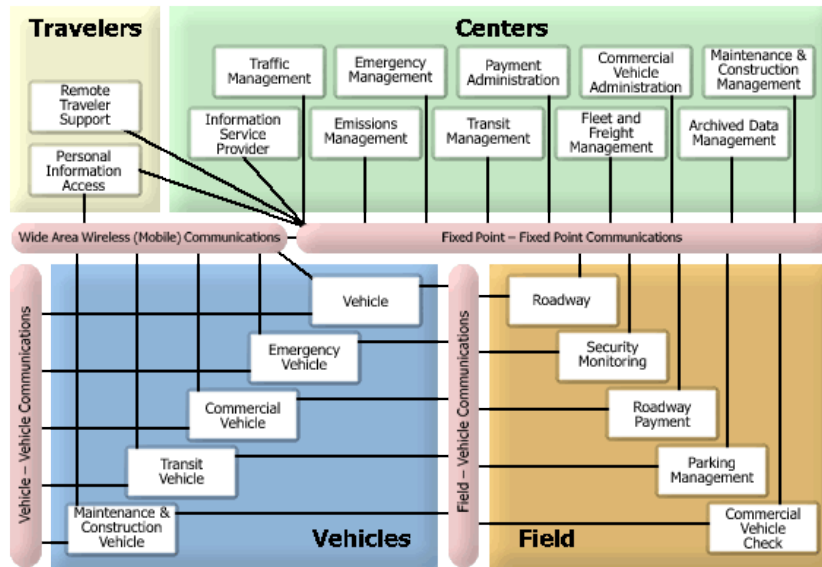


**7.2.5 Deployment Plan for ITS Projects Equipment**

- (1) Equipment to Deploy
- 1) ITS Physical Architecture

The ITS Physical Architecture of the National ITS Architecture 7.0 as shown in Figure 7-17 was utilized in considering a deployment plan. The figure shows the framework of centers, field, travelers, and vehicles, and the method of communication between these subsystems.



<b>Centers</b>	<ul style="list-style-type: none"> <li>• <a href="#">Archived Data Management</a></li> <li>• <a href="#">Commercial Vehicle Administration</a></li> <li>• <a href="#">Emergency Management</a></li> <li>• <a href="#">Emissions Management</a></li> <li>• <a href="#">Fleet and Freight Management</a></li> <li>• <a href="#">Information Service Provider</a></li> <li>• <a href="#">Maintenance and Construction Management</a></li> <li>• <a href="#">Payment Administration</a></li> <li>• <a href="#">Traffic Management</a></li> <li>• <a href="#">Transit Management</a></li> </ul>
<b>Field</b>	<ul style="list-style-type: none"> <li>• <a href="#">Commercial Vehicle Check</a></li> <li>• <a href="#">Parking Management</a></li> <li>• <a href="#">Roadway</a></li> <li>• <a href="#">Roadway Payment</a></li> <li>• <a href="#">Security Monitoring</a></li> </ul>
<b>Travelers</b>	<ul style="list-style-type: none"> <li>• <a href="#">Personal Information Access</a></li> <li>• <a href="#">Remote Traveler Support</a></li> </ul>
<b>Vehicles</b>	<ul style="list-style-type: none"> <li>• <a href="#">Commercial Vehicle</a></li> <li>• <a href="#">Emergency Vehicle</a></li> <li>• <a href="#">Maintenance and Construction Vehicle</a></li> <li>• <a href="#">Transit Vehicle</a></li> <li>• <a href="#">Vehicle</a></li> </ul>

**Actions for Implementation**

Building Facilities  
Deploy Equipment

Deploy Equipment

Provide Device

Mount On-board Unit

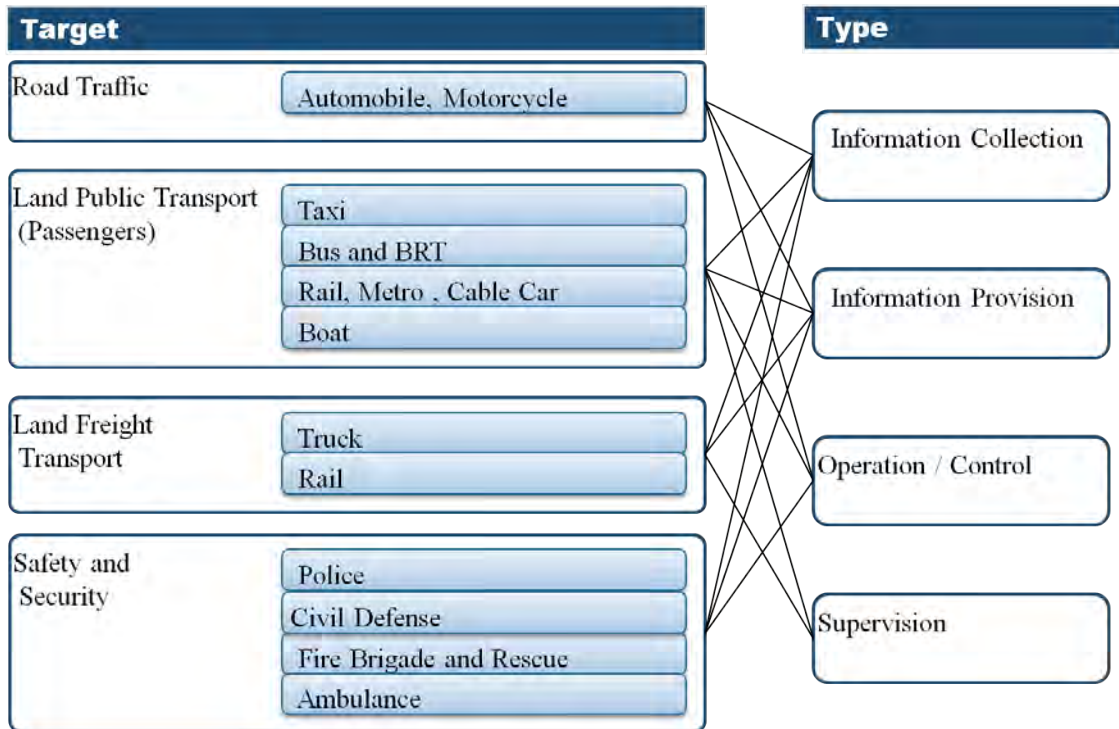
What? Where? How many?

Source: The National ITS Architecture 7.0

**Figure 7-17 ITS Physical Architecture**

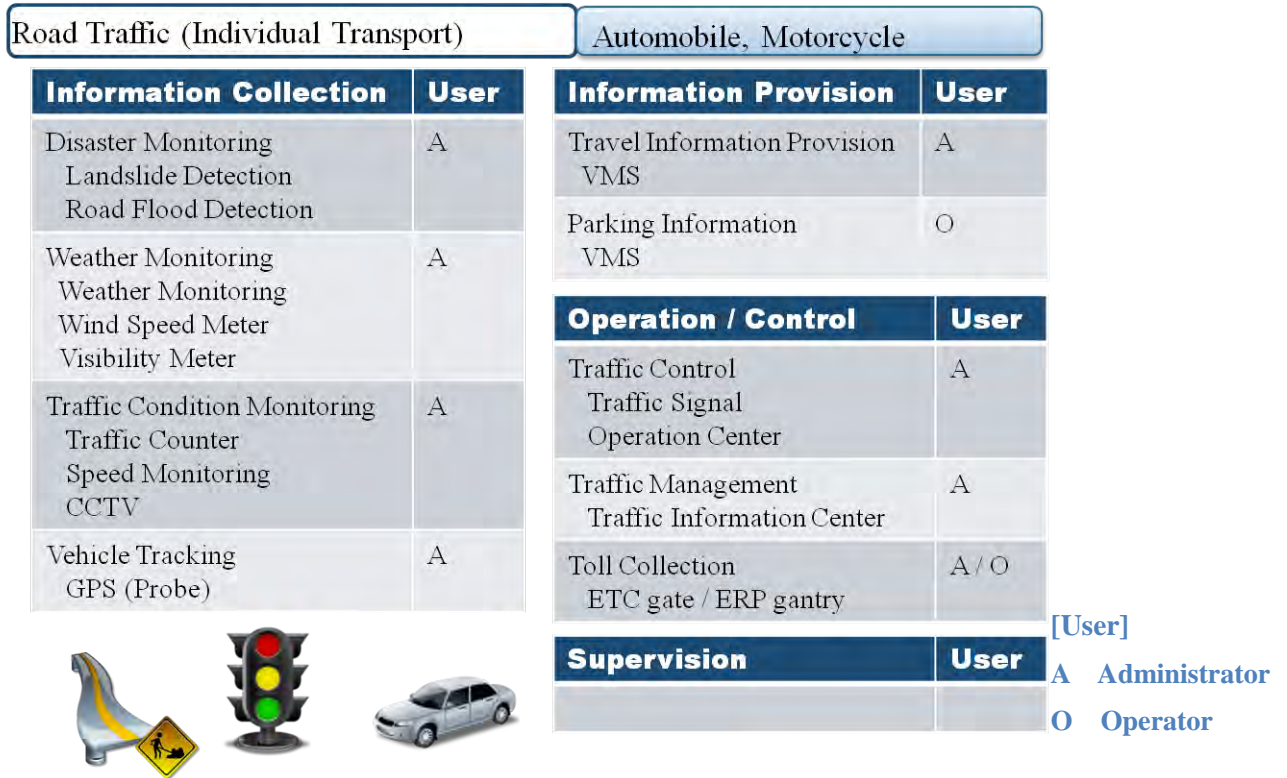
2) Equipment to Deploy for ITS

In considering ITS equipment, the relation of its services and targets should be defined by setting “which equipment is used?” and “who is using it?”. Hence, these connections, the information collection and provision, operation and control, and supervision as the targets and road traffic, land public transport (passengers), land freight transport, and safety and security as the services, were defined. The result is shown in Figure 7-18. Based on the results of the above, the ITS services and facilities necessary for each target were examined. The results are shown from Figure 7-19 to Figure 7-29.



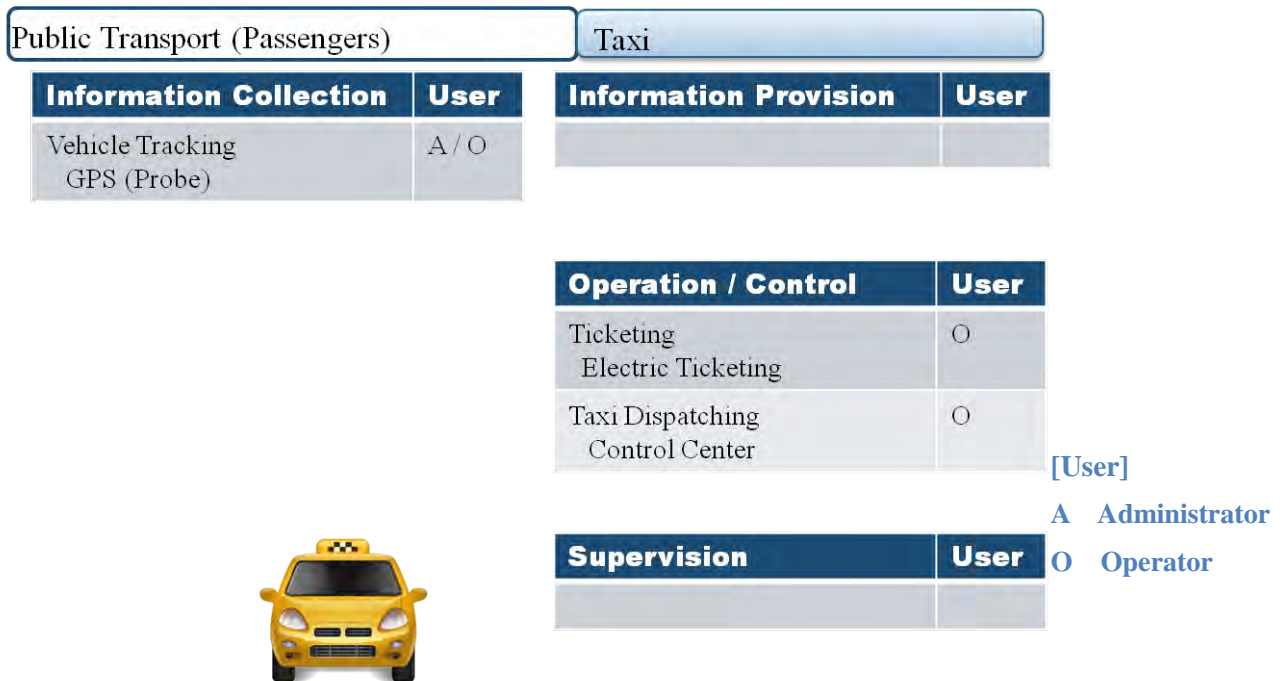
Source: JICA Study Team

Figure 7-18 Connection of Targets and Service Types



Source: JICA Study Team


Figure 7-19 Information Collection and User (Road Traffic)



Source: JICA Study Team

Figure 7-20 Information Collection and User (Public Transport - Taxi)

Public Transport (Passengers)		Bus and BRT	
Information Collection	User	Information Provision	User
Security Control at Bus Terminals CCTV	O	Traveler Information at Bus Terminals VMS / Monitor	O
Security Control inside Buses CCTV	O	Traveler Information at Bus Stops VMS / Monitor	O
Vehicle Tracking GPS (Probe)	A / O	Traveler Information inside Buses VMS / Monitor	O
		Operation / Control	User
		Ticketing Electric Ticketing	O
		Bus Operation Control Control Center	O
		Supervision	User
		Operation Monitoring Monitoring Center	A

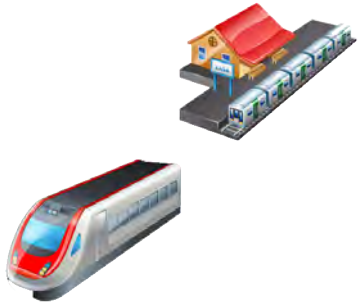


[User]  
**A Administrator**  
**O Operator**

Source: JICA Study Team

**Figure 7-21 Information Collection and User (Public Transport – Bus and Bus Rapid Transit (BRT))**

Public Transport (Passengers)		Rail, Metro , Cable Car	
Information Collection	User	Information Provision	User
Security Control at Stations CCTV	O	Traveler Information at Stations VMS / Monitor	O
		Traveler Information at Trains (METRO, SuperVIA) VMS / Monitor	O
		Operation / Control	User
		Ticketing Electronic Ticketing	O
		Operation Control Control Center	O
		Safety Control Railway Crossing	O
		Supervision	User [User]
		Operation Monitoring Monitoring Center	A




**A Administrator**

**O Operator**

Source: JICA Study Team

**Figure 7-22 Information Collection and User  
 (Public Transport – Rail, Metro, and Cable Car)**

Public Transport (Passengers)		Boat	
Information Collection	User	Information Provision	User
Location Monitoring GPS	O	Traveler Information at Ports VMS / Monitor	O
Security Control at Ports CCTV	O		
		Operation / Control	User
		Ticketing Electronic Ticketing	O
		Boat Operation Control Control Center	O
		Supervision	User [User]
		Operation Monitoring Monitoring Center	A



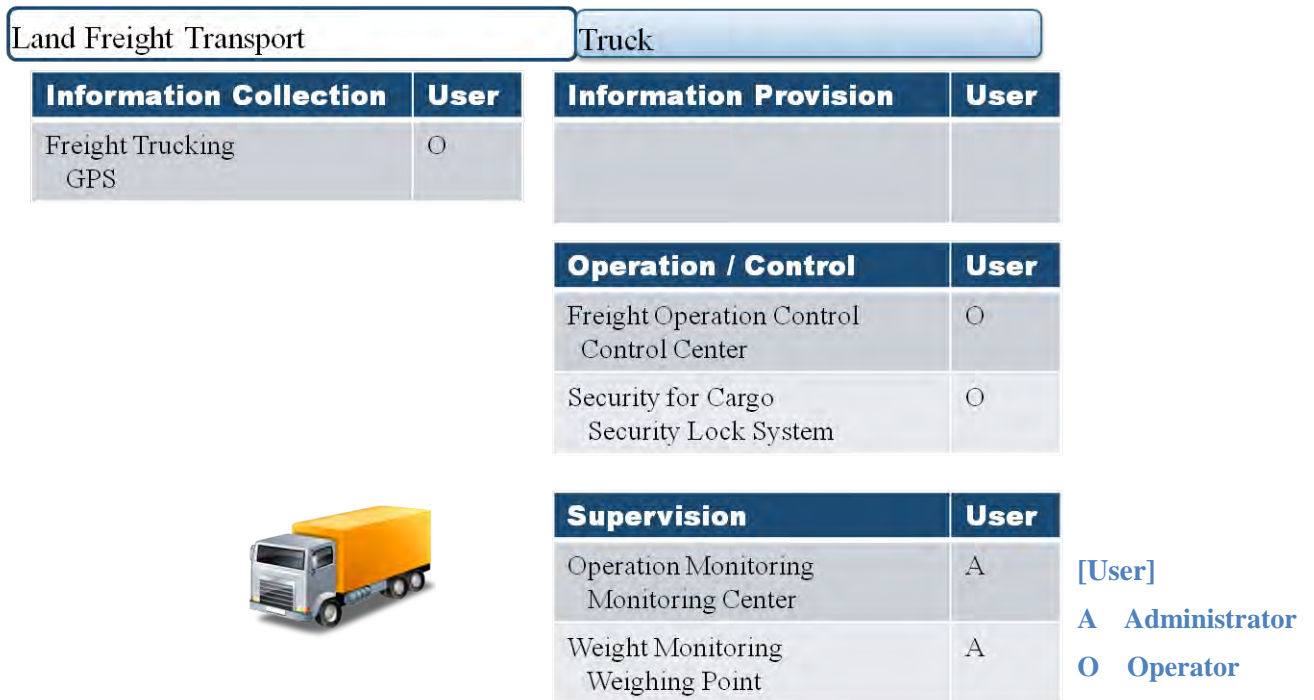
**A Administrator**

**O Operator**

Source: JICA Study Team

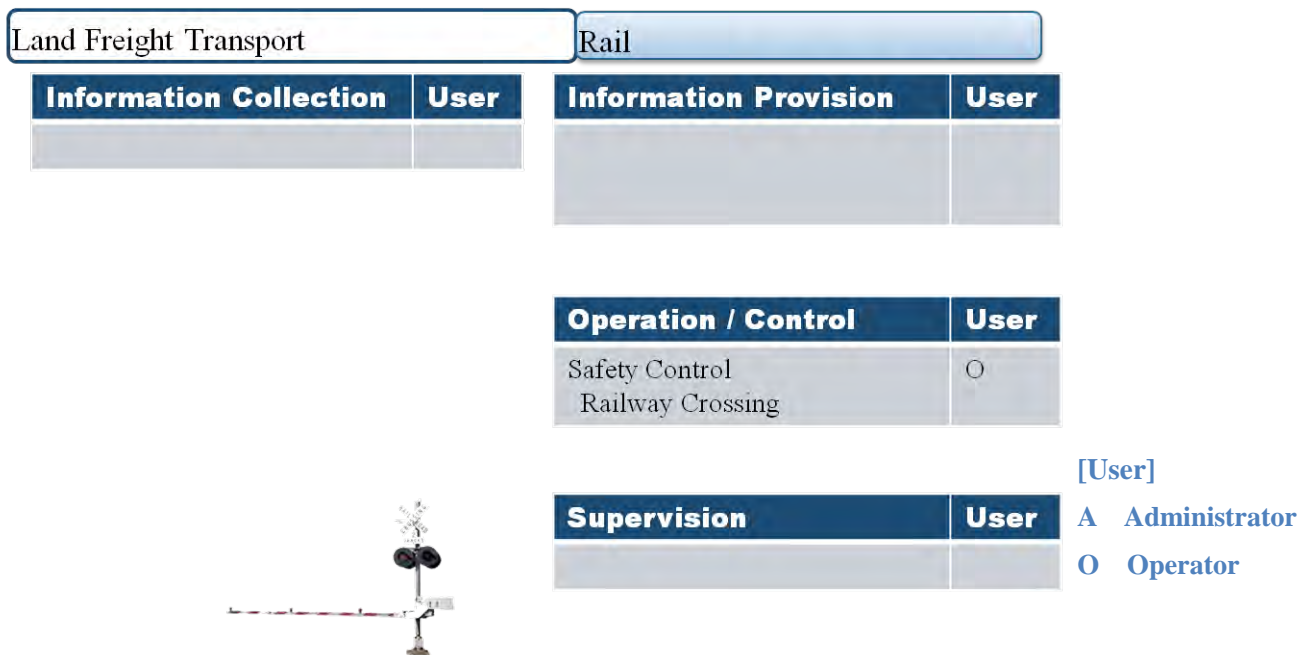
**Figure 7-23 Information Collection and User (Public Transport – Boat)**





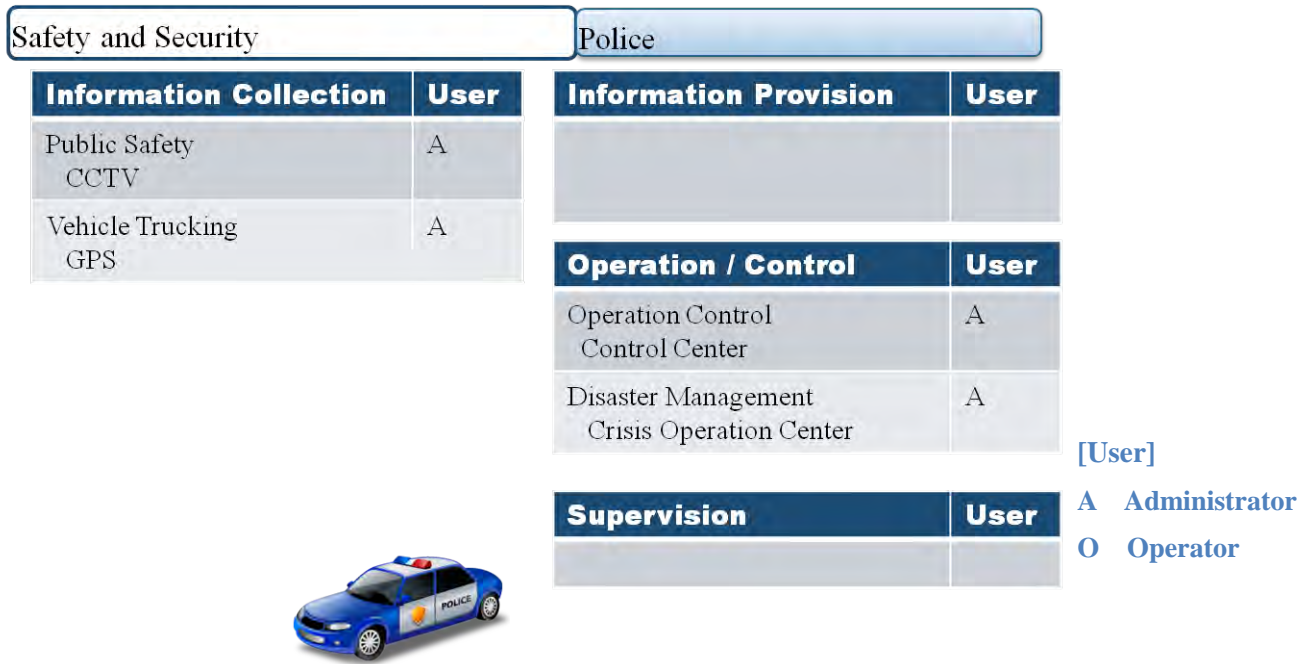
Source: JICA Study Team

Figure 7-24 Information Collection and User (Land Freight Transport - Truck)



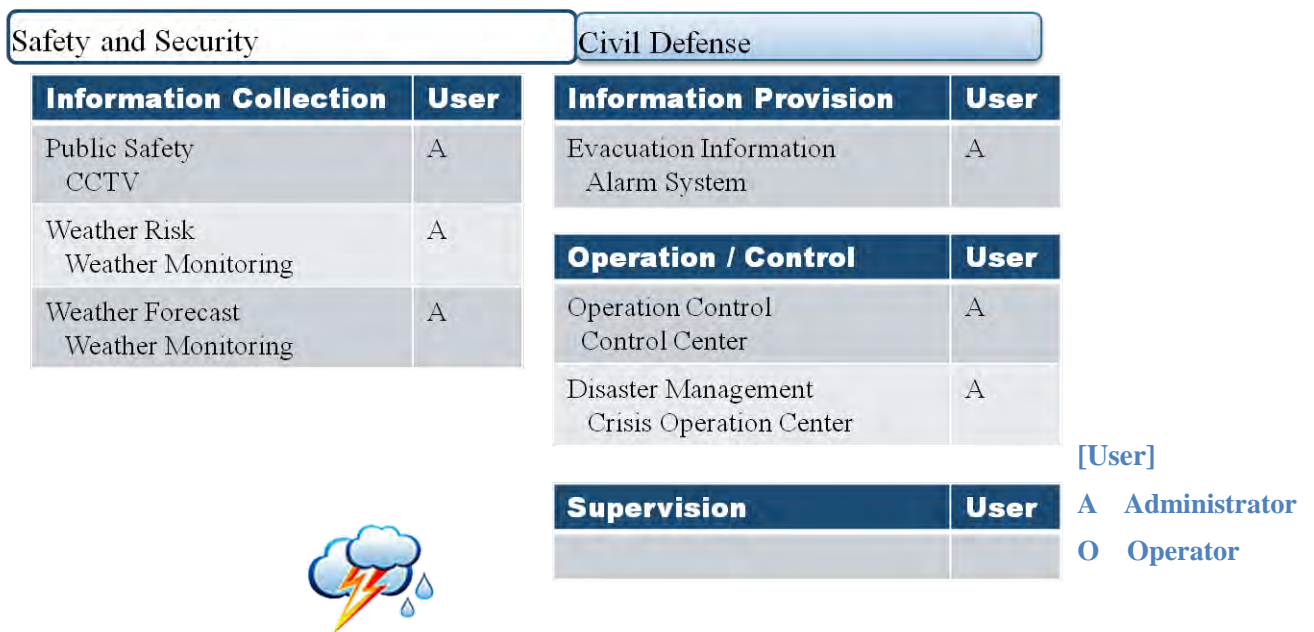
Source: JICA Study Team

Figure 7-25 Information Collection and User (Land Freight Transport - Rail)



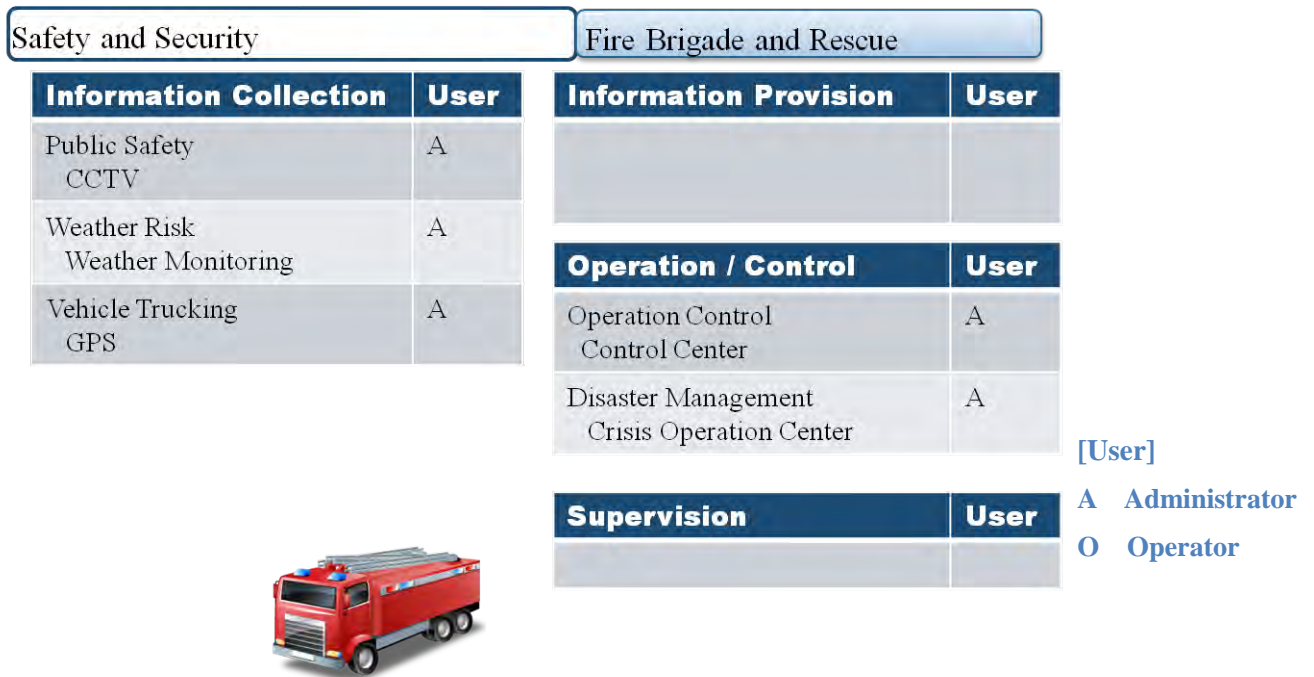
Source: JICA Study Team

Figure 7-26 Information Collection and User (Safety and Security - Police)



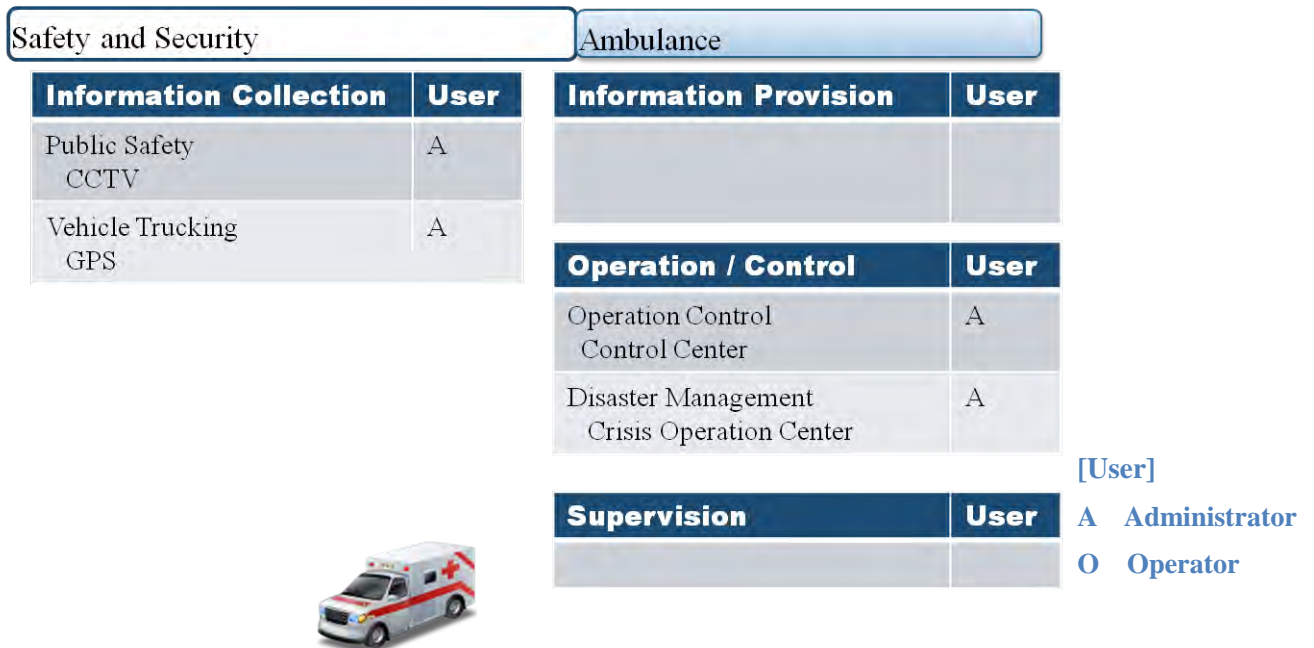
Source: JICA Study Team

Figure 7-27 Information Collection and User (Safety and Security – Civil Defense)



Source: JICA Study Team

**Figure 7-28 Information Collection and User  
 (Safety and Security – Fire Brigade and Rescue)**



Source: JICA Study Team

**Figure 7-29 Information Collection and User (Safety and Security – Ambulance)**



(2) Concept of Deployment

Based on the results of the connection of targets and services, how to deploy the ITS facilities required by each target was considered. The results are shown in Tables 7-2 to 7-12.

1) For Road Traffic (Automobile, Motorcycle)

**Table 7-2 Concept of Deployment (Road Traffic)**

	Equipment	Methodology of Deployment
1	Landslide Detection	- Arterial road with high risk of landslide
2	Road Flood Detection	- Points where flooding occurred because of rain and waves
3	Weather Monitoring	- With landslide and flood detection - Area-wise condition is monitored by meteorological organization
4	Wind Speed Meter	- Points where road closure occurred because of strong winds - On bridges
5	Visibility Meter	- Arterial road where thick fog occurred in high frequency
6	Traffic Counter	- Points with high traffic volume - Considering traffic flow characteristics
7	Speed Monitoring	- Equipment for surveillance is already installed in the whole Rio City - Points with high accident risk shall be added
8	CCTV	- Points with high disaster and accident risks because of rain, wind, wave, fog, and landslide (with landslide detection, flood detection, rain gauge, wind speed meter, and visibility meter) - Points with high accident risk - Inside tunnels
9	GPS (Probe)	- Target number of samples is 3–5 vehicles per hour per link
10	VMS	- Intersections before the roads with high disaster and accident risks - Main intersections and junctions and entrance of freeway - Border of cities - Before congestion points - Regular interval along arterial road - Around car parks
11	Traffic Signal	- Priority signals along main bus and BRT routes - Adaptive control signals in congested areas
12	Operation Center	- Federal, state, municipality - Metropolitan Region
13	Traffic Information Center	- Linked with operation and media centers
14	ETC Gate / ERP Gantry	- At the gates of toll roads - All roads on the border of road pricing

Source: JICA Study Team

2) For Land Public Transport (Passengers) (Taxi)

**Table 7-3 Concept of Deployment (Land Public Transport - Taxi)**

	Equipment	Methodology of Deployment
1	GPS (Probe)	- All vehicles
2	Electronic Ticketing	- All vehicles
3	Control Center	- Each company

Source: JICA Study Team

3) For Land Public Transport (Passengers) (Bus and BRT)

**Table 7-4 Concept of Deployment (Land Public Transport – Bus and BRT)**

	Equipment	Methodology of Deployment
1	CCTV (Terminals)	- All terminals - Number of cameras in one terminal is based on the current condition of Novo Rio Terminal
2	CCTV (Bus)	- All vehicles (Now, all buses of Rio Onibus and BRTs have cameras)
3	GPS (Probe)	- All vehicles (Now, all buses of Rio Onibus and BRTs have GPS)
4	VMS / Monitor (Terminals)	- In waiting rooms of all terminals - Number of VMSs in one terminal is based on the current condition of the Novo Rio Terminal
5	VMS / Monitor (Stops)	- All stops with shelter
6	VMS / Monitor (Buses)	- All vehicles (Now, some buses of Rio Onibus and BRTs have monitors)
7	Electronic Ticketing	- All vehicles (Now, installed on all buses of Rio Onibus)
8	Control Center	- Each association
9	Monitoring Center	- ANTT ( <i>Agência Nacional de Transportes Terrestres</i> : National Land Transport Agency), DETRO ( <i>Departamento de Transportes Rodoviários</i> : Department of Road Transport), and municipalities

Source: JICA Study Team

- 4) For Land Public Transport (Passengers) (Rail, Metro, and Cable Car)

**Table 7-5 Concept of Deployment (Land Public Transport – Rail, Metro, and Cable Car)**

	Equipment	Methodology of Deployment
1	CCTV (Station)	- All stations - Cameras are already installed
2	VMS / Monitor (Station)	- All stations
3	VMS / Monitor (Trains)	- All cars
4	Electronic Ticketing	- All stations
5	Control Center	- SuperVIA and Metro have control centers - The center or system for information exchange is necessary
6	Rail Crossing	- All crossings
7	Monitoring Center	- AGETRANSP ( <i>Agência Reguladora de Transportes do Estado do Rio de Janeiro</i> : Regulatory Agency of Transportation State of Rio de Janeiro )

Source: JICA Study Team

- 5) For Land Public Transport (Boat)

**Table 7-6 Concept of Deployment (Land Public Transport – Boat)**

	Equipment	Methodology of Deployment
1	GPS (Boat)	- All boats (Now, GPS are already installed)
2	CCTV (Port)	- All ports (Now, cameras are already installed)
3	VMS / Monitor (Port)	- All ports
4	Electronic Ticketing	- All ports
5	Control Center	- Barcas has a control center - The center or system for information exchange is necessary
6	Monitoring Center	- AGETRANSP

Source: JICA Study Team

- 6) For Land Freight Transport (Truck)

**Table 7-7 Concept of Deployment (Land Freight Transport – Truck)**

	Equipment	Methodology of Deployment
1	GPS (Truck)	- All trucks
2	Control Center	- Each company
3	Security Lock	- All cargos
4	Monitoring Center	- Center for RMRJ (if necessary)
5	Weighing Point	- Border of municipalities (if necessary)
6	GPS (Truck)	- All trucks

Source: JICA Study Team

7) For Land Freight Transport (Rail)

**Table 7-8 Concept of Deployment (Land Freight Transport – Rail)**

	Equipment	Methodology of Deployment
1	Rail Crossing	- All crossings

Source: JICA Study Team

8) For Safety and Security (Police)

**Table 7-9 Concept of Deployment (Safety and Security – Police)**

	Equipment	Methodology of Deployment
1	CCTV	- All necessary points for security reasons
2	GPS	- All vehicles and staff
3	Control Center	- State and municipalities
4	Crisis Operation Center	

Source: JICA Study Team

9) For Safety and Security (Civil Defense)

**Table 7-10 Concept of Deployment (Safety and Security – Civil Defense)**

	Equipment	Methodology of Deployment
1	CCTV	- Not dedicated - Share the data with security and transportation-related agencies
2	Weather Monitoring	- Already installed - Share the data with related agencies
3	Weather Monitoring (for Forecast)	- Not dedicated - Share the data with related agencies
4	Alarm System	- In high risk areas of natural disaster
5	Control Center	- State and municipalities
6	Crisis Operation Center	

Source: JICA Study Team

10) For Safety and Security (Fire Brigade and Rescue)

**Table 7-11 Concept of Deployment (Safety and Security – Fire Brigade and Rescue)**

	Equipment	Methodology of Deployment
1	CCTV	<ul style="list-style-type: none"> <li>- Not dedicated</li> <li>- Share the data with security and transportation-related agencies</li> </ul>
2	Weather Monitoring	<ul style="list-style-type: none"> <li>- Already installed</li> <li>- Share the data with related agencies</li> </ul>
3	GPS	<ul style="list-style-type: none"> <li>- All vehicles</li> </ul>
4	Control Center	<ul style="list-style-type: none"> <li>- State and regional branches</li> </ul>
5	Crisis Operation Center	

Source: JICA Study Team

11) For Safety and Security (Ambulance)

**Table 7-12 Concept of Deployment (Safety and Security – Ambulance)**

	Equipment	Methodology of Deployment
1	CCTV	<ul style="list-style-type: none"> <li>- Not dedicated</li> <li>- Share the data with security and transportation-related agencies</li> </ul>
2	GPS	<ul style="list-style-type: none"> <li>- All vehicles</li> </ul>
3	Control Center	<ul style="list-style-type: none"> <li>- State (which covers Rio City) and municipalities</li> </ul>
4	Crisis Operation Center	

Source: JICA Study Team



(3) Deployment Plan

Based on the results shown in the preceding tables and interviews with road administrators, the current situation of with/without ITS facilities and management condition was organized. The placement of the new ITS facilities and ITS deployment plan for each individual service were considered.

1) For Road Traffic (Automobile, Motorcycle) – Related Meteorological

**i) Current Condition**

Many road administrators do not have ITS equipment for disaster and weather sensing systems. The concession company only has weather monitoring and wind speed meters.

**Table 7-13 Current Condition (Road Traffic)**

	Equipment	Federal	State	Municipality of Rio	Other Municipalities	Concession
1	Landslide Detection	No	No	No	No	No
2	Road Flood Detection	No	No	No	No	No
3	Weather Monitoring	Rain gauge dedicated for roads does not exist. Equipment of other entities in RMRJ CPTEC(2), INEA(20), SIMERJ(3), CBMERJ(7), AlertaRio (32)				Yes
4	Wind Speed Meter	No	No	No	No	Yes
5	Visibility Meter	No	No	No	No	No

Source: JICA Study Team

**ii) Methodology**

The methodology of deployment of ITS facilities is shown in Table 7-14. And in the next section, the deployment plan of each facility based on the results described above is shown.

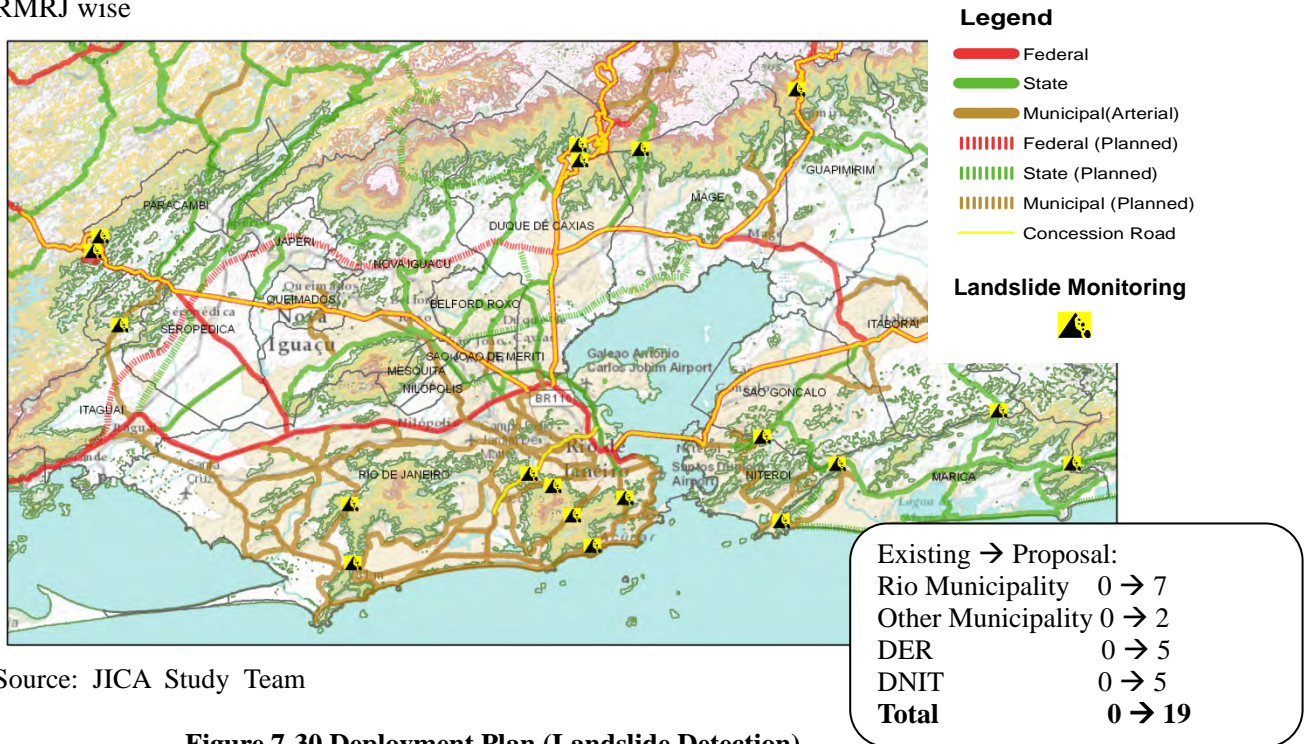
**Table 7-14 Methodology of Deployment (Road Traffic)**

	Equipment	Methodology of Deployment
1	Landslide Detection	Deploy a detector at a section with slope or hills by considering contour data
2	Road Flood Detection	(To be confirmed based on historical data of road flooding)
3	Weather Monitoring	Deploy at the same point as a landslide detector and in a blank zone of monitoring
4	Wind Speed Meter	Deploy on a bridge
5	Visibility Meter	Deploy at a section of more than 500 m in height

Source: JICA Study Team

A) Landslide Detection

RMRJ wise



Source: JICA Study Team

Figure 7-30 Deployment Plan (Landslide Detection)

B) Wind Speed and Visibility Meter

RMRJ wise



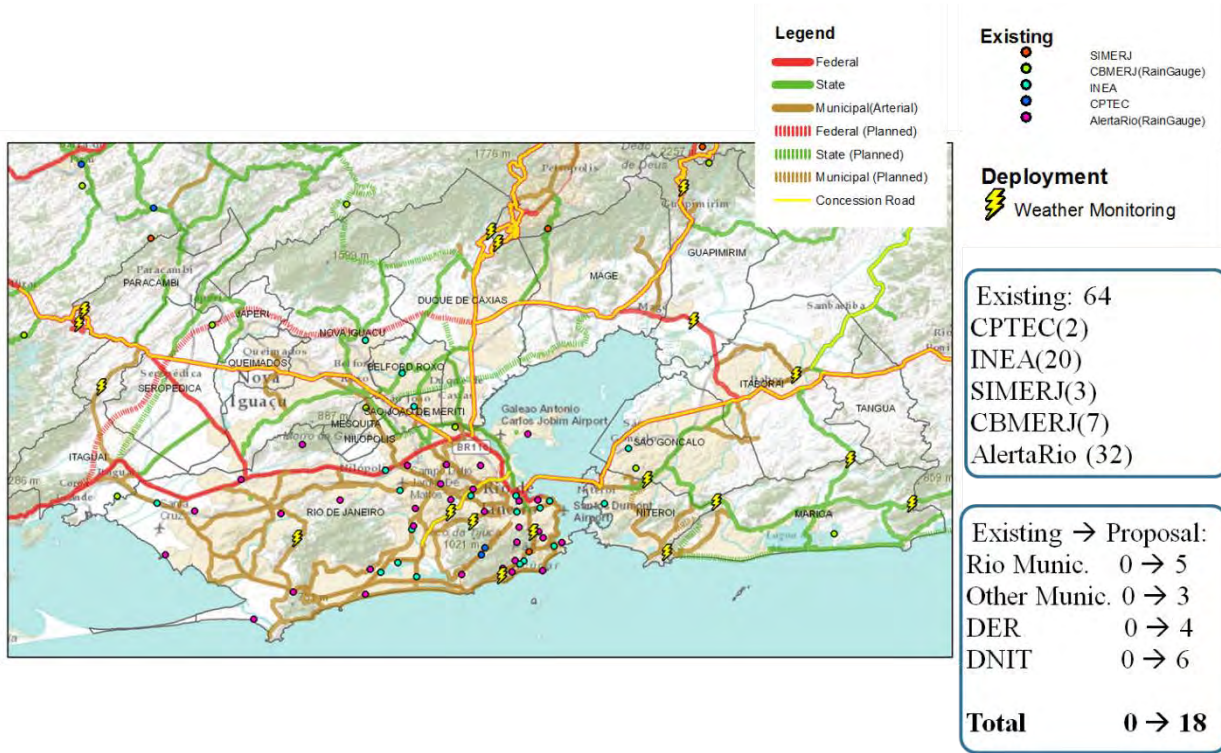
Source: JICA Study Team

Figure 7-31 Deployment Plan (Wind Speed and Visibility Meter)



C) Weather Monitoring

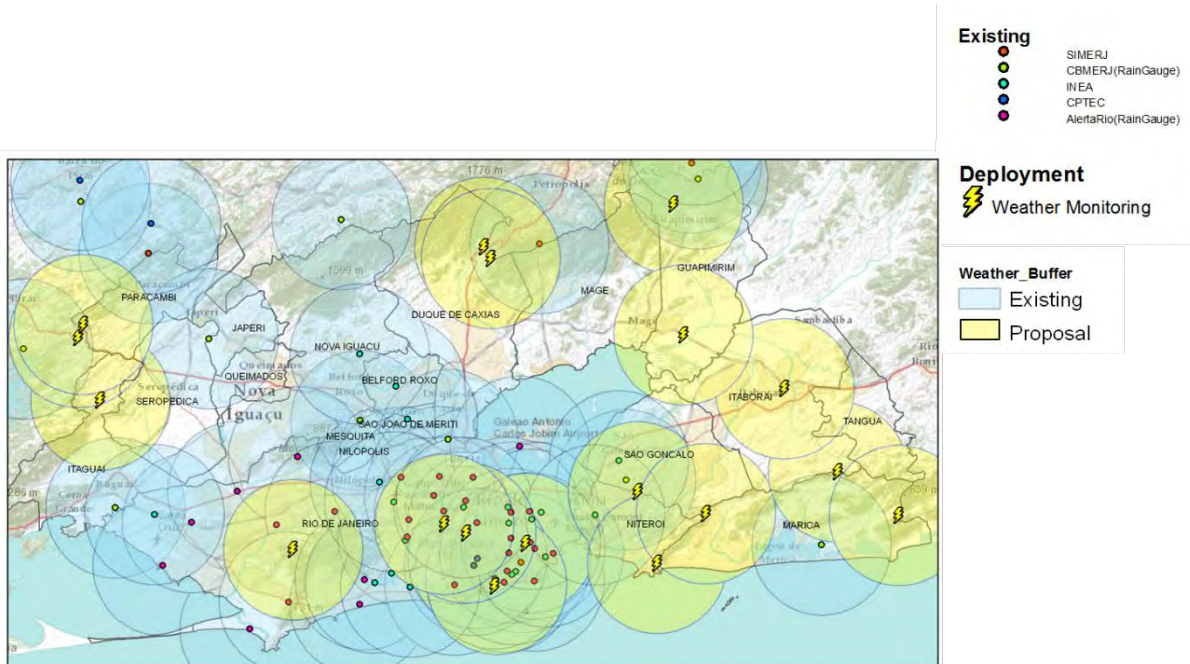
RMRJ wise



Source: JICA Study Team

Figure 7-32 Deployment Plan (Weather Monitoring - RMRJ)

Cover area (10 km buffer)



Source: JICA Study Team

Figure 7-33 Deployment Plan (Weather Monitoring – Cover Area)

2) For Road Traffic (Automobile, Motorcycle) – Related Traffic Volume/Speed

**i) Current Condition**

The federal, state, and municipality of Rio hold some ITS equipment related to vehicle sensing system for road traffic. The concession company owns them except the GPS.

**Table 7-15 Current Condition (Road Traffic)**

	Equipment	Federal	State	Municipality of Rio	Other Municipalities	Concession
1	Traffic Counter	Number count data is collected by the speed monitoring equipment				Yes
2	Speed Gun (including OCR)	Yes (5)	Yes (66)	Yes (387)	Not confirmed (Niteroi: No)	Yes
3	CCTV	No	Yes (4)	Yes (582)	Not confirmed (Niteroi: No)	Yes
4	GPS (Probe)	No	No	Maplink Data	No	No

Source: JICA Study Team

**ii) Methodology**

The methodology of deployment of ITS facilities is shown in Table 7-16. And in the next section, the deployment plan of each facility based on the results described above is shown.

**Table 7-16 Methodology of Deployment (Road Traffic)**

	Equipment	Methodology of Deployment
1	Traffic Counter	Deploy on sections with high traffic volume, on arterial roads, and on planned roads in order to build the monitoring network with speed monitoring equipment.
2	CCTV	Locate with landslide monitoring, wind speed and visibility meters. Deploy at a section with high traffic accident risk.
3	Speed Monitoring	Deploy supplementary equipment at the sections with high traffic accident risk. Traffic counters will to be replaced with speed monitoring equipment if necessary.
4	GPS (Probe)	Target number of probe vehicles is calculated by dividing target road length by average trip length.

Source: JICA Study Team



A) Traffic Counter  
 RMRJ wise

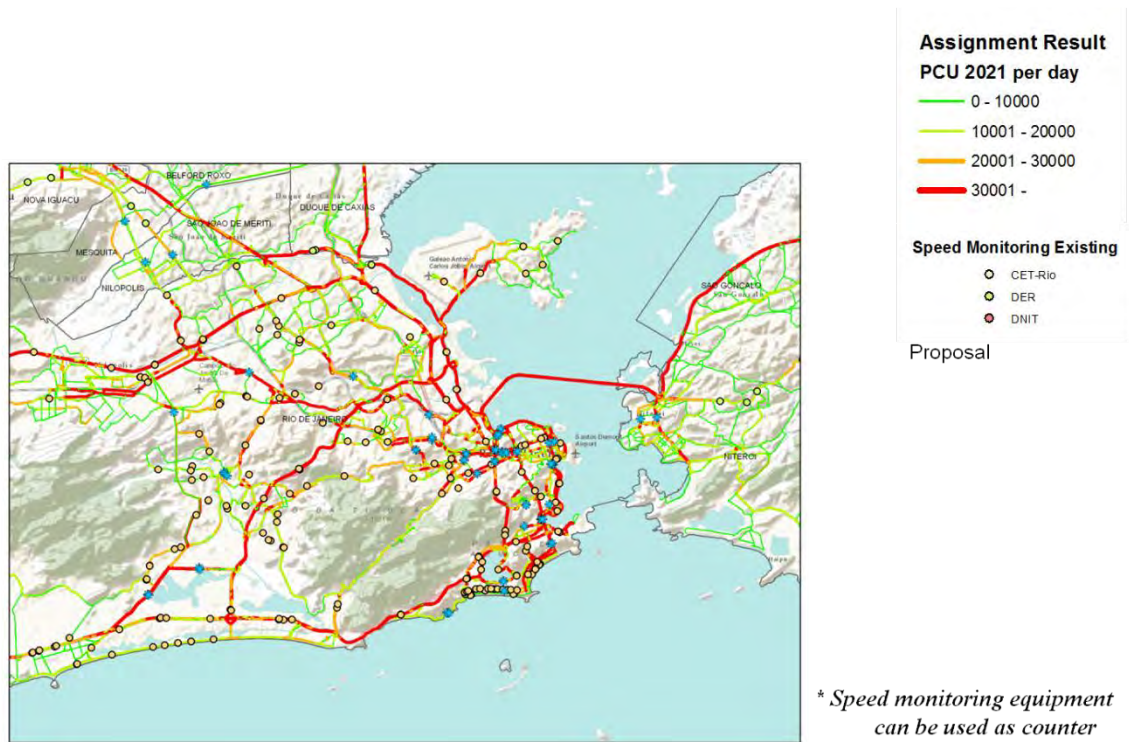


\* Speed monitoring equipment can be used as counter

Source: JICA Study Team

Figure 7-34 Deployment Plan (Traffic Counter - RMRJ)

Central Rio



\* Speed monitoring equipment can be used as counter

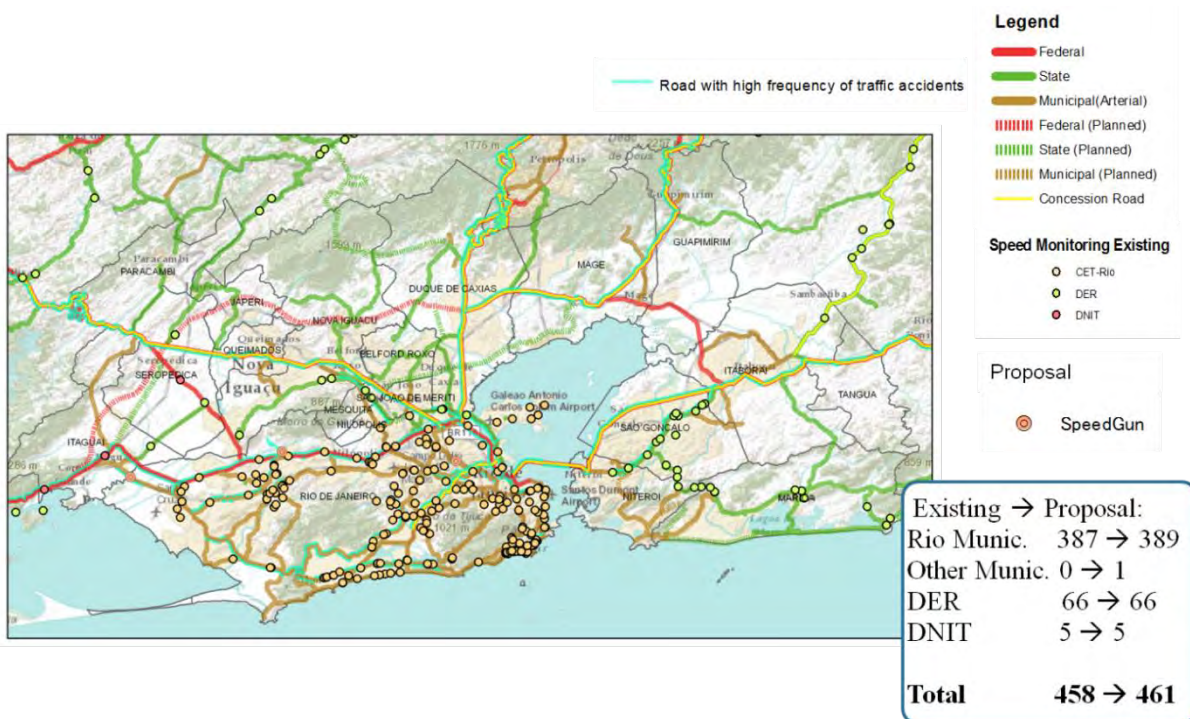
Source: JICA Study Team

Figure 7-35 Deployment Plan (Traffic Counter – Central Rio)



B) Speed Monitoring

RMRJ wise

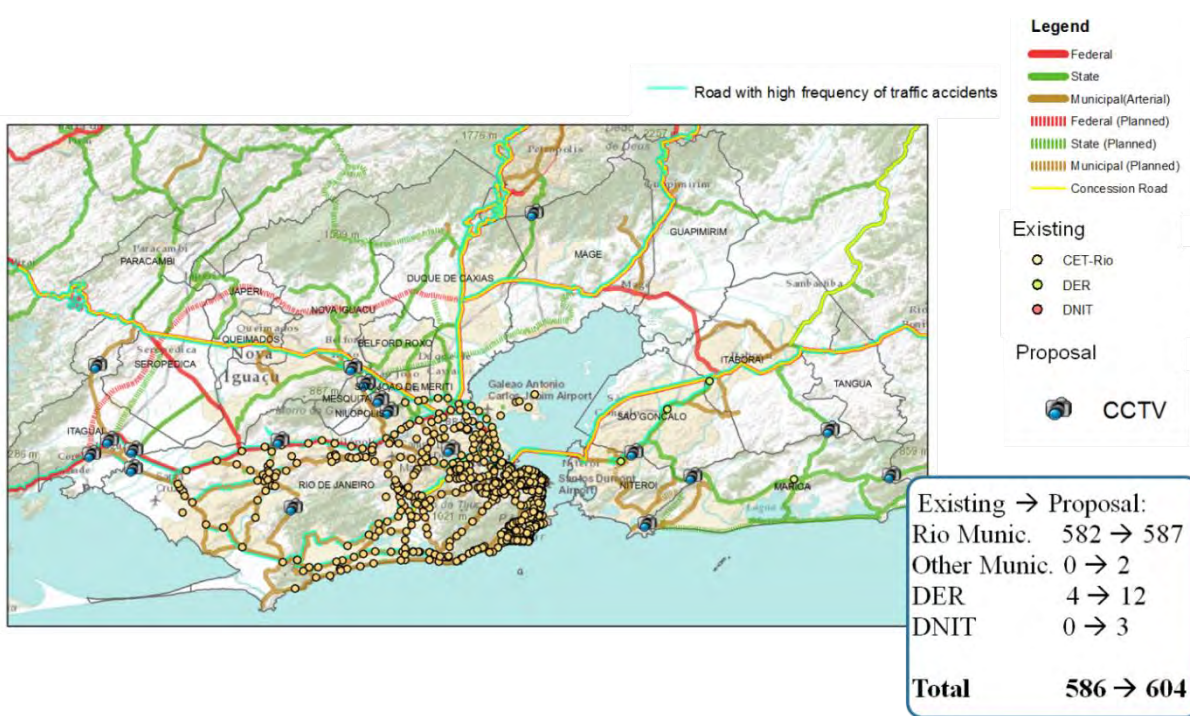


Source: JICA Study Team

Figure 7-36 Deployment Plan (Speed Monitoring)

C) CCTV

RMRJ wise



Source: JICA Study Team

Figure 7-37 Deployment Plan (CCTV)

D) GPS (Probe)

Target Road Network



Table 7-17 Road Length

Administrator	Length in RMRJ (km)
BR	209.9
BR Concession	301.5
RJ	511.7
RJ Concession	11.9
Municipality (Arterial)	461.7
Municipality Concession	17.4
Total	1,514.1

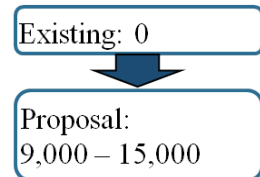
\* Including Planned Road

Source: JICA Study Team

Figure 7-38 Deployment Plan (GPS)

Average trip length per car per day

$$\frac{\text{Total Traveler Kilometer in 2021 Day}}{\text{Total number of Trips in 2021 Day}} = \text{About 12 km}$$



Target number of probe vehicles

$$\frac{\text{Target Road Network Length}}{\text{Average Trip Length per car per day}} * 24 \text{ hours } 3 - 5 \text{ samples} = \text{About } 9,000 - 15,000$$

3) For Road Traffic (Automobile and Motorcycle) – Related Traffic Situation

i) **Current Condition**

The federal, state, and municipality of Rio hold some ITS facilities related to operation center for road traffic. However, there is no facility that gathers information such as traffic information center. ETC is the only equipment that the concession company owns.

**Table 7-18 Current Condition (Road Traffic)**

	Equipment	Federal	State	Municipality of Rio	Other Municipalities	Concession
1	VMS for Road Traffic VMS for Parking Info.	No -	Yes (2) No	Yes (34) No	Not confirmed (Niteroi: No)	Yes -
2	Traffic Signal	-	-	Yes (about 2,265)	Yes (Niteroi: 250)	-
3	Operation Center	Yes (Regional)	Yes (Regional)	Yes (CET-Rio in COR)	Not confirmed (Niteroi: Yes)	Yes
4	Traffic Information Center	No	No	No (COR Bulletin)	No	No
5	ETC Gate ERP Gantry	No -	No -	No -	No -	Yes -

Source: JICA Study Team

ii) **Methodology**

The methodology of deployment of ITS facilities is shown in Table 7-19. And from the next section, the deployment plan of each facility based on the results described above is shown.

**Table 7-19 Methodology of Deployment (Road Traffic)**

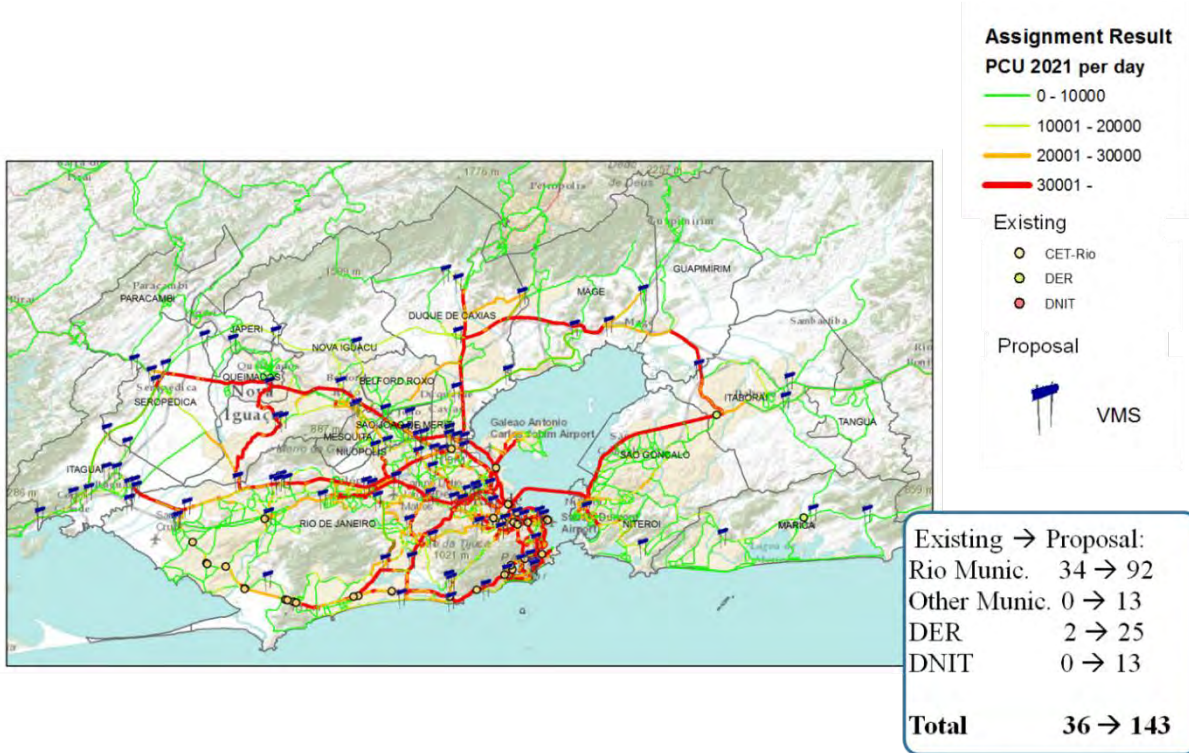
	Equipment	Methodology of Deployment
1	VMS	Deploy based on the deployment concept for road traffic. Select main parking in Rio for parking information.
2	Traffic Signal	Select signals along arterial roads in the municipality of Rio for adaptive control. For other municipalities, the number of target signals is estimated using traveler kilometers. Select signals along BRT lines for priority control.
3	Operation Center	Integrated control center is required to cover RMRJ road network (details shall be mentioned in the master plan).
4	Traffic Information Center	Integrated control center can play the role of an information center (details shall be mentioned in the master plan).
5	ETC Gate ERP Gantry	Possibly in all gates where ETC equipment are not installed (concession road only). Deploy in the border of ERP area.

Source: JICA Study Team



A) VMS for Road Traffic

RMRJ wise



Source: JICA Study Team

Figure 7-39 Deployment Plan (VMS for Road Traffic - RMRJ)

Central Rio

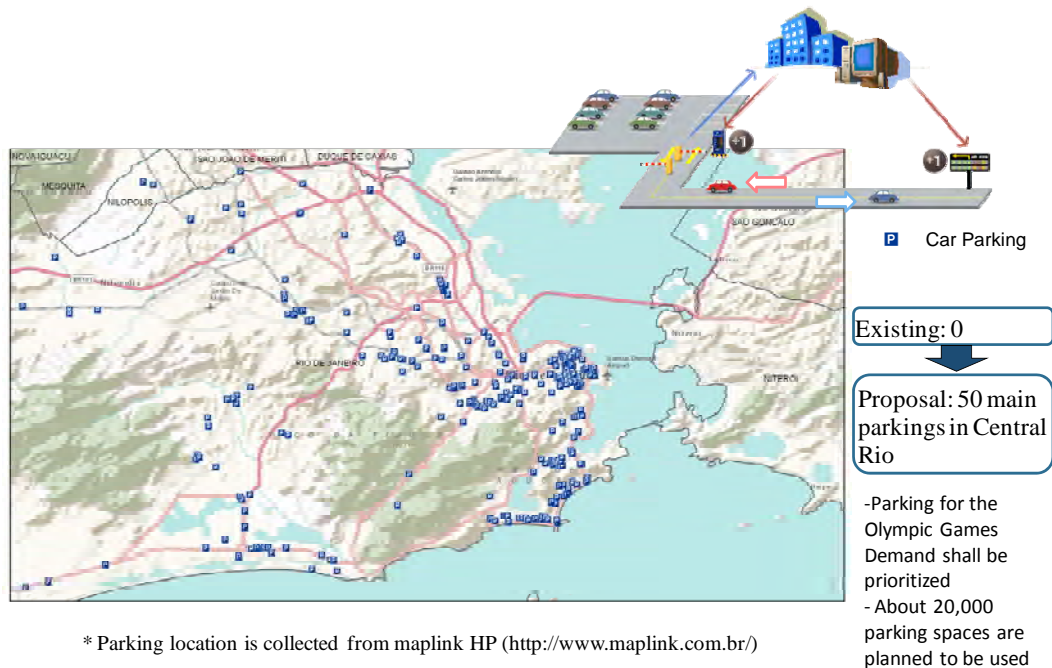


Source: JICA Study Team

Figure 7-40 Deployment Plan (VMS for Road Traffic – Central Rio)

B) VMS for Parking Information

RJ wise

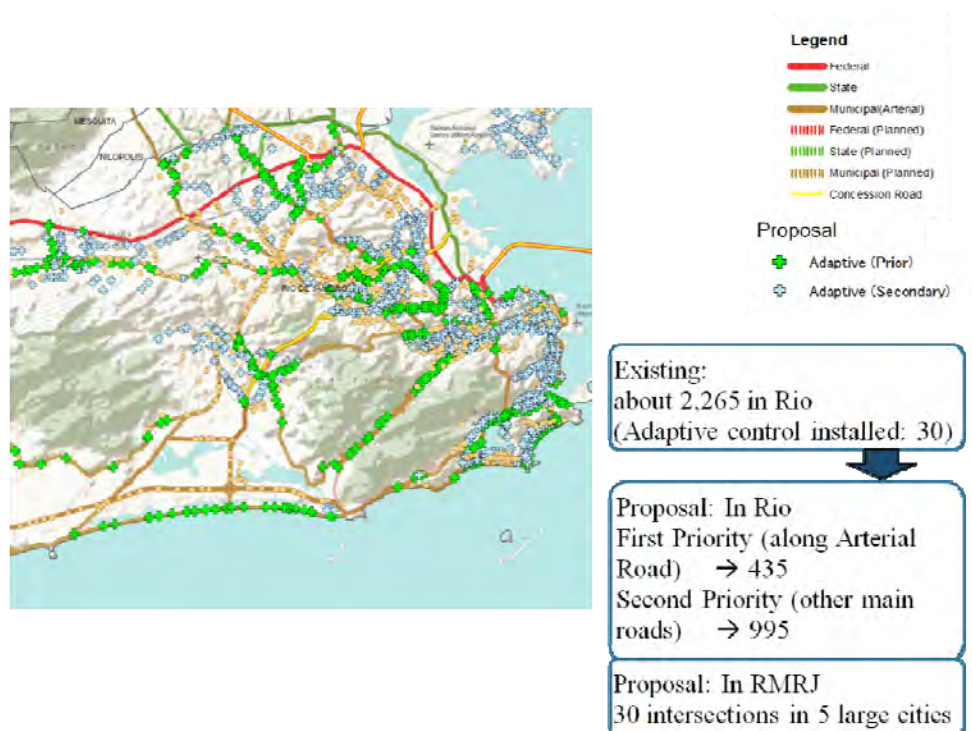


Source: JICA Study Team

Figure 7-41 Deployment Plan (VMS for Parking Information)

C) Traffic Signal for Adaptive Control

RJ wise



Source: JICA Study Team

Figure 7-42 Deployment Plan (Traffic Signal for Adaptive Control - RJ)



RMRJ wise

Rank of population

1. Sao Goncalo, 2. Duque de Caxias, 3. Nova Iguacu, 4. Niteroi, 5. Belford Roxo

D) Traffic Signal for BRT Priority



Source: JICA Study Team

Figure 7-43 Deployment Plan (Traffic Signal for BRT Priority)

E) ETC

All concession roads

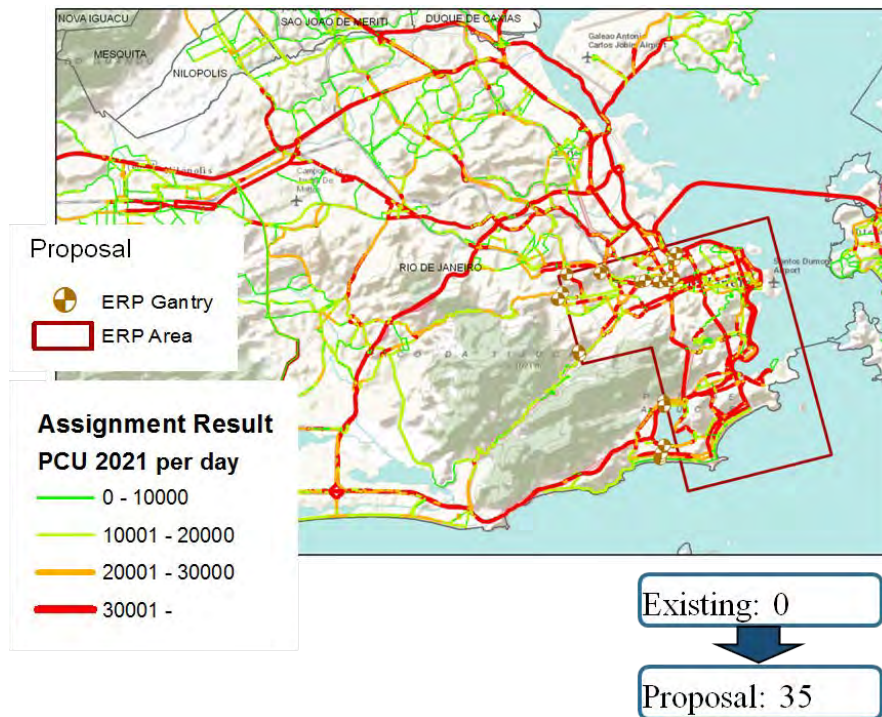


Source: JICA Study Team

Figure 7-44 Deployment Plan (ETC)

F) ERP

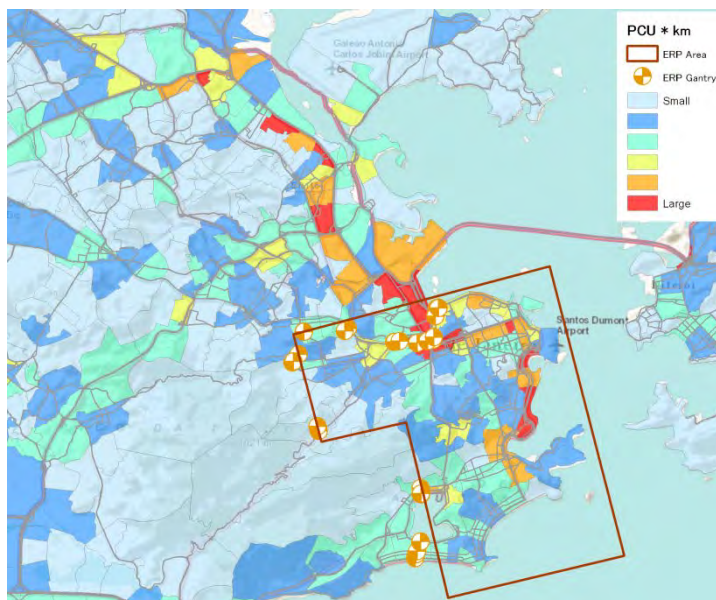
Proposed ERP area



Source: JICA Study Team

Figure 7-45 Deployment Plan (ERP)

[Ref] Traveler kilometer per area in 2011 day

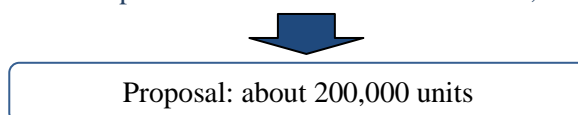


Source: JICA Study Team

Figure 7-46 Traveler Kilometer per Area in 2011 Day

[Ref] Estimated on-board unit to be disseminated

- Number of trips related to ERP area is about 500,000 vehicles trips



4) Land Public Transport (Passenger) (Taxi)

**i) Current Condition**

The municipality of Rio holds ITS facilities related to operation center for land public transport. However, electronic ticketing has not been acquired.

**Table 7-20 Current Condition (Land Public Transport)**

	Equipment	Federal	State	Municipality of Rio	Other Municipalities
1	GPS (Probe)	-	-	Yes (depends on the companies)	Not confirmed
2	Electronic Ticketing	-	-	No	No
3	Control Center	-	-	Yes (depends on the companies)	Not confirmed

Source: JICA Study Team

**ii) Methodology**

The methodology of deployment of ITS facilities is shown in Table 7-21. And in the next section, the deployment plan of each facility based on the results described above is shown.

**Table 7-21 Methodology of Deployment (Land Public Transport)**

	Equipment	Methodology of Deployment
1	GPS (Probe)	Number of vehicles registered in each municipality
2	Electronic Ticketing	Number of vehicles registered in each municipality
3	Control Center	Number of companies or cooperatives

Source: JICA Study Team



A) Taxi GPS (Probe) and Electronic Ticketing

Number of taxis (example)

**Table 7-22 Number of Taxis**

City	No. of Taxi	Source
Rio de Janeiro	32,000	Interview to SMTR
Niterói	1,900	NITTRANS WEBSITE
Sao Goncalo	1,200	O São Gonçalo (Newspaper website)

Existing: -



Proposal:

Rio → maximum 32,000

Others → to be confirmed

Source: JICA Study Team

B) Control Center

The number of companies or cooperatives is not confirmed.

**Table 7-23 Related Organizations**

Municipality	Related Organization
Rio de Janeiro	Secretaria Municipal de Transportes de Rio de
Duque de Caxias	Secretária Municipal de Transportes de Duque de Caxias
Itaguaí	Secretaria de Transportes de Itaguaí
Belford Roxo	Secretaria de Segurança, Trânsito de Defesa Civil de Belford Roxo
Guapimirim	Secretaria de Transportes de Guapimirim
Itaboraí	Secretaria Municipal de Trânsito
Japerí	Secretaria de Obras e Serviços Públicos de Japerí
Magé	Secretaria de Transportes de Magé
Mangaratiba	Secretaria de Transportes de Mangaratiba
Maricá	Secretaria Municipal de Transporte
Mesquita	Secretaria de Transportes de Mesquita
Nilópolis	Secretaria de Transportes de Nilópolis
Niterói	Secretaria de Serviços Públicos, Trânsito e Transporte de Niterói
Nova Iguaçu	Secretaria Municipal de Transportes de Nova Iguaçu
Paracambi	Secretaria de Transportes de Paracambi
Queimados	Secretaria de Transportes de Queimados
São Gonçalo	Secretaria Municipal de Transportes de São Gonçalo
São João de Meriti	Secretaria de Trânsito de São João de Meriti
Seropédica	Secretaria de Transportes de Seropédica
Tanguá	Secretaria de Transportes de Tanguá

Source: JICA Study Team

5) Land Public Transport (Passenger) (Bus and BRT)

i) **Current Condition**

The municipality of Rio holds ITS facilities related to operation center for land public transport. However, electronic ticketing has not been acquired. In ITS facilities for land public transport (bus and BRT), the holding period of the facility is different in each road administrator. The municipality of Rio holds all the facilities related to BRT.

**Table 7-24 Current Condition (Land Public Transport)**

	Equipment	International Bus	Inter State Bus	Inter Municipal Bus	Municipal Bus of Rio	Bus of Other Municipalities	BRT (Municipality of Rio)
1	CCTV (Terminals)	Yes (Novo Rio: 56)	Yes (Novo Rio: 56)	Yes (Novo Rio: 56)	Not confirmed	Not confirmed	Yes
2	CCTV (Buses)	Not confirmed	Not confirmed	Yes (4 per bus)	Yes	Not confirmed	Yes (4 per bus)
3	GPS (Probe)	Not confirmed	Not confirmed	Yes (DETRO)	Yes (SMTR)	No (Niteroi: in planning)	Yes (SMTR)
4	VMS / Monitor (Terminals)	Yes (Novo Rio)	Yes (Novo Rio)	Yes (Novo Rio)	No	No	Yes
5	VMS / Monitor (Stops)	-	-	-	No	No	Yes (8 per station)
6	VMS / Monitor (Buses)	Not confirmed	Not confirmed	Not confirmed	Yes (various depends on the bus)	Not confirmed	Yes (3 per bus)
7	Electronic Ticketing	-	-	Yes (RioCard)	Yes (RioCard)	Not confirmed	Yes (RioCard)
8	Control Center	Not confirmed	Not confirmed	Yes (Rio Onibus)	Yes (Rio Onibus)	Not confirmed	Yes (Rio Onibus)
9	Monitoring Center	No	No	No (DETRO: in planning)	Yes (SMTR)	No	Yes (SMTR)

Source: JICA Study Team



**ii) Methodology**

The methodology of deployment of ITS facilities is shown in Table 7-25. And in the next section, the deployment plan of each facility based on the results described above is shown.

**Table 7-25 Methodology of Deployment (Land Public Transport)**

	Equipment	Methodology of Deployment
1	CCTV (Terminals)	All terminals at the same level as Novo Rio
2	CCTV (Buses)	All vehicles at the same level as BRT vehicles
3	GPS (Probe)	All vehicles at the same level as BRT vehicles
4	VMS / Monitor (Terminals)	All terminals at the same level as Novo Rio
5	VMS / Monitor (Stops)	Sheltered bus stops along arterial roads in the municipality of Rio For RMRJ, estimated from the population of Rio and RMRJ For BRT, keep the current condition
6	VMS / Monitor (Buses)	Bus lines operated in tourist areas At least one VMS or monitor shall be required in a bus
7	Electronic Ticketing	For the buses of Rio Onibus , keep the current condition All vehicles for municipal buses except the municipality of Rio Card for cashless payment shall be integrated
8	Control Center	Integrated control center is required in each region or union Integrated control center is required to cover all type of buses
9	Monitoring Center	Monitoring centers for ANTT, DETRO, and municipalities are required to be developed or improved Information exchange between traffic operators and other transport operators (details shall be mentioned in the master plan)

Source: JICA Study Team

A) International Bus and Interstate Bus

**Terminals**

Number of terminals: 2

\* Deployment for inter-municipal bus shall be further developed in the long term

**Table 7-26 Number of Terminals**

Number	Location	Type of Service
Novo Rio	Rio de Janeiro	International Interstate Intermunicipal
Roberto Silveira	Niterói	Interstate Intermunicipal

**CCTV (Terminals)**

Existing: Novo Rio → Yes

Proposal: 2 terminals

**VMS / Monitor (Terminals)**

Existing: Novo Rio → Yes

Proposal: 2 terminals

**Bus**

International Bus -> Number of lines: 6 (shown in Table 7-27 below)

Interstate Bus -> Number of lines: 181

Source: JICA Study Team

**Table 7-27 Number of Bus Lines using the NOVO RIO Terminal**

\*Assumption: 1 vehicle for 1 line

International Bus Line using the NOVO RIO Terminal				
	Origin	Destination	N. LINE	COMPANY
1	Rio de Janeiro	Buenos Aires (Argentina)	1	CRUCERO DEL NORTE AND PLUMA
2	Rio de Janeiro	Rosario (Argentina)	1	CRUCERO DEL NORTE AND PLUMA
3	Rio de Janeiro	Assunção (Paraguay)	1	PLUMA
4	Rio de Janeiro	Cidade Del Leste (Paraguay)	1	PLUMA
5	Rio de Janeiro	Santiago (Chile)	1	PLUMA
6	Rio de Janeiro	Puerto Suarez (Bolívia)	1	ANDORINHA

**GPS (Bus)**

Existing: not confirmed

Proposal: 187 vehicles

**VMS / Monitor (Bus)**

Existing: not confirmed

Proposal: 187 vehicles

Source: ANTT website

Source: JICA Study Team

B) Inter-municipal Bus

**Terminals**

Number of terminals: 18

(excluding NovoRio and Robeiro Silveira)

**Bus**

Number of buses: 5,688 in RMRJ

2,800 in RJ

(estimated)

Number of lines: 565 in RMRJ

273 in RJ

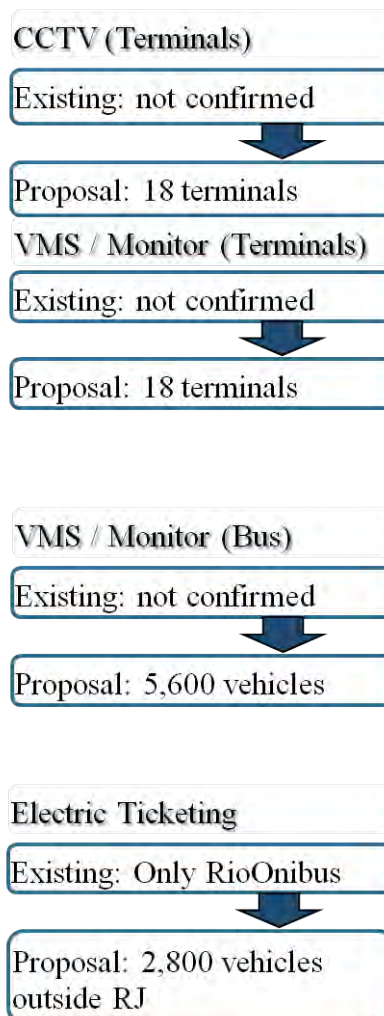
\* Deployment for inter-municipal bus shall be further developed in the long term.

\* Assumption: the number of vehicles in RJ is estimated from the number of lines in RMRJ.

**Table 7-28 Number of Terminals, Lines, and Buses**

Name	Location
<b>Novo Rio</b>	<b>Rio de Janeiro</b>
Menezes Cortes	Rio de Janeiro
MISERICÓRDIA (Praça XV)	Rio de Janeiro
Mariano Procópio	Rio de Janeiro
Américo Fontenele	Rio de Janeiro
Nova Aurora	Belford Roxo
Mascarenhas	Dq. Caxias
Plinio Casado	Dq. Caxias
Jose Carlos Lacerda	Dq. Caxias
Guapimirim	Guapimirim
Venda das Pedras	Itaboraí
Terminal de Itaguaí	Itaguaí
Rodoviária de Magé	Magé
Terminal de Maricá	Maricá
Terminal de Nilópolis	Nilópolis
Rodoviária de Nv. Iguaçú	Nv. Iguaçú
Rodoviaria de Éden	S. J. Meriti
João Goulard	Niterói
<b>Roberto Silveira</b>	<b>Niterói</b>
Jayme Mendonça Campos	São Gonçalo

Region	No. of Lines	No. of Buses
Inside RMRJ	565	5,688
Rio	273	About 2,800 (estimated)



Source: Fetranpor website

DETRO website

Source: JICA Study Team

C) Municipal Bus of Rio

**Terminals**

Number of terminals: 24  
 (Excluding Central do Brasil and Praca XV)

**Bus stops**

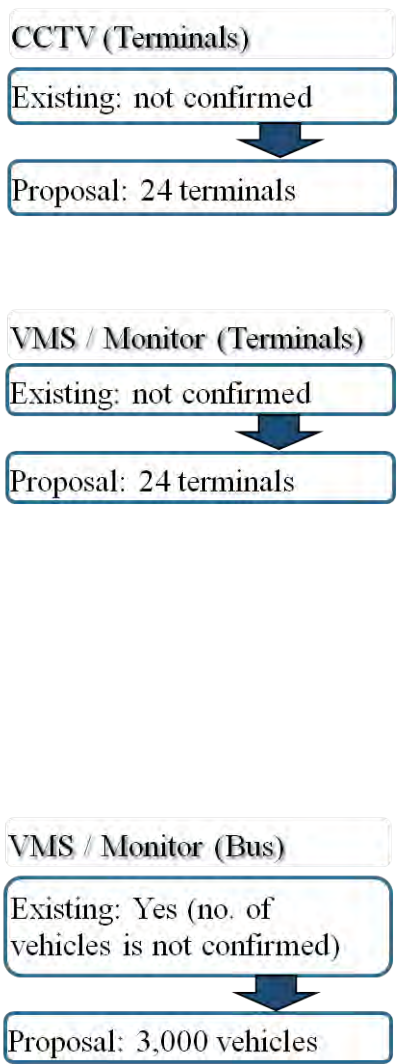
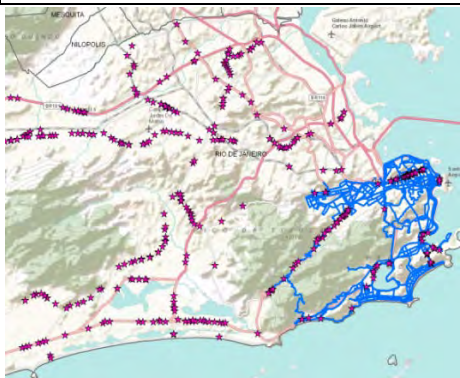
Number of stops with shelter: 2136  
 About 400-500 stops along arterial roads shall be selected (marked with stars in Figure 7-47)

**Bus inside**

Number of vehicles: 9000 .....Source: interview with SMTR  
 About 3,000 vehicles in Centro and Copacabana areas (main tourist area in RJ)  
 shall be selected (marked as blue lines in Figure 7-47)

**Table 7-29 Name of Terminals, Bus Stops, and Buses**

Name
Alvorada
Da JOATINGA
Serrinha
Terreirão
Cascadura (Deputado Souza Marques)
Cascadura (Pça. Nossa Senhora Do Amparo)
Procópio Ferreira (Central do Brasil)
Misericórdia (Praça XV)
Alfredo Agache (Mergulhão)
Cosme Velho
Puc
Ribeira
Fundão
Banda de Ipanema
Irará (Amarelinho – Enock Anselmo Dos Santos)
Curicica
Arquiteto Julius Sass (Gardênia Azul)
Freguesia (Rodoviário Urbano José Duarte)
Madureira
Américo Ayres
Arquiteto Paciello
Pavuna
Penha – Daniel Barata
Santa Cruz
Padre Henrique Otte
Usina



Source: JICA Study Team

**Figure 7-47 Bus Lines and Stops**



D) Bus of Other Municipalities

**Terminals**

Number of terminals: 0  
 (All terminals are shared with inter-municipal bus lines)

**Bus stops**

Number of stops with shelter: 2,136 (estimated)  
 About 350-450 stops along arterial roads shall be selected  
 .....Estimated from the population between the municipality of Rio and RMRJ

**Bus inside**

Number of vehicles: 7,800 (estimated)  
 About 2,700 vehicles along arterial roads shall be selected  
 .....Estimated from the population between the municipality of Rio and RMRJ

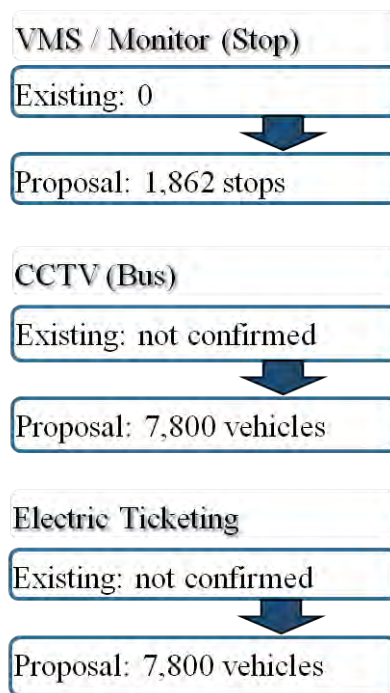
**Table 7-30 Names of Terminals**

Name	Municipality
Guapimirim	Guapimirim
Venda das Pedras	Itaboraí
Terminal de Itaguaí	Itaguaí
Rodoviária de Magé	Magé
Terminal de Maricá	Maricá
Terminal de Nilópolis	Nilópolis
Rodoviária de Nv. Iguaçu	Nv. Iguaçu
Rodoviaria de Éden	S. J. Meriti
João Goulard	Niterói
Jayme Mendonça Campos	São Gonçalo

**Table 7-31 Population in 2010**

Population (2010)	
Municipality of Rio	6,323,037
RMRJ	11,835,708
Ratio	1.9

\* Deployment for inter-municipal bus shall be further developed in the long term



Source: JICA Study Team

E) BRT in Rio

Terminals/Stations and Buses

Number of terminals: 1 terminal and 32 stations (current)

14 terminals and 141 stations (in the future)

(16 shall be integration terminals)

Number of buses : 87 vehicles (current)

2,800 vehicles (in the future)

Estimated from projected passengers

Provided by Rio Onibus

Terminals and Stations with all equipment

Existing: 33 terminals and stations



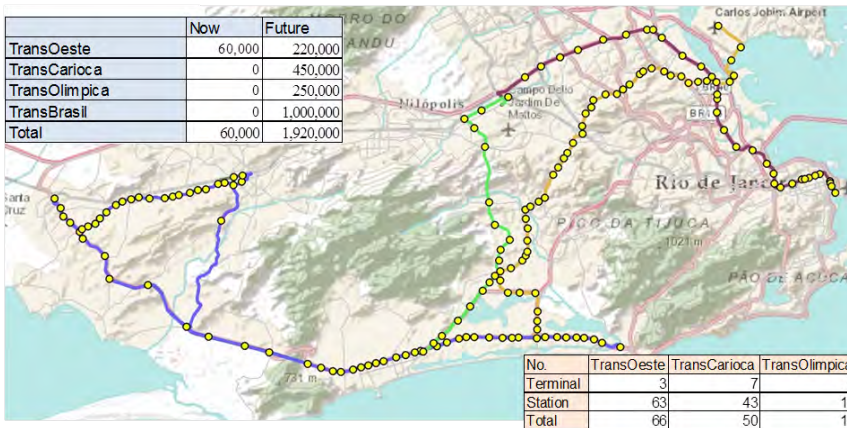
Proposal: 155 terminals and stations

Bus with all equipment

Existing: 87 vehicles



Proposal: about 2,800 vehicles



Name	Integration Point
Aeroporto Internacional	BRT - Airport
Alvorada	BRT - BRT
Av. Brasil	BRT - BRT
Parque Olímpico	BRT - BRT
Recreio	BRT - BRT
Terminal das Missoes	BRT - Bus
Terminal Guanabara	BRT - Bus
Terminal Margaridas	BRT - Bus
Vicente de Carvalho	BRT - Metro
Jardim Oceanico	BRT - Metro L4
Deodoro	BRT - SuperVia
Madureira	BRT - SuperVia
Mercadao	BRT - SuperVia
Olaria	BRT - SuperVia
Santa Cruz	BRT - SuperVia
Terminal Central	BRT - SuperVia
<b>Total</b>	<b>16</b>

Source: Provided by SMTR

Figure 7-48 Bus Terminals and Stops

6) Land Public Transport (Passenger) (Rail, Metro, Cable Car, and Tram)

i) **Current Condition**

The concession company hold almost all of the ITS facilities related to land public transport (rail, metro, cable car, and tram). However, almost all road administrators do not have them.

**Table 7-32 Current Condition (Land Public Transport)**

	Equipment	Federal	State	Municipality of Rio	Other Municipalities	Concession
1	CCTV (Station)	-	-	-	-	Yes
2	VMS / Monitor (Station)	-	-	-	-	Yes
3	VMS / Monitor (Trains)	-	-	-	-	No (only new vehicles)
4	Electronic Ticketing	-	-	-	-	Yes
5	Control Center	-	-	-	-	Yes
6	Safety at Rail Crossing	-	-	-	-	Not enough
7	Monitoring Center	-	AGETRA NSP	-	-	-

Source: JICA Study Team

ii) **Methodology**

The methodology of deployment of ITS facilities is shown in Table 7-33. And in the next section, the deployment plan of each facility based on the results described above is shown.

**Table 7-33 Methodology of Deployment (Land Public Transport)**

	Equipment	Methodology of Deployment
1	CCTV (Station)	All stations (SuperVIA, Metro, and Cable Car)
2	VMS/Monitor (Station)	All stations (SuperVIA, Metro, and Cable Car)
3	VMS/Monitor (Trains)	All vehicles (SuperVIA and Metro)
4	Electronic Ticketing	All stations (SuperVIA, Metro, and Cable Car)
5	Control Center	Integrated center is required to cover all modes (details shall be mentioned in master plan)
6	Safety at the Rail Crossing	All crossings
7	Monitoring Center	Integrated center is required to cover all modes (details shall be mentioned in master plan)

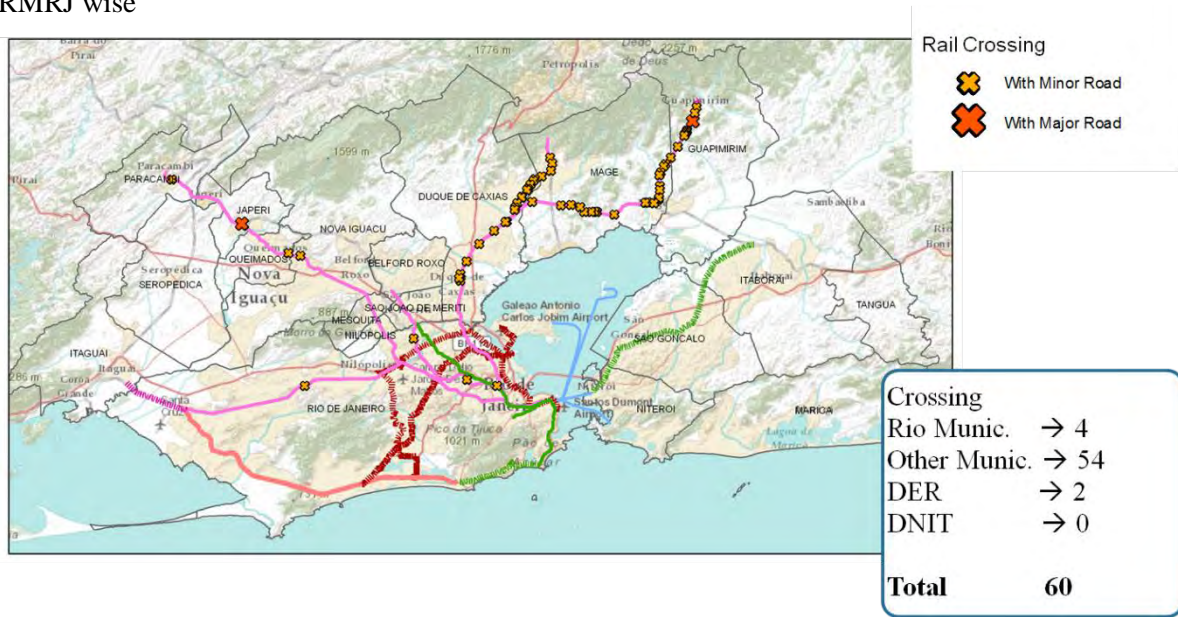
Source: JICA Study Team





iv) Safety at the Crossing

RMRJ wise



Source: JICA Study Team

Figure 7-51 Deployment Plan (Safety at the Crossing)

v) Metro: CCTV (Station), VMS/Monitor (Station), VMS/Monitor (Train) and Electronic Ticketing (Station)

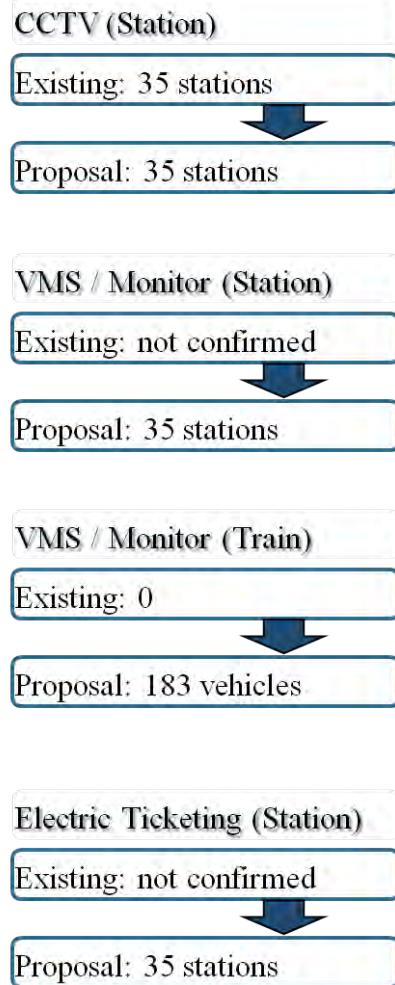


Figure 7-52 Route Map of Metro

Inside the Train

Number of vehicles: 183

Number of fleets: 32

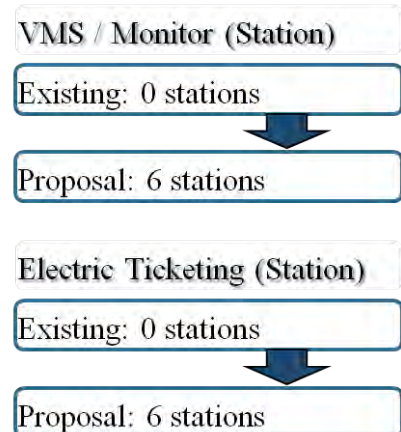


Source: JICA Study Team

vi) Cable Car: CCTV (Station), VMS/Monitor (Station) and Electronic Ticketing (Station)



Figure 7-53 Route Map of Cable Car



Source: JICA Study Team

7) Land Public Transport (Boat)

i) **Current Condition**

The concession company owns and manages the ITS facilities for (boat) land public transport.

**Table 7-34 Current Condition (Land Public Transport)**

	Equipment	Federal	State	Municipality of Rio	Other Municipalities	Concession
1	GPS (Boat)	-	-	-	-	Yes
2	CCTV (Port)	-	-	-	-	Yes (157)
3	VMS / Monitor (Port)	-	-	-	-	No
4	Electronic Ticketing	-	-	-	-	Yes
5	Control Center	-	-	-	-	Yes
6	Monitoring Center	-	AGETRAM SP	-	-	-

Source: JICA Study Team

ii) **Methodology**

The methodology of deployment ITS facility is shown in Table 7-35. And in the next section, the deployment plan of each facility based on the results described above is shown.

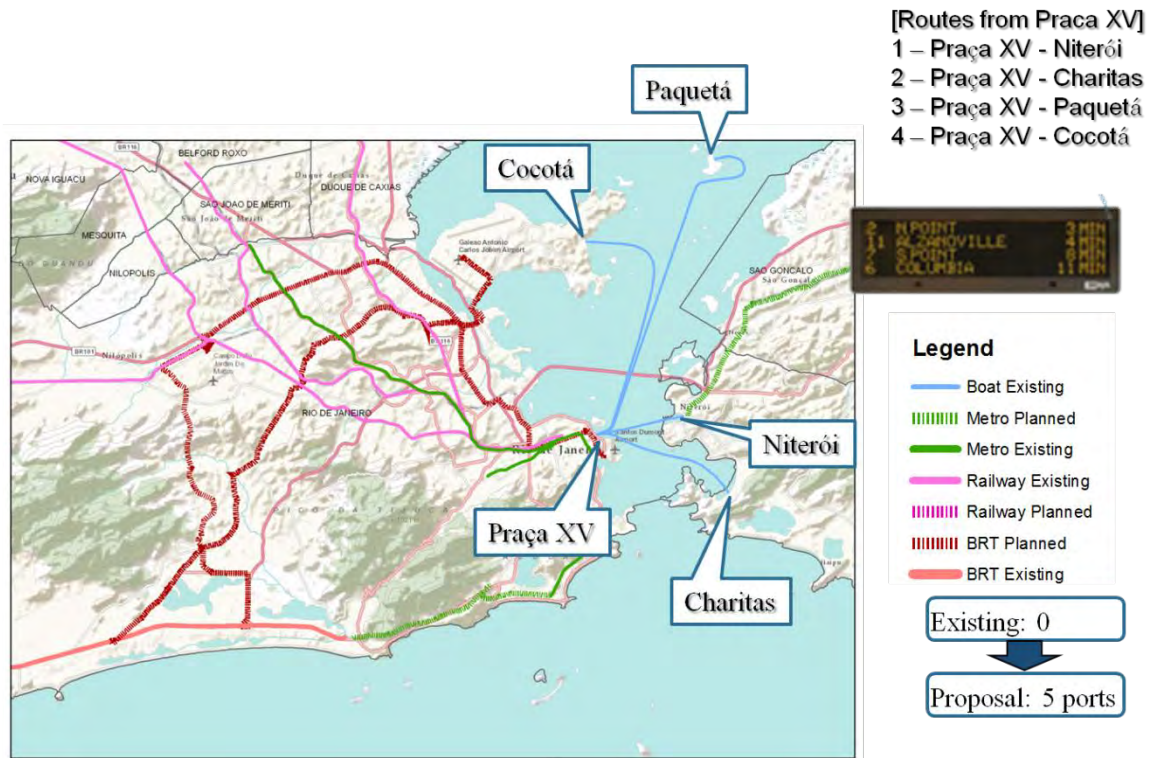
**Table 7-35 Methodology of Deployment (Land Public Transport)**

	Equipment	Methodology of Deployment
1	GPS (Boat)	Keep in current condition
2	CCTV (Port)	Keep in current condition
3	VMS/Monitor (Port)	Deploy in the port in order to provide arrival/departure information and information of other modes
4	Electronic Ticketing	Keep in current condition
5	Control Center	Integrated center is required to cover all modes (details shall be mentioned in the master plan)
6	Monitoring Center	

Source: JICA Study Team

A) VMS/Monitor

Port of Barcas



Source: JICA Study Team

Figure 7-54 Location of the Port



8) Land Freight Transport (Truck and Rail)

**i) Current Condition**

The concession company owns and manages the ITS facilities for (truck and rail) land freight transport.

**Table 7-36 Current Condition (Land Freight Transport)**

	Equipment	Federal	State	Municipality of Rio	Other Municipalities	Concession Company
1	GPS (Truck)	-	-	-	-	Yes
2	Control Center	-	-	-	-	Yes
3	Security Lock	-	-	-	-	Yes
4	Monitoring Center	Not confirmed	-	-	-	-
5	Weighing Point	No in RMRJ	-	-	-	-
6	Safety at the Crossing	Not enough	-	-	-	-

Source: JICA Study Team

**ii) Methodology**

The methodology of deployment ITS facility is shown in Table 7-37. And in the next section, the deployment plan of each facility based on the results described above is shown.

**Table 7-37 Methodology of Deployment (Land Freight Transport)**

	Equipment	Methodology of Deployment
1	GPS (Truck)	Leave it to private companies. Information exchange shall be necessary.
2	Control Center	Leave it to private companies. Information exchange shall be necessary.
3	Security Lock	Leave it to private companies. Information exchange shall be necessary.
4	Monitoring Center	Based on ANTT needs
5	Weighing Point	Deploy on a section at the border of the metropolitan region to monitor the weight of in-bound cargo. Deploy on a road which is maintained intensively like the bridge and flyover.
6	Safety at Crossing	All crossings

Source: JICA Study Team

A) Weighing Point

RMRJ wise



Source: JICA Study Team

Figure 7-55 Deployment Plan (Weighing Point)

B) Safety at the Crossing

RMRJ wise



Source: JICA Study Team

Figure 7-56 Deployment Plan (Safety at the Crossing)

## 7.2.6 Rough Cost Estimates

### (1) Cost Estimation Policy

When requirements are not specified in the early stages of the project, a rough order of magnitude estimate is used as a solution in estimating capital cost. The rough order of magnitude estimate is the least accurate estimate, and it is -50% to +50% accurate. In this master plan study, the rough order of magnitude estimate is brought to conduct the rough cost estimates of each ITS project.

### (2) Summary of the Result of Cost Estimates

Table 7-38 below shows a list of the ITS projects. The conditions and assumptions used as basis of the rough cost estimates are shown in sub-clauses (3) and (4).

**Table 7-38 Rough Cost Estimates of ITS Projects**

No.	ITS Project Name	Amount (R\$)	Amount (¥)
1	ITS Center	59.900.000	2,371,000,000
2	Real Time Traffic/Transport Condition Information Processing	45.900.000	1,815,000,000
3	Olympic Security and Transport Coordination Center	48.900.000	1,936,000,000
4	Bus Condition Information Provision	122.300.000	4,840,000,000
5	Dissemination of On-board Unit for More Integrated Transport	344.900.000	13,643,000,000
6	Information Exchange of Road Operators	55.400,000	2,193,000,000
7	Information Exchange via ITS Center between Municipalities	58.100.000	2,299,000,000
8	Improvement of Traffic/Transit Operation Center with Essential ITS Equipment in Rio Municipal Area	245.600.000	9,716,000,000
9	Improvement of Traffic/Transit Operation Center with Essential ITS Equipment in Other Municipal Areas in RMRJ	204.700.000	8,096,000,000
10	Emergency Operating Management	18.500.000	733,000,000
11	Commercial Vehicle Operation and Management	17.600.000	696,000,000
12	Advanced Vehicle Safety Systems	Depends on the industrial car maker's technological development	
13	Deployment of X-band Radars	4.600.000	182,000,000

Source: JICA Study Team

(3) Conditions of Cost Estimates

1) Common conditions and assumptions

The rough cost estimate is conducted based on the following common conditions and assumptions:

- Equipment cost is based on the consultant's experience;
- Installation cost is 10% of the equipment cost;
- Consultancy service is taken into consideration from the viewpoint of proper design, and schedule and quality management of implementation during the design and procurement stages;
- Consultancy service cost is 10% of the sum of the equipment and installation costs.

2) Conditions and assumptions for individual ITS projects in the ITS master plan

The conditions and assumptions for individual ITS projects are summarized in Table 7-39 below.

**Table 7-39 Conditions and Assumptions for Individual ITS Projects**

No.	ITS Project Name	Conditions and Assumptions
1	ITS Center	<ul style="list-style-type: none"> <li>- System for collecting and providing information</li> <li>- Target organizations/agencies: 33 (refer to Table 7-40)</li> <li>- Including construction cost for the ITS Center building which has a total floor space of approximately 1,200 m<sup>2</sup> (40 m x 30 m)</li> </ul>
2	Real Time Traffic/Transport Condition Information Processing	<ul style="list-style-type: none"> <li>- System for processing and unifying data</li> </ul>
3	Olympic Security and Transport Coordination Center	<ul style="list-style-type: none"> <li>- Sharing of security information between COR and CICC toward hosting of large-scale events such as Olympic Games and World Cup</li> <li>- System for information exchange between traffic and bus operators (introduction of PTPS (Public Transportation Priority System))</li> <li>- System for information exchange among mass transportation operators such as bus, metro, and train operators</li> </ul>
4	Bus Condition Information Provision	<ul style="list-style-type: none"> <li>- Bus location system (obtain location of bus, information provision at bus stop and inside of bus)</li> <li>- Next bus information panel: 500 sets (assuming 500, which have the largest number of passengers of all bus stops, 2,134 in the municipality of Rio and 7,800 in municipalities other than Rio)</li> <li>- Information display in bus terminal: 44 sets</li> <li>- Information display in bus: 3,000 vehicles (assuming 3,000 of all buses, 9,000 in the municipality of Rio and 7,800 in municipalities other than Rio)</li> <li>- Bus operation center: three centers (introduction of operation centers same as RIO ONIBUS to three unions: Transonibus, Setransduc, Setrerj)</li> <li>- Bus GPS: 9,000 sets (all buses in municipalities other than Rio)</li> </ul>
5	Dissemination of On-board Unit for More Integrated Transport System	<ul style="list-style-type: none"> <li>- Distribution of On-board Unit: 200,000 sets</li> <li>- ETC: 8 sets</li> <li>- ERP: 35 sets</li> <li>- Free Flow Cashless System: 50 parking areas (where there is high ratio of utilization)</li> <li>- DSRC antenna: 25 sets (assuming the number of antennas which will be procured by the Ministry of Public Management, Home Affairs, Posts and Telecommunications in Japan)</li> </ul>



6	Information Exchange of Road Operators	<ul style="list-style-type: none"> <li>- System for information exchange among road administration offices</li> <li>- Target organizations/agencies: 8 (refer to Table 7-40)</li> <li>- VMS: 36 sets</li> <li>- CCTV: 11 sets</li> <li>- OCR: 21 sets</li> <li>- MOE: 10 sets</li> <li>- Dynamic Lane Management: 10 sets</li> <li>i) Taxi Dispatching System: Assuming introduction to 5 taxi companies</li> <li>- Rail Crossing Management: 88 sets</li> </ul>
7	Information Exchange via ITS Center between Municipalities	<ul style="list-style-type: none"> <li>- System for information exchange among the municipalities in Rio Metropolitan Area</li> <li>- Target municipalities: 19 (BelfordRoxo, DuquedeCaxias, Guapimirim, Itaboraí, Itaguaí, Japeri, Maricá, Magé, Mesquita, Nilópolis, Niterói, NovaGuaçu, Paracambi, Queimados, Rio de Janeiro, SãoGonçalo, SãoJoãodeMeriti, Seropédica, and Tanguá,)</li> </ul>
8	Improvement of Traffic/Transit Operation Center with Essential ITS Equipment in Rio Municipal Area	<ul style="list-style-type: none"> <li>- Adaptive Signal Control: 400 intersections</li> <li>- VMS: 58 sets</li> <li>- CCTV: 5 sets</li> <li>- OCR: 68 sets</li> <li>- Work Zone Monitoring: assuming 1 system</li> <li>- Park Availability Information Provision: assuming 1 system</li> <li>- Concentrated Infrastructure Monitoring: assuming 1 system</li> <li>- MOE: 5 sets</li> <li>- Dynamic Lane Management: 10 sets</li> <li>- Taxi Dispatching System: Assuming introduction to 10 taxi companies</li> <li>- Rail Crossing Management: 11 sets</li> </ul>
9	Improvement of Traffic/Transit Operation Center with Essential ITS Equipment in Other Municipal Areas in RMRJ	<ul style="list-style-type: none"> <li>- Adaptive Signal Control: 150 intersections</li> <li>- VMS: 13 sets</li> <li>- CCTV: 5 sets</li> <li>- OCR: 8 sets</li> <li>- Work Zone Monitoring: assuming 1 system</li> <li>- Concentrated Infrastructure Monitoring: assuming 1 system</li> <li>- MOE: 9 sets</li> <li>- Dynamic Lane Management: 10 sets</li> <li>- Taxi Dispatching System: Assuming introduction to 5 taxi companies</li> <li>- Rail Crossing Management: 88 sets</li> </ul>
10	Emergency Operating Management	<ul style="list-style-type: none"> <li>- Traffic Light Prioritizing System: assuming 1 system operated with adaptive signal control system</li> <li>- Distribution of On-board Unit for emergency vehicle: Assuming 200 vehicles</li> <li>- DSRC antennas: assuming 100 sets in 50 intersections</li> </ul>
11	Commercial Vehicle Operation and Management	<ul style="list-style-type: none"> <li>- Weigh in Motion system: 6 sets</li> <li>- Distribution of On-board Unit for commercial vehicle: Assuming 1000 vehicles</li> </ul>
12	Advanced Vehicle Safety Systems	<ul style="list-style-type: none"> <li>- Vehicle to Roadway Communication System</li> <li>- Vehicle to Vehicle Communication System</li> </ul>
13	Deployment of X-band Radars	<ul style="list-style-type: none"> <li>- X-band radar system for rainfall measurement</li> </ul>

Source: JICA Study Team

**Table 7-40 ITS Related Organizations**

	Public Organization	Concessionaire / Private Company	Number of ITS related organization/Concessionaire/Private companies which have information to be aggregated to ITS Center (shown in bold letters)	Road-related Organization
Federal Governmental Organization	ANTT	<b>CCR-Ponte (Road)</b>	3	3
	<b>DNTT(Road)</b>	<b>Autopista Fluminense (Road)</b>		
	CONTRAN			
	DENATRAN			
	ANATEL			
	ABNT			
State Organization	DETRAN-RJ	<b>SuperVia (Train)</b>	19	3
	PRODERJ-RJ	<b>Tram (Train)</b>		
	AGETRANSP-RJ	<b>Metro (Metro)</b>		
	AMTU	<b>SindpassBus concessionaire(BUS)</b>		
	CENTRAL-SETRANS	<b>TransOnibus(BUS)</b>		
	RIO TORIHOS-SETRANS	<b>Seranspass(BUS)</b>		
	DETRO-SETRANS	<b>Setransduc(BUS)</b>		
	CODERTE-SETRANS	<b>Setrerj(BUS)</b>		
	<b>DER-RJ(Road)</b>	<b>Sinterj(BUS)</b>		
	AMTU-SETRANS	<b>Sinfrerj(BUS)</b>		
	CBMERJ-CIVIL	<b>Setransol(BUS)</b>		
	<b>DEFENCE-SEDEC</b>			
	<b>SIMERJ-CESTAD-CIVIL DEFENCE-SEDEC</b>	<b>Novo Rio (Bus terminal)</b>		
	INEA-SEA	<b>Rota 116 (Road)</b>		
	<b>CCR-Vialagos (Road)</b>			
	<b>CCR-Barcas (Ferry)</b>			
Municipal Organization	COR	<b>Bike-Rio (Rental Bicycle)</b>	11	2
	SMTR	<b>Internorte (Bus)</b>		
	<b>CETRIO-SMTR(Road)</b>	<b>Intersul (Bus)</b>		
	SECONSERVA	<b>Transcarioca (Bus)</b>		
	SMAC	<b>Santa Cruz (Bus)</b>		
	CIVIL DEFENCE-SMSDC	<b>Radio Taxi (Taxi)</b>		
	<b>GEORIO-SMO</b>	<b>Coopamar (Taxi)</b>		
		<b>Chile Taxi (Taxi)</b>		
		<b>Lamsa (Road)</b>		
<b>Total</b>			<b>33</b>	<b>8</b>

Source: JICA Study Team

(4) Breakdown of Rough Cost Estimates

Breakdown of the rough cost estimates of each ITS project is as follows:

ITS Project Name: ITS Center

No.1

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	Concessionaire/Private Company						
	Information Exchange System	hardware and software	system	33	50,000	1,650,000	41,709
2)	ITS Center						
	Information Exchange System		system	1	100,000	100,000	2,528
	Information Distribution System		system	1	100,000	100,000	2,528
3)	Installation and Test					185,000	4,676
	<b>Sub total</b>					<b>2,035,000</b>	<b>51,441</b>
<b>2</b>	<b>Civil Construction</b>						
1)	ITS Center Building	1200 m <sup>2</sup>	lot	1		120,000	3,033
	<b>Sub total</b>					<b>120,000</b>	<b>3,033</b>
<b>3</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1		215,500	5,447
	<b>Sub total</b>					<b>215,500</b>	<b>5,447</b>
	<b>TOTAL</b>					<b>2,370,500</b>	<b>59,922</b>

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

ITS Project Name: Real Time Traffic/Transport Condition Information Processing

No.2

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	ITS Center						
	Probe Information Server		system	1	400,000	400,000	10,111
	Transit Information Server		system	1	400,000	400,000	10,111
	Point Information Server		system	1	300,000	300,000	7,583
	Incident Monitoring Server		system	1	300,000	300,000	7,583
	Weather Monitoring Server		system	1	100,000	200,000	5,056
2)	Installation and Test					160,000	4,044
	<b>Sub total</b>					<b>1,760,000</b>	<b>44,489</b>
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1		176,000	4,449
	<b>Sub total</b>					<b>176,000</b>	<b>4,449</b>
	<b>TOTAL</b>					<b>1,936,000</b>	<b>48,938</b>

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

ITS Project Name: Olympic Security and Transport Coordination Center

No.3

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	System Integration into CICC or COR						
		lot	1	1,000,000	1,000,000	25,278	
	Information Exchange system between transit operators						
	Information Exchange System for Bus Operator (RioOnibus)	system	1	100,000	100,000	2,528	
	Information Exchange System for Metro	system	1	100,000	100,000	2,528	
	Information Exchange System for Train	system	1	100,000	100,000	2,528	
	Information Exchange system for COR	system	1	100,000	100,000	2,528	
	Information Exchange system for CICC	system	1	100,000	100,000	2,528	
2)	Installation and Test				150,000	3,792	1)*10%
	<b>Sub total</b>				<b>1,650,000</b>	<b>41,709</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	165,000	4,171	1.*10%
	<b>Sub total</b>				<b>165,000</b>	<b>4,171</b>	
	<b>TOTAL</b>				<b>1,815,000</b>	<b>45,880</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

ITS Project Name: Bus Condition Information Provision

No4

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	Bus terminal						
	Next Bus Information Panel	set	500	3,000	1,500,000	37,917	
	Information Display in Bus terminal	set	44	5,000	220,000	5,561	
	Information Display in Bus	set	3000	500	1,500,000	37,917	
	Bus Operation Center	system	3	200,000	600,000	15,167	
	Bus GPS	set	9000	20	180,000	4,550	
2)	Installation and Test				400,000	10,111	1)*10%
	<b>Sub total</b>				<b>4,400,000</b>	<b>111,223</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	440,000	11,122	1.*10%
	<b>Sub total</b>				<b>440,000</b>	<b>11,122</b>	
	<b>TOTAL</b>				<b>4,840,000</b>	<b>122,346</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team



ITS Project Name: Dissemination of On-Board Unit for more integrated Transport

No.5

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	On board Unit	set	200000	30	6,000,000	151,668	
2)	Road side						
	ETC	set	8	100,000	800,000	20,222	
	Free Flow Cashless Parking system	set	50	5,000	250,000	6,320	
	ERP	set	35	100,000	3,500,000	88,473	
	DSRC	set	25	5,000	125,000	3,160	
3)	Center						
	ETC	system	1	100,000	100,000	2,528	
	Free Flow Cashless Parking system	system	1	100,000	100,000	2,528	
	ERP	system	1	200,000	200,000	5,056	
	DSRC	system	1	200,000	200,000	5,056	
4)	Installation and Test				1,127,500	28,501	sum[(1)~(3)]*10%
	<b>Sub total</b>				<b>12,402,500</b>	<b>313,511</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	1,240,250	31,351	1.*10%
	<b>Sub total</b>				<b>1,240,250</b>	<b>31,351</b>	
	<b>TOTAL</b>				<b>13,642,750</b>	<b>344,862</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

ITS Project Name: Information Exchange of Road Operators

No.6

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	Road Office/Road Concessionaire						
	Information exchange system for Road Office/Road Concessionaire	system	8	100,000	800,000	20,222	
2)	Road Side						
	VMS	DNIT13,DER23	set	36	15,000	540,000	13,650
	CCTV	DNIT 3,DER 8	set	11	2,000	22,000	556
	OCR	DNIT13,DER8	set	21	10,000	210,000	5,308
	MOE	DNIT 6,DER 4	set	10	4,000	40,000	1,011
	Rail Crossing Management	DNIT 0,DER 4	set	4	50,000	200,000	5,056
3)	Installation and Test				181,200	4,580	1)*10%
	<b>Sub total</b>				<b>1,993,200</b>	<b>50,384</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	199,320	5,038	1.*10%
	<b>Sub total</b>				<b>199,320</b>	<b>5,038</b>	
	<b>TOTAL</b>				<b>2,192,520</b>	<b>55,423</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

ITS Project Name: Information Exchange via ITS Center between Municipalities

No.7

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	Municipalities in metropolitan area						
	Information exchange system for 19 municipalities in metropolitan	system	19	100,000	1,900,000	48,028	
2)	Installation and Test				190,000	4,803	1)*10%
	<b>Sub total</b>				<b>2,090,000</b>	<b>52,831</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	209,000	5,283	1.*10%
	<b>Sub total</b>				<b>209,000</b>	<b>5,283</b>	
	<b>TOTAL</b>				<b>2,299,000</b>	<b>58,114</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

ITS Project Name: Improvement of Traffic/Transit Operation Center with  
 Essential ITS Equipment in Rio Municipality Area

No.8

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	Adaptive Signal Control	system	1	3,200,000	3,200,000	80,890	
2)	VMS	set	58	15,000	870,000	21,992	
3)	CCTV	set	5	2,000	10,000	253	
4)	OCR	set	68	10,000	680,000	17,189	
5)	Work Zone Monitoring	system	1	300,000	300,000	7,583	
6)	Parking Availability Information Provision	system	10	100,000	1,000,000	25,278	
7)	Concentrated Infrastructure Monitoring	system	1	100,000	100,000	2,528	
8)	MOE	set	5	4,000	20,000	506	
9)	Dynamic Lane Management	set	10	30,000	300,000	7,583	
10)	Bus Related ITS	system			0	0	Included in Project No.4
11)	Taxi Dispatching System	system	10	100,000	1,000,000	25,278	
12)	Rail Crossing Management	set	11	50,000	550,000	13,903	
13)	Installation and Test				803,000	20,298	sum[1)~12)]*10%
	<b>Sub total</b>				<b>8,833,000</b>	<b>223,281</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	883,300	22,328	1.*10%
	<b>Sub total</b>				<b>883,300</b>	<b>22,328</b>	
	<b>TOTAL</b>				<b>9,716,300</b>	<b>245,609</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

ITS Project Name: Improvement of Traffic/Transit Operation Center with  
 Essential ITS Equipment in Other Municipality Areas in RMRJ

No.9

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	Adaptive Signal Control	system	1	1,200,000	1,200,000	30,334	150 intersections
2)	VMS	set	13	15,000	195,000	4,929	
3)	CCTV	set	2	2,000	4,000	101	
4)	OCR	set	8	10,000	80,000	2,022	
5)	Work Zone Monitoring	system	1	300,000	300,000	7,583	
6)	Parking Availability Information Provision	system					not necessary
7)	MOE	set	3	4,000	12,000	303	
8)	Dynamic Lane Management	set					not necessary
9)	Bus Related ITS	system					Included in Project No.4
10)	Taxi Dispatching System	system	5	100,000	500,000	12,639	
11)	Rail Crossing Management	set	88	50,000	4,400,000	111,223	
13)	Installation and Test				669,100	16,914	sum[1]~12]*10%
	<b>Sub total</b>				<b>7,360,100</b>	<b>186,049</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	736,010	18,605	1.*10%
	<b>Sub total</b>				<b>736,010</b>	<b>18,605</b>	
	<b>TOTAL</b>				<b>8,096,110</b>	<b>204,654</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

ITS Project Name: Emergency Operating Management

No.10

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	Traffic Light Prioritizing for system Emergency Vehicle	system	1	100,000	100,000	2,528	
2)	ODU on emergency vehicle	set	200	30	6,000	152	
3)	DSRC	set	100	5,000	500,000	12,639	
2)	Installation and Test				60,600	1,532	sum[1]~3]*10%
	<b>Sub total</b>				<b>666,600</b>	<b>16,850</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	66,660	1,685	1.*10%
	<b>Sub total</b>				<b>66,660</b>	<b>1,685</b>	
	<b>TOTAL</b>				<b>733,260</b>	<b>18,535</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

ITS Project Name: Commercial Vehicle Operation and Management

No.11

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	Weigh in Motion	set	6	100,000	600,000	15,167	Including Center System
2)	ODU on Commercial Vehicle	set	1000	30	30,000	758	
2)	Installation and Test				3,000	76	sum[(1)+2)]*10%
	<b>Sub total</b>				<b>633,000</b>	<b>16,001</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	63,300	1,600	1.*10%
	<b>Sub total</b>				<b>63,300</b>	<b>1,600</b>	
	<b>TOTAL</b>				<b>696,300</b>	<b>17,601</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

The table of cost estimates for No. 12 Advanced Vehicle Safety System is omitted

ITS Project Name: Deployment of X-band Radars

No.13

Items	Specifications	Unit	Q'ty	Unit Price (¥1000)	Amount (¥1000)	Amount (R\$1000)	Note
<b>1</b>	<b>Equipment</b>						
1)	X-band rainfall radar	system	1	150,000	150,000	3,792	
2)	Installation and Test				15,000	379	1)*10%
	<b>Sub total</b>				<b>165,000</b>	<b>4,171</b>	
<b>2</b>	<b>Consultancy Service</b>	Design and Supervision	lot	1	16,500	417	1.*10%
	<b>Sub total</b>				<b>16,500</b>	<b>417</b>	
	<b>TOTAL</b>				<b>181,500</b>	<b>4,588</b>	

Exchange rate: R\$1=¥ 39.56 as of Nov.1 2012

Source: JICA Study Team

### 7.2.7 Economic Analysis

Economic analysis was conducted for each proposed ITS menu. The analysis utilized the macro/meso/micro simulation and the effect of “with” or “without” ITS menu was calculated and evaluated.

- (1) Economic Costs
  - 1) Project Costs

In this study, the project cost utilized the result of rough cost estimates given in Subsection 6.2.5. The project costs consist of the equipment cost, installation cost, and consultancy services cost.

- 2) Operating Costs

The operating costs consist of the annual operating routine costs commencing after construction and opening to traffic. In this study, the operating costs utilized 10% of the project costs, because the information on operating costs could not be calculated.

- (2) Quantification of Economic Benefits (Direct Benefits)
  - 1) Methodology of economic analysis

In this evaluation, the following are two kinds of direct benefits estimated quantitatively:

- Savings on vehicle operating costs (VOC benefit)
- Savings on passenger travel time costs (TTC benefit)

The accident reduction benefit was not estimated due to lack of necessary information on the costs and number of accidents per vehicle/km per accident type, such as fatality, injury, and damage to properties.

- 2) With and Without Project Comparison Method

The economic benefits were estimated based on the so-called “with and without project comparison method”. The “with project” situation means that one of the proposed projects is implemented, while the “without project” means that none of the projects are implemented.

- 3) Vehicle Operating Cost (VOC)

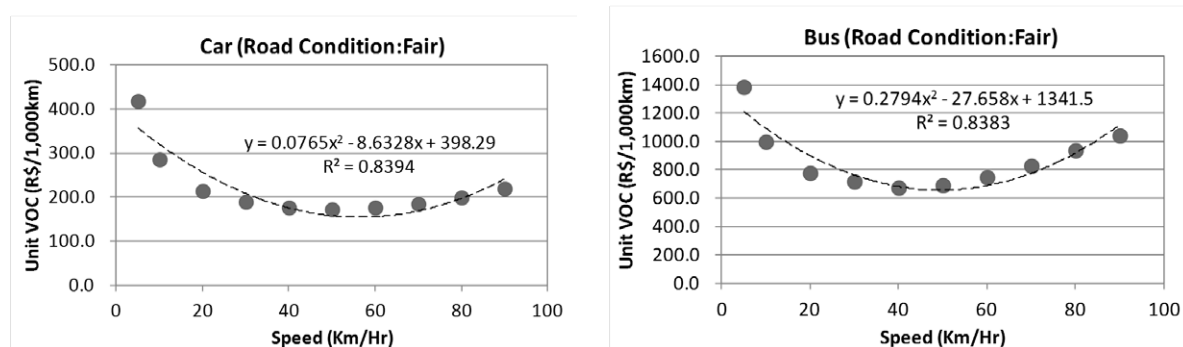
VOC consists of the following components:

- i) Fuel cost;
- ii) Lubricant oil cost;
- iii) Tire cost;
- iv) Maintenance cost;
- v) Depreciation cost;
- vi) Interest cost;
- vii) Crew cost of commercial vehicles; and
- viii) Overhead cost.



In this study, the VOC utilized the results of the Feasibility Study on the Improvement of Transport System in the Metropolitan Area of Belem in the Federative Republic of Brazil (October 2003). The current VOC was estimated by multiplying the GDP per capita growth rate in Brazil. The unit VOCs (Rs/km) was calculated originally for two types, namely, car and bus.

All cost components of VOC were aggregated and the relationships between travel speed and unit VOC were estimated as shown in Figure 7-57 below.



Source: JICA Study Team

Figure 7-57 Travel Speed and Unit VOC in 2011 Prices

4) Travel Time Cost (TTC)

The savings on passenger travel time cost is another important component of economic benefit. The Feasibility Study on the Improvement of Transport System in the Metropolitan Area of Belem in the Federative Republic of Brazil (October 2003) estimated the values of time of car passengers at R\$10.9/hour/person for work trip, and R\$35.7/hour/person for work trip for bus passengers (2002 prices). Based on these time values, the current (2011) and future (2015, 2020) time values were estimated using the consumer price index (CPI) growth rate. The current and future TTC of cars and buses are shown in Table 7-41.

Table 7-41 TTC in 2011 Prices

	2011	2016	2021
Car	35.7	40.2	45.2
Bus	116.6	131.5	148.2

(Unit: R\$/hour/person)

Source: JICA Study Team

5) Formulas for Benefit Estimation

The economic benefits (VOC savings and TTC savings) were estimated by applying the above unit VOCs and value of time to the results of the macro/meso/micro simulation results. The formulas for benefit calculation are shown below:

$$VOC(B) = \sum_n \sum_m [(Q_{w/o})_{n,m} \times (L^m) \times (UVOC_n)] - \sum_n \sum_m [(Q_{with})_{n,m} \times (L^m) \times (UVOC_n)]$$

$$Time(B) = \sum_n \sum_m [(Q_{w/o})_{n,m} \times TIM(W/O)_m \times TV_n] - \sum_n \sum_m [(Q_{with})_{n,m} \times TIM(WITH)_m \times TV_n]$$

- Where: VOC (B) : Total VOC saving benefit  
 (Q<sub>w/o</sub>)<sub>n,m</sub> : Traffic volume of vehicle type (n), on Link (m) in “without” project case  
 L<sup>m</sup> : Length of link (m)  
 UVOC<sub>n</sub> : Unit VOC of vehicle type (n)  
 (Q<sub>with</sub>)<sub>n,m</sub> : Traffic volume of vehicle type (n), on Link (m) in “with” project case  
 Time (B) : Total time saving benefit  
 TIM(W/O)<sub>m</sub> : Travel time on Link (m) in “without” project case  
 TIM(WITH)<sub>m</sub> : Travel time on Link (m) in “with” project case  
 TV<sub>n</sub> : Travel time value of vehicle type (n)

6) Benefit Estimation using Macro/Meso/Micro Simulation

In order to estimate the effect of the proposed project, the macro/meso/micro simulation was conducted based on the assumed effective area of each project. The analysis software used was AIMSUN, traffic simulation software. The projects conducting estimation are: 1. Bus Information Provision, 2. ITS Center, 3. BRT Priority System, 4. ETC, and 5. ERP. The road network and OD data required for the analysis is the same as traffic demand analysis. Except for the ERP project (ERP project was assumed to be conducted in 2021), the traffic situation was analyzed by the case of with/without project in 2016 and 2021. The indicator of economic analysis on each project (traffic volume, travel speed travel distance, and etc.) was estimated, and the effect of implementation was grasped. The condition of estimation in each project is shown in Table 7-42, and the area of analysis is shown in Figure 7-58.

**Table 7-42 Condition of Macro/Meso/Micro Simulation**

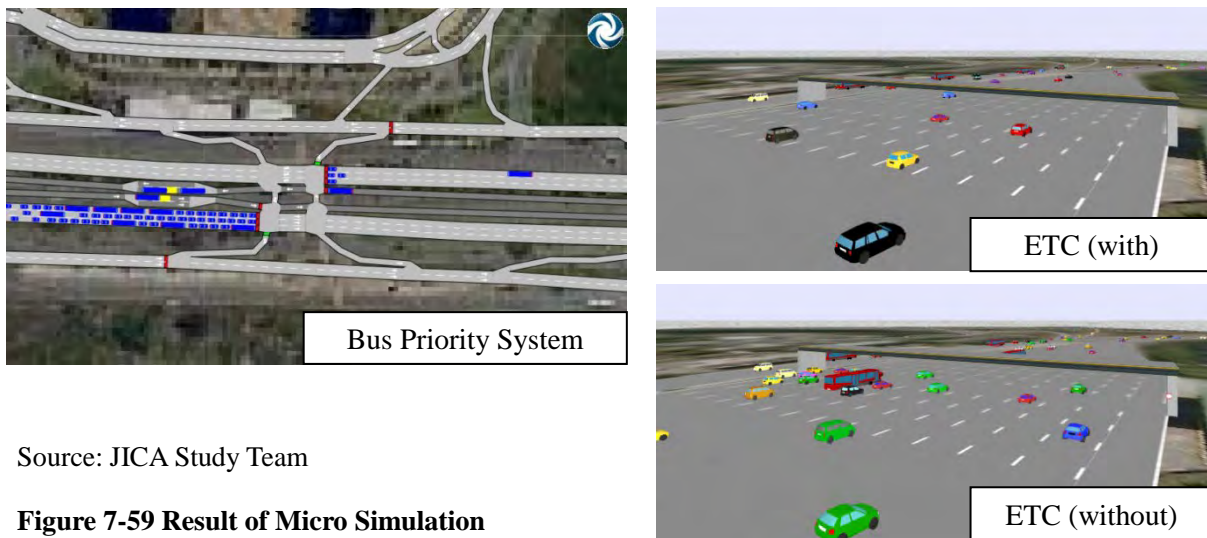
Project Name	Simulation Condition	
	With/Without	Method
1. Bus Information Provision	Bus Location System/None	Meso
2. ITS Center	Provide Congestion Information/None	Meso
3. BRT Priority System	Installed BRT Priority Signal/None	Micro
4. ETC	Installed ETC/None	Micro
5. ERP	Entrance Restriction by ERP / None	Macro

Source: JICA Study Team



Source: JICA Study Team

Figure 7-58 Simulation Area of Each Project



Source: JICA Study Team

Figure 7-59 Result of Micro Simulation

7) Estimated Economic Benefits

The estimated economic benefits are shown in Table 7-43.

The benefits of all the projects are in positive values, therefore, all the proposed projects are very effective, especially ETC and ERP.

**Table 7-43 Estimated Benefits**

Year	Without/With Project	VOC	TTC	Total
<b>1. Bus Information Provision</b>				
2016	Without	150	620	770
	With	152	543	695
	Benefit (Without – With)	-2	77	75
2021	Without	152	738	891
	With	160	589	751
	Benefit (Without – With)	-8	149	141
<b>2. ITS Center</b>				
2016	Without	1,256	4,390	5,645
	With	1,265	4,263	5,528
	Benefit (Without – With)	-9	127	118
2021	Without	1,230	4,353	5,583
	With	1,225	4,231	5,456
	Benefit (Without – With)	5	122	127
<b>3. BRT Priority System</b>				
2016	Without	145	464	609
	With	108	345	453
	Benefit (Without – With)	37	119	156
2021	Without	142	448	590
	With	111	358	469
	Benefit (Without – With)	31	90	121
<b>4. ETC</b>				
2016	Without	9,907	21,819	31,726
	With	9,903	16,663	26,566
	Benefit (Without – With)	4	5,156	5,160
2021	Without	9,844	21,401	31,245
	With	9,837	16,254	26,091
	Benefit (Without – With)	7	5,147	5,154
<b>5. ERP</b>				
2021	Without	-	11,869	11,869
	With	-	9,377	9,377
	Benefit (Without – With)	-	2,492	2,492

(Unit: R\$ in million/year)

Source: JICA Study Team

(3) Economic Evaluation

1) Preconditions for Economic Cost and Benefit Analysis

Cost-benefit cash flow analyses were carried out under the following preconditions:

- 1) Price level : 2011 prices
- 2) Opening year : 2016 (ERP:2021)
- 3) Evaluation period : until 2030
- 4) Residual values : No residual values were counted
- 5) Opportunity cost of capital : 12%

2) Evaluation Results

The results of the economic evaluation are summarized below:

1. Bus Information Provision

- Economic internal rate of return (EIRR) = 32.9%
- Benefit/cost ratio (B/C) = 4.22
- Net present value (NPV) = R\$183 million

2. ITS Center

- Economic internal rate of return (EIRR) = 44.3%
- Benefit/cost ratio (B/C) = 4.99
- Net present value (NPV) = R\$225 million

3. BRT Priority System

- Economic internal rate of return (EIRR) = 75.3%
- Benefit/cost ratio (B/C) = 8.86
- Net present value (NPV) = R\$290 million

4. ETC

- Economic internal rate of return (EIRR) = 51.9%
- Benefit/cost ratio (B/C) = 5.89
- Net present value (NPV) = R\$72 million

5. ERP

- Economic internal rate of return (EIRR) = 23.2%
- Benefit/cost ratio (B/C) = 6.18
- Net present value (NPV) = R\$695 million



The above results indicate that all the projects are economically feasible with EIRR higher than the opportunity cost of capital (>12%), B/C higher than unity (>1.0), and positive values of NPV (> 0). This is because the ITS project is not a large-scale infrastructure and is low cost compared to normal public works, such as bridge construction. Also, the effect of these projects is high; therefore, the benefit is high. The cost-benefit streams are shown in Table 7-44 to Table 7-48.

**Table 7-44 Cost-Benefit Stream (Bus Information Provision)**

Year	Rate of Return	Cost Benefit (Million R\$)					Benefit (Million R\$)		B-C Balance
		Installation Cost	Operating Cost	Total	Economic Value	Present Worth	Travel Time Cost	Present Worth	
2011	1.00								
2012	0.89								
2013	0.80	61.17		61.17	52.00	41.45			-41.45
2014	0.71	30.59		30.59	26.00	18.51			-18.51
2015	0.64	30.59		30.59	26.00	16.52			-16.52
2016	0.57		12.23	12.23	10.40	5.90	75.91	43.07	37.17
2017	0.51		12.23	12.23	10.40	5.27	88.84	45.01	39.74
2018	0.45		12.23	12.23	10.40	4.70	101.76	46.03	41.33
2019	0.40		12.23	12.23	10.40	4.20	114.69	46.32	42.12
2020	0.36		12.23	12.23	10.40	3.75	127.61	46.02	42.27
2021	0.32		12.23	12.23	10.40	3.35	140.53	45.25	41.90
2022	0.29		12.23	12.23	10.40	2.99	140.53	40.40	37.41
2023	0.26		12.23	12.23	10.40	2.67	140.53	36.07	33.40
2024	0.23		12.23	12.23	10.40	2.38	140.53	32.21	29.82
2025	0.20		12.23	12.23	10.40	2.13	140.53	28.76	26.63
2026	0.18		12.23	12.23	10.40	1.90	140.53	25.68	23.78
2027	0.16		12.23	12.23	10.40	1.70	140.53	22.92	21.23
2028	0.15		12.23	12.23	10.40	1.51	140.53	20.47	18.95
2029	0.13		12.23	12.23	10.40	1.35	140.53	18.28	16.92
2030	0.12		12.23	12.23	10.40	1.21	140.53	16.32	15.11
Total		122.35	183.52	305.87	259.99	121.49	1,914.15	512.79	391.30

EIRR	32.94%
NPV	182.57
B/C	4.22

PVC	81.40
PVB	263.97

Source: JICA Study Team

**Table 7-45 Cost-Benefit Stream (ITS Center)**

Year	Rate of Return	Cost Benefit (Million R\$)					Benefit (Million R\$)		B-C Balance
		Installation Cost	Operating Cost	Total	Economic Value	Present Worth	Travel Time Cost	Present Worth	
2011	1.00								
2012	0.89								
2013	0.80	54.43		54.43	46.27	36.88			-36.88
2014	0.71	27.22		27.22	23.13	16.47			-16.47
2015	0.64	27.22		27.22	23.13	14.70			-14.70
2016	0.57		10.89	10.89	9.25	5.25	118.35	67.16	61.91
2017	0.51		10.89	10.89	9.25	4.69	120.26	60.93	56.24
2018	0.45		10.89	10.89	9.25	4.19	122.16	55.26	51.07
2019	0.40		10.89	10.89	9.25	3.74	124.06	50.11	46.37
2020	0.36		10.89	10.89	9.25	3.34	125.97	45.42	42.09
2021	0.32		10.89	10.89	9.25	2.98	127.87	41.17	38.19
2022	0.29		10.89	10.89	9.25	2.66	127.87	36.76	34.10
2023	0.26		10.89	10.89	9.25	2.38	127.87	32.82	30.45
2024	0.23		10.89	10.89	9.25	2.12	127.87	29.30	27.18
2025	0.20		10.89	10.89	9.25	1.89	127.87	26.16	24.27
2026	0.18		10.89	10.89	9.25	1.69	127.87	23.36	21.67
2027	0.16		10.89	10.89	9.25	1.51	127.87	20.86	19.35
2028	0.15		10.89	10.89	9.25	1.35	127.87	18.62	17.28
2029	0.13		10.89	10.89	9.25	1.20	127.87	16.63	15.42
2030	0.12		10.89	10.89	9.25	1.07	127.87	14.85	13.77
Total		108.86	163.29	272.15	231.33	108.10	1,889.50	539.41	431.31

EIRR	44.32%
NPV	225.24
B/C	4.99

PVC	72.42
PVB	297.67

Source: JICA Study Team

**Table 7-46 Cost-Benefit Stream (BRT Priority System)**

Year	Rate of Return	Cost Benefit (Million R\$)					Benefit (Million R\$)		B-C Balance
		Installation Cost	Operating Cost	Total	Economic Value	Present Worth	Travel Time Cost	Present Worth	
2011	1.00								
2012	0.89								
2013	0.80	32.79		32.79	27.87	22.22			-22.22
2014	0.71	16.39		16.39	13.94	9.92			-9.92
2015	0.64	16.39		16.39	13.94	8.86			-8.86
2016	0.57		6.56	6.56	5.57	3.16	155.82	88.42	85.25
2017	0.51		6.56	6.56	5.57	2.82	148.99	75.48	72.66
2018	0.45		6.56	6.56	5.57	2.52	142.16	64.31	61.79
2019	0.40		6.56	6.56	5.57	2.25	135.33	54.66	52.41
2020	0.36		6.56	6.56	5.57	2.01	128.51	46.34	44.33
2021	0.32		6.56	6.56	5.57	1.79	121.68	39.18	37.38
2022	0.29		6.56	6.56	5.57	1.60	121.68	34.98	33.38
2023	0.26		6.56	6.56	5.57	1.43	121.68	31.23	29.80
2024	0.23		6.56	6.56	5.57	1.28	121.68	27.89	26.61
2025	0.20		6.56	6.56	5.57	1.14	121.68	24.90	23.76
2026	0.18		6.56	6.56	5.57	1.02	121.68	22.23	21.21
2027	0.16		6.56	6.56	5.57	0.91	121.68	19.85	18.94
2028	0.15		6.56	6.56	5.57	0.81	121.68	17.72	16.91
2029	0.13		6.56	6.56	5.57	0.72	121.68	15.82	15.10
2030	0.12		6.56	6.56	5.57	0.65	121.68	14.13	13.48
<b>Total</b>		<b>65.58</b>	<b>98.37</b>	<b>163.94</b>	<b>139.35</b>	<b>65.12</b>	<b>1,927.58</b>	<b>577.12</b>	<b>512.00</b>

EIRR	75.34%
NPV	290.01
B/C	8.86

PVC	43.63
PVB	333.64

Source: JICA Study Team

**Table 7-47 Cost-Benefit Stream (ETC)**

Year	Rate of Return	Cost Benefit (Million R\$)					Benefit (Million R\$)		B-C Balance
		Installation Cost	Operating Cost	Total	Economic Value	Present Worth	Travel Time Cost	Present Worth	
2011	1.00								
2012	0.89								
2013	0.80	13.76		13.76	11.70	9.33			-9.33
2014	0.71	6.88		6.88	5.85	4.16			-4.16
2015	0.64	6.88		6.88	5.85	3.72			-3.72
2016	0.57		2.75	2.75	2.34	1.33	37.22	21.12	19.79
2017	0.51		2.75	2.75	2.34	1.19	37.21	18.85	17.67
2018	0.45		2.75	2.75	2.34	1.06	37.20	16.83	15.77
2019	0.40		2.75	2.75	2.34	0.95	37.19	15.02	14.08
2020	0.36		2.75	2.75	2.34	0.84	37.18	13.41	12.57
2021	0.32		2.75	2.75	2.34	0.75	37.18	11.97	11.22
2022	0.29		2.75	2.75	2.34	0.67	37.18	10.69	10.01
2023	0.26		2.75	2.75	2.34	0.60	37.18	9.54	8.94
2024	0.23		2.75	2.75	2.34	0.54	37.18	8.52	7.98
2025	0.20		2.75	2.75	2.34	0.48	37.18	7.61	7.13
2026	0.18		2.75	2.75	2.34	0.43	37.18	6.79	6.36
2027	0.16		2.75	2.75	2.34	0.38	37.18	6.06	5.68
2028	0.15		2.75	2.75	2.34	0.34	37.18	5.41	5.07
2029	0.13		2.75	2.75	2.34	0.30	37.18	4.83	4.53
2030	0.12		2.75	2.75	2.34	0.27	37.18	4.32	4.04
<b>Total</b>		<b>27.53</b>	<b>41.29</b>	<b>68.82</b>	<b>58.50</b>	<b>27.34</b>	<b>557.77</b>	<b>160.98</b>	<b>133.64</b>

EIRR	51.93%
NPV	71.50
B/C	5.89

PVC	18.31
PVB	89.82

Source: JICA Study Team

**Table 7-48 Cost-Benefit Stream (ERP)**

Year	Rate of Return	Cost Benefit (Million R\$)					Benefit (Million R\$)		B-C Balance
		Installation Cost	Operating Cost	Total	Economic Value	Present Worth	Travel Time Cost	Present Worth	
2011	1.00								
2012	0.89								
2013	0.80	148.34		148.34	126.09	100.52			-100.52
2014	0.71	21.19		21.19	18.01	12.82			-12.82
2015	0.64	21.19		21.19	18.01	11.45			-11.45
2016	0.57	21.19		21.19	18.01	10.22			-10.22
2017	0.51	21.19		21.19	18.01	9.13			-9.13
2018	0.45	21.19		21.19	18.01	8.15			-8.15
2019	0.40	21.19		21.19	18.01	7.28			-7.28
2020	0.36	21.19		21.19	18.01	6.50			-6.50
2021	0.32		29.67	29.67	25.22	8.12	659.49	212.34	204.22
2022	0.29		29.67	29.67	25.22	7.25	659.49	189.59	182.34
2023	0.26		29.67	29.67	25.22	6.47	659.49	169.28	162.80
2024	0.23		29.67	29.67	25.22	5.78	659.49	151.14	145.36
2025	0.20		29.67	29.67	25.22	5.16	659.49	134.95	129.78
2026	0.18		29.67	29.67	25.22	4.61	659.49	120.49	115.88
2027	0.16		29.67	29.67	25.22	4.11	659.49	107.58	103.46
2028	0.15		29.67	29.67	25.22	3.67	659.49	96.05	92.38
2029	0.13		29.67	29.67	25.22	3.28	659.49	85.76	82.48
2030	0.12		29.67	29.67	25.22	2.93	659.49	76.57	73.64
Total		296.69	296.69	593.38	504.37	217.44	6,594.92	1,343.73	1,126.29

EIRR	23.18%
NPV	695.14
B/C	6.18
PVC	142.78
PVB	837.91

Source: JICA Study Team

(4) Sensitivity Analysis in Economic Evaluation

In order to check the strength of all the proposed projects, economic feasibility and sensitivity analyses were carried out using different cost and benefit values within a probable range against the base case. The prepared cases for the sensitivity analysis are as follows:

- Project costs go up by: +10%, +15%, and +20%;
- Project benefits go down by: -10%, -15%, and -20%; and
- Different combinations of the above changes in costs and benefits.

Summarized results of the sensitivity analysis are shown from Table 7-49 to Table 7-53.

**Table 7-49 Results of Sensitivity Analysis (EIRR): Bus Information Provision**

Benefit Cost	Base Case	-10%	-15%	-20%
Base Case	32.94%	29.92%	28.33%	26.68%
+10%	30.20%	27.29%	25.76%	24.18%
+15%	26.36%	23.61%	22.16%	20.66%
+20%	21.67%	19.10%	17.75%	16.34%

Source: JICA Study Team

**Table 7-50 Results of Sensitivity Analysis (EIRR): ITS Center**

Benefit Cost	Base Case	-10%	-15%	-20%
Base Case	44.32%	40.49%	38.47%	36.39%
+10%	40.85%	37.16%	35.22%	33.22%
+15%	35.99%	32.51%	30.68%	28.79%
+20%	30.06%	26.83%	25.13%	23.38%

Source: JICA Study Team

**Table 7-51 Results of Sensitivity Analysis (EIRR): BRT Priority System**

Benefit Cost	Base Case	-10%	-15%	-20%
Base Case	75.34%	70.08%	67.31%	64.43%
+10%	70.57%	65.49%	62.82%	60.04%
+15%	63.87%	59.05%	56.52%	53.89%
+20%	55.65%	51.16%	48.80%	46.35%

Source: JICA Study Team

**Table 7-52 Results of Sensitivity Analysis (EIRR): ETC**

Benefit Cost	Base Case	-10%	-15%	-20%
Base Case	51.93%	47.73%	45.52%	43.24%
+10%	48.12%	44.08%	41.96%	39.76%
+15%	42.80%	38.98%	36.97%	34.90%
+20%	36.29%	32.74%	30.88%	28.96%

Source: JICA Study Team

**Table 7-53 Results of Sensitivity Analysis (EIRR): ERP**

Benefit Cost	Base Case	-10%	-15%	-20%
Base Case	23.18%	21.77%	21.01%	20.21%
+10%	21.91%	20.51%	19.76%	18.96%
+15%	20.05%	18.67%	17.93%	17.15%
+20%	17.68%	16.32%	15.58%	14.81%

Source: JICA Study Team

The results of the sensitivity analysis showed the strength of the project's economic feasibility. Even if the project costs went up by 20% and the economic benefits went down by 20% simultaneously, the project will maintain values of EIRR higher than the opportunity cost of capital (> 12%).

(5) Conclusions of the Initial Economic Evaluation

The conclusions derived from the initial economic evaluation are summarized as follows:

- i) All proposed projects are economically feasible.
- ii) Since the benefit of TTC is especially high, the proposed project is effective as an improvement measure of traffic congestion (improvement of traffic speed, delay time, etc.).
- iii) It is assumed that higher effects are expected by conducting these projects.

### 7.2.8 Implementation Schedule

The implementation schedule of ITS projects is also described in previous sections; hence, the JICA Study Team summarized the schedule of all the projects. However, the milestone of ITS projects for Rio de Janeiro is the Rio 2016 Olympic and Paralympic Games. The short-term projects shall focus on the Rio de Janeiro municipal area to archive the success of the Olympic Games.

However, the objectives of ITS are not only for the Olympic Games, but also for the traffic/transit management for daily life. For example, the target area of the ITS Center is the Rio de Janeiro Metropolitan Area and is not just short term. Hence, the implementation schedule was developed considering four major aspects like: 1. Olympic period, 2. Rio de Janeiro municipal area, 3. Information integration and existing system utilization, and 4. Security and transport. The implementation schedule is shown below.

ITS Project Name	2013				2014				2015				2016				2017				2018				2019			
	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
1 ITS Center	PQ,TENDERING/ DD				Construction/Deployment																							
2 Real Time Traffic/Transport Condition Information Processing	PQ,TENDERING/ DD				Construction/Deployment												Further Expansion and Integration for Interaction Projects											
3 Olympic Security and Transport Coordination Center	PQ,TENDERING/ DD				Construction/Deployment																							
4 Bus Condition Information Provision	PQ,TENDERING/ DD				Construction/Deployment												Further Expansion and Integration for Interaction Projects											
5 Dissemination of On-Board UNIT for more Integrated Transport	PQ,TENDERING/ DD				Construction/Deployment												Further Expansion and Integration for Interaction Projects											
6 Information Exchange of Road Operator					PQ,TENDERING/ DD				Construction/Deployment																			
7 Information Exchange via ITS Center between Municipalities	PQ,TENDERING/ DD				Construction/Deployment												PQ,TENDERING/ DD				Construction/Deployment							
8 Improvement of Traffic/Transit Operational Center with Essential ITS Equipment at Rio de Janeiro Municipality Area	PQ,TENDERING/ DD				Construction/Deployment												Further Expansion and Integration for Interaction Projects											
9 Improvement of Traffic/Transit Operational Center with Essential ITS Equipment at Other Municipality Area in RMRJ					PQ,TENDERING/ DD				Construction/Deployment																			
10 Emergency Vehicle Operating Management	PQ,TENDERING/ DD				Construction/Deployment												Construction/Deployment											
11 Commercial Vehicle Operation and Management					PQ,TENDERING/ DD				Construction/Deployment												Construction/Deployment							
12 Advanced Vehicle Safety Systems	Car Maker's Technological Development Field																											
13 Deployment of X-band Radar	Need to confirm development policy for weather monitoring in RMRJ																											

Construction/Deployment :Priority Project  
Construction/Deployment :Secondary Project  
→ :Further Expansion and Integration for Interaction Projects

\*1Q: From January    \*\*PQ: Procurement    DD: Detailed Design

Source: JICA Study Team

**Figure 7-60 Implementation Schedule**