

[Weekday, Morning]



ST_NAME	km/h	Rank
RUA PINHEIRO GUIMARAES	2.5	1
RUA SILVA FREIRE	4.2	2
RUA CONDE DE BAEPENDI	4.7	3
AVENIDA PRINCESA ISABEL	5.5	4
PRACA EUVALDO LODI	6.3	5
RUA SOUZA BARROS	6.4	6
RUA GAGO COUTINHO	8.3	7
VIADUTO ODUVALDO COZZI	8.6	8
RUA DA RELACAO	8.7	9
RUA POMPEU LOUREIRO	8.7	10
VIADUTO CAPITAO SERGIO DE CARVALHO	9.7	11
RUA DIVISORIA	10.2	12
RUA DO RUSSEL	10.3	13
RUA BOLIVAR	10.4	14
AVENIDA BEIRA MAR	11.8	15
RUA CAMPOS DE MELO	13.0	16
AVENIDA NIEMEYER	13.0	17
AVENIDA NELSON CARDOSO	13.1	18
RUA MINISTRO TAVARES DE LIRA	13.1	19
AVENIDA NOSSA SENHORA DE COPACABANA	13.7	20

[Weekday, Evening]



ST_NAME	km/h	Rank
RUA MESTRE VALENTIM	0.8	1
RUA GAGO COUTINHO	0.9	2
RUA SILVA FREIRE	1.5	3
TUNEL SANTA BARBARA	1.7	4
AVENIDA SEIS	2.0	5
VIADUTO SANTIAGO DANTAS	2.5	6
BR-116	4.6	7
RUA FERREIRA BORGES	5.3	8
AVENIDA GEREMARIO DANTAS	7.6	9
RUA SOUZA BARROS	7.8	10
AVENIDA RIO BRANCO	7.9	11
RUA PRIMEIRO DE MARCO	8.0	12
TUNEL DA JOATINGA	8.3	13
AVENIDA ALMIRANTE BARROSO	8.7	14
AVENIDA BORGES DE MEDEIROS	9.3	15
PRACA CRUZ VERMELHA	9.3	16
RUA MARIO RIBEIRO	9.3	17
AVENIDA NOSSA SENHORA DE COPACABANA	9.5	18
RUA MINISTRO TAVARES DE LIRA	10.3	19
ELEVADO DAS BANDEIRAS	10.8	20

Source: JICA Study Team

Figure 3-29 Twenty Selected Lowest-speed Roads

**ii) Congestion Point (Link)**

After calculating the average speed in each link of the study network, the 20 lowest-speed points (links) were selected. In this analysis, only arterial roads were considered. Figure 3-30 below shows the list of the 20 selected links.

These points are assumed to be the bottlenecks of the road network. These roads will also be considered in formulating the ITS master plan. However, a different solution will be applied for each bottleneck depending on the reason of congestion at each location.

[Weekday, Morning]



ST_NAME	Rank
AVENIDA MARECHAL FONTENELE	1
AVENIDA PRINCESA ISABEL	2
ESTRADA LAGOA BARRA	3
AVENIDA MARECHAL FONTENELE	4
LINHA AMARELA	5
AVENIDA MARECHAL FONTENELE	6
LINHA AMARELA	7
RUA CONDE DE BONFIM	8
ESTRADA LAGOA BARRA	9
AVENIDA MARECHAL FONTENELE	10
ESTRADA DOS BANDEIRANTES	11
AVENIDA MARECHAL FONTENELE	12
AVENIDA MARECHAL FONTENELE	13
AVENIDA MARECHAL FONTENELE	14
RUA JOAO VICENTE	15
AVENIDA MARECHAL FONTENELE	16
VIADUTO DO GASOMETRO	17
ESTRADA LAGOA BARRA	18
RUA CANDIDO BENICIO	19
VIADUTO CAPITAO SERGIO DE CARVALHO	20

[Weekday, Evening]

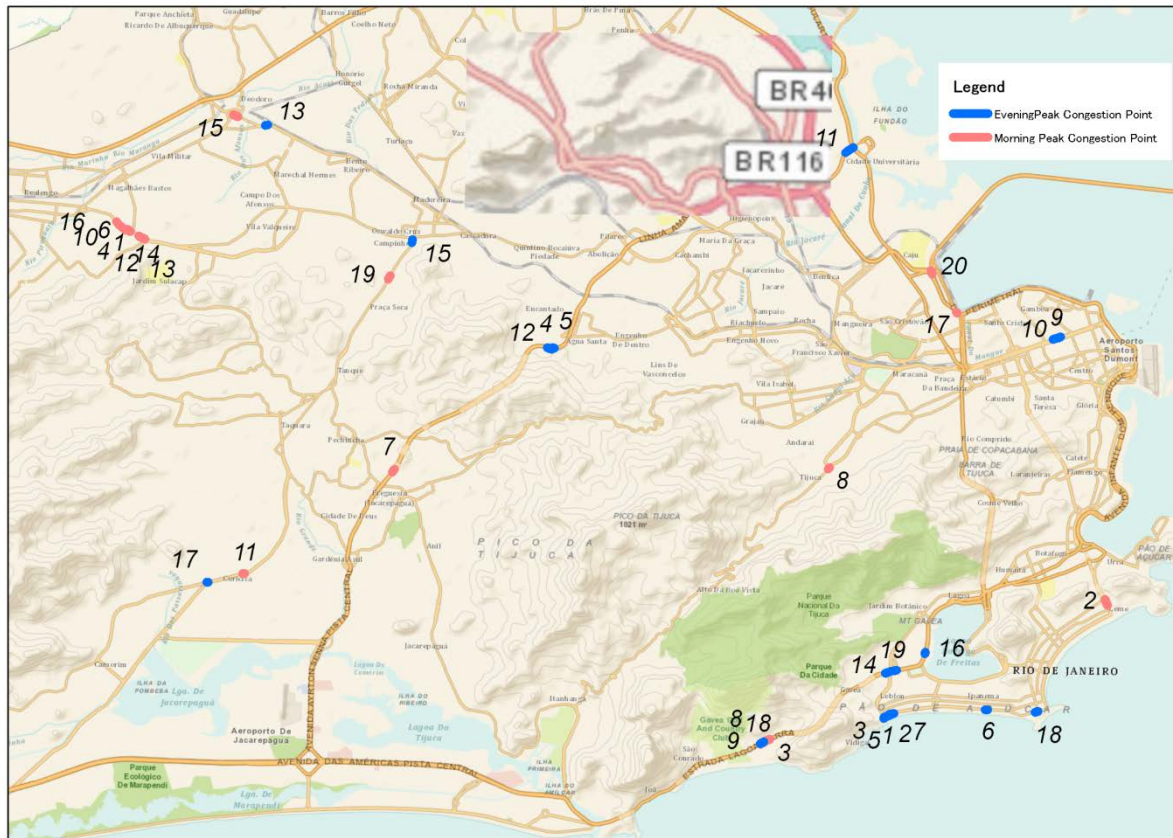


ST_NAME	Rank
AVENIDA DELFIM MOREIRA	1
AVENIDA DELFIM MOREIRA	2
AVENIDA DELFIM MOREIRA	3
LINHA AMARELA	4
AVENIDA DELFIM MOREIRA	5
AVENIDA VIEIRA SOUTO	6
AVENIDA DELFIM MOREIRA	7
ESTRADA LAGOA BARRA	8
AVENIDA PRESIDENTE VARGAS	9
AVENIDA PRESIDENTE VARGAS	10
AVENIDA BENTO RIBEIRO DANTAS	11
LINHA AMARELA	12
RUA JOAO VICENTE	13
AVENIDA PADRE LEONEL FRANCA	14
RUA CANDIDO BENICIO	15
AVENIDA BORGES DE MEDEIROS	16
ESTRADA DOS BANDEIRANTES	17
RUA FRANCISCO OTAVIANO	18
RUA MARIO RIBEIRO	19
AVENIDA CESARIO DE MELO	20

Source: JICA Study Team

**Figure 3-30 Twenty Selected Lowest-speed Links**

[Weekday, Morning and Evening]



[Morning]

[Evening]

ST_NAME	Rank
AVENIDA MARECHAL FONTENELE	1
AVENIDA PRINCESA ISABEL	2
ESTRADA LAGOA BARRA	3
AVENIDA MARECHAL FONTENELE	4
LINHA AMARELA	5
AVENIDA MARECHAL FONTENELE	6
LINHA AMARELA	7
RUA CONDE DE BONFIM	8
ESTRADA LAGOA BARRA	9
AVENIDA MARECHAL FONTENELE	10
ESTRADA DOS BANDEIRANTES	11
AVENIDA MARECHAL FONTENELE	12
AVENIDA MARECHAL FONTENELE	13
AVENIDA MARECHAL FONTENELE	14
RUA JOAO VICENTE	15
AVENIDA MARECHAL FONTENELE	16
VIADUTO DO GASOMETRO	17
ESTRADA LAGOA BARRA	18
RUA CANDIDO BENICIO	19
VIADUTO CAPITAO SERGIO DE CARVALHO	20

ST_NAME	Rank
AVENIDA DELFIM MOREIRA	1
AVENIDA DELFIM MOREIRA	2
AVENIDA DELFIM MOREIRA	3
LINHA AMARELA	4
AVENIDA DELFIM MOREIRA	5
AVENIDA VIEIRA SOUTO	6
AVENIDA DELFIM MOREIRA	7
ESTRADA LAGOA BARRA	8
AVENIDA PRESIDENTE VARGAS	9
AVENIDA PRESIDENTE VARGAS	10
AVENIDA BENTO RIBEIRO DANTAS	11
LINHA AMARELA	12
RUA JOAO VICENTE	13
AVENIDA PADRE LEONEL FRANCA	14
RUA CANDIDO BENICIO	15
AVENIDA BORGES DE MEDEIROS	16
ESTRADA DOS BANDEIRANTES	17
RUA FRANCISCO OTAVIANO	18
RUA MARIO RIBEIRO	19
AVENIDA CESARIO DE MELO	20

Source: JICA Study Team

Figure 3-31 Twenty Selected Lowest-speed Links in the Morning and Evening

3) Relation between Speed and Traffic Volume

After comparing the traffic volume data provided by CET-Rio with the travel speed data obtained through the travel speed survey, the basic characteristics of the volume-delay relationship were plotted. In this analysis, only traffic count points with volumes higher than 100 vehicles/h and travel speeds less than 50 km/h were used. The speed of each point was assumed to be the same as that of the closest link.

Scatter diagrams were drawn from the selected data points as shown in Figure 3-32 below.

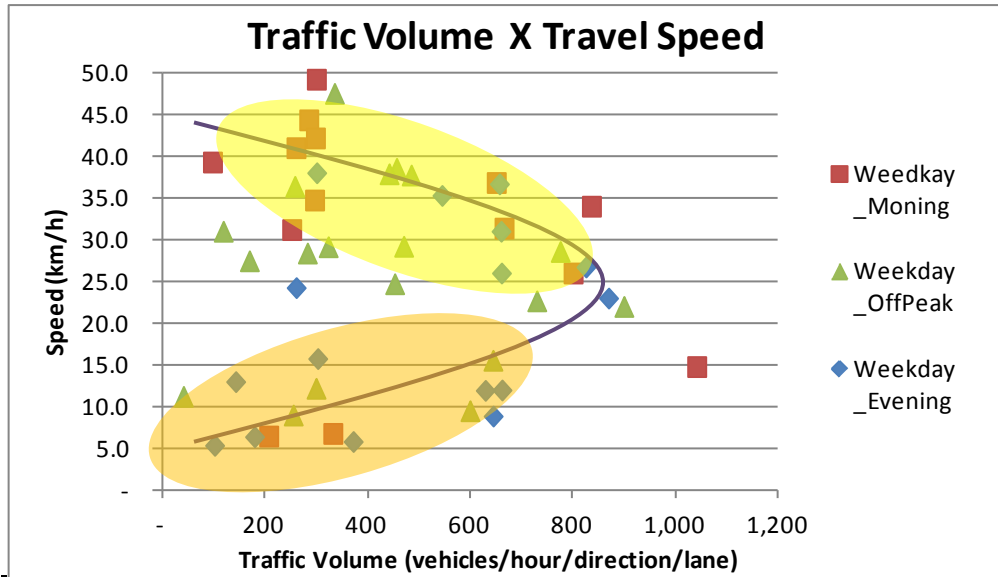


Source: JICA Study Team

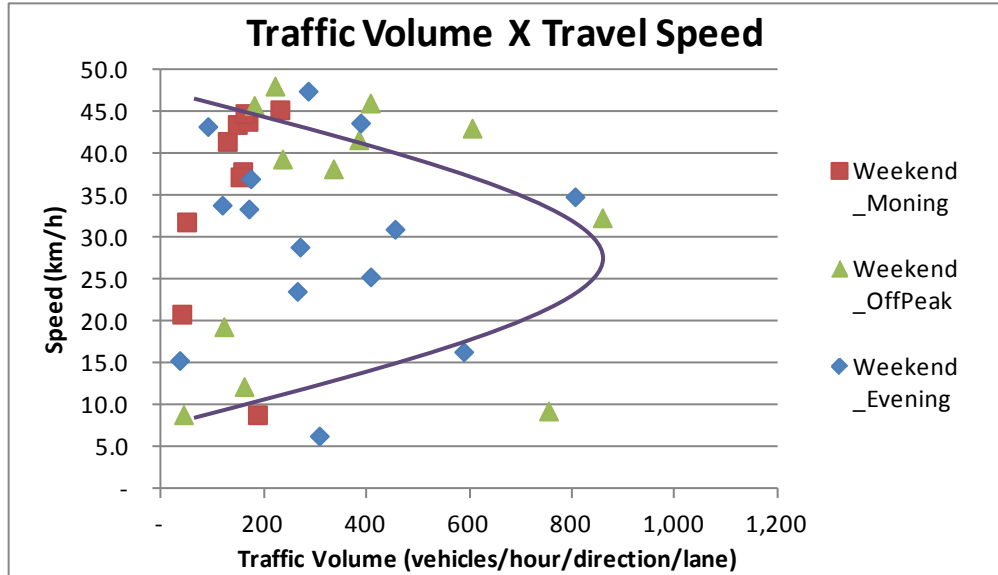
Figure 3-32 Traffic Count Points

Based on the weekday data, a tendency for travel speed to decrease when traffic volume becomes higher is observed. In addition, the characteristics of free flow domain and traffic jam domain could be obtained from the graph.

[Weekday]



[Weekend]



Source: JICA Study Team

Figure 3-33 Scatter Diagram between Traffic Volume and Speed

(3) Existing Traffic Count Data Analysis

1) CET-Rio Data

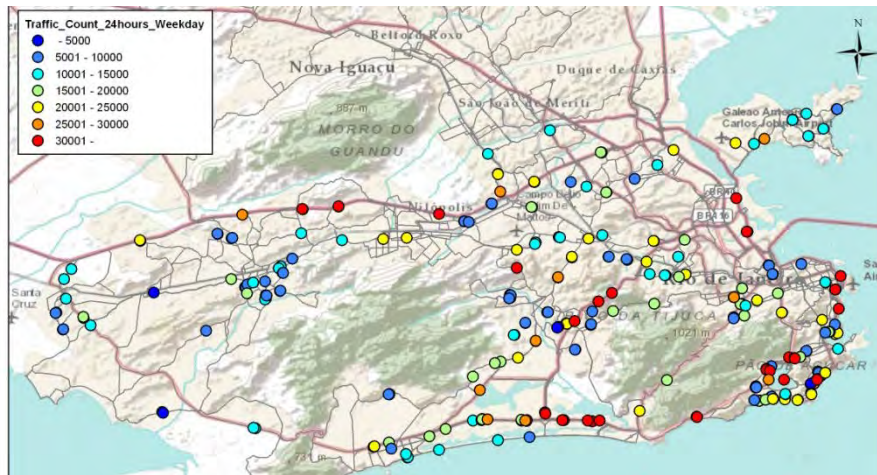
Traffic count data was provided by CET-Rio. Traffic characteristics were drawn from the average traffic volume data in May 2012.

**i) Traffic Volume**

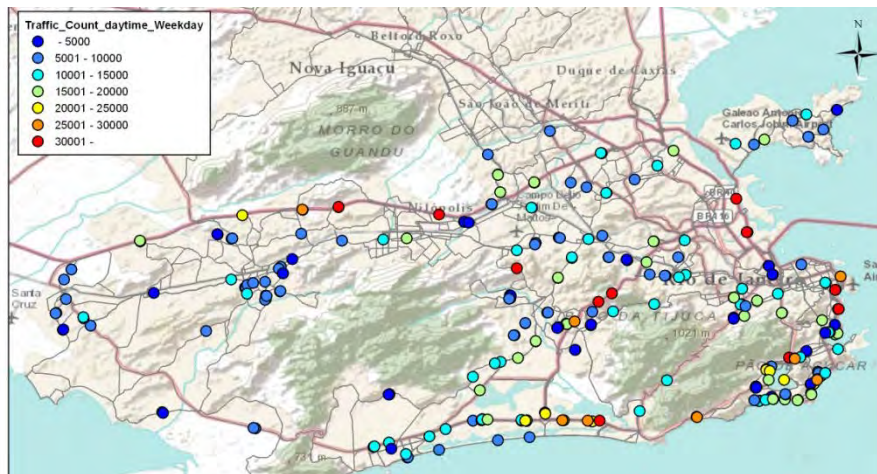
Traffic volume during daytime (7:00 a.m. – 7:00 p.m.), nighttime (7:00 p.m. – 7:00 a.m.), 24 hours (7:00 am – 7:00 a.m.), morning peak (7:00 a.m. – 9:00 a.m), and evening peak (5:00 p.m. – 7:00 p.m.) are shown in Figures 3-34 to 3-36.

High traffic volume is observed along Av. Brasil, Av. das Americas and Linha Amarela during daytime and nighttime. In addition, high traffic volume locations are observed in the Centro and Copacabana areas during daytime as shown in Figure 3-34 below.

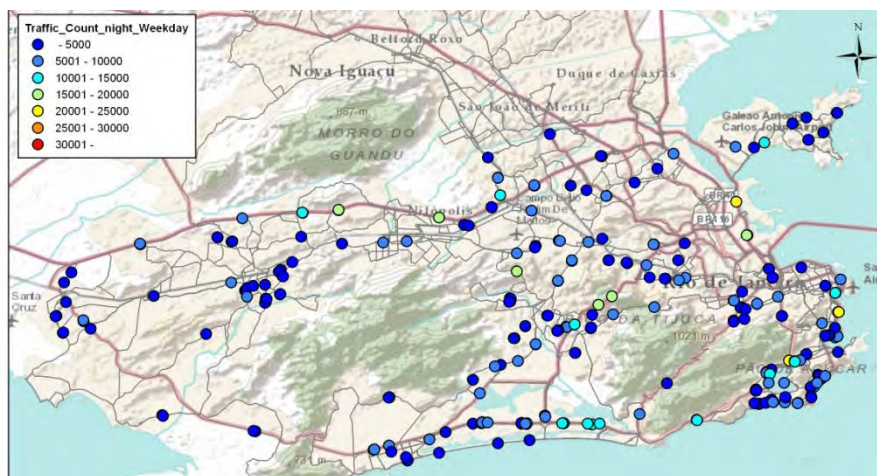
[Weekday, 24 hours]



[Weekday, Daytime]



[Weekday, Night]



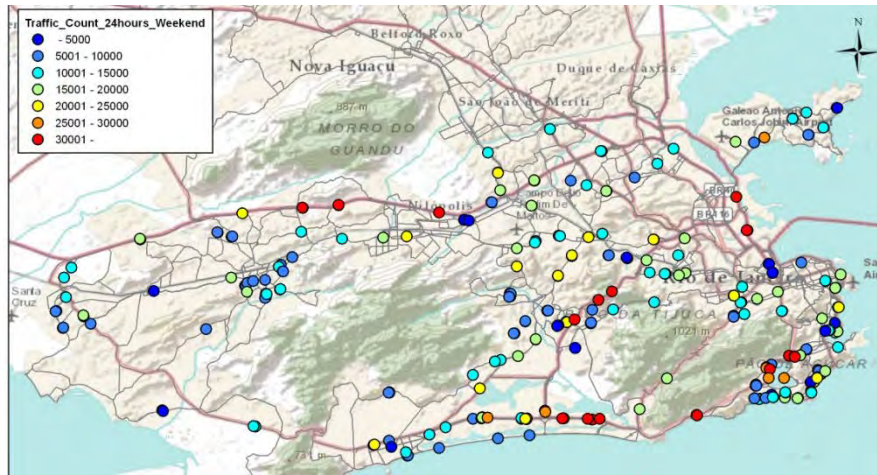
Source: JICA Study Team

Figure 3-34 Traffic Volume during Weekday

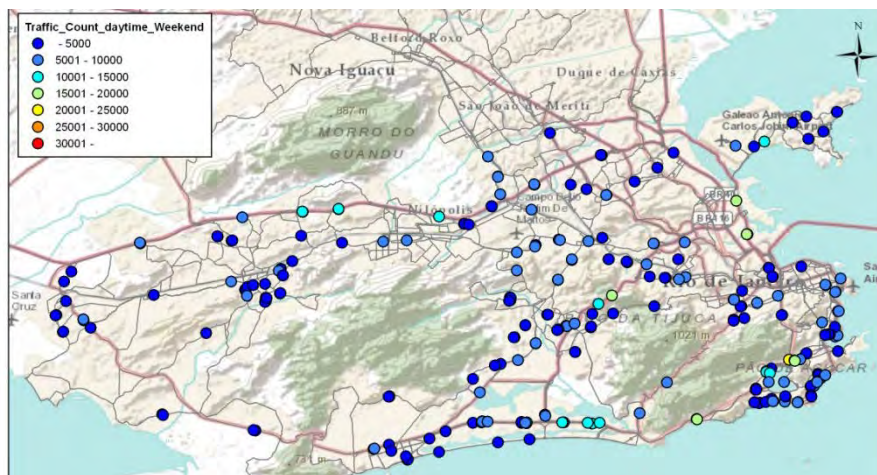


High traffic volume is observed along Av. Brasil, Av. das Americas and Linha Amarela. In addition, high traffic volume is observed around Lagoa Rodrigo de Freitas during the weekend.

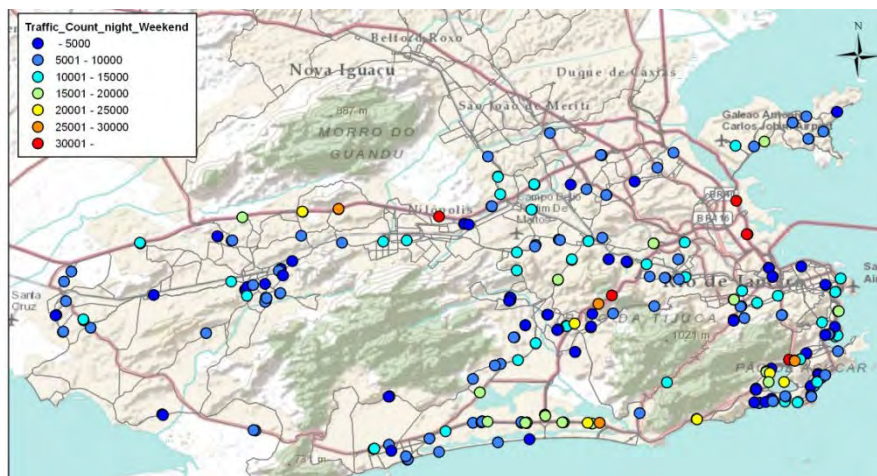
[Weekend, 24 hours]



[Weekend, Daytime]



[Weekend, Nighttime]

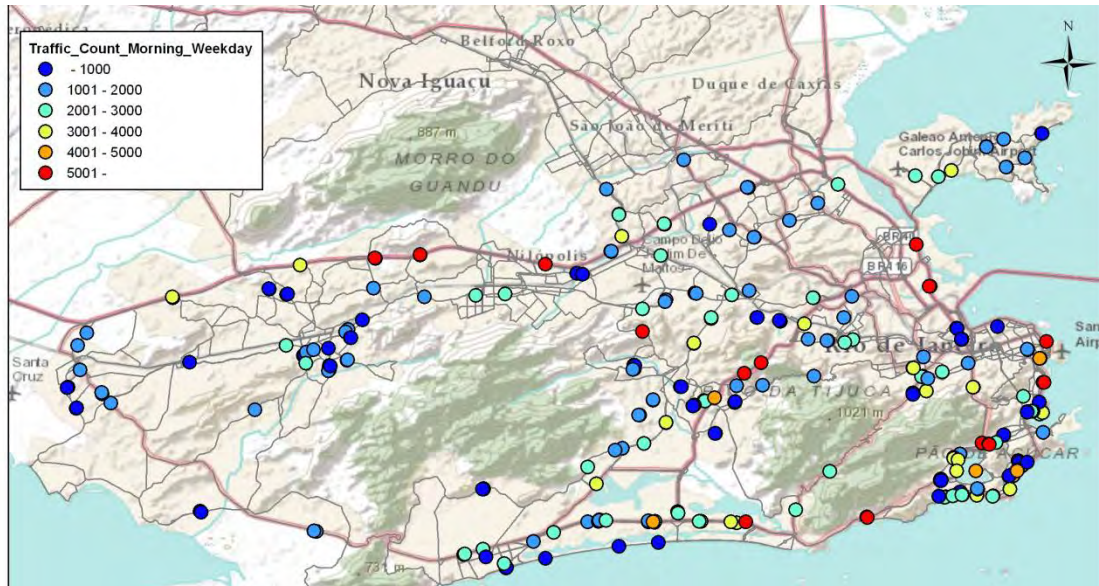


Source: JICA Study Team

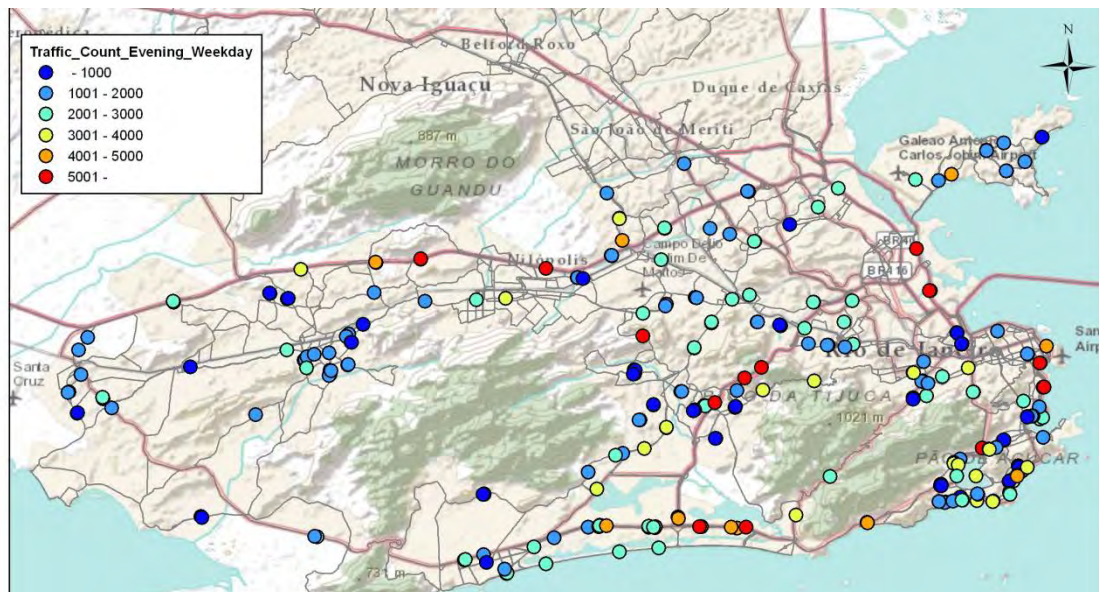
Figure 3-35 Traffic Volume during Weekend

During peak times, the traffic volumes along Av. Brasil, Av. das Americas and Linha Amarela are high.

[Weekday, Morning Peak]



[Weekday, Evening Peak]



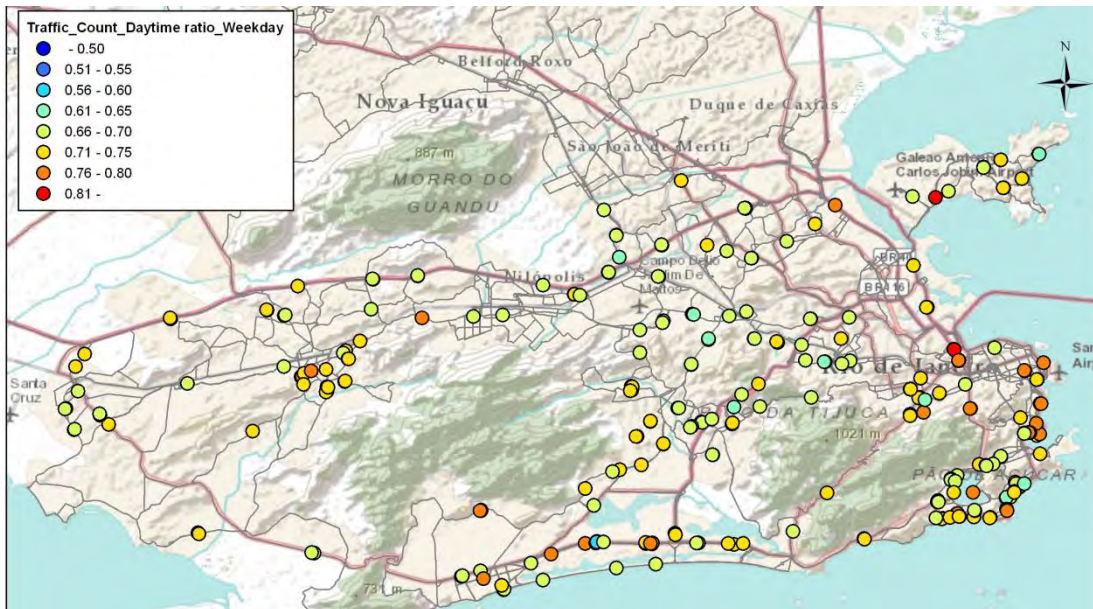
Source: JICA Study Team

Figure 3-36 Traffic Volume at Peak Times during Weekday

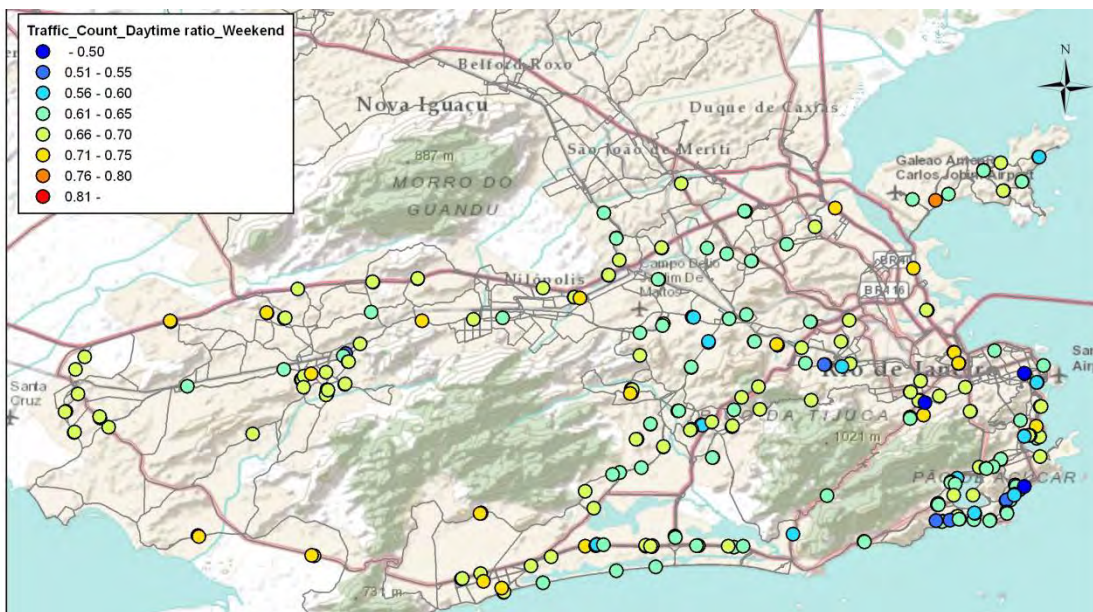
ii) **Ratio of Daytime and Nighttime Volumes**

The ratio of daytime to nighttime traffic volume is calculated by dividing the daytime volume by 24 hours. The calculation results are shown in Figure 3-37 below. It can be seen that the daytime traffic volume is much higher than the nighttime traffic volume. This tendency is clear during weekday.

[Daytime Share, Weekday]



[Daytime Share, Weekend]



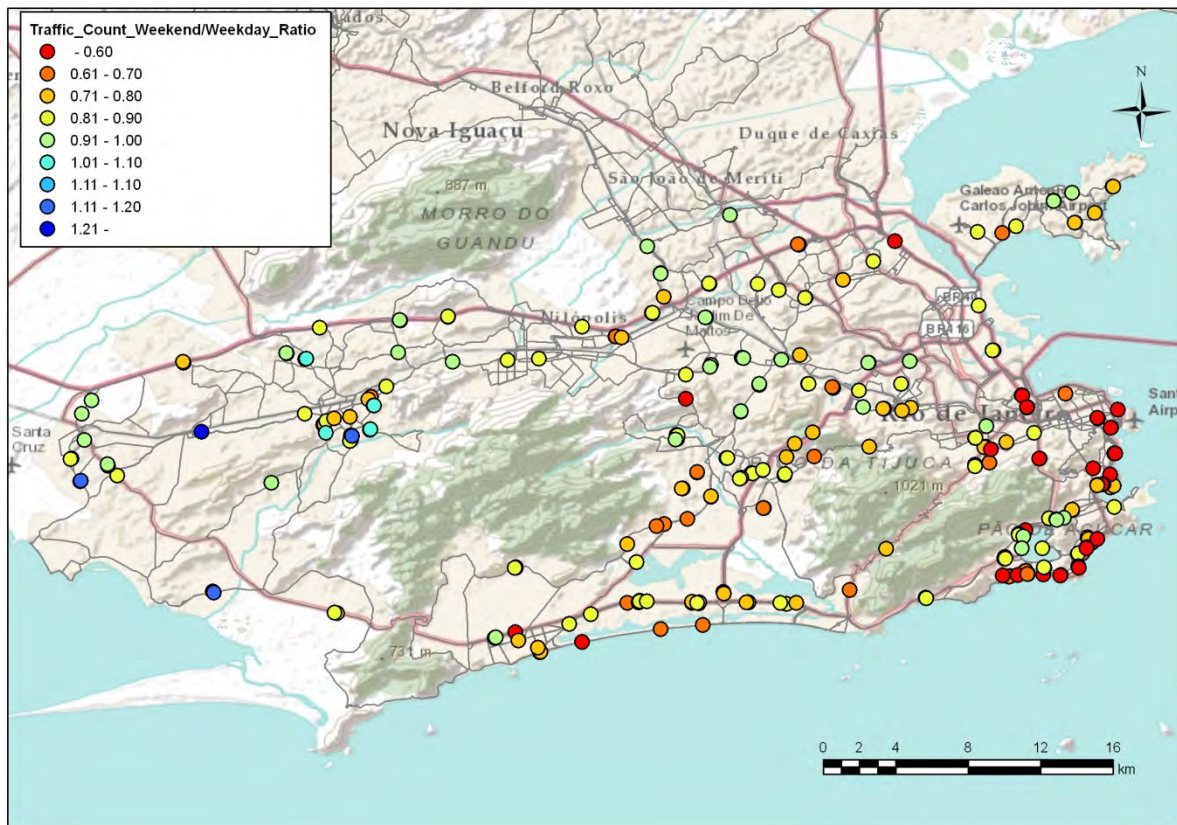
Source: JICA Study Team

**Figure 3-37 Ratio of Daytime and Nighttime Volumes**

**iii) Ratio of Weekday and Weekend Volumes**

The ratio of weekday to weekend traffic volume is calculated by dividing the weekday daytime volume by the weekend daytime volume. The calculation results are shown in Figure 3-38 below. In general, traffic volume during weekday is higher than that during weekend. This tendency is clearer in the Centro and Copacabana areas.

[Weekend/Weekday Ratio based on Daytime Volume]



Source: JICA Study Team

**Figure 3-38 Ratio of Weekday and Weekend Volumes**

2) SMTR Data

In the survey data provided by SMTR, the date and duration of data collection vary across each location as shown in Table 3-10 below. Thus, this data was not used for analyzing traffic characteristics but for validation and demand forecast in traffic modeling. The basic characteristics of traffic volume at each point are shown in Appendix 7.

**Table 3-10 Data Collection Points List Provided by SMTR**

Post	Local	Volumetric count	
		Date	Duration
1	Av. Das Americas Leste	21/09/2011	16:00- 19:59
2	Av. Das Americas Oeste	21/09/2011	16:00- 19:59
3	Av. Abelardo Bueno	21/09/2011	16:00- 19:59
4	Av. Alfredo Baltazar da Silveira	22/09/2011	06:00- 09:59
5	Tunel Reboucas	20/09/2011	16:00- 19:59
6	Tunel Santa Barbara	28/09/2011	06:00- 19:59
7	Praca Sibelius	20/09/2011	06:00- 09:59
8	Av. Borges de Medeiros	20/09/2011	06:00- 09:59
9	Av. Delfim Moreira	20/09/2011	06:00- 09:59
10	Tunel Alaor Prata (Tunel Velho)	21/09e22/09/2011	06:00- 09:59
11	Av. Venceslau Bras	21/09/2011	06:00- 09:59
12	Av. Henrique Dosdswort (Corte Cantagalo)	21/09/2011	06:00- 09:59
13	Aterro do Flamengo	26/09/2011	06:00- 09:59
14	Jardim Botânico	27/09/2011	06:00- 19:59
15	Rua Humaita	23/09/2011	06:00- 09:59
16	Av. Nacoes Unidas	26/09/2011	06:00- 19:59
17	Praia do Botafogo/Flamengo	26/09/2011	06:00- 19:59
18	Av. Rui Barbosa	27/09/2011	06:00- 19:59
19	Av. Oswaldo Cruz	27/09/2011	06:00- 19:59
20	Rua Conde de Bonfim	30/09/2011	06:00- 19:59
21	Av. Maracana	29/09/2011	06:00- 19:59
22	Radial Oeste, em frente ao Maracana	28/09/2011	06:00- 19:59
23	Av. Sao Francisco Xavier alt. Maracana	29/09/2011	06:00- 19:59
24	Perimetral/Av. Rodrigues Alves	03/10/2011	06:00- 19:59
25	Av. Francisco Bicalhoaltura Leopoldina	03/10/2011	06:00- 19:59
26	Linha Vermelha (São Cristóvão)		06:00- 19:59
27	Av. Pres. Vargas	29/09/2011	06:00- 09:59
28	Av. Pres. Joao Goular (acesso Ilha)	27/09/2011	06:00- 19:59
29	Av. Meneses Cortes	30/09/2011	06:00- 09:59
30	Av. Dom Helder	23/09/2011	06:00- 19:59
31	Av. Amaro Cavalcanti, em frente Engenhao	03/10/2011	06:00- 19:59
31A	Av. Arquias Cordeiro	03/10/2011	06:00- 19:59
32	Av. Marechal Alencastro	30/09/2011	

Source: JICA Study Team

The parameters for traffic modeling were calculated through this survey data. The average number of passengers in buses and vans, time proportion, and modal share between automobiles and buses in vehicle-unit derived from the survey data are described as follows:

[Average Number of Passengers in Buses and Vans]

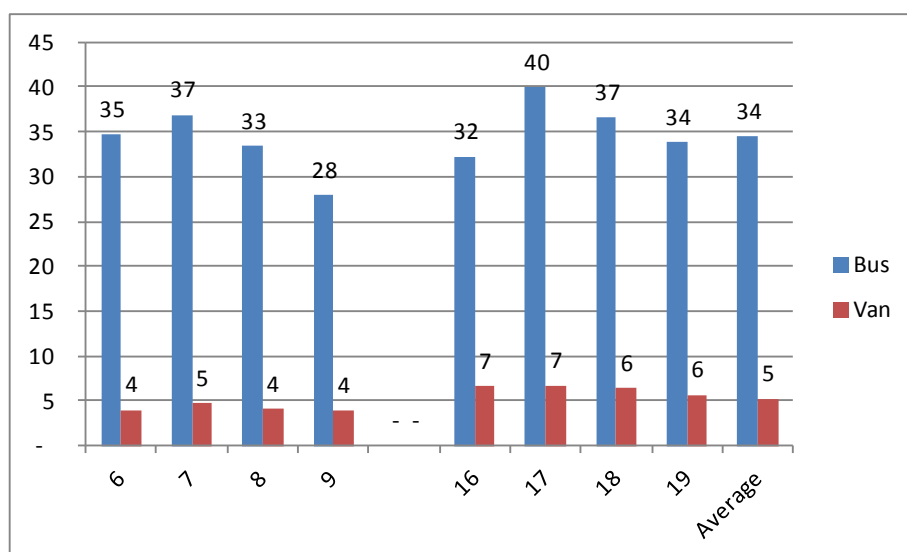
The calculated average number of passengers was 34 for buses and 5 for vans.

<Classification of No. of Passengers for Bus>

Faixas de Ocupação	Pass.Ônibus
Vazio	0
Meia Lotação Assentos	19
Lotação Assentos	37
Algumas pessoas em pé	55
Muitas pessoas em pé	70
Lotada	81
Super Lotada	90

<Classification of No. of Passengers for Van>

Faixas de Ocupação	Pass.Vans
Insul Filme	Não Visual
Vazio	0
até Meia Lotação Assentos	8
Meia a completa lotação de Assentos	15
Lotação de Assentos com pessoas em pé	20



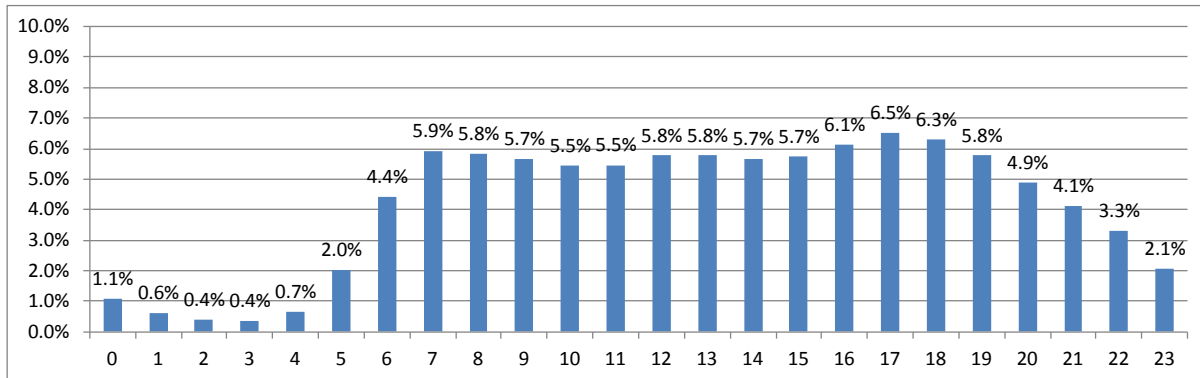
Average Number of Passengers for All Stations

Source: JICA Study Team

Figure 3-39 Average Number of Passengers

[Time Proportion]

Time proportion seems to be stable during daytime as shown in Figure 3-40 below. The highest traffic volume was observed at 5:00 p.m.



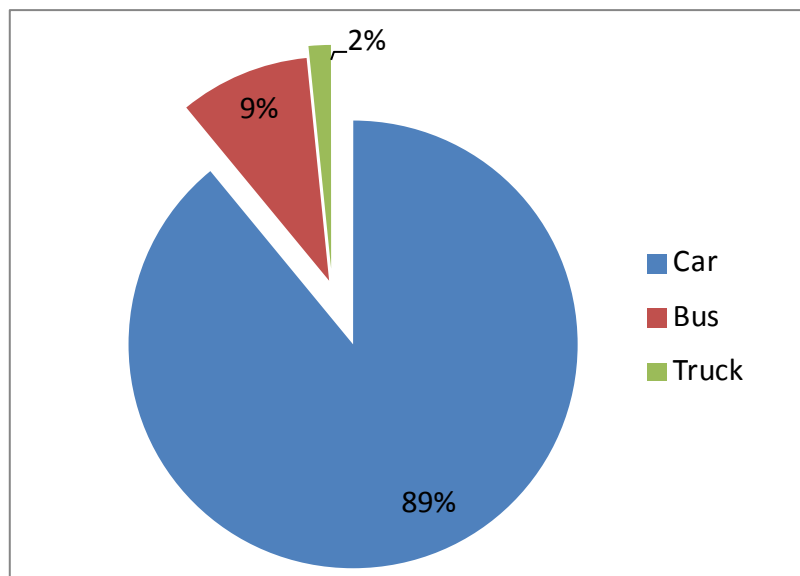
Average Time Proportion for All Stations

Source: JICA Study Team

**Figure 3-40 Time Proportion**

[Modal Share between Automobiles and Buses in Vehicle Unit]

The modal shares among cars/automobiles, buses, and trucks are shown in Figure 3-41 below. It can be noted that about 90% of the traffic volume was automobile traffic on average.



Average Share for All Stations

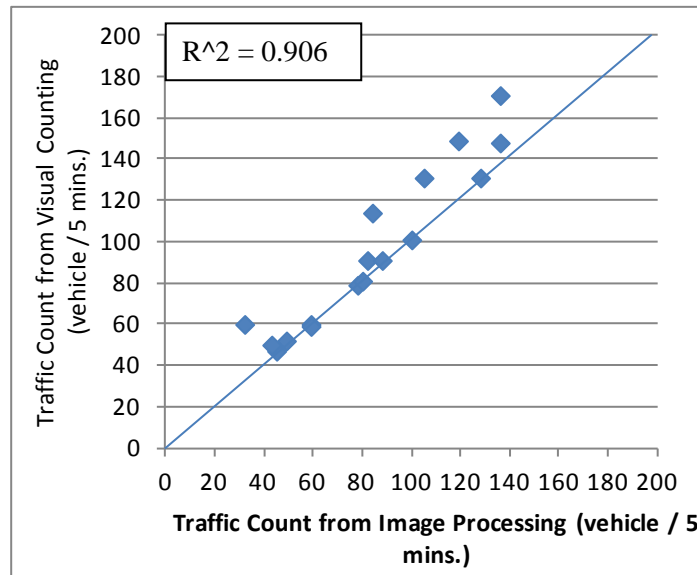
Source: JICA Study Team

**Figure 3-41 Modal Share Derived from Cross sectional Traffic Volume**

(4) CCTV Image Processing

1) Overall Accuracy

A comparison between the traffic count results from the image processing data and results from the visual counting was made to evaluate the accuracy of the image processing method. Reasonable accuracy was reached with an  $R^2$  of 0.906, as shown in Figure 3-42 below.



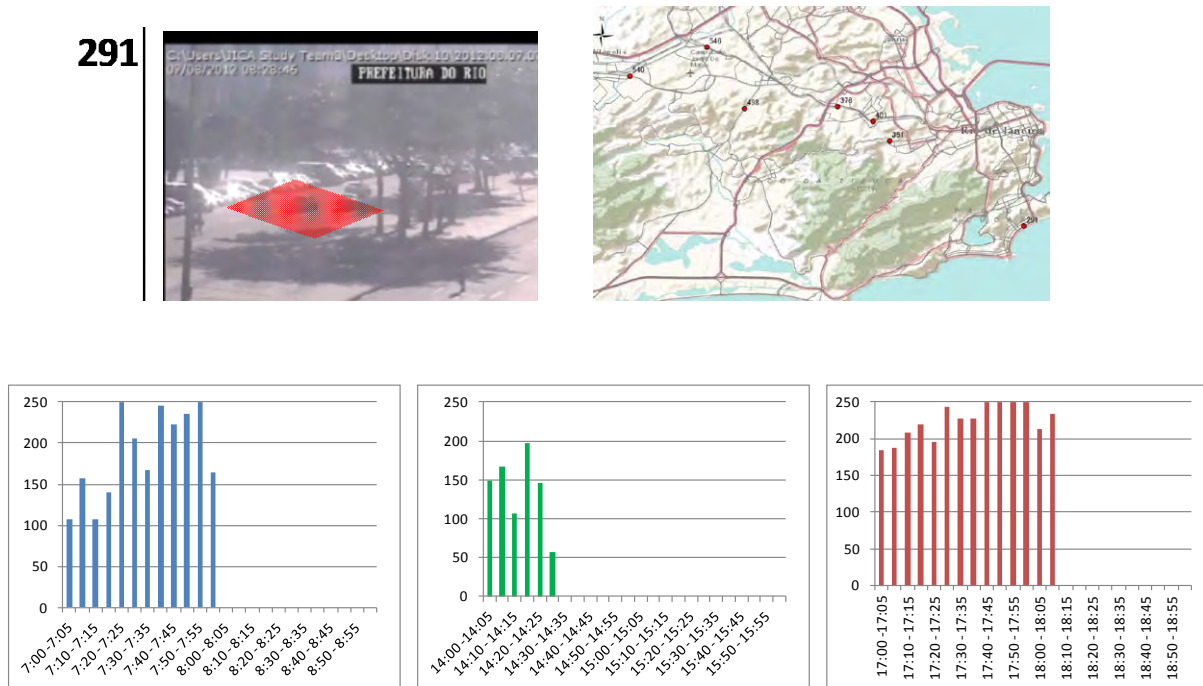
Source: JICA Study Team

Figure 3-42 Comparison of Traffic Count Results from Image Processing and Visual Counting



2) Traffic Count Data for Each Location

The traffic volumes from the CCTV image processing were reduced every 5 minutes as shown in the graphs of Figures 3-43 to 3-49. The detailed traffic characteristics during peak and off-peak times are also displayed in the graphs.



\* The quality of image is quite low.

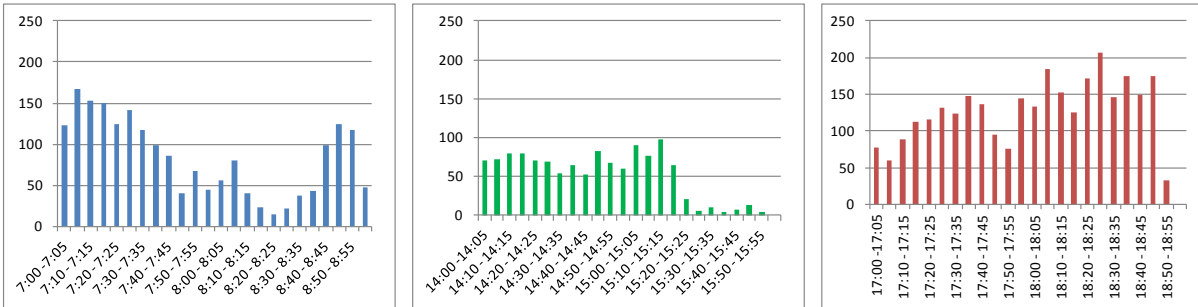
Source: JICA Study Team

**Figure 3-43 Traffic Count Result by Image Processing for Point No. 291 (in vehicle/5 min)**

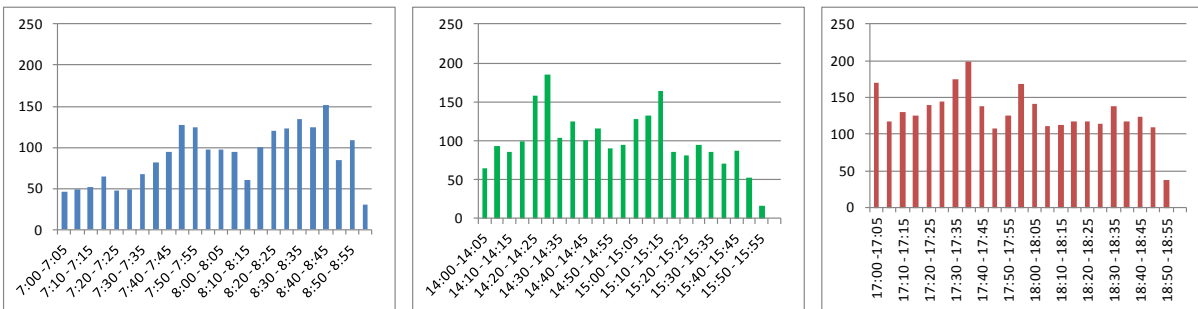
351



[1]

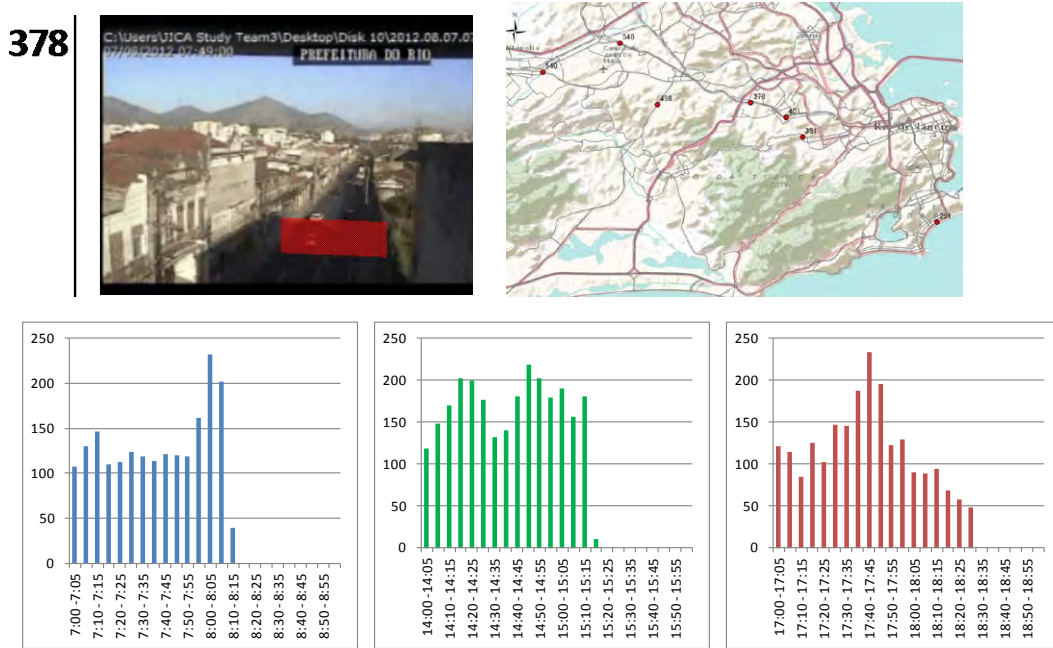


[2]



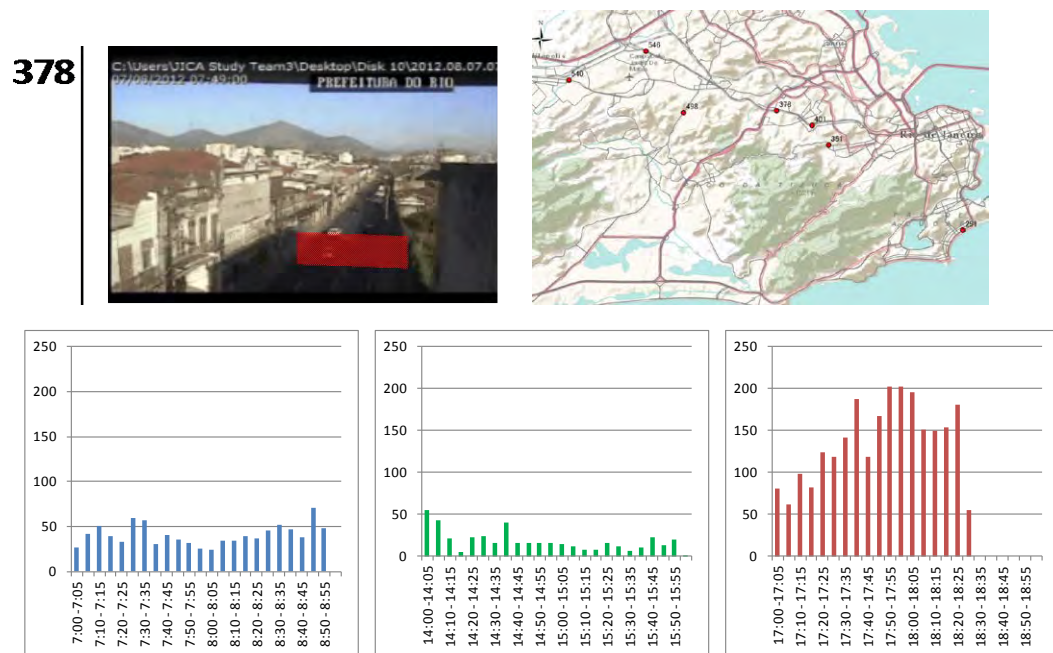
Source: JICA Study Team

Figure 3-44 Traffic Count Result by Image Processing for Point No. 351 (in vehicle/5 min)



Source: JICA Study Team

Figure 3-45 Traffic Count Results by Image Processing for Point No. 378 (in vehicle/5 min)



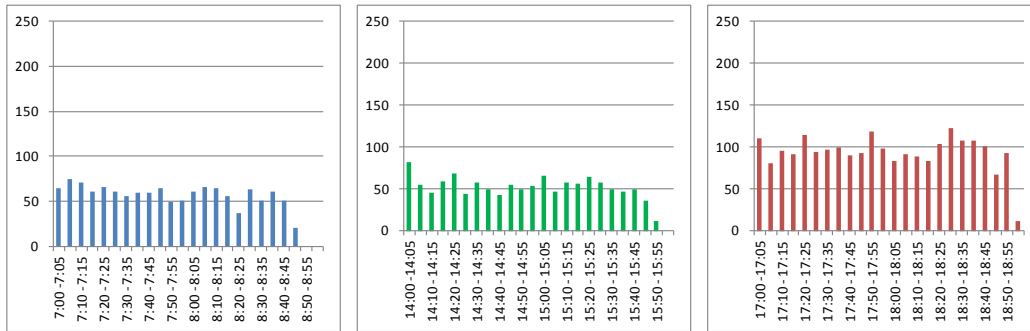
Source: JICA Study Team

Figure 3-46 Traffic Count Results by Image Processing for Point No. 401 (in vehicle/5 min)

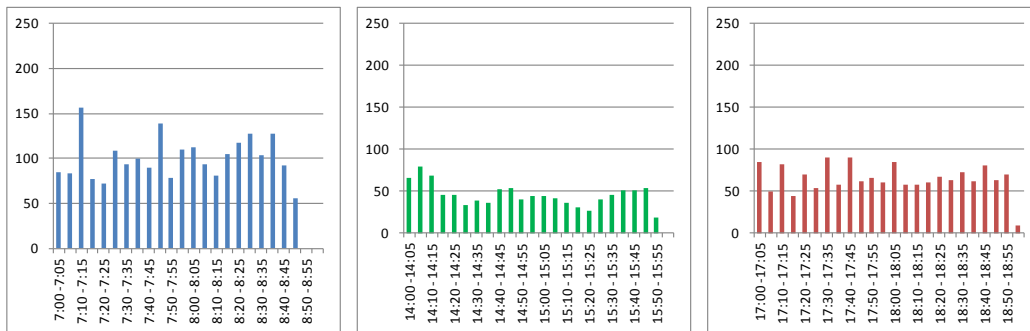
498



[1]



[2]



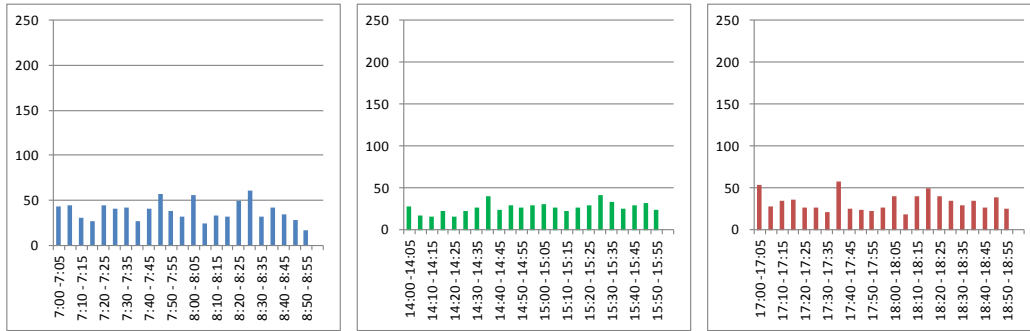
Source: JICA Study Team

Figure 3-47 Traffic Count Results by Image Processing for Point No. 498 (in vehicle/5 min)

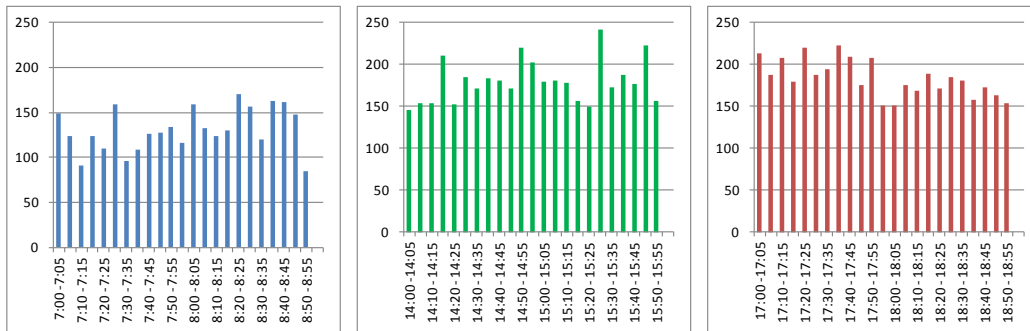
540



[1]



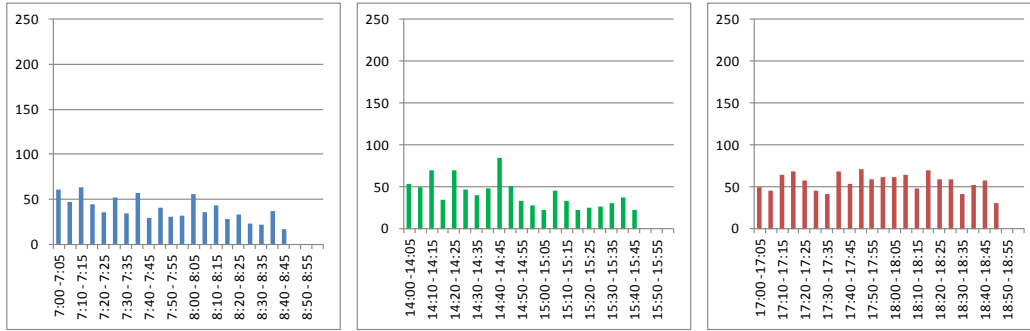
[2]



Source: JICA Study Team

Figure 3-48 Traffic Count Results by Image Processing for Point No. 540 (in vehicle/5 min)

546



Source: JICA Study Team

Figure 3-49 Traffic Count Results by Image Processing for Point No. 546 (in vehicle/5 min)