Government of India
Government of Tamil Nadu
Highways & Minor Ports Department (HMPD)
Tamil Nadu Infrastructure Development Board (TNIDB)

PREPARATORY STUDY FOR CHENNAI PERIPHERAL RING ROAD DEVELOPMENT IN INDIA

FINAL REPORT

VOL.2

December 2018

Japan International Cooperation Agency (JICA)

JICA Study Team constituted by
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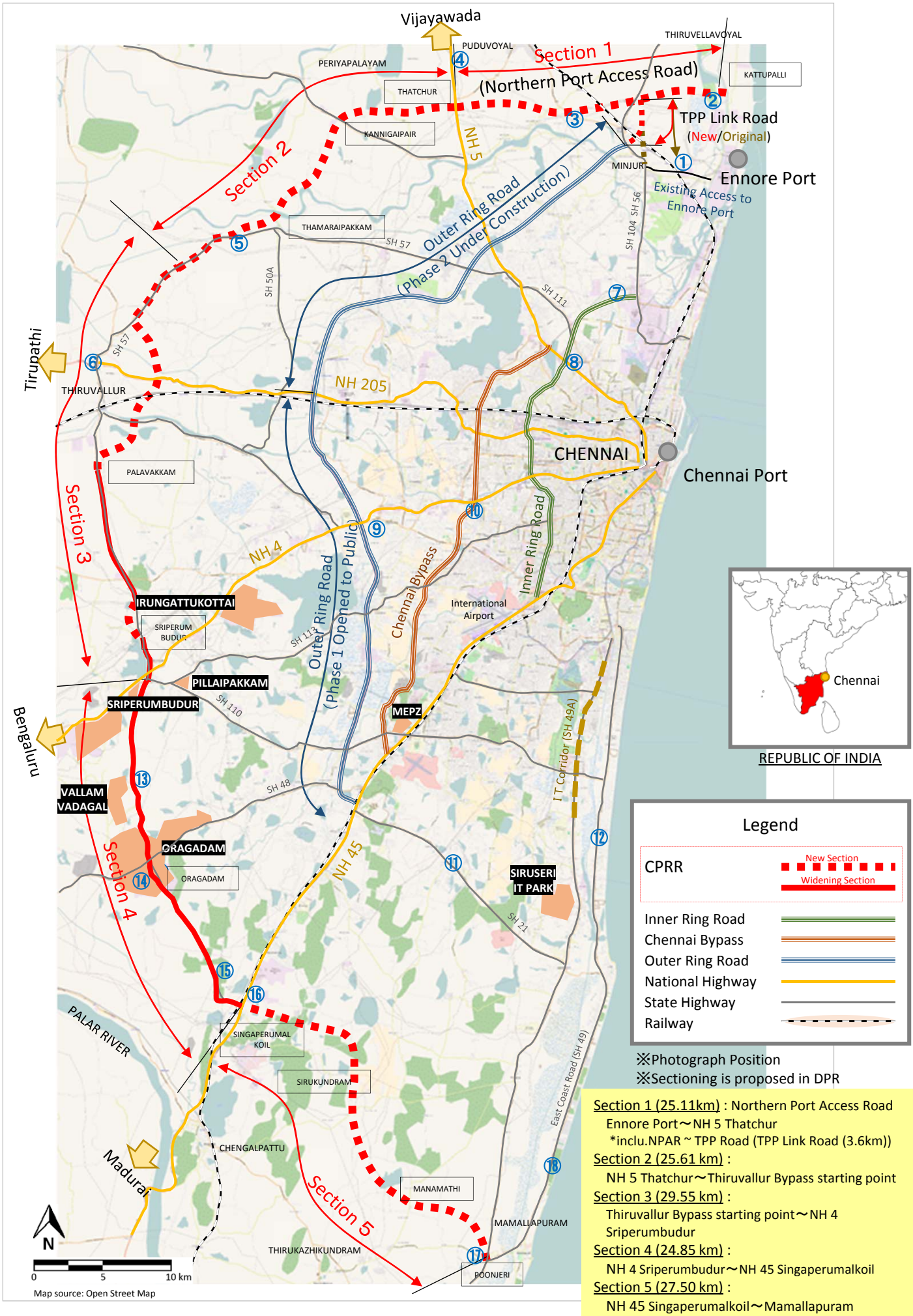


REPUBLIC OF INDIA

Legend

CPRR	New Section / Widening Section
Inner Ring Road	
Chennai Bypass	
Outer Ring Road	
National Highway	
State Highway	
Railway	

※Photograph Position
※Sectioning is proposed in DPR

Section 1 (25.11km) : Northern Port Access Road
Ennore Port～NH 5 Thatchur
*inclu.NPAR ~ TPP Road (TPP Link Road (3.6km))
Section 2 (25.61 km) :
NH 5 Thatchur～Thiruvallur Bypass starting point
Section 3 (29.55 km) :
Thiruvallur Bypass starting point～NH 4 Sriperumbudur
Section 4 (24.85 km) :
NH 4 Sriperumbudur～NH 45 Singaperumalkoil
Section 5 (27.50 km) :
NH 45 Singaperumalkoil～Mamallapuram

LOCATION MAP OF CHENNAI PERIPHERAL RING ROAD

		
①	②	③
		
④。	⑤	⑥
		
⑦	⑧	⑨

EXISTING CONDITIONS (1/2)

		
⑩	⑪	⑫
		
⑬	⑭	⑮
		
⑯	⑰	⑱

EXISTING CONDITIONS (2/2)

PREPARATORY STUDY FOR CHENNAI PERIPHERAL RING ROAD DEVELOPMENT IN INDIA

FINAL REPORT VOL.2

TABLE OF CONTENTS

List of Figures

List of Tables

Abbreviations

ATIS	Advance Traveler Information System
ATCC	Automatic Traffic Counter cum Classifier
ATCS	Area Traffic Signal Control System
BC (B/C)	Benefit Cost Ratio
BRT	Bus Rapid Transit
BTS	Bus Tracking System
BP	Beginning Point
CE	Chief Engineer
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CFS	Container Freight Station
CCTV	Closed-Circuit Television
CMA	Chennai Metropolitan Area
CMDA	Chennai Metropolitan Development Authority
CMRL	Chennai Metropolitan Rail Limited
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
CP (C/P)	Counterpart
CPRR	Chennai Peripheral Ring Road
CRZ	Coastal Regulation Zone
C/S	Construction Supervision
CSCL	Chennai Smart City Limited
CTP	Chennai Traffic Police
CTTS	Comprehensive Traffic and Transportation Study
D/D	Detailed Design
DEA	Department of Economic Affairs
DFR (DF/R)	Draft Final Report
DOE	Department of Environment
DPR	Detailed Project Report
EC	Environmental Clearance
ECR	East Coast Road
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EP	End Point
ETC	Electronic Toll Collection
ETMS	Electronic Ticket Management System
F/F	Fact Finding
FIDIC	Federation International des Ingenious-Conseils
FIRR	Financial Internal Rate of Return
FMB	Field Measurement Book
FR (F/R)	Final Report
GCC	Greater Chennai Corporation
GOI	the Government of India
GOJ	the Government of Japan
GoTN	the Government of Tamil Nadu
GPS	Global Positioning System
GST	Goods and Service Tax
HMPD	Highways & Minor Ports Department
HTMS	Highway Traffic Management System
IC	Interchange
ICR (IC/R)	Inception Report
IHMCL	Indian Highways Management Company Limited
IIT	Indian Institute of Technology

IPCC	Intergovernmental Panel on Climate Change
IRC	Indian Road Congress
IRR	Inner Ring Road/Internal Rate of Return
IT	Information Technology
ITMS	Integrated Traffic Management System
ITR	Interim Report
ITS	Intelligent Transport System
JCT (Jct)	Junction
JICA	Japan International Cooperation Agency
JST	JICA Study Team
LA (L/A)	Loan Agreement
LARAP	Land Acquisition & Resettlement Action Plan
LPS	Land Plan Schedule
LVUP	Light Vehicle Under Pass
MJB	Major Bridge
MM (M/M)	Man-Month
MNB	Minor Bridge
MTC	Metropolitan Transport Corporation
MORTH	Ministry of Road Transport and Highways
NEXCO	Nippon Expressway Co., Ltd.
NH	National Highway
NHAI	National Highway Authority of India
NPV	Net Present Value
NURM	National Urban Renewal Mission
NUTP	National Urban Development Plan
OD	Origin & Destination
ODA	Official Development Assistance
OM (O&M)	Operation & Maintenance
ORR	Outer Ring Road
PAF	Project Affected Family
PAH	Project Affected Household
PAP	Project Affected Person
PIS	Passenger Information System
PIT	Project Implementation Team
PMC	Project Management Consultant
PWC	Pricewaterhouse Cooper
PQ	Pre-Qualification
RAP	Resettlement Action Plan
RF	Reserved Forest
RFID	Radio Frequency IDentifier
ROB	Railway Overhead Bridge
ROW	Right of Way
SBD	(JICA) Standard Bidding Documents
SEC (Sec)	Section
SH	State Highway
SIA	Social Impact Assessment
SLA	Service Level Agreement
SPM	Suspended Particulate Matter
SS	Suspended Solids
STL	Sub Team Leader
SPV	Special Purpose Vehicle
TANGEDCO	Tamil Nadu Generation and Distribution Corporation
TEU	Twenty-foot Equivalent Unit
TIS	Traffic Information System
TL	Team Leader

TMS	Traffic Management System
TN	Tamil Nadu
TNIDB	Tamil Nadu Infrastructure Development Board
TNRDC	Tamil Nadu Road Development Company
TNRSP	Tamil Nadu Road Sector Project
TNSDC	Tamil Nadu State Data Center
TNSEAC	Tamil Nadu State Expert Appraisal Committee
TNSEIAA	Tamil Nadu State Environmental Impact Assessment Authority
TNSPCB	Tamil Nadu State Pollution Control Board
TPP	Thiruvottiyur Ponneri Pancheti
TPY	Truck Parking Yard
TUFIDCO	Tamil Nadu Finance and Infrastructure Development Corporation
UNFCCC	United Nations Framework Convention on Climate Change
VGF	Viability Gap Funding
VMS	Variable Message Signs
VUP	Vehicle Under Pass
WB	World Bank
WIM	Weigh-In-Motion

1. INTRODUCTION

1.1 Background of the Study

As in other major cities in India, traffic congestion is getting worse in Chennai Metropolitan Area (hereinafter referred to as "CMA"), which is the target area of the study, because road infrastructure improvements have not caught up with the increase in traffic demand due to population growth and economic development. The Government of Tamil Nadu (GoTN) is promoting the development of roads and public transportation as a countermeasure to traffic congestion in CMA. The major arterial road network in CMA consists of National Highways No. 5, No. 205, No. 4, and No. 45 as major radial roads, and Inner Ring Road (IRR), Chennai Bypass, and Outer Ring Road (ORR) as ring roads. The implementation of the Chennai Peripheral Ring Road (CPRR) Project is expected to contribute to the further expansion of the Radial-Ring Road Network corresponding to the growing traffic demand. In addition, as a countermeasure to alleviate congestion at the center of CMA where the development site for road infrastructure is limited, the improvement of Intelligent Transport System (ITS) facilities that promote efficient use of the road is an issue.

Based on this background, the Government of India (GoI) has prepared the Detailed Project Report (DPR) describing the development plan of CPRR and ITS and has requested the Government of Japan (GoJ) for loan assistance.

1.2 Objectives of the Study

The study aims to collect necessary information to appraise the Project for it to be implemented under the Official Development Assistance (ODA) scheme through the confirmation of the objectives and the outline of the Project, including project cost, implementation schedule, procurement and construction method, project organization, capability of operation and maintenance, as well as social and environmental conditions.

1.3 Scope of the Study

Scope of the Study is shown in Section 4.2 in this report.

1.4 Components of the Final Report

The subject of this study was originally the CPRR Project and the Chennai City ITS Project; however, the procedure for environmental and social consideration of the CPRR Project was delayed. For this reason, JICA decided to separate the Chennai City ITS Project from the CPRR Project and aimed only for the Chennai City ITS project as the initial goal for the March 2018 Loan Agreement (L/A). For the CPRR project, JICA and HMPD confirmed that the section 1 will be the priority for the ODA loan.

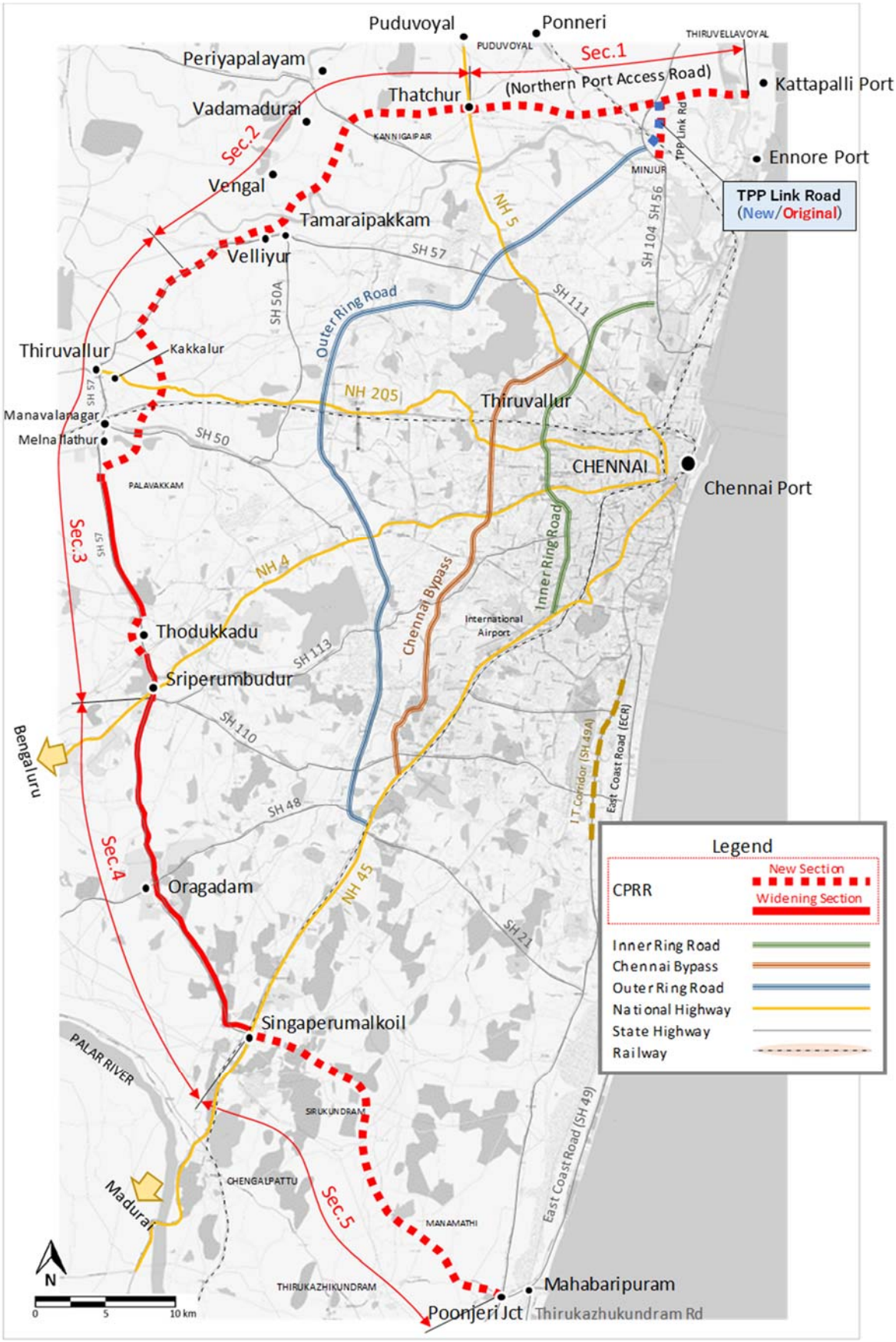
With this, the CPRR Project is compiled as Volume 1 and the Chennai City ITS Project as Volume 2 in this report.

2. PRESENT CONDITION AND CIRCUMSTANCES OF THE PROJECT

2.1 Present Condition and Issues of Road Network

Roads in CMA have been developed following the pattern of the Radial-Ring Road Network as shown in Figure 2.1.1. Major radial roads which originate at the center of Chennai City are NH4 (towards Mumbai via Bengaluru), NH5 (towards Kolkata), NH45 (towards Madurai), and NH205 (towards Tirupathi). With respect to ring roads, the IRR was first proposed as a city bypass road in 1968, and construction started in the 1980s from its central arm connecting NH45 to NH5. Subsequently, the northern and southern arms were developed. Then, the second ring road, the Chennai Bypass, was opened in 2008. However, since the urbanized area of Chennai is rapidly expanding, these two ring roads were incorporated into the built-up area. Therefore, the third ring road, or the ORR, is currently being developed, and the CPRR was even proposed to enhance the road network.

In Tamil Nadu State, there are highways and roads of 62,468 km in length, and a large part of National Highways (NH) and State Highways (SH) have double or more lanes (99% for NH and 97% for SH).



Source: JICA Study Team based on OpenStreetMap

Figure 2.1.1 Road Network in CMA

The issues of the road network in CMA are summarized as follows:

(1) Concentration of Traffic in the Core Area of Chennai

The incompletion of the road network development in the pattern of the Radial-Ring Road Network in CMA (construction of ring roads has not caught up with the increase in traffic demand) is causing serious traffic congestion in major roads towards the city center. Traffic is concentrated particularly in the core area of Chennai. It was found that more than 200,000 vehicles per day are traversing NH45 and IRR, including motorbikes. On the other hand, the traffic volume on the same road but in the suburbs is less than 70,000 vehicles per day. Similar characteristics were found in other major roads. As a result, the travel speed of traffic towards Chennai City in the morning peak hour becomes less than 30 km/hr in the city center.

It is therefore required to disperse incoming traffic before it comes into the city center.

(2) High Proportion of Large Vehicles

A high ratio of large vehicles is found in the suburban section of NH5, NH4, and NH45. This indicates that these roads are used by a large number of commercial vehicles, such as heavy lorries and trailers, to access the industrial areas and the Kattupalli/Ennore/Chennai Ports. The high proportion of slow-moving large vehicles causes a decrease in the overall travel speed of traffic.

A large number of large vehicles are frequently passing through small villages in the suburbs. Thus, there are a lot of pedestrians and motorcycles in the villages that are always facing high risks of traffic accidents.

Hence, a new link connecting industrial areas in the suburban area to ports shall be developed to ease the load of existing highways.

(3) Expansion of Built-up Areas

Rapid economic growth and increase in the population of CMA is encouraging the urbanized built-up area to expand, thereby changing the classification of IRR and Chennai Bypass from bypass roads to urban highways. The ORR which is currently being constructed will be, once it opens, the newest ring road with the largest radius of 20 to 30 km; however, urban development is approaching such current outskirts.

The necessity of the development of further ring roads has been recognized to enhance the road network as well as improve redundancy of the network.

2.2 Present Condition and Issues of Traffic in the Study Area

(1) Traffic Signal Shortage

There are many intersections without traffic signals in Chennai. At such intersections, barricades and roundabouts are adopted as alternative facilities. However, such facilities cause problems such as traffic congestion and increase in travel time. In addition, pedestrian safety is threatened because crossing at intersections without signals involves great danger.

In short, the lack of signals causes traffic congestion and prolonged travel time. Therefore, it is necessary to secure efficient traffic operation and pedestrian safety by installing traffic signals.

(2) Processing Capacity and Operation at the Chennai Port

Due to the small processing capacity and the inefficient operation of the Chennai Port, large vehicles flow into community roads and form a long queue on roads.

Since improvements to the operation of Chennai Port and the utilization of Ennore Port are in progress, some developments to the situation are expected.

(3) Issues due to the Road Structure/Operation

Although the ORR is partially open to public, there are problems of connection with the main radial roads. The junction at the connecting point with NH4 and NH45 is still under construction. Therefore, the ORR is not effectively utilized.

In Chennai, there are many sections where sidewalks and parking lots are not provided. In such sections, the risk of traffic accidents involving pedestrians is high, as parked vehicles occupy a lane, cause traffic jams, and increase travel time.

In addition, at many intersections of trunk roads, vehicles travelling on service roads cannot go straight or

turn right, but must take a detour instead.

These road structure and operational problems lead to traffic congestion, increase in travel time, and fatal accidents. Therefore, it is required to improve the efficiency of traffic flow and pedestrian safety by reviewing the road structure and operations.

(4) Deterioration of Pavement

There are sections where roads are depressed due to deterioration of pavement. Pavement deterioration lowers travel speed, making overtaking difficult. Especially in Chennai, where many industrial parks are located in suburbs, there is a large volume of heavy vehicles in the access roads, and depression of roads are also evident. Pavement deterioration also causes logistics problems such as damage in handling and transport of trucks and increase of logistics time. Therefore, it is necessary to improve road pavements to allow smooth flow of traffic.

2.3 Present Condition and Issues of Intelligent Transport System (ITS) Facilities in the Study Area

The present condition of the entire ITS in Chennai is described in the Final Report of the Data Collection Survey for Chennai Metropolitan Region ITS which was completed in March 2017. This clause reports the latest conditions of ITS updated in this study, which are directly related to the ITS components of the Japanese ODA Loan Project.

(1) City Bus System of Metropolitan Transport Corporation (MTC)

The City Bus System is composed of the following components:

- Bus Tracking System
- Passenger Information System
- Electronic Ticket Management System

The Bus Tracking System and Passenger Information System are systematically linked to function (the Electronic Ticket Management System functions independently).

(2) Traffic Management System of Chennai Traffic Police (CTP)

The current Traffic Management System of CTP was confirmed as follows:

1) Command Control Center

The Command Control Center has been established in the CTP building, and limited functions are in operation.

2) Call Center in Command Control Center

Approximately 20 operators are stationed in the Command Control Center for 24 hours a day, handling emergency calls, inquiries, claims, etc.

3) Traffic Signal System and CCTV Camera

Traffic signals have been installed at 385 junctions in the city. The current signals are of the fixed pattern type, not the signal coordination type. The signal patterns are adjusted or changed by the police officers as necessary. There are many signals that are not working or are turned off. CCTV cameras have also been installed at the junctions.

4) Variable Message Sign Board (VMS)

VMS have been installed at 53 junctions in the city. The existing VMS provides static messages such as warnings on traffic rules, not dynamic traffic information. Two different languages, i.e. English and Tamil, are shown.

5) E-Challan System

E-Challan System is used for traffic violation enforcement. The handy terminals deployed to the police officers issue the enforcement ticket for the fine imposed on the traffic violation at the site. The data inputted on the handy terminal is collected at the Command Control Center, and the system manages the traffic

violation record. E-Challan System has already been introduced to the CTP, and approximately 400 handy terminals are in use as of now.

6) Advance Traveler Information System (ATIS)

The ATIS provides traffic information to road users as pre-trip information. A prototype system was developed by the Indian Institute of Technology (IIT)-Madras, and the pilot was carried out in a relatively limited area, i.e., on the roads surrounding the campus of IIT Madras. The project is funded by the Government of India, and related government organizations such as CTP are aimed to utilize the system.

(3) Chennai Metro Rail Limited (CMRL)

Smart cards which can be used only for Chennai Metro have been introduced. There are two card types, i.e., Type-A (Mifare) and Felica. Multi-type card readers which can read and write both types of cards have been introduced at the gates of Chennai Metro stations. The ticketing and recharging terminals for both types of cards are also available in these stations.

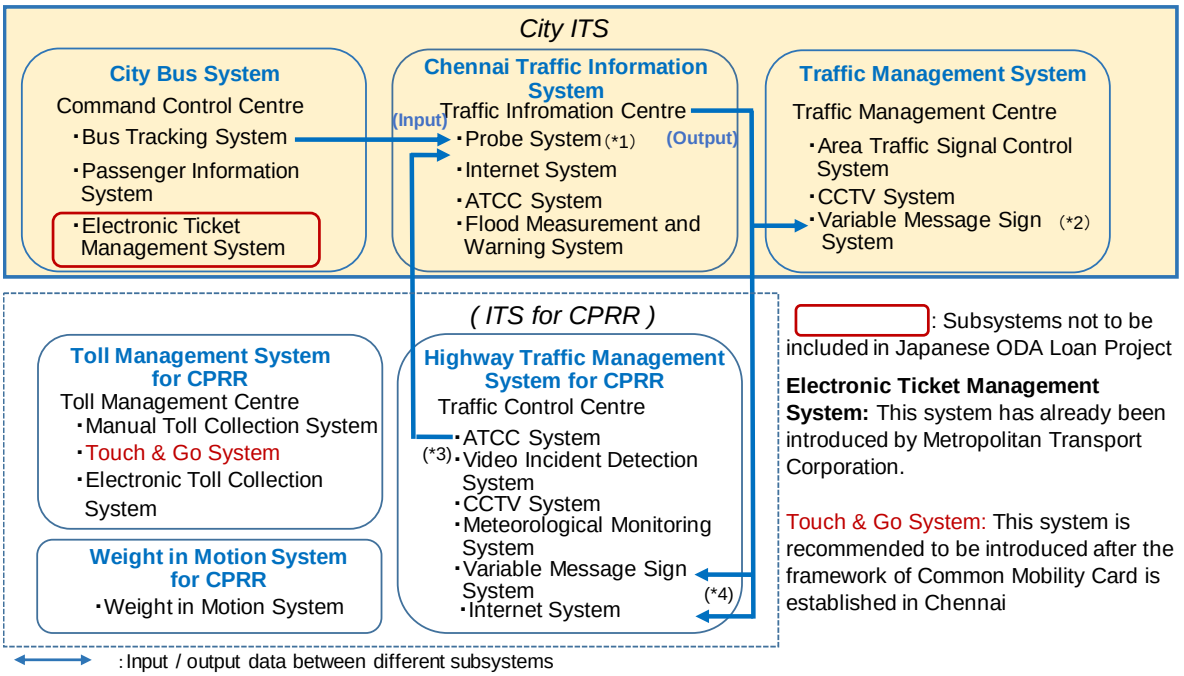
The clearinghouse has already been developed in Chennai Metro and was designed to handle a maximum of 32 operators, taking into consideration the introduction of a common mobility card in Chennai in the future. It functions as a management system of the cards as well. The memory of both types of the cards has also been designed to accommodate the same number of operators. A card initializing process is required upon issuance. Simple card issuance terminals for the initialization, which are processed by manual operation not automatic, are used because there are still a relatively small number of cards used for the metro.

3. PRIORITIZATION AND FORMULATION OF THE PROJECT FOR JICA LOAN SCHEME

3.1 ITS Components

Figure 3.1.1 shows the overall ITS components, which are candidates for Japanese ODA Loan Project. The considerations were mainly made for the City ITS in Volume 2 of this report.

As to the Touch & Go System, it is recommended to adopt the common mobility card which can be used for other transport modes, e.g. Chennai metro rail, city buses, etc. Under the situation where the common mobility card does not exist yet in Chennai, it is recommended that the Touch & Go System be introduced after the framework of the common mobility card is established in Chennai.



*1: To generate congestion information on the road network based on the probe data obtained from Bus Tracking System

*2: To provide congestion information on the general roads under the authority of Traffic Police

*3: To complement the Probe System to generate congestion information after completion of CPRR

*4: To provide congetion information generated by Chennai Traffic Information System. Other information will be generated by Highway Traffic Management System for CPRR and provided.

Source: JICA Study Team

Figure 3.1.1 Overall ITS Components for Japanese ODA Loan Project

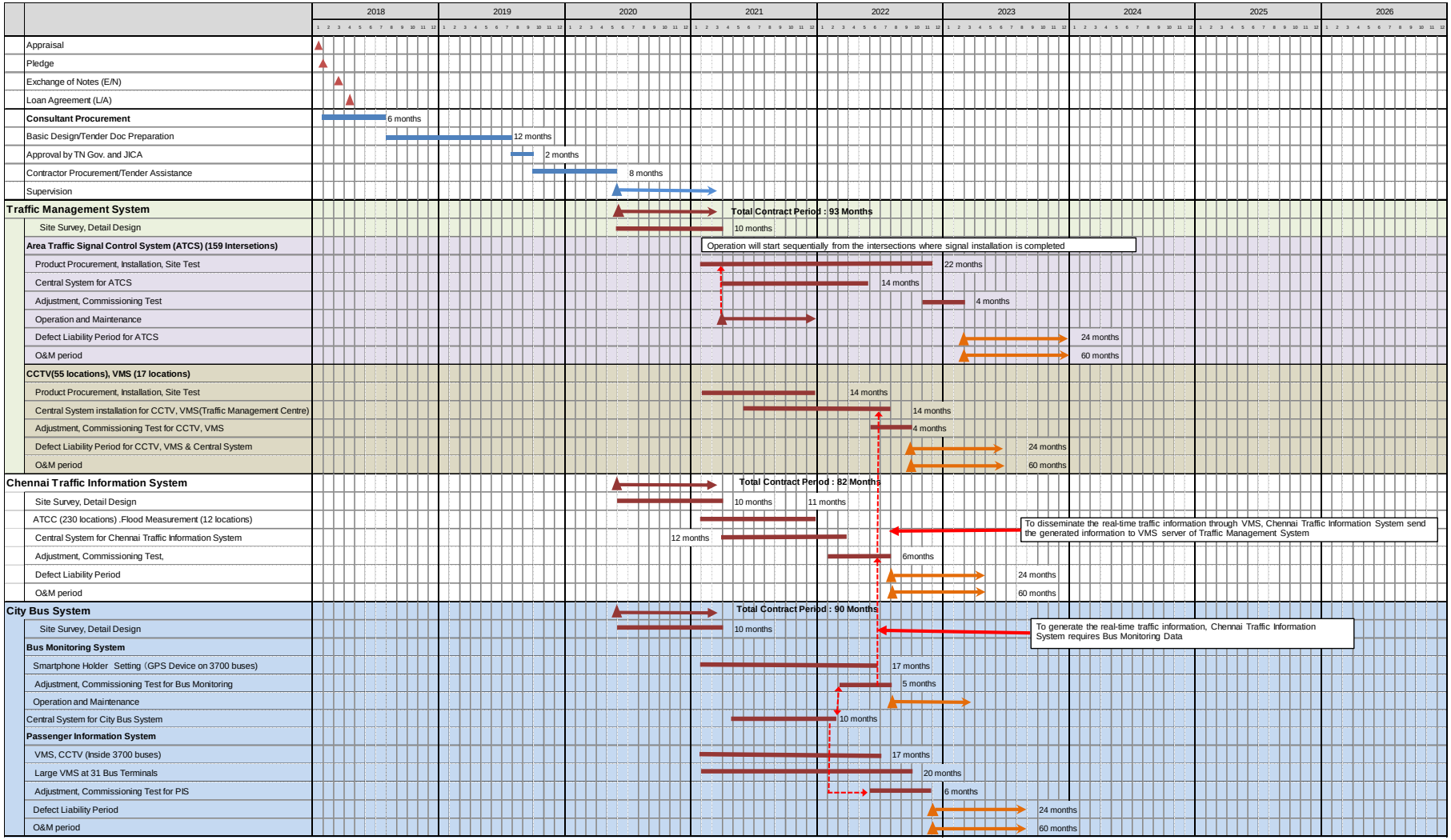
3.2 Prioritization of Components for Implementation

3.2.1 Prioritization of ITS Components (City ITS)

(1) City ITS Components for the 1st Phase

The City ITS components for the 1st phase are shown in the form of implementation schedule in Table 3.2.1 on the next page.

Table 3.2.1 Proposed City ITS Components for the 1st Phase



Source: JICA Study Team

3.3 Consulting Services for the Prioritized Project

(1) Mode of Contract Scheme

The 'Design Build', i.e., design, supply, and installation, in which the Employer prescribes the requirement of the systems and performance while the Contractor carries out the detailed design, best suits the project because of ITS Project, which is mainly composed of the systems and equipment.

The Design Build is adopted to other public projects of ITS in India. The major examples are 'MITRA Project' of City Bus Monitoring and Passenger Information System in Mysore, Karnataka State (World Bank), 'KSRTC Project' of Inter-City Bus Monitoring and Passenger Information System in Karnataka State (State Budget) and 'B-TRAC Project' of Traffic Management System of Bengaluru Traffic Police in Karnataka State (State Budget).

'Procurement of Plant Design, Supply and Installation' of '(JICA) Standard Bidding Documents Under Japanese ODA Loans (SBD)' is recommended to be used for Japanese ODA Loan Project. This SBD is prepared for the Design Build Project and has been used for several ITS projects under the Japanese ODA loan in India and other countries. This SBD has been made based on FIDIC 'Yellow Book' (Plant and Design-Build).

(2) Tender Method of Consultant Procurement

It is very important that the requirements be clearly defined/prescribed so that the bidders can properly reflect the requirements on their proposals particularly because of the ITS Project that utilizes advanced technology. This is a different method from 'Turn Key Project', or Engineering Procurement and Construction (EPC) where the Contractor takes almost the entire responsibilities on the design and construction. In particular, the Indian local contractors do not have sufficient experiences of ITS projects yet. Under such situation, ensuring the quality throughout the project, particularly the upper stage, i.e., basic design and contractor procurement, is very important because the quality of the upper stage will affect the entire project including the stages of implementation, operation and maintenance. Therefore, procuring the consultant through an international competitive bidding including the stages of basic design and contractor procurement is recommended.

(3) Selection Method of Contractor Procurement: Quality and Cost Based Selection (QCBS)

ITS facilities such as emergency call box, traffic counter, CCTV, weather monitoring facility, VMS and center system are obligated to be installed on national highways under the jurisdiction of NHAI in India where a certain level of traffic volume is expected (more than 40,000 daily traffic volume). However, currently, there is no road where these facilities have been installed correctly and actually no information is provided. As for City ITS in India, Ahmadabad in Gujarat State is the only city that provides dynamic traffic information in real time by Traffic Information System installed (The system was introduced by Japanese company under the Scheme of Support for Japanese Small and Medium Enterprise Overseas Business Development by JICA).

It is considered that the above situation of ITS in India has been caused by the fact that contractors who have sufficient technical capabilities for developing and handling the advanced system were not selected, and the selection method of the contractor procurement is considered one of the predominant factors behind the failure. ITS consists of several subsystems where technical aspects are vitally important such as software processing method, interface between subsystems or external systems and integration of systems. Therefore, selecting a contractor who holds enough technical capabilities determines the success of a project. To properly evaluate the technical capabilities of the bidders and select an appropriate contractor, adopting the Quality and Cost Based Selection (QCBS), an evaluation point of technical evaluation is reflected in addition to the financial evaluation, is strongly recommended.

The Smart City Mission, which will develop 100 smart cities, is the case in India that the selection method was altered from the conventional cost-based selection to QCBS. The first several cities such as Mumbai and Surat adopted cost-based selection for cost saving. But those cities fell into a situation that the integration of system could not be achieved because the contractor did not have enough technical capabilities. In the light of this fact, it was decided to adopt QCBS for the project of Smart City Mission. For example, the ratio of technical evaluation and financial evaluation for QCBS is 8:2 in Agra and 7:3 in Jabalpur and Lucknow.

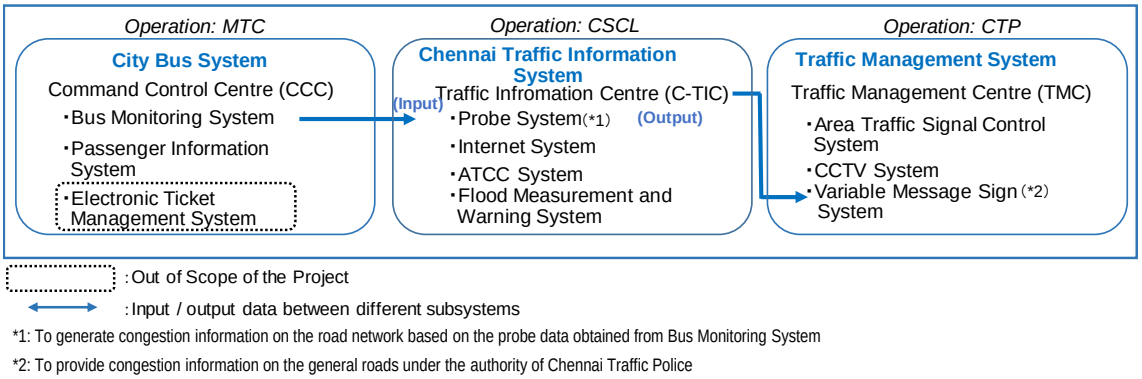
Furthermore, QCBS was used for the project of city bus system in Mysore, Karnataka State financed by World Bank to select a contractor. The ratio of technical evaluation and financial evaluation was 6:4. The

system has already been in operation and the project earned a high reputation for one of the successful ITS projects in India.

4. PRELIMINARY DESIGN OF CITY ITS

4.1 Scope and Objectives of Preliminary Design of City ITS

The scope of City ITS, which will be introduced to Chennai Metropolitan Area by the Japanese ODA loan, hereinafter referred to as the Project, was determined based on the studies carried out so far and discussions with Tamil Nadu government as shown in Figure 4.1.1. There are three components, i.e., Chennai Traffic Information System, Traffic Management System, and City Bus System. Each component is composed of some subsystems. The preliminary design of these components, including identifying quantity of equipment and cost estimation, was carried out for the formulation of Japanese ODA Loan Project.



Source: JICA Study Team

Figure 4.1.1 Scope of City ITS for the Project

4.2 Outline of City ITS

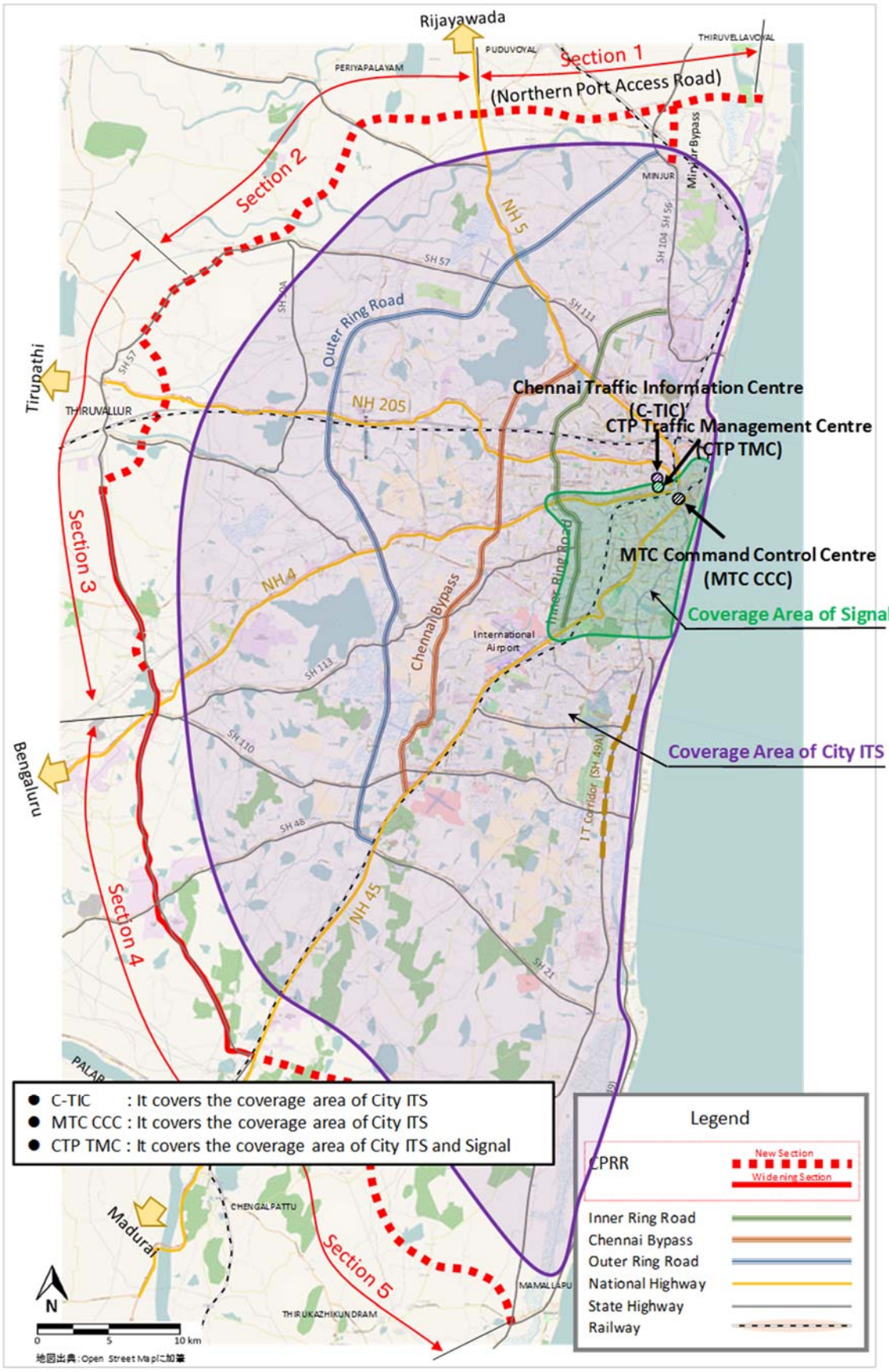
The City ITS components are planned to be developed in two phases. In the first phase, it will be developed covering the area inside Chennai Peripheral Ring Road (CPRR). While the second phase, the coverage area will be expanded to outside CPRR. The project of the Japanese ODA loan that this report discusses is the first phase. The ITS components in the second phase will be developed later together with the construction of CPRR and traffic information including CPRR, which will be provided to the road users.

The purple-colored in Figure 4.2.1 shows the coverage area of City ITS in the first phase. The green-colored in Figure 4.2.1 shows the coverage of Area Traffic Signal Control System in the first phase to cover the core area of the city.

The following three centers will be developed to realize the purposes described in Figure 4.1.1 above.

- Center of Chennai Traffic Information System (C-TIC)
- Center of Traffic Management System (CTP TMC)
- Command Control Center of City Bus System (MTC CCC)

C-TIC and CTP TMC will be established in the headquarters of Chennai Traffic Police. MTC CCC will be established in the headquarters of MTC. The locations and coverage area of these centers are also indicated in Figure 4.2.1.



Source: JICA Study Team

Figure 4.2.1 Location Map of Coverage Area and Centers of City ITS

5. IMPLEMENTATION ORGANIZATION FOR CITY ITS

The responsibilities of related organizations for City ITS are demarcated as shown in Table 4.2.1.

The Chennai Smart City Limited (CSCL) is the executing agency of the Project and will be responsible for the procurement and installation for all components of City ITS. The maintenance and evaluation of Service Level Availability (SLA) will also be executed under the responsibility of CSCL. The operation of each component will be carried out by the respective organizations, i.e., CSCL for Chennai Traffic Information System, CTP for Traffic Management System, and MTC for City Bus System. The ownership of the system and equipment of components will belong to these organizations respectively as shown in Table 4.2.1.

Table 4.2.1 Demarcation of Responsibility of Related Organizations for City ITS

System	Subsystem	Responsible Organization by Project Stage			
		Procurement and Installation	Operation	Maintenance (*1)	Ownership of System and Equipment
Chennai Traffic Information System	Chennai Traffic Information Centre (C-TIC)	CSCL	CSCL	CSCL	CSCL
	Probe System / Internet System				
	Automatic Traffic Counter-cum-classifier (ATCC) System				
	Flood Measurement and Warning System				
Traffic Management System	Traffic Management Center (TMC)	CSCL	CTP	CSCL	CTP
	Area Traffic Signal Control System (ATCS)				
	Variable Message Sign (VMS) System				
	CCTV Traffic Monitoring System				
City Bus System	Bus Tracking System (BTS)	CSCL	MTC	CSCL	MTC
	Passenger Information System (PIS)				

Source: JICA Study Team

CSCL: Chennai Smart City Limited, CTP: Chennai Traffic Police, MTC: Metropolitan Transport Corporation
(*1): The responsible organization for maintenance will be in charge of the evaluation of the Service Level Agreement (SLA) and O&M payment accordingly.

6. PROCUREMENT PLAN, CONSTRUCTION PLAN AND COST ESTIMATES

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7. TENTATIVE IMPLEMENTATION SCHEDULE

The implementation schedule in consideration of the whole project stage from basic design to operation and maintenance period is considered and already presented in Table 3.2.1.

8. PROJECT EVALUATION

8.1 Methodology

The main objective of the economic analysis is to examine the investment efficiency of the project from the viewpoint of national economy using cost-benefit analysis, in case where it can be applied. Market prices are converted to economic ones where the influence of market distortion is removed (shadow prices). Opportunity costs are used for the costs of goods and services if their markets do not exist. Economic internal rate of return (EIRR) is used as an indicator of efficiency of project investment.

Benefit of the project is assumed to be toll revenue and it is impossible to collect tolls for the City ITS System. Therefore, the financial analysis is not conducted for the City ITS Project.

8.2 Project Evaluation on City ITS

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9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Necessity and Effect of the Chennai City ITS Project

The economic validity of Chennai City ITS Project was also examined and evaluated taking into account the traffic situation in 2017. Sensitivity analysis is carried out in several cases such as changes in the benefit and/or cost as summarized below. The economic internal rate of return (EIRR) in the original case is so high that it is robust to some extent against unfavorable situations (benefit decreasing, cost increasing, or both cases) in principle. As a result of economic analysis, the EIRR of Chennai City ITS Project is 15.27% under most severe case as shown in Table 9.1.1. It was confirmed that this Project also contributes to economic development of Chennai Metropolitan Area.

Table 9.1.1 Sensitivity Analysis of EIRR

	No Change in Cost	Increase in Cost by 10%
No Change in Benefit	20.16%	17.83%
Decrease in Benefit by 10%	17.58%	15.27%

Source: JICA Study Team

9.2 Confirmation of Appropriateness of the City ITS Project Components

9.2.1 Demarcation of Responsibility of Related Organizations

The responsibilities of the related organizations for City ITS are demarcated as shown in Table 9.2.1.

The CSCL is the executing agency of the Project and will be responsible for the procurement and installation of all components of City ITS. The maintenance and evaluation of Service Level Availability (SLA) will also be executed under the responsibility of CSCL. The operation of each component will be carried out by the respective organizations, i.e., CSCL for Chennai Traffic Information System, CTP for Traffic Management System, and MTC for City Bus System. The ownership of the system and equipment of the components will belong to these organizations, respectively, as shown in Table 9.2.1.

Table 9.2.1 Demarcation of Responsibility of Related Organizations for City ITS

System	Subsystem	Responsible Organization by Project Stage			
		Procurement and Installation	Operation	Maintenance (*1)	Ownership of System and Equipment
Chennai Traffic Information System	Chennai Traffic Information Centre (C-TIC)	CSCL	CSCL	CSCL	CSCL
	Probe System / Internet System				
	Automatic Traffic Counter-cum-classifier (ATCC) System				
	Flood Measurement and Warning System				
Traffic Management System	Traffic Management Center (TMC)	CSCL	CTP	CSCL	CTP
	Area Traffic Signal Control System (ATCS)				
	Variable Message Sign (VMS) System				
	CCTV Traffic Monitoring System				
City Bus System	Bus Tracking System (BTS)	CSCL	MTC	CSCL	MTC
	Passenger Information System (PIS)				

Source: JICA Study Team

CSCL: Chennai Smart City Limited, CTP: Chennai Traffic Police, MTC: Metropolitan Transport Corporation
(*1): The responsible organization for maintenance will be in charge of evaluation of SLA (Service Level Agreement) and O&M payment accordingly.

9.2.2 Procurement Plan

Some specialized ITS equipment of servers and softwares are difficult to procure in India, so import from abroad is assumed. The table below summarizes the main equipment procurement categories.

Table 9.2.2 Procurement of ITS Equipment

ITS Component		Domestic	Import
Chennai Traffic Information System (C-TIC)			
	Center System (including Probe System, Internet System)	All items except listed at the right	Probe server ATCC2 server software
	Automatic Traffic Counters-cum-classifier (ATCC) System	All items	-
	Flood Measurement and Warning System	All items	-
City Bus System (MTC)			
	Bus Monitoring System	All items except listed at the right	Monitoring server software
	Passenger Information System	All items except listed at the right	Passenger information software
Traffic Management System (Chennai Traffic Police)			
	Traffic Management Center	All items except listed at the right	Signal control system server Signal control system server software
	Area Traffic Signal Control System	All items except listed at the right	Signal control database Signal controller
	CCTV Traffic Monitoring System	All items	-
	Variable Message Sign (VMS) System	All items	-

Source: JICA Study Team

9.2.3 Project Implementation Schedule

Implementation schedule in consideration of the whole project stage from basic design to operation and maintenance period is considered and tabulated in Table 3.2.1.

CHAPTER 1 INTRODUCTION

1.1 Outline of the Study

1.1.1 Background of the Study

As in other major cities in India, traffic congestion is getting worse in Chennai Metropolitan Area (hereinafter referred to as "CMA"), which is the target area of the study, because road infrastructure improvements have not caught up with the increase in traffic demand due to population growth and economic development.

The Government of Tamil Nadu (GoTN) is promoting the development of roads and public transportation as a countermeasure to traffic congestion in CMA. The major arterial road network in CMA consists of National Highways No. 5, No. 205, No. 4, and No. 45 as major radial roads, and Inner Ring Road (IRR), Chennai Bypass, and Outer Ring Road (ORR) as ring roads. The implementation of the Chennai Peripheral Ring Road (CPRR) Project is expected to contribute to the further expansion of the Radial-Ring Road Network corresponding to the growing traffic demand.

In addition, as a countermeasure to alleviate congestion at the center of CMA where the development site for road infrastructure is limited, the improvement of Intelligent Transport System (ITS) facilities that promote efficient use of the road is an issue.

Based on this background, the Government of India (GoI) has prepared the Detailed Project Report (DPR) describing the development plan of CPRR and ITS and has requested the Government of Japan (GoJ) for loan assistance.

1.1.2 Objectives of the Study

The DPR presents the implementation plan for the following:

- Construction of CPRR (widening section: 36.5 km, new section: 96.9 km, total: 133 km), and
- Development of ITS facilities for CPRR and for the CMA road network.

The study aims to collect necessary information to appraise the Project for it to be implemented under the Official Development Assistance (ODA) scheme through the confirmation of the objectives and the outline of the Project, including project cost, implementation schedule, procurement and construction method, project organization, capability of operation and maintenance, as well as social and environmental conditions.

1.1.3 Scope of the Study

In accordance with the agreement between JICA and the Consultant, the following work items are carried out in the study:

[1] Preparation and Discussion of Inception Report (IC/R)

[2] Review of the Background of the Project

[3] Survey on the Current Situation and Issues of Chennai Peripheral Ring Road (CPRR)

[4] Traffic Survey and Traffic Demand Forecast

[5] Formulation of the Project

[6] Prioritization of Project Components

[7] Preliminary Design

[8] Construction Planning

[9] Study on the Procurement Method

[10] Formulation of Project Implementation Schedule

[11] Confirmation of Project Implementation Structure

[12] Confirmation of Operation and Maintenance (O&M) Structure

[13] Environmental and Social Considerations

[14] Study on Countermeasures against Climate Change

[15] Project Cost Estimate

[16] Study on Points to Consider for Project Implementation

[17] Project Evaluation

[18] Preparation of Basis of ITS Technical Specifications

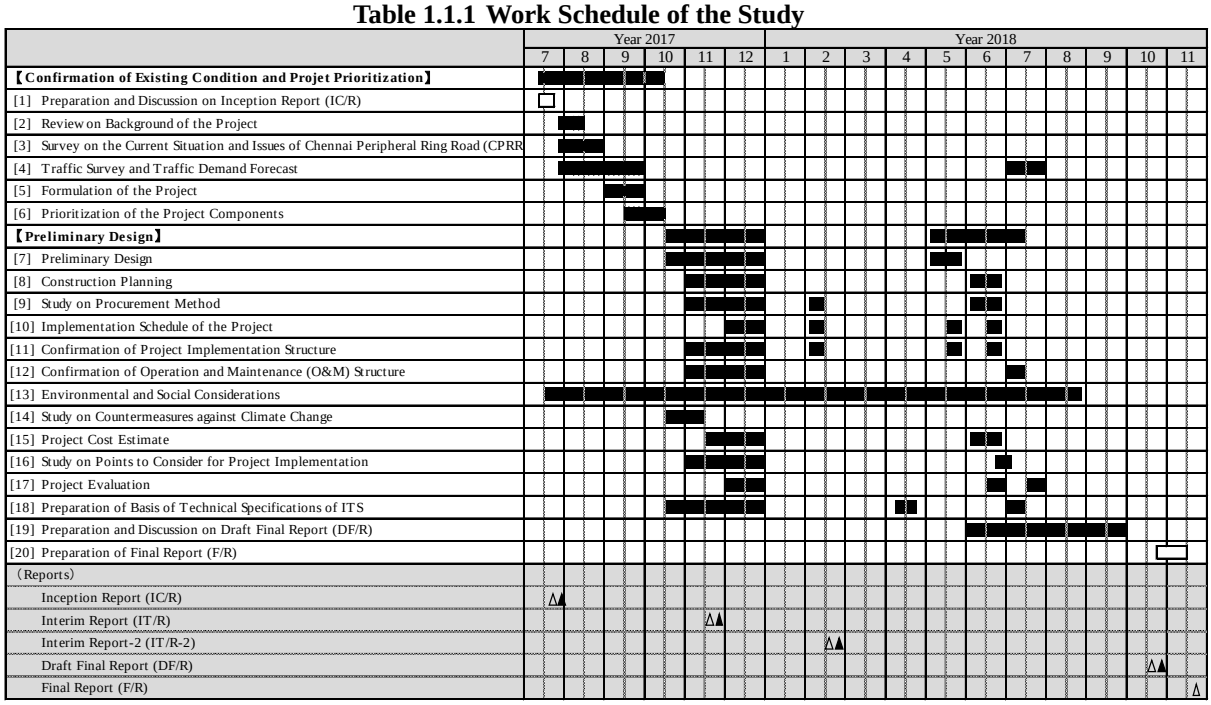
[19] Preparation and Discussion on Draft Final Report (DF/R)

[20] Preparation of Final Report (F/R)

1.1.4 Work Schedule of the Study

The study was started in the middle of July 2017, and the F/R will be submitted in November 2018. Table 1.1.1 shows the work schedule of the study.

Table 1.1.1 Work Schedule of the Study



Source: JICA Study Team

1.1.5 Objectives of the Final Report

The objectives of Final Report (F/R) are:

- To compile the results of the preliminary design of the Chennai City ITS Project and the design review of the CPRR Project into the report, and
- To update environmental and social consideration procedures for early project implementation.

1.1.6 Components of the Final Report

The subject of this study was originally the CPRR Project and the Chennai City ITS Project; however, the procedure for environmental and social consideration of the CPRR Project was delayed. For this reason, JICA decided to separate the Chennai City ITS Project from the CPRR Project and aimed only for the Chennai City ITS project as the initial goal for the March 2018 Loan Agreement (L/A). For the CPRR project, JICA and HMPD confirmed that the section 1 will be the priority for the ODA loan.

With this, the CPRR Project is compiled as Volume 1 and the Chennai City ITS Project as Volume 2 in this report.

1.1.7 Organization of the Study

JICA entrusted the study to the Consultant, and the Consultant dispatched the JICA Study Team to India, comprised the following 16 members:

JICA Study Team

1)	Mr. Takayasu Nagai	Team Leader/Road Planning
2)	Mr. Ippei Iwamoto	Deputy Team Leader/Road Planning 2/Road Design
3)	Mr. Hiroya Totani	ITS Planning/Design 1
4)	Mr. Noboru Kondo	ITS Planning/Design 2
5)	Mr. Akira Magario	Road Structure Design 1 (Geometric, Interchange (IC))
6)	Mr. Seiya Hikino	Road Structure Design 2 (Viaduct, Bridge, Road Structures)
7)	Mr. Eiji Wakatsuki	ITS Operation
8)	Mr. Hisanari Ushirooka	Traffic Demand Forecast 1
9)	Mr. Yuki Sugiyama	Traffic Demand Forecast 2
10)	Mr. Makoto Yajima	Economic and Financial Analysis
11)	Mr. Kiyoshi Dachiku	Road Operation and Maintenance Planning
12)	Mr. Kenichi Moritani	Natural Condition Survey
13)	Mr. Daisaku Kiyota	Social Environmental Consideration
14)	Ms. Natsumi Hara	Environmental Consideration
15)	Ms. Kakiko Ide	Social Consideration
16)	Mr. Motoki Iwamaru	Construction Planning (Procurement/Cost Estimate)

The following two agencies are designated to be the counterparts (C/P) in the Government of Tamil Nadu.

C/P Agencies

1) Highways and Minor Ports Department (HMPD)
2) Tamil Nadu Infrastructure Development Board (TNIDB)

1.2 Record of Meetings

The JICA Study Team had several meetings with various stakeholder organizations of the CPRR Project and the Chennai City ITS Project to carry out confirmation of the current situation and proposal on the prioritized section for the Japanese ODA Loan Project.

HMPD is a C/P agency for the CPRR Project, and TNIDB is a C/P agency for the Chennai City ITS Project.

Kick-off meetings with HMPD and TNIDB are held individually, and the JICA Study Team explained the procedure of the Japanese ODA Loan Projects from the preparatory survey to the signing of L/A, as well as the position of the preparation survey and the Japanese ODA Loan Projects to C/Ps.

1.2.1 Meetings with Concerned Agencies of City ITS

The 'Data Collection Survey for Chennai Metropolitan Region ITS', which was completed in March 2017, proposed mainly three ITS components of the City ITS, i.e., (i) City Bus System, (ii) Chennai Traffic Information System, and (iii) Traffic Management System.

The meetings were held mainly with the agencies related to these ITS components of the City ITS. The list of the meetings with those agencies, which mentions the major agenda and results of the meetings, are shown in Table 1.2.1. Minutes of major meetings are presented in Appendix-1.

Table 1.2.1 Meeting List with Concerned Agencies of ITS

Date	Agency	Major Agenda	Results
20 Jul. 2017	TNIDB	a) Explanation of inception report b) Explanation of ITS component c) Explanation of process of Japanese ODA Loan Project d) Organizational framework for the study	・TNIDB confirmed that the Steering Committee for the matters of both CPRR and ITS will be established for the Study. ・TNIDB instructed CSCL to work closely with JST. ・TNIDB requested JST to consider implementing ITS project earlier than that of CPRR.
24 Jul. 2017	NHAI	a) Request of clarification of jurisdiction of NHAI in Chennai Metropolitan Area b) Request of clarification of ETC (FASTag)	・The road sections under the jurisdiction of NHAI in Chennai Metropolitan Area were confirmed. ・The rules of toll tariff were clarified. ・The contact person of IHMCL in Delhi for clarification in detail of ETC (FASTag) was informed.
25 Jul. 2017	CMRL	a) Request of clarification of current progress and plans of Chennai Metro Network Construction b) Request of clarification of inter-modal connectivity c) Request of clarification of operation status of Chennai Metro d) Request of clarification of status and plans of smart card and common mobility card	・Both Type-A and Felica cards are in use ・The clearinghouse for the common mobility card has already been developed in CMRL HQ. ・However, the existing smart card can be used only for Chennai Metro
2 Aug. 2017	IHMCL	a) Request of clarification of ETC (FASTag) in India	・The overall framework, overall system configuration, data flow, payment procedure, and current situation of ETC (FASTag) in India were clarified.
3 Aug. 2017	CTP	a) Request of clarification of the latest situation of ITMS project b) Request of clarification of details of the existing system and their plans c) Request of clarification of various other related matters	・Commissioner of Chennai Police commented that they wish to carry out a pilot of the traffic signal before a large-scale implementation. ・CTP informed that ITMS is still under court case but expected to be

Date	Agency	Major Agenda	Results
			finalized soon. ・The details of the existing system, e.g., command control center, number and locations of traffic signal and VMS, etc., were clarified. ・The area under the jurisdiction of CTP was clarified.
5 Sep. 2017	MTC	a) Request of clarification of scope of bus systems between Japanese ODA Loan Project and Smart City Project b) Request of clarification of status of the existing system and plan c) Proposal of introduction of common mobility card	・MTC and CSCL informed that the high-level officials of Tamil Nadu government consider that Bus Tracking System and Passenger Information System shall be introduced under Japanese ODA Loan Project. ・MTC and CSCL commented that the smartphone shall be used for GPS device. ・MTC and CSCL commented that the schedule of Japanese ODA loan shall be shortened. ・MTC and CSCL informed that the specification of bus systems had already been prepared and commented that it shall be fully utilized for Japanese ODA Loan Project. ・Approx. 8,000 handy-terminals for bus ticketing have already been introduced.
5 Sep. 2017	CSCL	a) Request of clarification of responsible organization of Chennai Traffic Information System b) Request of clarification of scope of Flood Measurement and Warning System under Japanese ODA Loan Project	・It was confirmed that CSCL will be in-charge of procurement, installation and O&M for Chennai Traffic Information System. ・It was confirmed that Flood Measurement and Warning System will be included in Japanese ODA Loan Project.
15 Sep. 2017	CTP	a) Proposal of coverage area and implementation schedule of Traffic Management System b) Request of clarification of the responsible organization of VMS which includes the area beyond the jurisdiction of CTP c) Request of clarification of other related matters	・CTP commented that the implementation of Japanese ODA loan project takes too long and therefore the core area shall be covered by ITMS project due to the necessity of immediate measure. ・CTP clarified that CTP will be responsible for coordination with other traffic police for VMS operation. ・It was confirmed that the centers of the Chennai Traffic Information System and Traffic Management System will be located in the building of CTP. ・It was confirmed that JICA Study Team will study on the enforcement related systems upon request made by CTP.
18 Sep.	CSCL	a) Request of clarification of organization	・The information of organization

Date	Agency	Major Agenda	Results
2017		structure and capability for ITS Project of CSCL b) Request of clarification of responsible organization for all City ITS components	structure was provided. ・CSCL clarified that the High-powered Committee is a decision-making body. ・CSCL informed that CSCL will be responsible for all City ITS components as follows: - Procurement, installation, operation and maintenance; - SLA evaluation and O&M payment accordingly; - Asset of Traffic Management System will be handed over to CTP; - Asset of City Bus System will be handed over to MTC; and - Asset of C-TIC will remain under CSCL. ・The information of capability of CSCL for ITS project and the details of the High-powered Committee will be provided later.
21 Sep. 2017	CSCL	a) Proposal of revised detailed implementation schedule of Chennai Traffic Information System, City Bus System, and Traffic Management System	・CSCL commented that the schedule of implementation shall still further shortened.
26 Sep. 2017	Transport Dept.	a) Report on the results of the discussions held with MTC and request of confirmation	・In addition the Chief Secretary, Transport, commented as follows: - The operation of the city bus systems requires to commence from February 2018. - MTC needs the city bus systems for all major cities in Tamil Nadu state.
27 Sep. 2017	TNIDB	a) Report on the results of the discussions held with all related agencies during the study activities	・CEO, TNIDB, commented that the implementation schedule shall be shortened as follows: - To complete the consultant procurement, preparation of basic design and tender document before L/A - To announce the tender soon after L/A ・The letter requesting above matter will be issued from TNIDB to JICA. ・CEO, TNIDB, clarified that the construction schedule is fine as JST proposed. ・CEO, TNIDB, commented that all City ITS components shall be included under Japanese ODA loan, including the core area for the traffic signal on the condition that the abovementioned matter is sorted out.
30 Nov. 2017	BMTC (in Bengaluru)	a) Interviews on confirmation of actual practice of O&M of city bus and system	・The following items were confirmed: - Organizational structure - Number of staff and their roles - Shift arrangement

Date	Agency	Major Agenda	Results
			- Demarcation of roles between BMTC and Contractor
06 Dec. 2017	L&T	a) Interviews on technical details of signal system, ANPR, and other related matters with regard to City ITS	・The following items were confirmed: - O&M period of ITS (five years in many cases) - Communication for signal and OFC availability in Chennai - Accuracy of ANPR in India - Cost for signal and O&M - Details of the project in PUNE (signal project that L&T is involved)
13 Dec. 2017	CSCL	a) Confirmation of demarcation of the related organizations for City ITS b) Confirmation of decision-making flow of the project	・The following items were confirmed: - Demarcation of the organizations (CSCL, CTP and MTC) for three ITS components by project phase. - Decision-making flow for requesting budget, making payment, procuring for new project, system upgrade for the ongoing project, etc.
19 Dec. 2017	CTP	a) Demarcation of coverage area between ITMS Project and Japanese ODA Loan Project b) Space for center for C-TIC and CTP TMC c) Other major items for the Project	・It was agreed that the core area will be covered by Japanese ODA Loan Project and other areas by ITMS Project ・It was agreed that the signals installed by ITMS Project and Japanese ODA Loan Project will not be integrated. ・It was agreed that CTP will consider the spaces sufficient for the centers and will be finalized during the basic design stage ・It was agreed that the duct-based wiring method will be adopted for the communication for the signal at junction ・It was agreed that CCTV cameras at the junction for the purpose of surveillance will be installed by CTP as different project.
19 Dec. 2017	MTC	a) Finalization of the number of equipment of City Bus System b) Confirmation of spaces for the center	・The following were agreed: - Information board: 7 bus terminals - GPS devices: 4,000 units - In-bus camera: 1,000 units - In-bus LED display: 1,000 units ・It was agreed that GPS device will be adopted instead of mobile phone for bus probe data collection. ・It was agreed that the mobile application for bus information will be developed by Indian side. ・The location of the center in the MTC building was confirmed and it was agreed that the space will be renovated making the existing two

Date	Agency	Major Agenda	Results
			rooms one to ensure the space for the operation.

Source: JICA Study Team

1.2.2 Meetings with Others

A meeting with Japan External Trade Organization (JETRO) was held on 26 July 2017 to make an interview about the requested and desired road projects by Japanese-related organizations in Tamil Nadu State.

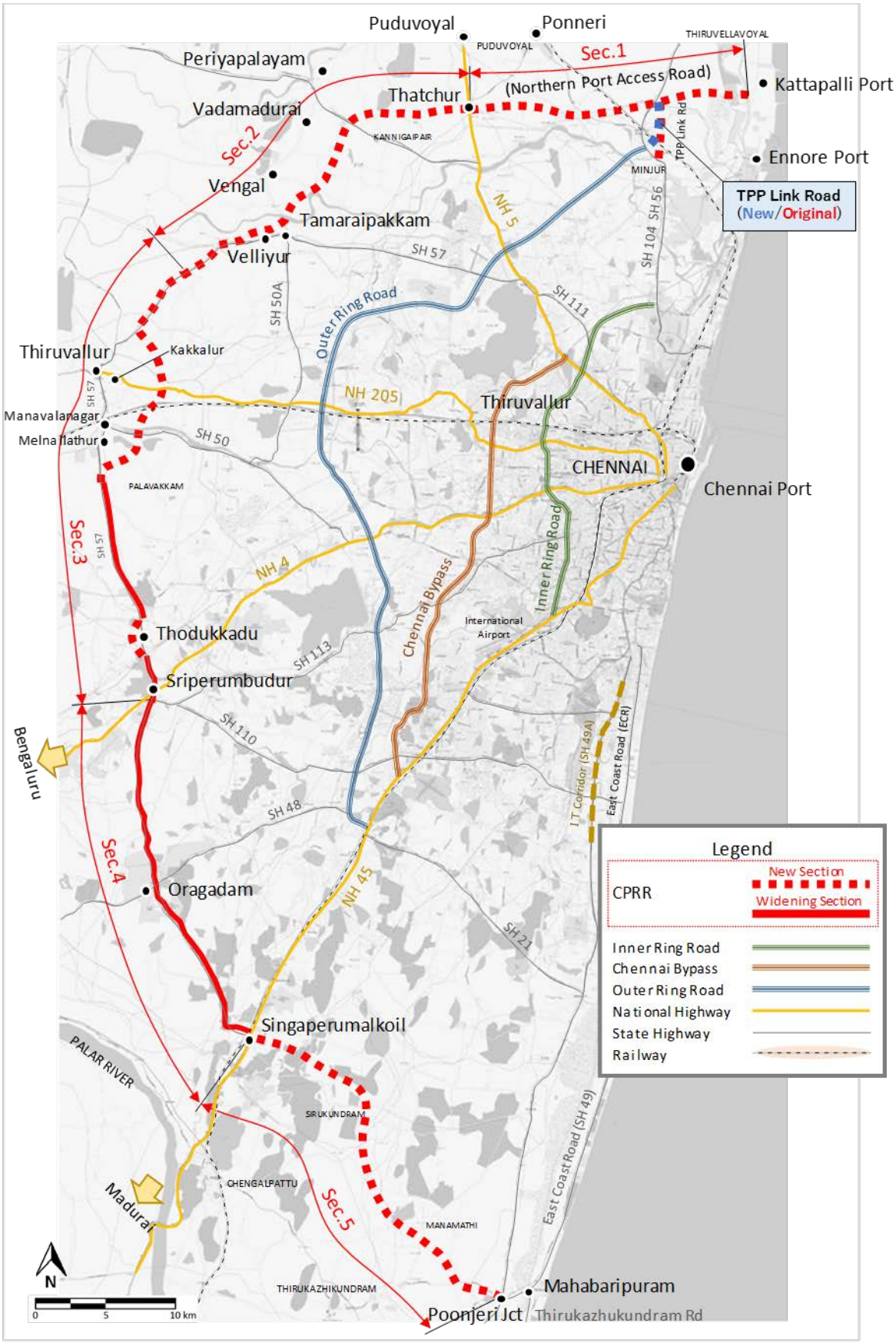
CHAPTER 2 PRESENT CONDITION AND CIRCUMSTANCES OF THE PROJECT

2.1 Present Condition and Identified Issues of Roads and Traffic in the Study Area

2.1.1 Present Condition and Issues of Road Network

Roads in CMA have been developed following the pattern of the Radial-Ring Road Network as shown in Figure 2.1.1. Major radial roads which originate at the center of Chennai City are NH4 (towards Mumbai via Bengaluru), NH5 (towards Kolkata), NH45 (towards Madurai), and NH205 (towards Tirupathi). With respect to ring roads, the IRR was first proposed as a city bypass road in 1968, and construction started in the 1980s from its central arm connecting NH45 to NH5. Subsequently, the northern and southern arms were developed. Then, the second ring road, the Chennai Bypass, was opened in 2008. However, since the urbanized area of Chennai is rapidly expanding, these two ring roads were incorporated into the built-up area. Therefore, the third ring road, or the ORR, is currently being developed, and the CPRR was even proposed to enhance the road network.

Table 2.1.1 and Table 2.1.2 show the statistics on the road network in Tamil Nadu State. There are highways and roads of 62,468 km in length, and a large part of National Highways (NH) and State Highways (SH) have double or more lanes (99% for NH and 97% for SH).



Source: JICA Study Team based on OpenStreetMap

Figure 2.1.1 Road Network in CMA

Table 2.1.1 Existing Roads in Tamil Nadu State

Classification of Road	Length (km)
National Highways (NH wing-1985 & NHAI-3009)	4,994
State Highways	12,095
Major District Roads	11,628
Other District Roads & Sugarcane Roads	33,751
Total	**62,468**

Source: Highway Department

Table 2.1.2 Details of Roads in Tamil Nadu State

Unit: km

No.	Category wise	Single Lane	Intermediate Lane	Double Lane	Multi Lane	Total
1	National Highways	12	26	2,731	2,225	**4,994**
2	State Highways	56	350	9,795	1,894	**12,095**
3	Major District Roads	422	7,663	3,367	176	**11,628**
4	Other District Roads	29,287	3,507	893	64	**33,751**
Total		**29,777**	**11,546**	**16,786**	**4,359**	**62,468**

Source: Highway Department

The issues of the road network in CMA are summarized as follows:

(1) Concentration of Traffic in the Core Area of Chennai

The incompletion of the road network development in the pattern of the Radial-Ring Road Network in CMA (construction of ring roads has not caught up with the increase in traffic demand) is causing serious traffic congestion in major roads towards the city center. Traffic is concentrated particularly in the core area of Chennai. It was found that more than 200,000 vehicles per day are traversing NH45 and IRR, including motorbikes. On the other hand, the traffic volume on the same road but in the suburbs is less than 70,000 vehicles per day. Similar characteristics were found in other major roads. As a result, the travel speed of traffic towards Chennai City in the morning peak hour becomes less than 30 km/hr in the city center.

It is therefore required to disperse incoming traffic before it comes into the city center.

(2) High Proportion of Large Vehicles

A high ratio of large vehicles is found in the suburban section of NH5, NH4, and NH45. This indicates that these roads are used by a large number of commercial vehicles, such as heavy lorries and trailers, to access the industrial areas and the Kattupalli/Ennore/Chennai Ports. The high proportion of slow-moving large vehicles causes a decrease in the overall travel speed of traffic.

A large number of large vehicles are frequently passing through small villages in the suburbs. Thus, there are a lot of pedestrians and motorcycles in the villages that are always facing high risks of traffic accidents.

Hence, a new link connecting industrial areas in the suburban area to ports shall be developed to ease the load of existing highways.

(3) Expansion of Built-up Areas

Rapid economic growth and increase in the population of CMA is encouraging the urbanized built-up area to expand, thereby changing the classification of IRR and Chennai Bypass from bypass roads to urban highways. The ORR which is currently being constructed will be, once it opens, the newest ring road with

the largest radius of 20 to 30 km; however, urban development is approaching such current outskirts.

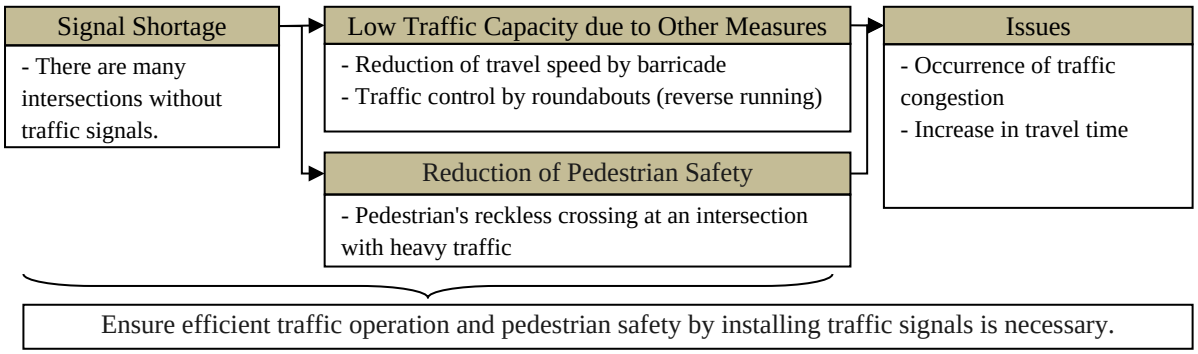
The necessity of the development of further ring roads has been recognized to enhance the road network as well as improve redundancy of the network.

2.1.2 Present Condition and Issues of Traffic in the Study Area

(1) Traffic Signal Shortage

There are many intersections without traffic signals in Chennai. At such intersections, barricades and roundabouts are adopted as alternative facilities. However, such facilities cause problems such as traffic congestion and increase in travel time. In addition, pedestrian safety is threatened because crossing at intersections without signals involves great danger.

In short, the lack of signals causes traffic congestion and prolonged travel time. Therefore, it is necessary to secure efficient traffic operation and pedestrian safety by installing traffic signals.



Source: JICA Study Team

Figure 2.1.2 Issues due to Traffic Signal Shortage

1) Reduction of Travel Speed by Barricades

Barricades are installed to reduce the travel speed of vehicles at some crosswalks and intersections. They are installed even in trunk roads with three lanes per direction. However, high speed vehicles suddenly need to change lanes to avoid barricades. Thus, it is assumed that barricades lower travel speeds but also induce accidents by sudden lane changing.

Source: JICA Study Team

Figure 2.1.3 Installation of Barricades

2) Crossing Pedestrian

There are crosswalks on trunk roads with over six lanes, but no signals are installed in most cases. Therefore, pedestrians are forced to cross the road amidst heavy traffic which causes accidents.

There are some sections where barricades are installed in front of crosswalks to decrease the speeds of vehicles and to shorten the crossing distance. Regardless, pedestrians are still in danger.

In cases where a school is located along a trunk road, a large number of students cross the road in the morning and evening as many of them use public transport. Even when a pedestrian bridge is installed near the school, students still tend to cross the road. It is assumed that the reason for this is the long distance between the pedestrian bridge and the bus stop.

For these reasons, it is said that there is a high risk of traffic accidents around schools.

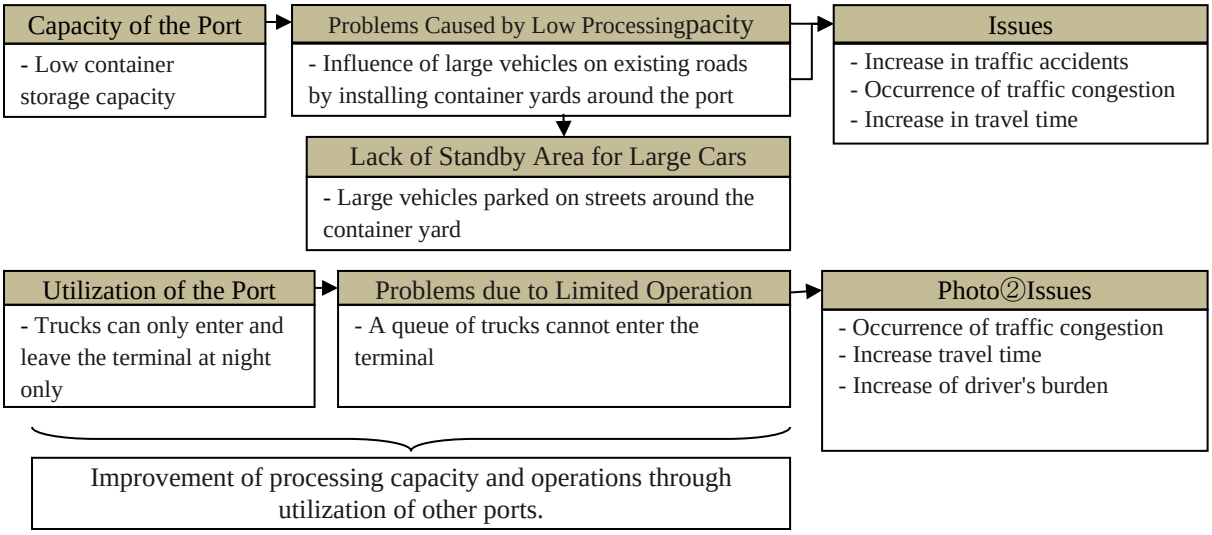
Source: JICA Study Team

Figure 2.1.4 Crossing Pedestrians

(2) Processing Capacity and Operation at the Chennai Port

As shown in Figure 2.1.5, due to the small processing capacity and the inefficient operation of the Chennai Port, large vehicles flow into community roads and form a long queue on roads.

Since improvements to the operation of Chennai Port and the utilization of Ennore Port are in progress, some developments to the situation are expected.



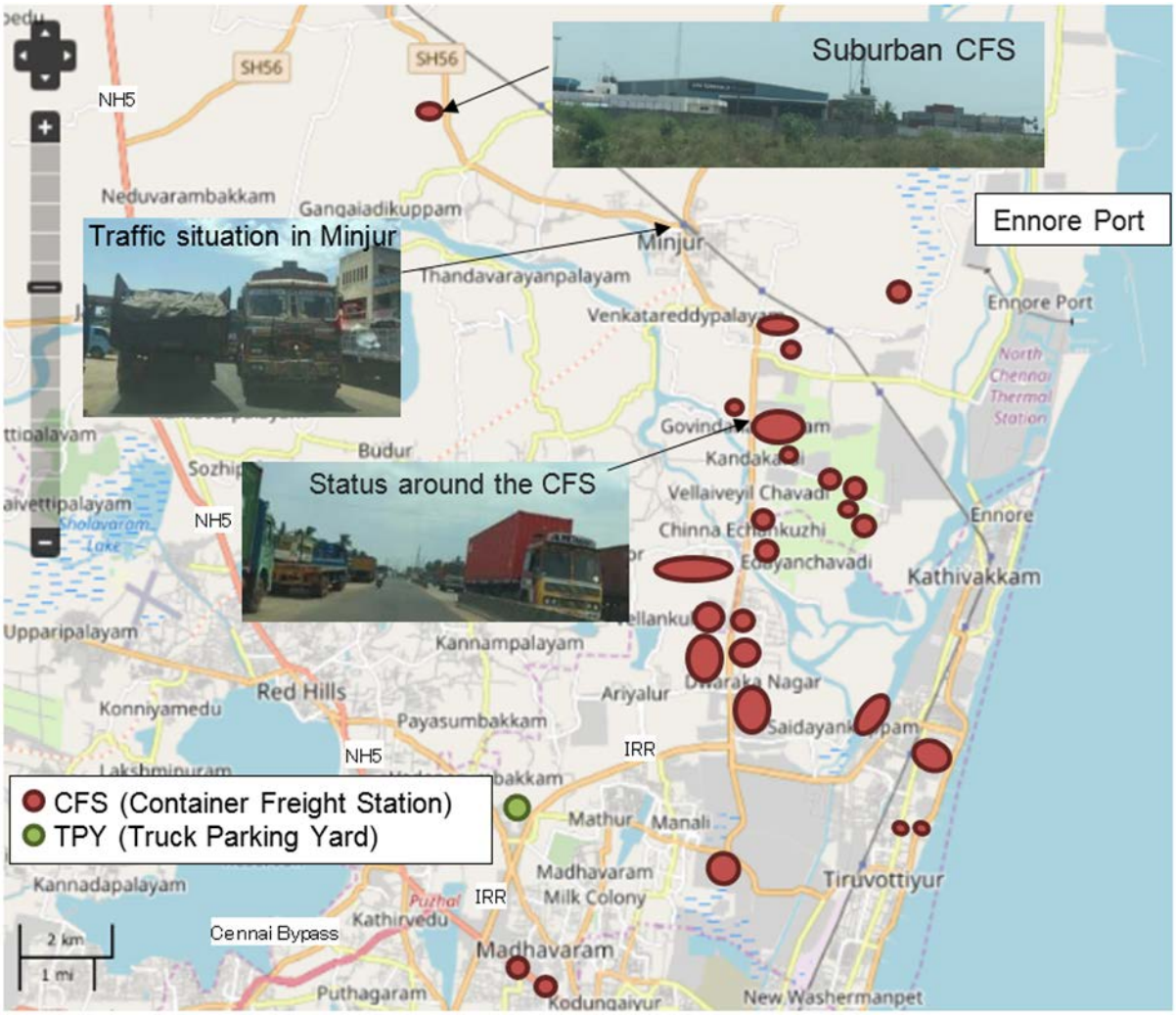
Source: JICA Study Team

Figure 2.1.5 Issues due to Small Processing Capacity and Inefficient Operation at the Chennai Port

1) Influence of Large Vehicles on Community Roads

The yard of Chennai Port is narrow, and the capacity to handle containers is limited. Container cargo landing from a ship must be immediately taken out of the yard. Therefore, there are container freight stations around the port to compensate for the shortage of port capacity (Figure 2.1.6).

However, there are cases wherein container freight stations are located in the suburbs, where trunk roads are not constructed, so there are sections where large vehicles pass through community roads (Figure 2.1.7).



Source: JICA Study Team

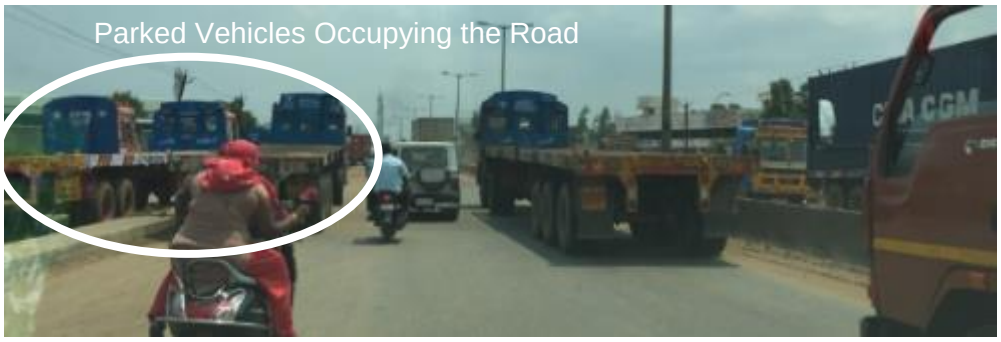
Figure 2.1.6 Location of Container Freight Stations

Source: JICA Study Team

Figure 2.1.7 Traffic around Chennai Port

1) On-Street Parking due to Lack of Standby Space for Large Vehicles

On the road around the container freight station, large vehicles are waiting for loading and unloading on the service road and the main road as shown in Figure 2.1.8. These vehicles cause a decrease in traffic capacity and worsened traffic congestion.



Source: JICA Study Team

Figure 2.1.8 Street Parking of the Large Vehicles around the Container Freight Station

2) Track Queue

There are 3,000 to 4,000 container vehicles that enter and exit the port each day. The entry and exit of trucks to Chennai Port is limited to nighttime only, and there is only one entrance on the north side of the port. Therefore, trucks that cannot enter the terminal form a long queue on the access road to the port. These vehicles occupy a lane, cause traffic congestion, and increase travel time.

In addition, according to the interview survey conducted by the JICA Study Team, the average waiting time of these large vehicles is 30 to 40 hours, and the burden on the truck driver is also high.

Source: JICA Study Team

Figure 2.1.9 Waiting Queue of Large Vehicles

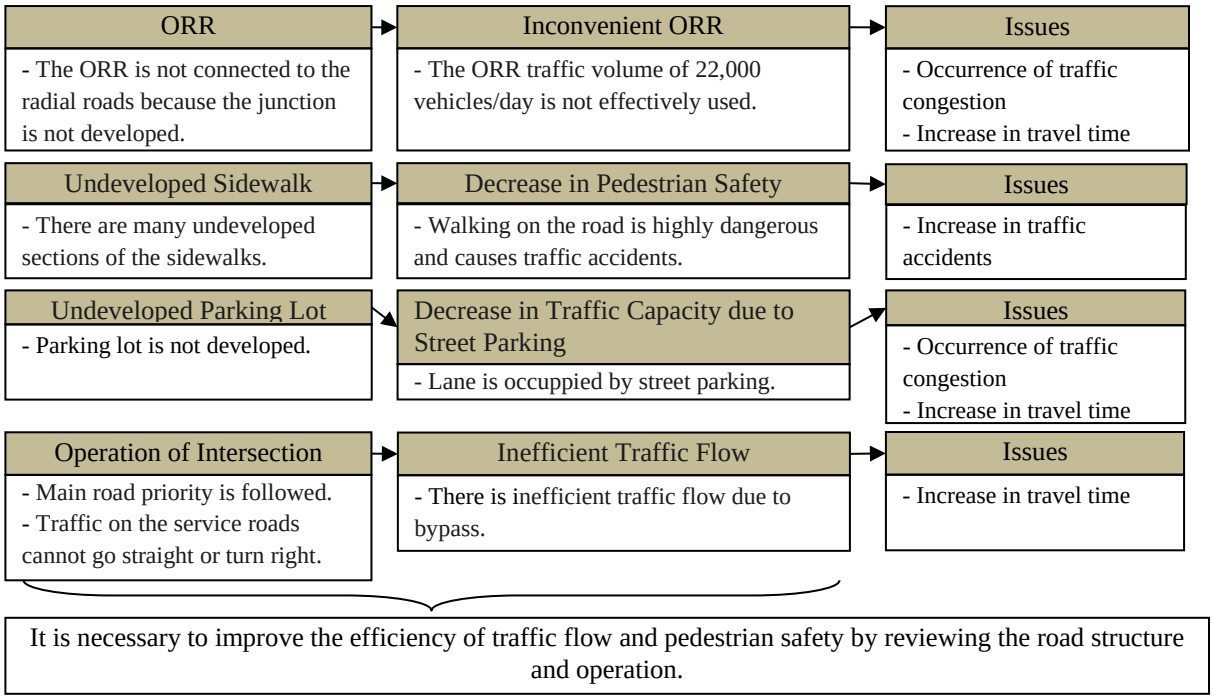
(3) Issues due to the Road Structure/Operation

Although the ORR is partially open to public, there are problems of connection with the main radial roads. The junction at the connecting point with NH4 and NH45 is still under construction. Therefore, the ORR is not effectively utilized.

In Chennai, there are many sections where sidewalks and parking lots are not provided. In such sections, the risk of traffic accidents involving pedestrians is high, as parked vehicles occupy a lane, cause traffic jams, and increase travel time.

In addition, at many intersections of trunk roads, vehicles travelling on service roads cannot go straight or turn right, but must take a detour instead.

These road structure and operational problems lead to traffic congestion, increase in travel time, and fatal accidents. Therefore, it is required to improve the efficiency of traffic flow and pedestrian safety by reviewing the road structure and operations.



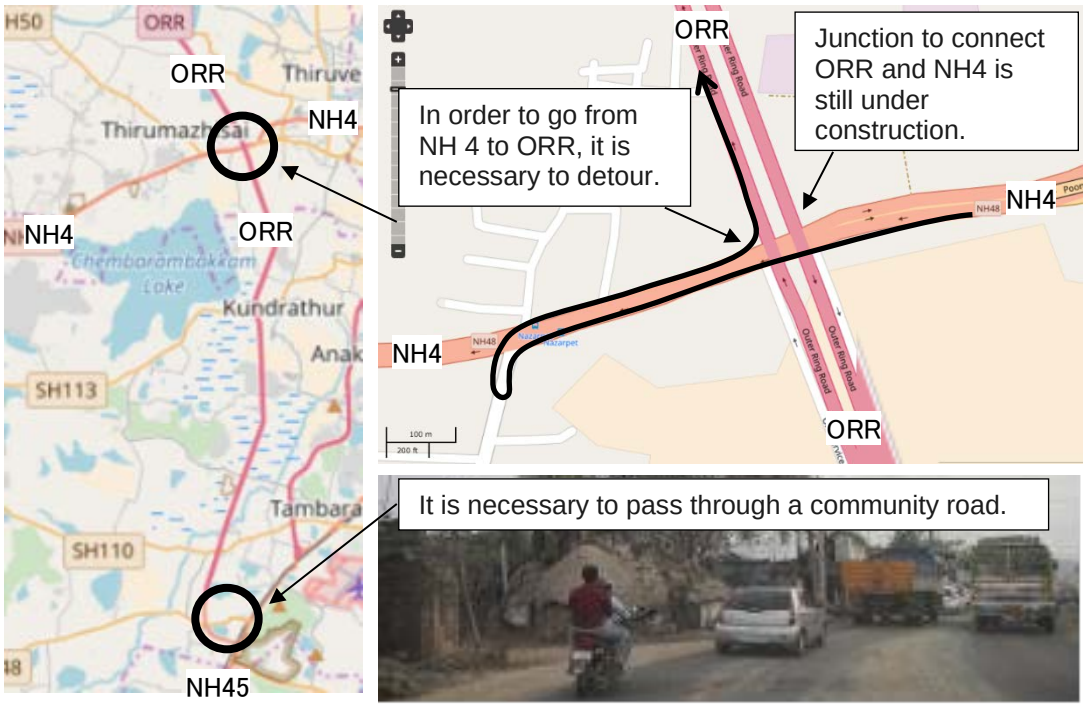
Source: JICA Study Team

Figure 2.1.10 Issues due to Road Structure and Operation

1) Undeveloped Junction of ORR

Although the ORR is partially open to public, it is not effectively used because the traffic volume of ORR is only 10% of the IRR. The reasons are as follows:

- The connection between NH4 and ORR is still under construction, and vehicles are forced to take a detour.
- The connection between NH45 and ORR is under construction, and vehicles are forced to pass through a narrow community road.



Source: JICA Study Team

Figure 2.1.11 Undeveloped Junction of ORR

2) Undeveloped Sidewalk

There are many sections where sidewalks are not provided, and pedestrians are forced to walk on the carriageway. Also, pedestrians precariously walk on the inner side of the road to avoid parked vehicles and stalls that are on the road.

It is necessary to construct sidewalks to separate pedestrians and vehicles and to secure a safe walking space.

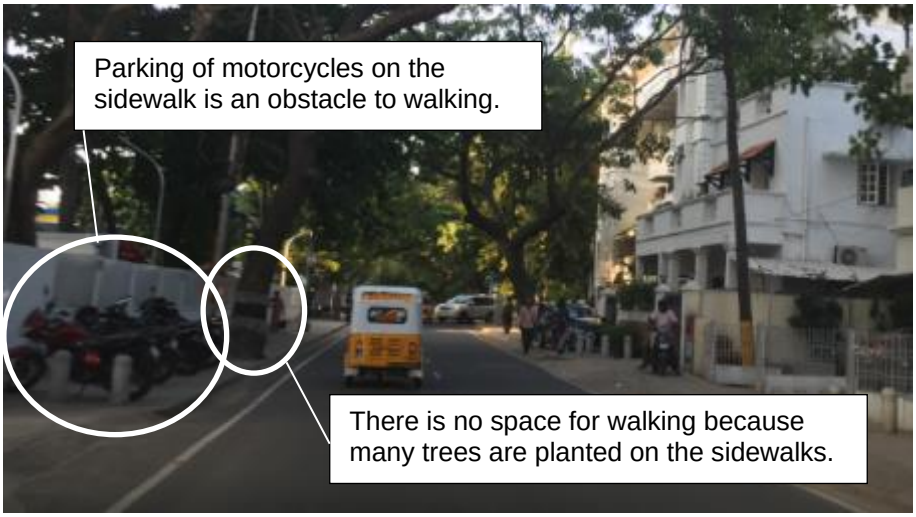
Source: JICA Study Team

Figure 2.1.12 Undeveloped Sidewalk

3) Misuse of Sidewalks

As shown in Figure 2.1.13, there are many areas where sidewalks are occupied by parked vehicles or are obstructed by trees. In such situations, pedestrians are forced to walk on the carriageway.

In order for sidewalks to serve their proper function, it is necessary to install motorcycle parking lots and to prohibit planting of trees on sidewalks.



Source: JICA Study Team

Figure 2.1.13 Misuse of Sidewalks

4) Lanes Occupied by Parked Vehicles

As parking lots are not installed, many vehicles park on carriageways. There are some sections where one lane is covered by sand and cannot be recognized as a lane because it is not used for traffic as shown in Figure 2.1.14. Also, trucks occupy roads near the port and the industrial parks.

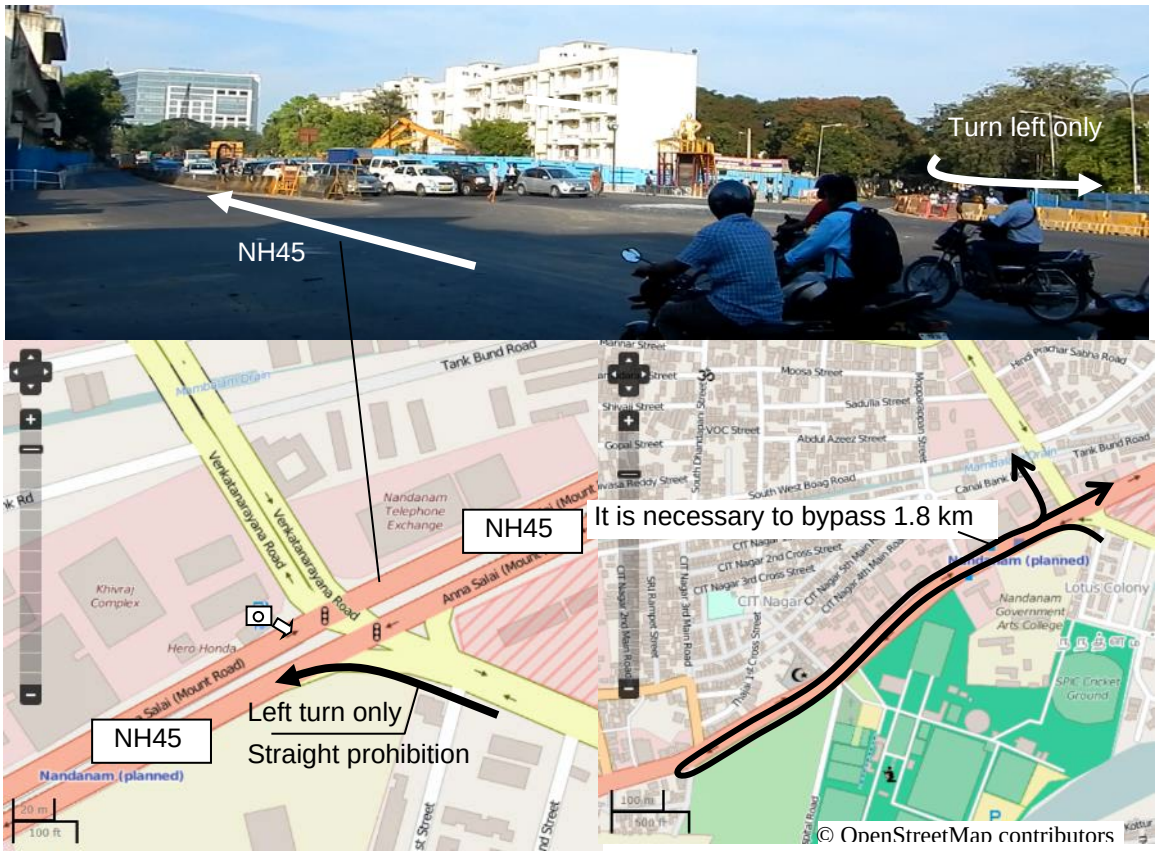
It is necessary to install parking lots in order to accommodate the parked and waiting vehicles on the road and maximize the road capacity.

Source: JICA Study Team

Figure 2.1.14 Lanes Occupied by Parked Vehicles

1) Inefficient Operations of Intersection

At signal intersections on arterial roads such as NH 45, as shown in the figure below, the traffic on the intersecting road cannot cross the arterial road. In this case, traffic flow is inefficient because vehicles on the service road are forced to make a detour.



Source: JICA Study Team

Figure 2.1.15 Inefficient Operation of Intersection

If straight and right turns are prohibited, vehicles are forced to make a U-turn then occupy one lane, which also reduces traffic capacity and decreases travel speed.

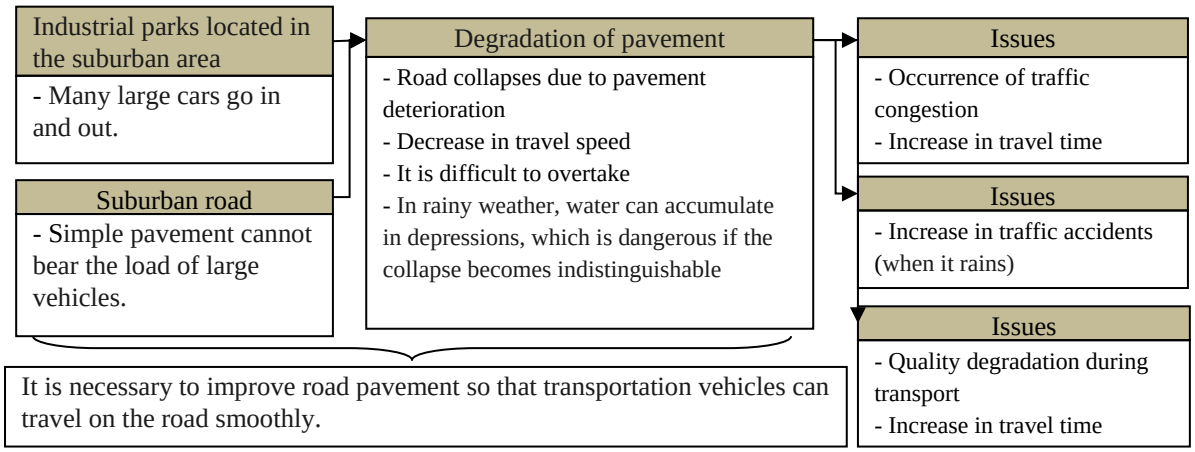
Source: JICA Study Team

Figure 2.1.16 U-Turn Point

(4) Deterioration of Pavement

There are sections where roads are depressed due to deterioration of pavement. Pavement deterioration lowers travel speed, making overtaking difficult. Especially in Chennai, where many industrial parks are located in suburbs, there is a large volume of heavy vehicles in the access roads, and depression of roads are

also evident. Pavement deterioration also causes logistics problems such as damage in handling and transport of trucks and increase of logistics time. Therefore, it is necessary to improve road pavements to allow smooth flow of traffic.



Source: JICA Study Team

Figure 2.1.17 Problems due to Deterioration of Pavement

Source: JICA Study Team

Figure 2.1.18 Road Collapse due to Deterioration of Pavement

(5) Other Issues

1) Street Parking of Large Vehicles around the Industrial Park

At the CPRR (Section 4) around the Oragadam Industrial Park, there are situations where large vehicles and corporate buses occupy the road as shown in Figure 2.1.19.

In the future, if the connecting point between the CPRR (Section 4) and the arterial road (NH4, NH45) is improved, traffic volume is expected to increase. Reduction of traffic capacity caused by on-street parking of large vehicles may cause traffic congestion.

Source: JICA Study Team

Figure 2.1.19 Large Vehicles around the Industrial Park

2) Buses Occupying the Road

Covered bus stops are installed around the railway station in Chennai. Many buses stop at designated locations, but there are also some that stop and load and unload passengers along carriageways. This becomes a factor of the decline in traffic capacity. If there is no designated stop, some buses occupy one lane, which also causes traffic congestion near the railway stations.

Even if bus bays are installed at the bus stops along the main roads, passengers wait for buses on the bus bay itself. It is assumed that passengers take such action to ensure that they get on the bus. Because passengers occupy the bus bay, the bus is forced to stop in the carriageway.

Source: JICA Study Team

Figure 2.1.20 Buses Occupying the Road

3) Unloading on Roads

Because there is no parking lot for freight cars, loading and unloading on roads become an obstacle to other vehicles.

Source: JICA Study Team

Figure 2.1.21 Occupation of Roads by Loading and Unloading on Roads

4) Decrease in Travel Speed due to Wildlife Crossing

On suburban roads, there are many instances where vehicles wait for animals to cross, causing traffic slowdown.

Source: JICA Study Team

Figure 2.1.22 Animal Crossing the Road

5) Reduction of Lane due to Sidewalk Stalls

There are many areas where one lane is occupied by people and vehicles that stop by sidewalk stalls. As a result, traffic capacity decreases and traffic congestion occurs. Also, since pedestrians cannot pass on the sidewalk, they are forced to walk on the roadway, which increases the risk of meeting traffic accidents.

Source: JICA Study Team

Figure 2.1.23 Reduction of Lane due to Sidewalk Stalls

6) Reduction of Lane due to Parked Auto-Rickshaw

Many auto-rickshaws are on standby in busy areas such as hotels and shopping malls. A lane is occupied by auto-rickshaws on standby which decreases traffic capacity and speed.

Source: JICA Study Team

Figure 2.1.24 Standby Auto-Rickshaw

7) Congestion due to Wedding Ceremonies and Other Events

When there are events such as wedding ceremonies, many vehicles of guests gather and queue at the event venue, thus disrupting the flow of traffic.

2.1.3 Present Condition and Issues of Intelligent Transport System (ITS) Facilities in the Study Area

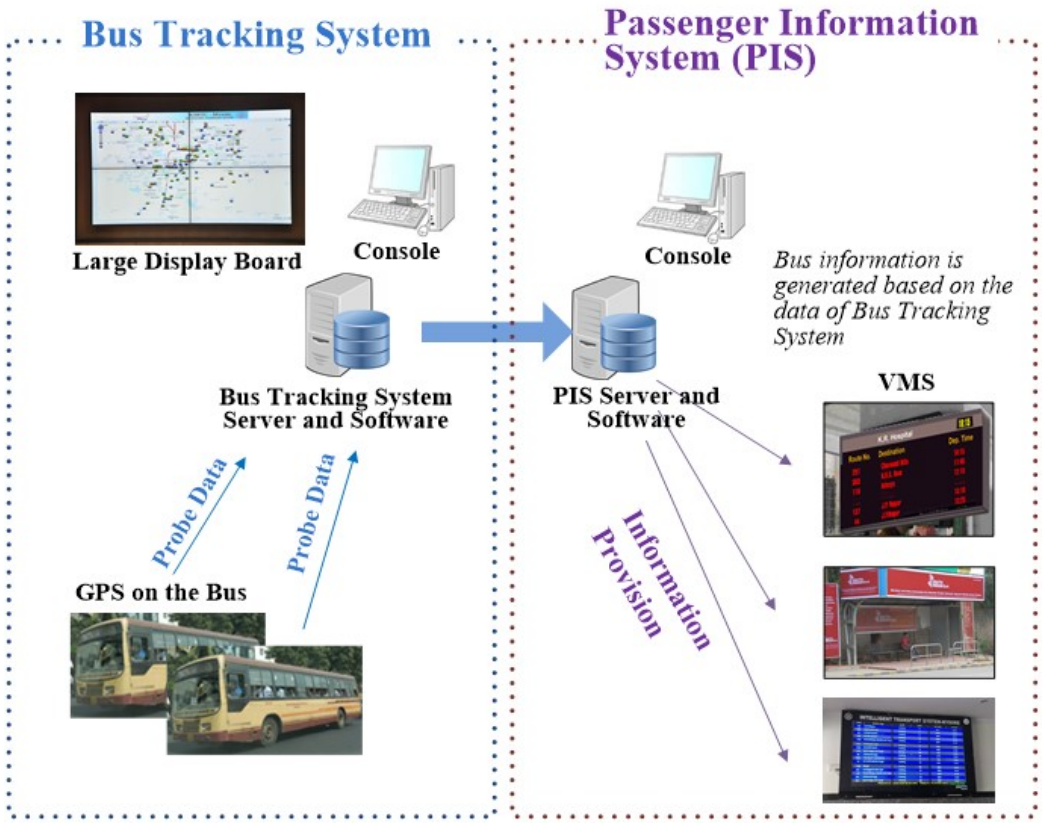
The present condition of the entire ITS in Chennai is described in the Final Report of the Data Collection Survey for Chennai Metropolitan Region ITS which was completed in March 2017. This clause reports the latest conditions of ITS updated in this study, which are directly related to the ITS components of the Japanese ODA Loan Project.

(1) City Bus System of Metropolitan Transport Corporation (MTC)

The City Bus System is composed of the following components:

- Bus Tracking System
- Passenger Information System
- Electronic Ticket Management System

The Bus Tracking System and Passenger Information System are systematically linked to function (the Electronic Ticket Management System functions independently). Both systems are shown in Figure 2.1.25.



Source: JICA Study Team

Figure 2.1.25 Images of Bus Tracking System and Passenger Information System

1) Bus Tracking System

This system is used for bus management, showing the current locations of city buses on the video wall at the command control center of the bus operator. The bus location information is collected from the GPS device installed on the bus. It was found that the Bus Tracking System has not yet been introduced.

2) Passenger Information System

This system provides information on bus operations (e.g., arrival/departure time) through Variable Message Sign Boards (VMS) at bus stops, websites, mobile applications, etc. The information is generated based on the bus location data obtained by the Bus Tracking System. It was found that this system has not yet been introduced.

3) Electronic Ticket Management System

This system is used for the collection of fare payment made by passengers and for management of revenue. It was found that this system has already been introduced. Approximately 8,000 handy ticketing devices were procured. The device is currently used only for ticket issuing, not for IC card usage. The hardware is compatible with both Type A and Felica. When the software is installed, this device can be used for both types of IC cards.

(2) Traffic Management System of Chennai Traffic Police (CTP)

The current Traffic Management System of CTP was confirmed as follows:

1) Command Control Center

The Command Control Center has been established in the CTP building, and limited functions are in operation.

2) Call Center in Command Control Center

Approximately 20 operators are stationed in the Command Control Center for 24 hours a day, handling emergency calls, inquiries, claims, etc.

3) Traffic Signal System and CCTV Camera

Traffic signals have been installed at 385 junctions in the city. The current signals are of the fixed pattern type, not the signal coordination type. The signal patterns are adjusted or changed by the police officers as necessary. There are many signals that are not working or are turned off. CCTV cameras have also been installed at the junctions. A typical image of the existing traffic signal together with a CCTV is shown in Figure 2.1.26.

Source: JICA Study Team

Figure 2.1.26 Existing Traffic Signal and CCTV Camera at Junction

4) Variable Message Sign Board (VMS)

VMS have been installed at 53 junctions in the city. The existing VMS provides static messages such as warnings on traffic rules, not dynamic traffic information. Two different languages, i.e. English and Tamil, are shown. A typical image of the VMS is shown in Figure 2.1.27.

Source: JICA Study Team

Figure 2.1.27 VMS and Displayed Message

5) E-Challan System

E-Challan System is used for traffic violation enforcement. The handy terminals deployed to the police officers issue the enforcement ticket for the fine imposed on the traffic violation at the site. The data inputted on the handy terminal is collected at the Command Control Center, and the system manages the traffic violation record. E-Challan System has already been introduced to the CTP, and approximately 400 handy terminals are in use as of now.

1) Advance Traveler Information System (ATIS)

The ATIS provides traffic information to road users as pre-trip information. A prototype system was developed by the Indian Institute of Technology (IIT)-Madras, and the pilot was carried out in a relatively

limited area, i.e., on the roads surrounding the campus of IIT Madras. The project is funded by the Government of India, and related government organizations such as CTP are aimed to utilize the system.

(3) Chennai Metro Rail Limited (CMRL)

Smart cards which can be used only for Chennai Metro have been introduced. There are two card types, i.e., Type-A (Mifare) and Felica. Multi-type card readers which can read and write both types of cards have been introduced at the gates of Chennai Metro stations. The ticketing and recharging terminals for both types of cards are also available in these stations.

The clearinghouse has already been developed in Chennai Metro and was designed to handle a maximum of 32 operators, taking into consideration the introduction of a common mobility card in Chennai in the future. It functions as a management system of the cards as well. The memory of both types of the cards has also been designed to accommodate the same number of operators. A card initializing process is required upon issuance. Simple card issuance terminals for the initialization, which are processed by manual operation not automatic, are used because there are still a relatively small number of cards used for the metro.

2.2 Organizations Related to Road and ITS Development

Organizations related to road and ITS development are described in this section. The correlation of the organizations is presented in Appendix-2.

2.2.1 Highways and Minor Ports Department (HMPD)

HMPD manages SHs and minor ports in Tamil Nadu State. CPRR is supposed to be an SH once it opens, but it is not declared at this moment; thus, the implementation agency for the construction of CPRR will be HMPD. Even NHs inside Chennai City are under the jurisdiction of HMPD. Details of HMPD are described in Section 6.2 of this report.

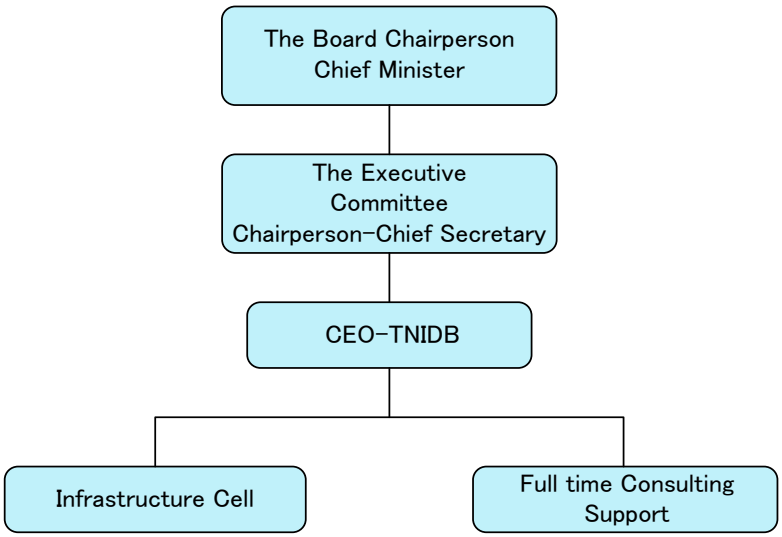
2.2.2 Tamil Nadu Infrastructure Development Board (TNIDB)

TNIDB is a nodal agency for planning and coordination of infrastructure development in Tamil Nadu State. It was established to facilitate the infrastructure development projects under the Ministry of Finance according to the Tamil Nadu Infrastructure Development Act 2012. It formulates, prioritizes, and evaluates the projects and coordinates with the related departments to acquire the state budgets and financial support from the central government. It also prepares feasibility study reports and detailed project reports and monitors the projects.

TNIDB is involved in the projects undertaken by the government (public project) and through Public Private Partnership (PPP project). The act stipulates that TNIDB is involved in the public project with more than INR 500 crores of the project cost and the PPP project with more than INR 10 crores.

The chair person is the Chief Minister and the vice-chair person is the Finance Minister. Under the chair person, the executive committee is formed. The executive committee is chaired by Chief Secretary. It consists of 10 concerned departments with officials and experts. The chief executive officer (CEO) under the executive committee deals with the day-to-day duties of TNIDB. Under the CEO, there are a core in-house team, external consultants and experts.

The organization structure is shown below.



Source: Edited by JICA Study Team based on TNIDB's website

Figure 2.2.1 Organization Structure of Tamil Nadu Infrastructure Development Board

2.2.3 Chennai Metropolitan Development Authority (CMDA)

CMDA is a planning agency for Chennai Metropolitan Area including Chennai District, part of Kanchipuram District and part of Thiruvallur District. CMDA prepares plans such as master plan and new town development plan. The plan is implemented by the individual government agencies in charge. Minister of Housing and Urban Development represents CMDA and there are following members for decision making.

Table 2.2.1 Members of Chennai Metropolitan Development Authority

Honorable Minister for Housing and Urban Development	Chairman
Vice- Chairman, CMDA	Vice Chairman
Member-Secretary, CMDA	Member
Secretary to Government H&UD, Finance, Industries, Transport	Member
Commissioner, Corporation of Chennai	Member
Managing Director CMWSS Board	Member
Director, Town & Country Planning	Member
Chief Urban Planner, CMDA	Member
Chief Engineer, Highways & Rural Works Department	Member
Chief Architect to Government	Member
Joint Director, Town & Country Planning	Member
Chairman, Tamil Nadu Housing Board	Member
Chairman Tamil Nadu Slum Clearance Board	Member
Member of the State Legislative Assembly	Member

Source: Summarized by JICA Study Team based on the Information on Website of CMDA

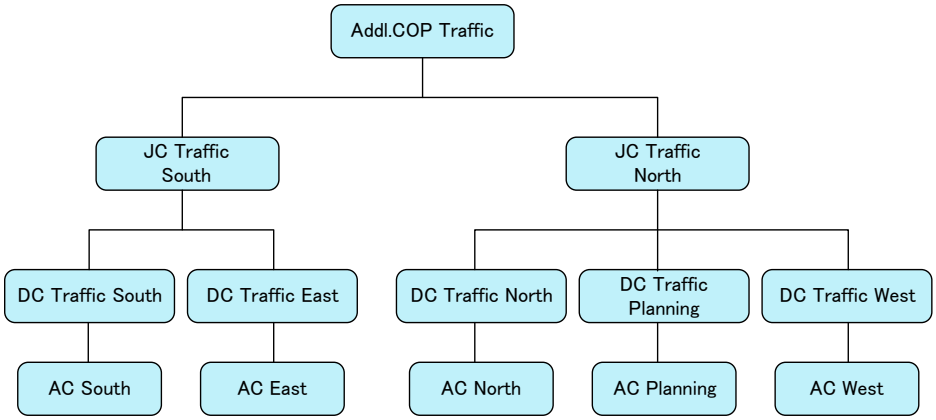
There are following units under the members

- Area Plans Unit
- Area Development Unit
- Master Plan Unit
- Road and Rail Unit
- Enforcement Cell (dealing with permission and authorization such as issuance of completion certificate of project, etc.)
- Construction Wing and General Unit.

2.2.4 Chennai Traffic Police (CTP)

CTP under Chennai Police manages traffic. They are responsible for regulating traffic and enforcing traffic rules in Chennai District. The Chennai Police is under the Ministry of Home, Prohibition and Excise and is headed by the Commissioner of Police. The Chennai Traffic Police is headed by the Additional Commissioner of Police. The jurisdiction area is divided into four (4) regions; North, South, East and West and each region is represented by Deputy Commissioner. There are also a Planning Division of Traffic Management under Chennai Traffic Police.

The organization structure is shown below.



* Addl.COP: Additional Commissioner of Police, JC: Joint Commissioner, DC: Deputy Commissioner, AC: Additional Commissioner

Source: Edited by JICA Study Team based on Website of Tamil Nadu Police Department

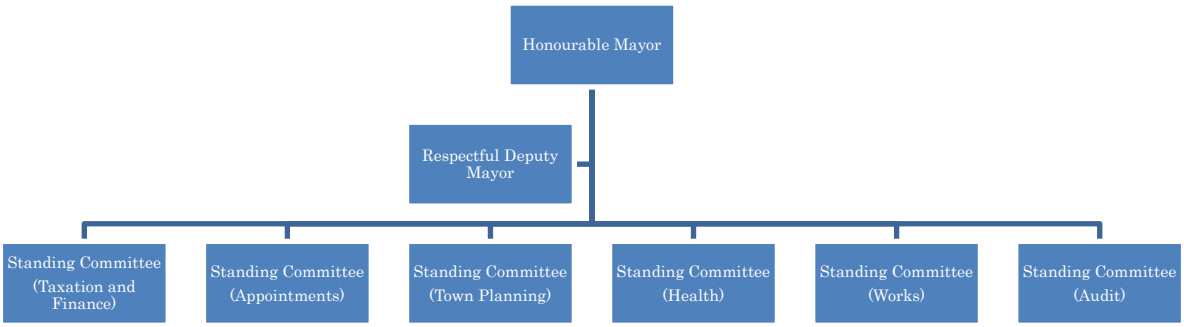
Figure 2.2.2 Organization Structure of Chennai Traffic Police

2.2.5 Greater Chennai Corporation (GCC)

GCC is an autonomous body of Chennai, a designated city by the Government Ordinance in Tamil Nadu State. GCC consists of administrative agencies with 200 members headed by the mayor and the City Council. The mayor and each City Council member are chosen by direct election, and the deputy mayor is elected among the City Council members by votation. The mayor and the deputy mayor preside over several Standing Committees. The Commissioner represents the administrative agency and controls each administrative service department such as Education, Insurance, and Health.

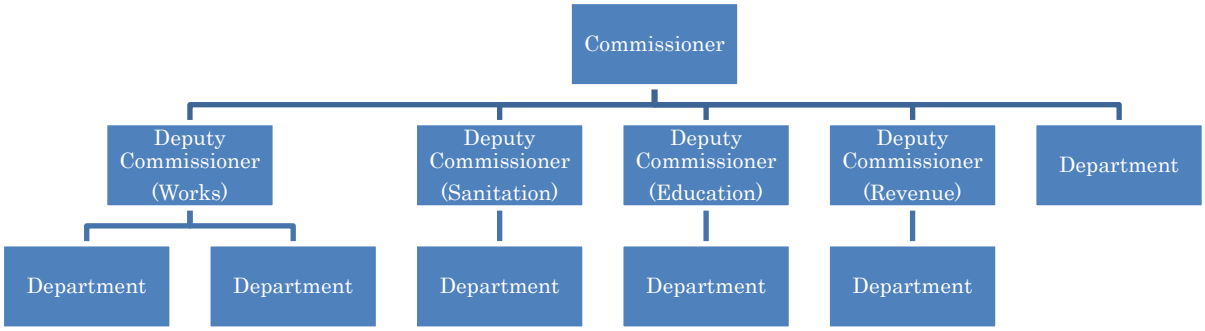
GCC has jurisdiction over the development and maintenance of city roads with a total length of approximately 5,560 km, excluding NH and SH in Chennai and roadside facilities such as bus stops, street lights, road signs, markings, drainage, sidewalks, and skywalks. The ownership of these facilities belongs to GCC. As for traffic signals, CTP carries out the maintenance, and the ownership belongs to them.

The organization structure is shown below.



Source: Edited by the JICA Study Team based on website of Greater Corporation of Chennai

Figure 2.2.3 Organizational Structure of the Executive Committee of Greater Corporation of Chennai



Source: Edited by the JICA Study Team based on website on Greater Corporation of Chennai

Figure 2.2.4 Organizational Structure of the Administrative Body of Greater Corporation of Chennai

2.2.6 Chennai Smart City Limited (CSCL)

CSCL is a Special Purpose Vehicle (SPV) for the Smart City Mission in Chennai. The roles of CSCL are planning, implementing, and managing the projects of Smart City Mission, as well as operating and maintaining the introduced facilities and systems.

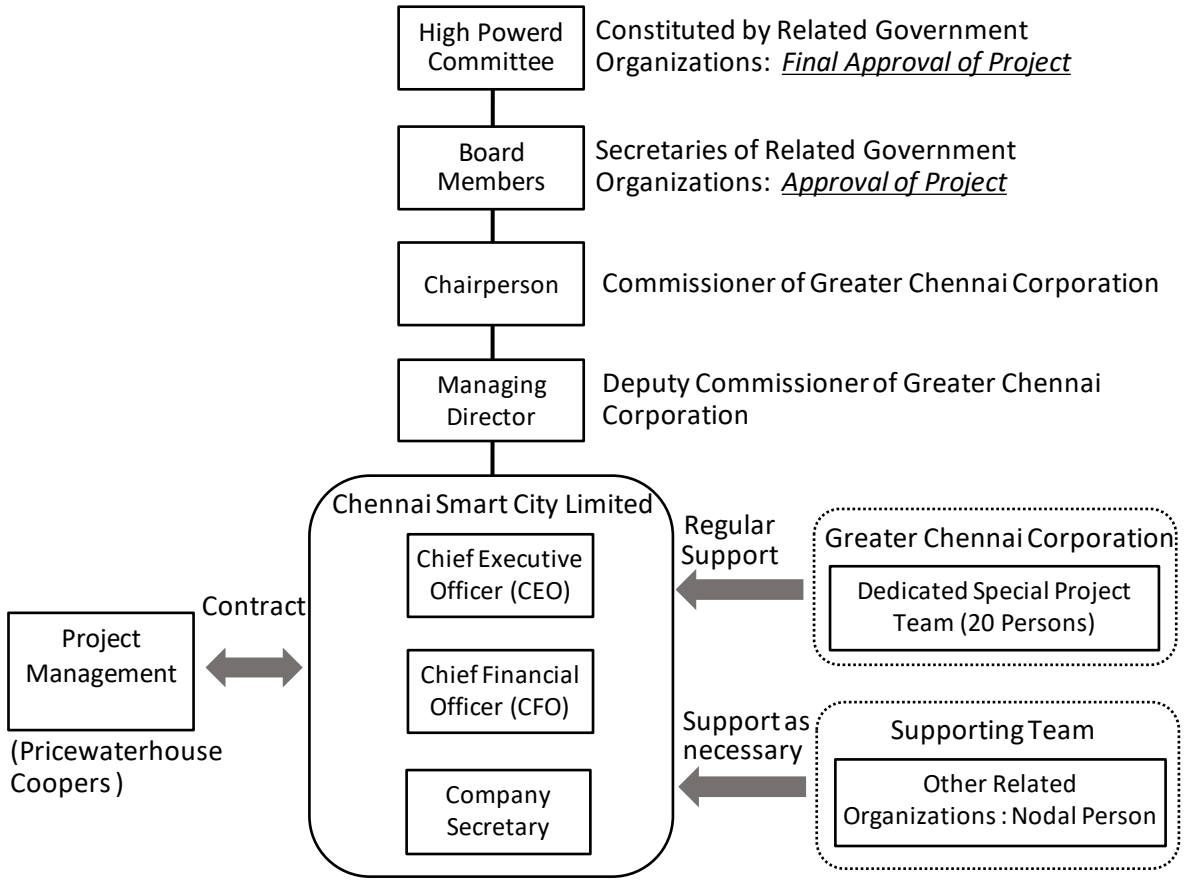
It was established in 2016 according to the Smart City Guidelines issued by the Government of India in June 2015. The coverage domain of CSCL includes several sectors as follows:

(The following are the descriptions of the objectives under the Smart City Mission which are extracted from the Smart City Guidelines.)

- *Adequate water supply,*
- *Assuring electricity supply,*
- *Sanitation including solid waste management,*
- *Efficient urban mobility and public transport,*
- *Affordable housing, especially for poor,*
- *Robust IT connectivity and digitalization,*
- *Good governance, especially e-Governance and citizen participation,*
- *Sustainable environment,*
- *Safety and security of citizens, particularly women, children and the elderly, and*
- *Health and education.*

Source: Smart City Guideline 2015, Government of India

Figure 2.2.5 shows the organization structure of CSCL.



Source: Edited by the JICA Study Team based on interviews with CSCL and related materials

Figure 2.2.5 Organization Structure of Chennai Smart City Limited

CSCL was established under the GCC. The Commissioner of GCC serves as the Chairperson, the Deputy Commissioner of GCC serves as the Managing Director, the CEO represents the CSCL, and the Chief Financial Officer (CFO) and Company Secretary constitute the CSCL as members.

For decision making, there are Board Members above the Chairperson who are in charge of the approval of projects. The Board Members are the secretaries of the related government organizations such as GCC, Tamil Nadu Finance and Infrastructure Development Corporation (TUFIDCO), etc. There is a High-powered Committee above the Board Members for the final approval of the project. It is constituted by the related government organizations.

For the implementation of the project, GCC established a Dedicated Special Project Team which consists of 20 persons. They provide support on a regular basis for CSCL. Other related organizations such as Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), Tamil Nadu Generation and Distribution Corporation (TANGEDCO), etc. are nominated nodal persons as supporting team. The Project Management Consultant (PMC) takes management roles for the projects of the Smart City Mission such as preparing the Detailed Project Report (DPR) and overseeing the consultants hired for the individual projects. The current PMC is Pricewaterhouse Coopers Limited.

There are 20 cities in India that were selected for the first round of the Smart City Mission. The Government of India created the Smart City Fund and INR 200 crores were delivered to the individual cities. The Smart City Fund Account was opened for the states included in the Smart City Mission.

2.2.7 Tamil Nadu Road Development Company (TNRDC)

TNRDC is a government company responsible for the implementation of tolled SHs which have been established under the HMPD. It raises funds, constructs, operates, and maintains. It is a joint venture corporation of Tamil Nadu Industrial Development Corporation Ltd (TIDCO) and Tidel Park Ltd. (TIDEL). TIDCO and TIDEL are 100% government-owned companies and have equal share of TNRDC.

TNRDC was appointed by Government Order No. 94, Industries Department, dated 23 April 2012 as Managing Associate for the Northern Port Access Road Project which is currently recognized as Section 1 of CPRR. In this connection, TNRDC is currently on preparation work for the project including land acquisition and resettlement procedure for Section 1.

Details of TNRDC are described in Section 5.2.4 of this report.

2.2.8 Tamil Nadu Road Infrastructure Development Corporation (TNRIDC)

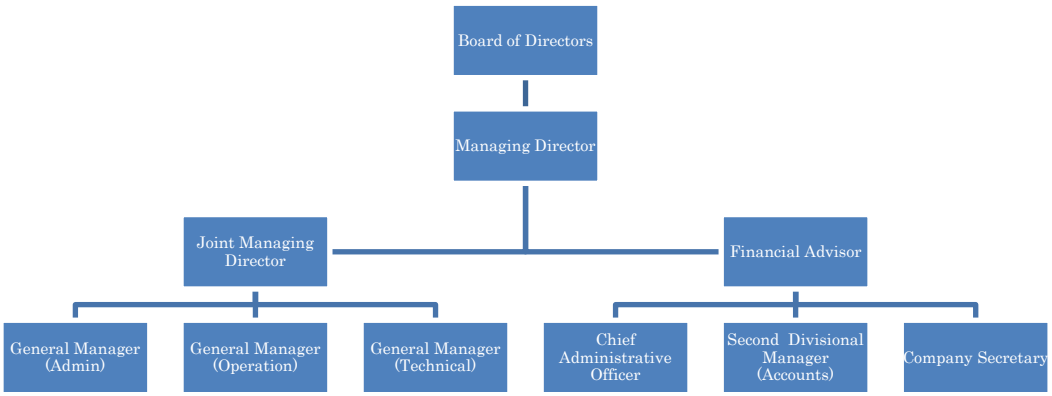
TNRIDC was established in 2005 as a non-profitable organization to implement, upgrade, and maintain road infrastructure in the State of Tamil Nadu. The Oragadam Industrial Corridor Project and the four-laning project of the Madurai Ring Road are being implemented by TNRIDC.

Details of TNRIDC are described in Section 5.2.5 of this report.

2.2.9 Metropolitan Transport Corporation (MTC)

MTC is a public city bus operator in CMA. It is a government agency under the Ministry of Transport. Metropolitan Transport Corporation offers almost 48,000 daily bus services on 842 bus routes. They own approximately 4,000 buses, and approximately 3,700 buses are operated. There are 32 bus depots, 71 bus terminals, and 151 major bus stops. There are also a number of small bus stops across Chennai. They carry approximately 4.5 million daily passengers. They operate several different types of buses with different fare categories such as ordinary, express deluxe, express, and Volvo AC services.

Metropolitan Transport Corporation is headed by the Board of Director. There are several departments and wings, such as Administration and Operation, and there are about 24,480 employees. The organizational structure is shown below.



Source: Edited by the JICA Study Team based on the website of GCC

Figure 2.2.6 Organization Structure of Metropolitan Transport Corporation

2.2.10 Tamil Nadu State Data Center

Tamil Nadu State Data Center is an ISO-certified data center of GoTN. It has been established under the National e-Governance Initiative of GoI. It offers single-point services for e-governance of Tamil Nadu State such as providing server rooms equipped with a cooling system, electric supply system by UPS, generators, data communication network, operation/maintenance of servers, user applications, etc. for computer services of various departments of the state government.

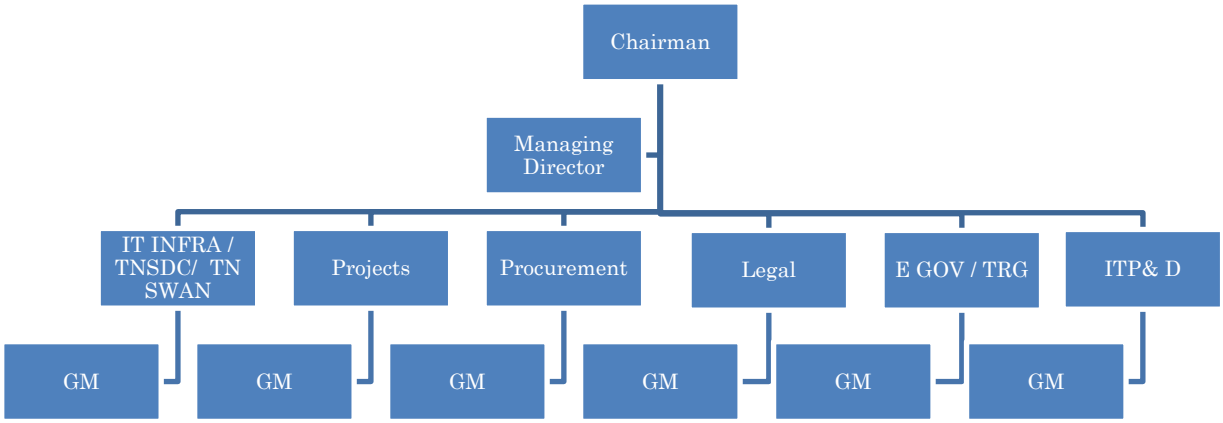
Tamil Nadu State Wide Area Network is established in Tamil Nadu State and is a major backbone network used for Tamil Nadu State Data Center. Bharat Sanchar Nigam Limited communication network is also used. A security policy for data protection is applied such as a firewall. Under the security policy, two backup data centers have been prepared, one in Bharat Sanchar Nigam Limited data center in Chennai and the other in Pune for disaster measure. Another backup center is planned in Tirchy in Tamil Nadu State.

The basic services offered by Tamil Nadu State Data Center are to provide the server spaces in the protected environment as above and operation/maintenance of servers for each department. In some cases, depending on the service agreement with the department, user applications are also prepared/procured, hosted on the server, and maintained by Tamil Nadu State Data Center. The examples of the applications

hosted include the services for tax collection/management, government's revenue management, land registrations, medical records of public hospital, etc. The servers of the Chennai Metro System are also located in Tamil Nadu State Data Center.

The Electronics Corporation of Tamil Nadu, established under the Government of Tamil Nadu, is an implementing agency that manages Tamil Nadu State Data Center and offers these services.

The figure below shows the organization structure of Electronic Corporation of Tamil Nadu and Tamil Nadu State Data Center.



*TRG: Technical Resource Group, ITP&D: Information Technology Promotion and Development,

GM: General Manager, TNSDC: Tamil Nadu State Data Center, TNSWAN: Tamil Nadu State Wide Area Network

Source: Edited by the JICA Study Team based on details of ELCOT website

Figure 2.2.7 Organization Structure of Electronic Corporation of Tamil Nadu and Tamil Nadu State Data Center

2.2.11 Chennai Metro Rail

Chennai Metro Rail Limited is an SPV for the construction and operation of the Chennai Metro. It was formed in March 2007 by the Government of India and the Government of Tamil Nadu with equal equity.

The Chennai Metro Rail is a rapid transit system in Chennai. The project is divided into two phases. Phase 1 is under construction and partially in operation. There are two corridors in Phase 1, totaling 45 km in length. About 55% of the Phase 1 corridor is underground and the rest of the structures are elevated. The following corridors are located along the arterial roads in the core area of Chennai City: Anna Salai (Mount Road or NH45), E.V. R Periyar Salai (P.H Road or NH4), and Nehru Salai (100 Ft Road or Inner Ring Road). The first stretch began its operation in June 2015. It is along Nehru Salai from Koyambedu to Alandur with 10 stations of approximately 10 km in length.

2.3 Development Plans and Projects Related to CPRR

2.3.1 Superior Development Plans

(1) National Urban Transport Policy (NUTP)

NUTP is a high-level urban transport policy in India. It was formulated by the Government of India, specifically the Ministry of Road Transport and Highways in 2006. The urban transport planning and implementation which are under the jurisdiction of the state government are to be carried out under the NUTP. The prime focuses are given to the following policies:

- To develop urban mass transport systems in the metropolises in India
- To develop urban transport infrastructure harmonized with urban development plans
- To implement various measures to shift the demand to the public transport
- To utilize ITS to solve issues of urban transport
- To develop road spaces for pedestrian and parking space

- To develop the bicycle pass
- To set Unified Metropolitan Transport Authority (UMTA) for cities with more than 40 lakhs (4 million) population.

(2) Comprehensive Traffic and Transportation Study

The Comprehensive Traffic and Transportation Study has been prepared by Chennai Metropolitan Development Authority in 2010. It envisages the vision and sets out the target and strategies for the target year of 2026 as follows:

1) Vision Envisaged by the Comprehensive Traffic and Transportation Study

The Comprehensive Traffic and Transportation Study states the vision under the framework of the second Chennai Master Plan and Vision Tamil Nadu 2026 as shown below:

"Provide safe, efficient, affordable and modern transport choices to people and businesses integrating economic, land use and transport concerns of Chennai Metropolitan Area to be fully prepared to take on the transport challenges of Chennai - the Megapolis."

2) Goals

The following indicators of modal share for the target year of 2026 are set as goals of the Comprehensive Traffic and Transportation Study.

Table 2.3.1 Target Figure of Modal Share in 2026 against 2008

Index	2008	Goal (2026)
Public Transport	41%	70%
IPT (auto, taxi, etc.)	11%	8%
Private Transport	48%	22%

Source: Summarized by the JICA Study Team based on CTTS, Chennai
Note1: The above table excludes non-motorized transport.
Note2: Construction of Mass Rail Transit, Metro Rail, Mono Rail, Light Rail Transit, Bus Rapid Transit based on plan is required, so that the public transport share rises to 70%. In addition, it is also important that parking lots, transfer stations, traffic information systems, etc. adjacent to the transport hub such as a bus stop or a railroad station is constructed. Besides, as measures of the policies, improvement of user convenience by introducing the common card and securing a regular schedule of trains are required. Most city buses, which are citizen's main transportation, are time-worn vehicles having low comfort. Thus, it is recommended that new vehicles are introduced to improve the comfort of the user. It is necessary for these measures to be carried out totally so that public transport share rises to 70%.

3) Strategy

To realize the vision and to achieve the goals stated above, the infrastructure development plan in phases (short, mid, and long term) is proposed as shown in the table below:

Table 2.3.2 Proposed Infrastructure Development: Short, Mid and Long Term

Term	Proposed Development
Short Term (2010-2015)	Pedestrian facilities (footpaths), bicycle network, traffic management, parking regulation, signal improvement, junction improvements, road markings, and signage
Medium Term (2016-2021)	Pedestrian subways, multi-level parking facilities, grade separators, flyover and underpass, traffic management centers, and skywalks
Long Term (2022-2026)	MRTS, Metro, monorail, LRT, suburban rail and BRT, intermodal stations, truck terminals, intercity bus terminals, elevated roads, freight corridors, missing roadway links, and major road widening

Source: Summarized by the JICA Study Team based on CTTS, Chennai

The cost estimates for the proposed developments are shown in the table below:

Table 2.3.3 Estimated Investment Cost

Term	Estimated Investment Cost
Short Term (2010-2015)	INR 52,689 crores
Medium Term (2016-2021)	INR 21,899 crores
Long Term (2022-2026)	INR 7,532 crores
Total	INR 82,120 crores

Source: Summarized by the JICA Study Team based on CTTS, Chennai

2.3.2 Urban Development Plans and Projects

(1) Development Plan for Chennai Metropolitan Area, 2006

Outline

The plan was issued in 2006 by Jawaharlal Nehru National Urban Renewal Mission (JNNURM), a massive city modernization scheme launched by the Government of India under the Ministry of Urban Development. The plan consists of 1) Introduction, 2) Demography, 3) Economy, 4) Land Use and Structure of Chennai, 5) Municipal Infrastructure, 6) Environment and Disaster Management, 7) Traffic and Transportation, 8) Urban Basic Services for the Poor, 9) Social Facilities, 10) Municipal Finances, 11) Vision and Goals and Strategies, and 12) Capital Investment Plan and Financing Strategy.

Objectives

The main objectives of the development plan are to have a strategy for the sustainable and planned growth of the city with appropriate policy and strategic interventions. The plan outlines the strategic policy and investment interventions to achieve the formulated vision for Chennai and comprised the following:

- Assessment of the existing situation with regard to demographic and economic growth, infrastructure services, municipal finances, etc.;
- Identification of gaps in service delivery including the issues faced by the urban poor;
- Vision and goal formulation for each sector to achieve the objectives enunciated above; and
- Formulation of a city investment plan with appropriate financing strategies for the identified interventions.

In addition, the plan also focuses on the reforms to be carried out at the state and local level in consonance with the vision and strategic plan outlined to sustain the planned interventions.

Population Projection

Population projections were carried out for the CMA based on the past trends. It is estimated that the CMA would increase to 12.6 million by 2026, of which Chennai City alone would account for 5.8 million.

Table 2.3.4 Population Projection

Unit: million

Description	Actual	Projection				
	2001	2006	2011	2016	2021	2026
CMA	7.041	7.896	8.871	9.966	11.197	12.582
Chennai City	4.343	4.628	4.950	5.239	5.540	5.856

Source: Development Plan for Chennai Metropolitan Area, 2006

Economic Growth

The plan did not make explicit projections of the Gross Regional Domestic Products (GRDP). Instead, the plan made the employment projection in CMA. It was worked out based on the existing and envisaged economic developments and past trends.

Table 2.3.5 Employment Projection in CMA

Unit: million

Description	Year			
	2011	2016	2021	2026
Male Willing to Work	2.791	3.225	3.725	4.298
Female Willing to Work	0.837	1.064	1.341	1.719
Total	3.628	4.289	5.065	6.017
Additional Jobs to Be Created	1.009	1.670	2.447	3.399

Source: Development Plan for Chennai Metropolitan Area, 2006

Water Demand

The plan projected the water demand in CMA for the future development of a water supply system.

Table 2.3.6 Total Water Demand in CMA

Unit: million liters per day

Description	Year			
	2011	2016	2021	2026
Resident Population	1,165	1,284	1,431	1,606
Office and Commercial	349	385	429	482
Industry	116	128	143	160
Total	1,630	1,797	2,003	2,248

Source: Development Plan for Chennai Metropolitan Area, 2006

The goals of the water supply sytem in the Chennai City area are as follows:

Table 2.3.7 Goals of Water Supply System in Chennai City Area

Description	Year		
	2011	2016	2021
Network Coverage for General Households	100%	100%	100%
Network Coverage for Urban Slum Households	100%	100%	100%
Per capita Supply	150 lpcd	150 lpcd	150 lpcd
Hours of Supply	6 hours/day	18 hours/day	24 hours/day
24 Hours and 7 Days' Supply	4 zones	8 zones	All 16 zones
Quality of Water	Safe and good	Safe and good	Safe and good
Non-Revenue Water	20%	15%	12%
O&M Cost Recovery	100%	100%	100%
Collection Efficiency	100%	100%	100%
Customer Satisfaction	Good	Good	Good

lpcd: liter per capita per day
Source: Development Plan for Chennai Metropolitan Area, 2006

Goals of Sewerage

The goals of the sewerage system in the Chennai City area are as follows:

Table 2.3.8 Goals of Sewerage System in Chennai City Area

Description	Year		
	2011	2016	2021
Coverage (Access)	100%	100%	100%
Treatment and Disposal	100%	100%	100%
Recycle and Reuse	25%	40%	50%
Customer Satisfaction	Good	Good	Good

Source: Development Plan for Chennai Metropolitan Area, 2006

Goals of Solid Waste Management

The goals of the solid waste management system in CMA are as follows:

Table 2.3.9 Goals of Solid Waste Management System in CMA

Description	Year		
	2011	2016	2021
Collection within the City	100%	100%	100%
Collection within the Urban Local Bodies	75%	100%	100%
Collection in Other Urban Agglomeration Areas	50%	100%	100%
Door to Door Collection	50%	75%	100%
Source Segregation	50%	75%	100%
Scientific Disposal	80%	100%	100%
Waste to Energy Generation	40%	70%	100%
Cost Recovery of O&M	50%	75%	100%

Source: Development Plan for Chennai Metropolitan Area, 2006

Transport

The plan projected the daily trips by public transport in CMA.

Table 2.3.10 Daily Trip Projection in CMA

Unit: million

Description		Actual	Projection				
		2001	2006	2011	2016	2021	2026
Population		7.041	7.896	8.871	9.966	11.197	12.582
Daily Per Capita Trips		1.30	1.34	1.50	1.60	1.60	1.65
Total Daily Person Trips		9.153	10.581	13.307	15.939	17.917	20.760
Modal Split (%)	Private	60.00	55.00	45.00	40.00	35.00	30.00
	Public	40.00	45.00	55.00	60.00	65.00	70.00
Total Daily Person Trips by Public Transport		3.661	4.761	7.319	9.564	11.646	14.532
By Rail (%)		12.00	16.00	25.00	30.00	35.00	40.00
By Road (%)		88.00	84.00	75.00	70.00	65.00	60.00
Daily Trips by Rail		0.439	0.762	1.830	2.869	4.076	5.813
Daily Trips by Road		3.222	3.999	5.489	6.694	7.570	8.719

Source: Development Plan for Chennai Metropolitan Area, 2006

The goals of the transportation system in CMA are as follows:

Table 2.3.11 Goals of Transportation in CMA

Description	Year		
	2011	2016	2021
Road Network as % of Total Area	12%	15%	15%
Share of Public Transport	45%	55%	75%
Rail Transport as share of Total Public Transport	10%	30%	40%
Average Speed (km/h)	20	30	35
Sidewalk Length to Total Road Length	50%	75%	95%
Reduction of Road Accidents	25%	50%	70%

Source: Development Plan for Chennai Metropolitan Area, 2006

(2) Second Master Plan for Chennai Metropolitan Area 2026, 2008

Outline

The plan was issued in 2008 by Chennai Metropolitan Development Authority. The plan consists of three volumes. Volume I contains 1) Review of the First Master Plan, 2) Demography, 3) Economy, 4) Traffic and Transportation, 5) Shelter, 6) Infrastructure, 7) Social Facilities, 8) Solid Waste Management, 9) Macro Drainage System in CMA, 10) Disaster Management, 11) Environment, 12) Special Strategy and Land Use Planning, 13) Development Regulations, and 14) Monitoring and Implementation of Master Plan. Volume II contains the details of Development Regulations. Volume III contains the Sectoral Background. The City Development Plan by JNNURM was also taken into consideration.

Objectives

The plan is the successor of the First Master Plan, which was issued in 1976 and has a target year of 2001. The master plan proposes (a) the manner in which the land in the planning area shall be used; (b) the allotment or reservation of land for residential, commercial, industrial and agricultural purposes, as well as for parks, playfields, and open spaces; (c) the provision for national highways, arterial roads, ring roads, major streets, lines of communication including railways, airports and canals; (d) the provision for regulating the zone, location, height, number of stories, and size of buildings and other structures, as well as the size of yards and other open spaces and the use of buildings, structures, and land; and, (e) the stages by which the master plan shall be carried out.

Population Projection

Population projections were carried out for CMA based on past trends. The following assumptions were made:

(1) The declining trend in the growth rate will also continue in the future years

(2) Past growth rates, existing density, potential for development, area available for development, accessibility to public transport system (especially the rail system), and the proximity to employment generating centers could be the basis for working out future projections and assignments.

The projection results are the same with the Development Plan for Chennai Metropolitan Area, 2006, as shown below:

Table 2.3.12 Population Projection

Unit: million

Description	Actual	Projection					
	2001	2006	2011	2016	2021	2026	Density*
Chennai City	4.343	4.628	4.950	5.239	5.540	5.856	333
Municipalities	1.581	1.852	2.175	2.560	3.020	3.569	149
Town Panchayats	0.386	0.473	0.589	0.741	0.945	1.222	78
Village Panchayats	0.731	0.870	1.059	1.296	1.599	1.988	32
CMA (Total)	7.041	7.896	8.871	9.966	11.197	12.582	105

*: Gross density (persons/ha) in 2026
Source: Second Master Plan for Chennai Metropolitan Area 2026, 2008

Economic Growth

The plan did not make explicit projections of the Gross Regional Domestic Products (GRDP), but made employment projections in CMA instead. It was worked out based on the existing and envisaged economic developments and past trends. The projection results are the same with the Development Plan for Chennai Metropolitan Area, 2006.

Projection of Travel Demand

The travel demands were projected based on the increase in per capita trips. The per capita trip that had been 1.44 in 2005 was projected to 1.60 by 2016 and 1.65 by 2026. The projection results are the same with the Development Plan for Chennai Metropolitan Area, 2006.

Water Demand

The future water demand at the rate of 150 liter per capita per day (lpcd) for the city and 100 lpcd for the rest of CMA were estimated. The estimates are the same with the Development Plan for Chennai Metropolitan Area, 2006.

Land Use Plan

The existing Land Use Plan for 2006 and the proposed Land Use Plan for 2026 are given in the table below.

Table 2.3.13 Land Use

Description	Chennai City				Rest of CMA			
	2006		2026		2006		2026	
	Extent (ha)	Share	Extent (ha)	Share	Extent (ha)	Share	Extent (ha)	Share
Residential[1)]	9,523	54.25%	8,343	47.36%	22,877	21.87%	45,594	45.01%
Commercial	1,245	7.09%	714	4.05%	390	0.37%	880	0.87%
Industrial[2)]	908	5.17%	823	4.67%	6,563	6.28%	10,690	10.55%
Institutional	3,243	18.48%	2,869	16.28%	3,144	3.01%	3,889	3.84%
Open Space and Recreation	366	2.09%	1,001	5.68%	200	0.19%	393	0.39%
Agricultural	99	0.56%	0	0.00%	12,470	11.92%	7,296	7.20%
Non-Urban	82	0.47%	113	0.64%	2,433	2.33%	2,333	2.30%
Others[3),4)]	2,087	11.89%	3,755	21.31%	56,507	54.03%	30,223	29.84%
Total	17,553	100.00%	17,618	100.00%	104,584	100.00%	101,298	100.00%

Notes 1): Data in 2026 contains "Mixed Residential Use"
2): Data in 2026 contains "Special and Hazardous Industrial Use"
3): Data in 2006 consists of "Vacant, Forest, Hills, Low Lying, Water Bodies, etc."
4): Data in 2026 consists of "Urbanizable, Roads, Water Bodies, Hills, Redhills Catchments Area, etc."
Source: Second Master Plan for Chennai Metropolitan Area 2026, 2008

(3) Vision Tamil Nadu 2023 (Strategic Plan for Infrastructure Development in Tamil Nadu), 2012

Outline

The plan was issued in 2012 by Tamil Nadu State with the assistance of ADB. The plan consists of three phases. Phase I contains vision formulation, namely: 1) Executive Summary, 2) Key Outcomes of the Vision, 3) Growth Strategies, and 4) Sectoral Investment Plans. Phase II contains detailed sector reports and project profiles. Phase III contains implementation road maps.

Objectives

The main objectives are 1) formulating a vision and growth strategy for the Tamil Nadu State, with sector-specific substrategies, 2) identifying thrust areas for growth and bottlenecks in such areas, and 3) identifying critical projects in important sectors including power, roads, port development, agriculture, irrigation, housing, health, higher education, urban development, public transport, industry, and tourism.

Population Projection

The plan does not clearly indicate the population projection. It just expects 15% increase over the next 11 years (1.28% in annual average). The goal of per capita gross domestic product (GDP) was set based on this population growth rate.

Economic Growth

Since one of the objectives is to formulate a growth strategy, the plan set the target of GRDP growth rates with GRDP shares for economic sectors. In addition, per capita income will increase from USD 1,625 in 2010 to USD 10,000 in 2023, which means that India will become an upper middle income nation in the world.

Table 2.3.14 GRDP Share by Sector

Sector	GDRP Share			Average Annual Growth Rate
	2004/05	2010/11	2022/23	
Primary	12.0%	12.6%	7.0%	5.1%
Manufacturing	20.0%	16.6%	22.0%	13.8%
Non-manufacturing	11.0%	9.2%	8.0%	9.5%
Services	57.0%	61.6%	63.0%	11.1%
Total	100.0%	100.0%	100.0%	10.9%

Source: Vision Tamil Nadu 2023 (Strategic Plan for Infrastructure Development in Tamil Nadu), 2012

Investment in Urban Infrastructure

The investment was focused on the following items with the purpose of developing state-of-the-art infrastructure, both physical and social, ensuring seamless connectivity between cities and rest of the state:

- development of Chennai City into a megapolis,
- development of ten world class cities,
- rehabilitation of 1.5 million families living in slums,
- universal access to 24 hours and 7 days water supply and sanitation services, and
- access to mass transit systems for efficient urban transport.

The summary of investment plan is shown below:

Table 2.3.15 Summary of Investment in Urban Infrastructure

Unit: billion INR

Project	Amount
Chennai City development	500
Urban development for the rest of Tamil Nadu	500
Development of ten world class cities (urban facilities estimated INR 100 billion per city)	1,000
Housing including housing for economically weaker sections	750
Total	2,750

Source: Vision Tamil Nadu 2023 (Strategic Plan for Infrastructure Development in Tamil Nadu), 2012

(4) Ponneri Industrial Node Development Plan in Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor, 2015

Outline

The Ponneri Industrial Node Development Plan was formulated in 2015 under the Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor (CBIC) with the assistance of JICA. The plan consists of 1) Executive Summary, 2) Introduction, 3) Overview of Thiruvallur District and Ponneri Industrial Node, 4) Node Development Vision, 5) Industrial Development Analysis, 6) Land Use Planning for Ponneri Node, 7) Infrastructure Development Plan, 8) Economic Cost Benefit Assessment, 9) Financial Assessment and Planning, 10) Environmental and Social Considerations for Node Development Plan, 11) Institutional & Financing Framework, 12) Investment Environment Improvement, and 13) Way Forward.

Objectives

The plan was formulated in consultation with related stakeholders with the following objectives:

- To prepare a Comprehensive Regional Perspective Plan for the Chennai-Bengaluru Industrial Corridor Region, along with the developing strategy for transforming the region into a globally competitive investment destination,
- To identify suitable nodes to be taken up for industrial development within the project influence area (States of Karnataka, Andhra Pradesh, and Tamil Nadu) and prepare a Master Plan and a Development Plan for at least two selected industrial nodes (amongst the various nodes identified under the study), and
- To identify components of infrastructure that need to be created and corrected to enable better functioning of the economy and industry and to enable development of the above nodes as a starting point to promote manufacturing and growth in the CBIC region.

Population Projection

The future population of the node, consisting of the working population and residential population, was projected in conjunction with the projected land offtake.

Table 2.3.16 Projected Population in Ponneri Node

	2016–2019	2020–2024	2025-
Working Population	90,665	373,475	888,074
Residential Population	0	0	400,000

Source: Ponneri Industrial Node Development Plan in Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor, 2015

Economic Growth

Real GDP growth rate in India was projected as follows:

Table 2.3.17 Real GDP Growth Rate in India

Description	Actual		Projection		
	1980–1999	2000–2012	2013–2020	2021–2030	2030-
Real GDP Growth Rate (p.a.)	5.6%	6.9%	6.3%	6.9%	6.9%
Ratio to Previous Period	-	1.23	0.91	1.10	1.00

Source: Ponneri Industrial Node Development Plan in Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor, 2015

Land Use Plan

Based on the development framework and the development concepts, the required area for each land use category in the priority area and the whole node area were estimated.

Table 2.3.18 Land Use Plan

Unit: ha

	2016-2019	2020-2024	2025-	Total
Industrial Area	399	622	2,885	3,906
Residential Area	0	0	1,054	1,054
Existing Settlement	0	0	885	885
Infrastructure (Road and Plant)	199	28	310	536
Water Body and Green Area	83	129	440	652
Others	319	36	403	757
Total	999	814	5,976	7,789
Existing Port Area				1,100
Grand Total				8,889

Source: Ponneri Industrial Node Development Plan in Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor, 2015

Road Development Plan

Based on the proposed internal node development plan and the identified projects, the implementation plan for internal node development was proposed as shown below:

Table 2.3.19 Road Development Plan

Unit: million INR

	2016	2017	2018	2019	2020	2021	2022	2023	2024-30	2031-33
Internal Road Works	109	147	133	0	0	6	32	41	0	186
Inter Section Works	0	4	2	0	0	0	0	0	0	0
River Bridge Works	13	13	13	7	7	7	7	7	0	0
Flyover Bridge Works	32	26	23	2	2	2	2	0	0	0
Road Facilities	146	157	168	0	0	0	0	8	0	0
Internal Public Transport Facilities	0	1	22	0	0	0	1	22	0	0
Major River Bridge Works	17	17	17	0	0	0	0	0	0	0
Total	317	365	378	9	9	15	42	78	0	186

Note: Figures in 2024-30 and 2031-33 are the same every year.

Source: Ponneri Industrial Node Development Plan in Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor, 2015

Water Supply

The domestic and industrial water demand in Ponneri Node was estimated as shown in the table below:

Table 2.3.20 Water Demand of Ponneri Node

Unit: million liters per day

Description	2018	2022	2033
Domestic Water			
Residential People Excluding Employees	0	0	38.6
Employees from the Inside of Node	0	0	15.4
Employees from the Outside of Node	3.4	10.4	34.8
Total	3.4	10.4	88.8
Including Water Loss	3.8	11.8	98.7
Industrial Water	16.2	41.4	158.6
Including Water Loss	18.0	46.0	176.2
Grand Total	21.8	57.8	274.9

Note: Water loss was assumed at 15% of water supply.
Source: Ponneri Industrial Node Development Plan in Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor, 2015

The summary of the cost estimate of the construction are presented in the table below:

Table 2.3.21 Construction Cost of Water Infrastructures

Unit: million INR

Item	2016–2018	2019–2021	2022–2033	Total
Portable Water Supply Works	665	521	12,863	14,049
Non-portable Water Supply Works	2,878	1,725	8,278	12,880
Domestic Sewerage Works	337	256	2,521	3,114
Treated Sewerage and Industrial Effluent Collection Works	671	595	4,427	5,693
Drainage Works	492	781	3,208	4,480
Total	5,042	3,878	31,296	40,216

Source: Ponneri Industrial Node Development Plan in Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor, 2015

The summary of the cost estimate of the O&M are presented in the table below:

Table 2.3.22 O&M Cost of Water Infrastructures

Unit: million INR

Item	2016–2018	2019–2021	2022–2033	Total
Portable Water Supply Works	69	268	5,172	5,509
Non-portable Water Supply Works	311	1,120	6,611	8,042
Domestic Sewerage Works	48	149	1,485	1,682
Treated Sewerage and Industrial Effluent Collection Works	89	324	2,786	3,199
Drainage Works	74	318	2,254	2,646
Total	591	2,180	18,307	21,078

Source: Ponneri Industrial Node Development Plan in Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor, 2015

Solid Waste Management

Summary of cost estimate are presented in the table below.

Table 2.3.23 Cost of Solid Waste Management Infrastructure

Unit: million INR

Item	2014–2018	2019–2023	2024–2033	Total
Construction Cost				
Hazardous Waste Infrastructure	0.0	316.3	1178.0	1494.3
Municipal Solid Waste Infrastructure	31.1	34.1	819.8	885.0
O&M Cost				
Hazardous Waste Infrastructure	0.0	36.0	2017.7	2053.7
Municipal Solid Waste Infrastructure	10.6	34.6	797.7	842.9

Source: Ponneri Industrial Node Development Plan in Comprehensive Integrated Master Plan for Chennai Bengaluru Industrial Corridor, 2015

2.3.3 Road Development Plans and Projects Other than CPRR

(1) Outer Ring Road (ORR)

The ORR is being constructed in phases. The section of Phase 1 of ORR that has been opened is from Vandalur on NH45 to Nemilinchery on NH205. The section of Phase 2 is under construction from Nemilinchery on NH205 to Minjur on NH5. The project is being implemented by TNRDC which was formed under HMPD.

(2) Widening of NH205 Including Construction of Thiruvallur Bypass

The National Highways Authority of India (NHAI) is widening the Thiruninravur-Thiruttani-Tirupati Section of NH205 to four lanes, and construction is in progress. As part of the project, NHAI is constructing a bypass for Thiruvallur town. The bypass starts at KM 43/800 of NH205 on western side of Thiruvallur, crosses SH57 at KM 44/500 on the northern side of Thiruvallur, ends at KM 50/600 of NH 205, starts again at KM 50/800, and ends at KM 52/000 of NH205.

(3) Widening of Section of SH57 from Singaperumalkoil to Sriperumbudur

A section of SH57 from Singaperumalkoil to Sriperumbudur is ongoing widening to six lanes with service roads by TNRIDC. The SH57 crossing the railway lines with manned level crossing in Singaperumalkoil for which the Project Wing of the Highways Department of GoTN is constructing a Road over Bridge (ROB).

(4) Widening of Old Mahabalipuram Road (OMR) (Phase-II)

The IT Corridor Project, is an initiative of GoTN to develop OMR as a world-class facility. TNRDC has incorporated an SPV called 'IT Expressway Ltd' (ITEL) to develop the IT Corridor Project. The entire stretch will be built as six-lane road with service roads and footpaths on both sides. The project is being implemented in two phases – Phase-I (20 km) between Madhya Kailash Temple Junction and Siruseri, and Phase-II (26 km) between Siruseri and Mahabalipuram. As the improvement of Phase-I is completed, ITEL is now planning to widen Phase-II to a 6-lane carriageway with service roads on both sides. As part of Phase-II, two bypasses are proposed for Kelambakkam and Thiruporur.

(5) Widening of East Coast Road (ECR) (Phase-I)

The stretch of ECR from KM 22/300 (Akkarai) to KM 135/500 (Puducherry) is maintained as a toll road by TNRDC. Recognizing the rapid recreational, commercial, and residential developments along the ECR and its influencing areas, TNRDC has decided to upgrade the road as a dual two-lane facility with improved geometry in two phases. Phase-I spans from KM 22/300 to KM 55/800 (Mahabalipuram), and Phase-II is from KM 55/800 to KM 135/500. Phase-I is under construction.

(6) Improvement of Grid Roads along ORR

The State Highways Department and CMDA have jointly identified 18 road networks to be developed on either side of Chennai ORR. The DPR for the development of grid roads along the ORR is under preparation.

(7) Construction of Elevated Road along OMR

Due to enormous growth in employment at IT companies and other commercial and major institutional

development that has taken place along OMR, Phase-I is experiencing traffic congestion which has resulted in considerable increase in travel time. Huge residential area developments coupled with Special Economic Zones are sprawling along OMR. These ongoing and contemplated developments are likely to have huge impacts on traffic flow along the corridor. Road widening requires considerable land acquisition which cause more social impact. Hence, GoTN desired to construct an elevated highway corridor along OMR from Taramani to Siruseri under Phase-I and Siruseri to Mahabalipuram under Phase-II, for a length of 45 km. The DPR for the project is under preparation.

(8) Construction of Elevated Road along NH45

NH45 is the gateway to Chennai from the southern part of Tamil Nadu. The stretch between the airport and Chengalpattu traverses through major urbanized areas and has major developments such as IT center, gated communities, malls, educational institutions, major industrial center, and SEZs. This area is also witnessing fast growth, and it will continue to attract more developments in the future also. The stretch experiences frequent traffic jam, and vehicles cannot move fast resulting to decrease in travel speed. Therefore, CMDA is preparing a detailed feasibility study report for construction of an exclusive elevated road for the thorough traffic from the Chennai Airport to the toll-plaza near Chengalpattu along NH45.

(9) Widening Project of TPP Road (State Highway 104)

TNRDC is executing the widening and improvement project of the road section from the IRR intersection to North Terminal Road, as “Ennore-Manali Road Improvement Project”.

2.3.4 Intelligent Transport System (ITS) Development Plans and Projects

(1) Integrated Traffic Management System (ITMS) Project

ITMS Project is the project of CTP that introduces systems and facilities for traffic management. It includes the replacement of traffic signals at approximately 100 junctions in the city and enforcement systems utilizing Automatic Number Plate Recognition (ANPR) cameras.

The tender for ITMS was awarded to M/s Purple InfoTech Ltd. a few years ago, but the termination notice was issued because of several reasons. For instance, the contractor did not carry out the first phase of the project in time. The project is under litigation.

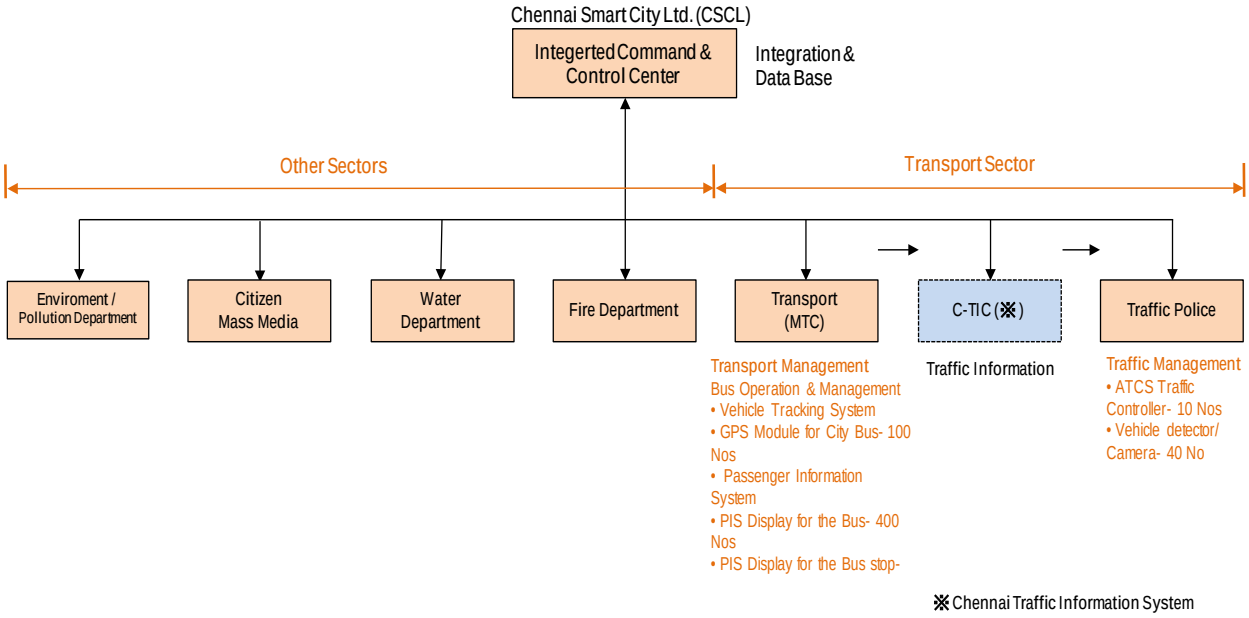
(2) Smart City Project

There is a plan under the Smart City Initiative to establish an Integrated Command Control Center (ICCC) and to develop information systems in several different sectors such as water, energy, environment, safety, etc. The ICCC will be developed under CSCL, and the information systems will collect data. The collected data will be aggregated in the ICCC and will be used for analysis. The analyzed data will be utilized for necessary measures. The Smart City Project targets to commence a part of service of any of the information systems from May 2018, and preparation of the specifications is underway.

The Chennai Traffic Information System, or Chennai Traffic Information Center (C-TIC), which is proposed to be developed by Japanese ODA Loan Project will be one of the information systems in the transport sector under the ICCC. The data collected by C-TIC will be shared and utilized by the ICCC in the future.

ICCC will be established in the building of GCC, and C-TIC will be in the building of CTP.

Figure 2.3.1 illustrates the concept of the Smart City Project establishing the ICCC and the information systems.



Source: Edited by the JICA Study Team based on interviews with CSCL

Figure 2.3.1 Concept of Smart City Project

A pilot project under the transport sector is planned to develop the Bus Tracking System by installing GPS devices on 100 buses, and the Passenger Information System by installing display boards at 50 bus stops and inside 400 buses. The installation of ten units of traffic signal controllers and 40 units of vehicle detection cameras are also included in the pilot project.

2.3.5 Present Condition of ITS for Arterial Roads

The current situation of ITS for arterial roads in Chennai is described in the Final Report of Data Collection Survey for Chennai Metropolitan Region ITS, which was completed in March 2017. This clause reports the latest situation of ITS obtained from this study.

(1) Responsible Organization for Arterial Roads and Project Implementation Scheme

There are nine arterial roads in Chennai. The IRR, ORR, SH49, and SH49A are under the jurisdiction of HMPD and TNRDC, while NH5, NH205, NH4, NH45, and Chennai Bypass are under the jurisdiction of NHAI. The following table shows the responsible organization and project implementation scheme for each arterial road:

Table 2.3.24 Responsible Organization for Arterial Roads and Project Implementation Scheme

Road Category		Responsible Organization	Project Scheme	BOT Contractor	Note
SH	IRR	HMPD	Public Works Project (EPC)		
	ORR	TNRDC	Private Project (BOT: Annuity *1)	GMR	
	SH-49		Public Works Project (EPC)		
	SH-49A		Public Works Project (EPC)		
NH	Chennai Bypass	NHAI	Public Works Project (EPC)		
	NH-5		Private Project (BOT: Toll *2)	L&T	Outside the boundary of GCC
	NH-205		Private Project (BOT: Toll *2)	Trans story Tirupati	
	NH-4		Private Project (BOT: Toll *2)	Essel	
	NH-45		Private Project (BOT: Anuuity *1)	Eagle	

*1: A scheme wherein the collected toll charges are first paid to the government and the Build-Operate-Transfer (BOT) Contractor receives annuities.

*2: A scheme that the BOT Contractor recovers the investment and gains profit by BOT style.

Source: Edited by the JICA Study Team based on interviews with related organizations and the report on the Data Collection Survey for Chennai Metropolitan Region ITS

The overview of the current situation of the arterial roads in Chennai is shown in the next page.

Source: Edited by the JICA Study Team based on interviews with related organizations and the report on the Data Collection Survey for Chennai Metropolitan Region ITS

Figure 2.3.2 Overview of the Current Situation of the Arterial Roads in Chennai

(1) Toll Plaza Plans

The locations for toll plazas in Chennai are shown in Figure 2.3.2 in the previous page. The current free roads of Section 1 (in service) and Section 2 (under construction) of ORR and IRR (in service) are planned to be converted into toll roads with new toll plazas to be built. The Kattupalli Port Access Road is also considered to be convert into a toll road.

(2) ITS Facilities for Arterial Roads

Highway Traffic Management Systems (HTMS) and Traffic Management Systems (TMS) have been introduced to arterial roads in Chennai. HTMS has been introduced only to ORR (Section 1) with limited facilities.

TMS has been introduced to NHs and Chennai Bypass under NHAI with the electronic toll collection (ETC) system of Radio Frequency Identifier (RFID) called FASTag, touch-and-go system using IC card, and manual toll collection system by cash. As for SH49 and SH49A under TNRD, touch-and-go system, and manual toll collection system have been introduced. The introduction of the ETC System is planned on ORR. The IC cards adopted for touch-and-go system are not the common type that can be used across different sections and/or transport modes; therefore, each card is available only for each specific road.

The following table shows the current situation for each road.

Table 2.3.25 Current Situation of ITS Facilities for Arterial Roads

Road Category		HTMS		TMS	
		Current Situation	Plan	Current Situation	Plan
SH	IRR	—	—	—	Cash
	ORR: Section 1	VMS, Emergency Call Box, Weather Observation	—	—	Cash, Touch & GO, ETC (FASTag)
	ORR: Section 2 (under construction)	—	VMS, Emergency Call Box, Weather Observation	—	Cash, Touch & GO, ETC (FASTag)
	SH49	—	—	Cash, Touch & Go	—
	SH49A	—	—	Cash, Touch & Go	—
NH	Chennai Bypass	—	—	Cash, ETC (FASTag)	—
	NH5	—	—	Cash, Touch & GO, ETC (FASTag)	—
	NH205	—	—	Cash	—
	NH4	—	—	Cash, Touch & GO, ETC (FASTag)	—
	NH45	—	—	Cash, Touch & GO, ETC (FASTag)	—

Source: Edited by the JICA Study Team based on interviews with related organizations and the report on the Data Collection Survey for Chennai Metropolitan Region ITS

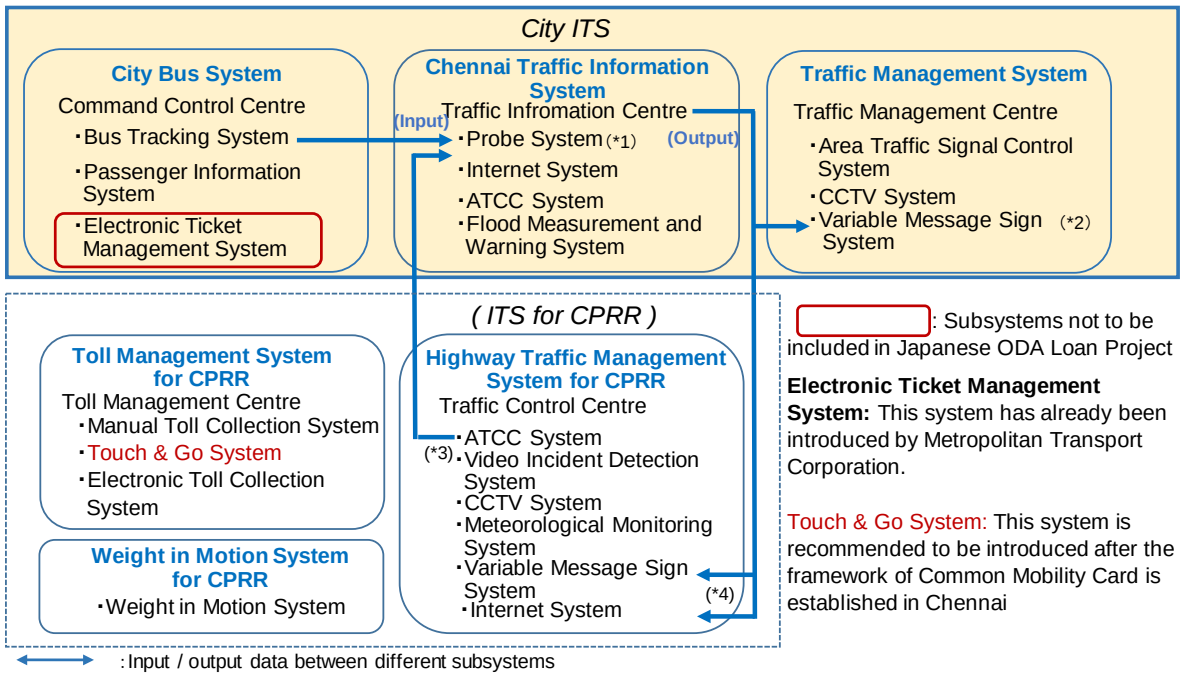
CHAPTER 3 PRIORITIZATION AND FORMULATION OF THE PROJECT FOR JICA LOAN SCHEME

3.1 ITS Components

3.1.1 Overall ITS Components

Figure 3.1.1 shows the overall ITS components, which are candidates for Japanese ODA Loan Project. The considerations were mainly made for the City ITS in Volume 2 of this report.

As to the Touch & Go System, it is recommended to adopt the common mobility card which can be used for other transport modes, e.g. Chennai metro rail, city buses, etc. Under the situation where the common mobility card does not exist yet in Chennai, it is recommended that the Touch & Go System be introduced after the framework of the common mobility card is established in Chennai.



*1: To generate congestion information on the road network based on the probe data obtained from Bus Tracking System

*2: To provide congestion information on the general roads under the authority of Traffic Police

*3: To complement the Probe System to generate congestion information after completion of CPRR

*4: To provide congetion information generated by Chennai Traffic Information System. Other information will be generated by Highway Traffic Management System for CPRR and provided.

Source: JICA Study Team

Figure 3.1.1 Overall ITS Components for Japanese ODA Loan Project

3.1.2 Conditions of Formulation of ITS Components

The conditions of formulation of ITS components are (i) requisites for the systems to function and (ii) current condition/existing plan of ITS in Chennai. The considerations were made as described below for the ITS components and subsystems shown in Figure 3.1.1.

(1) City ITS

1) Requisites for the Systems to Function

a) System Linkage among Different Components

The Bus Tracking System under the City Bus System is necessary for the Probe System under the Chennai Traffic Information System. This is because the Probe System will generate the congestion information on the road network in Chennai Metropolitan Area based on the probe data obtained from the Bus Tracking System.

The Probe System under the Chennai Traffic Information System is necessary for the Variable Message Sign System under the Traffic Management System. This is because the Variable Message Sign System will provide the congestion information generated by the Probe System.

b) System Linkage among Subsystems under Single Component

(i) City Bus System

The Bus Tracking System is necessary for the Passenger Information System. This is because the Passenger Information System will provide the bus operating information based on the bus location data obtained by the Bus Tracking System. On the other hand, the Electronic Ticket Management System functions independently from other subsystems.

(ii) Chennai Traffic Information System

The ATCC System is necessary for the Probe System. This is because the data collected by the ATCC System will complement the Probe System to generate the congestion information on the road sections where the city buses are not operated, e.g., Outer Ring Road, Chennai Bypass, etc.

The ATCC System and Probe System are necessary for the Internet System. This is because the Internet System will provide the congestion information which is generated based on these subsystems.

The Flood Measurement and Warning System functions independently from other subsystems. However, it is recommended that all subsystems be introduced together with under the Chennai Traffic Information System for utilizing the collected data for the road transport measures.

(iii) Traffic Management System

All subsystems, i.e., the Area Traffic Signal Control System, CCTV System, and Variable Message Sign System, function independently. However, it is recommended that all subsystems be introduced for controlling traffic in the city.

2) Current Condition / Existing Plan of ITS

a) Electronic Ticket Management System (City Bus System)

It was found that the Electronic Ticket Management System has already been introduced for the city bus by the Metropolitan Transport Corporation (MTC). Therefore, it was agreed with MTC that this subsystem will not be included under Japanese ODA Loan Project.

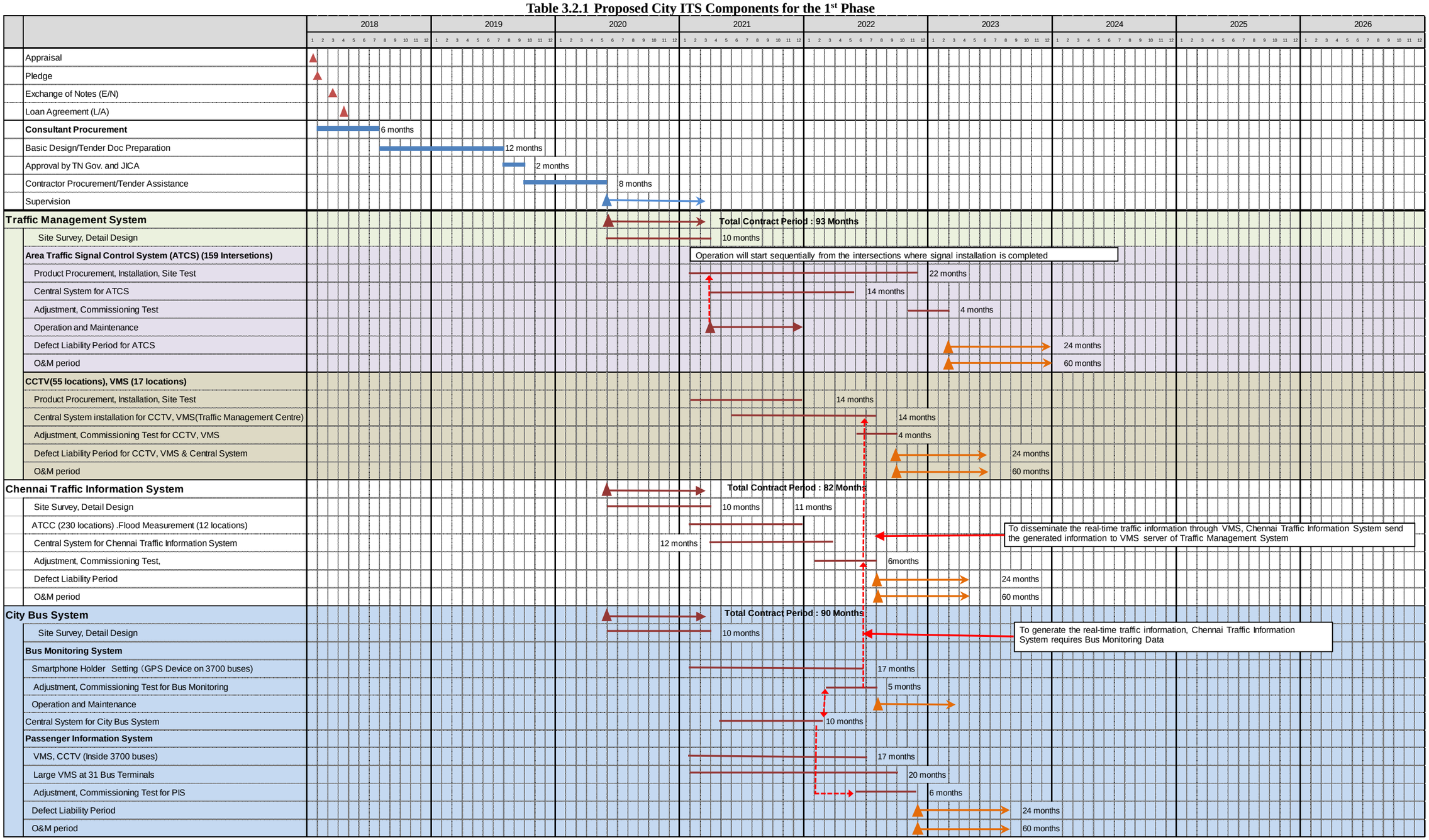
3.2 Prioritization of Components for Implementation

3.2.1 Prioritization of ITS Components (City ITS)

(1) City ITS Components for the 1st Phase

The City ITS components for the 1st phase are shown in the form of implementation schedule in Table 3.2.1 on the next page.

Table 3.2.1 Proposed City ITS Components for the 1st Phase



Source: JICA Study Team

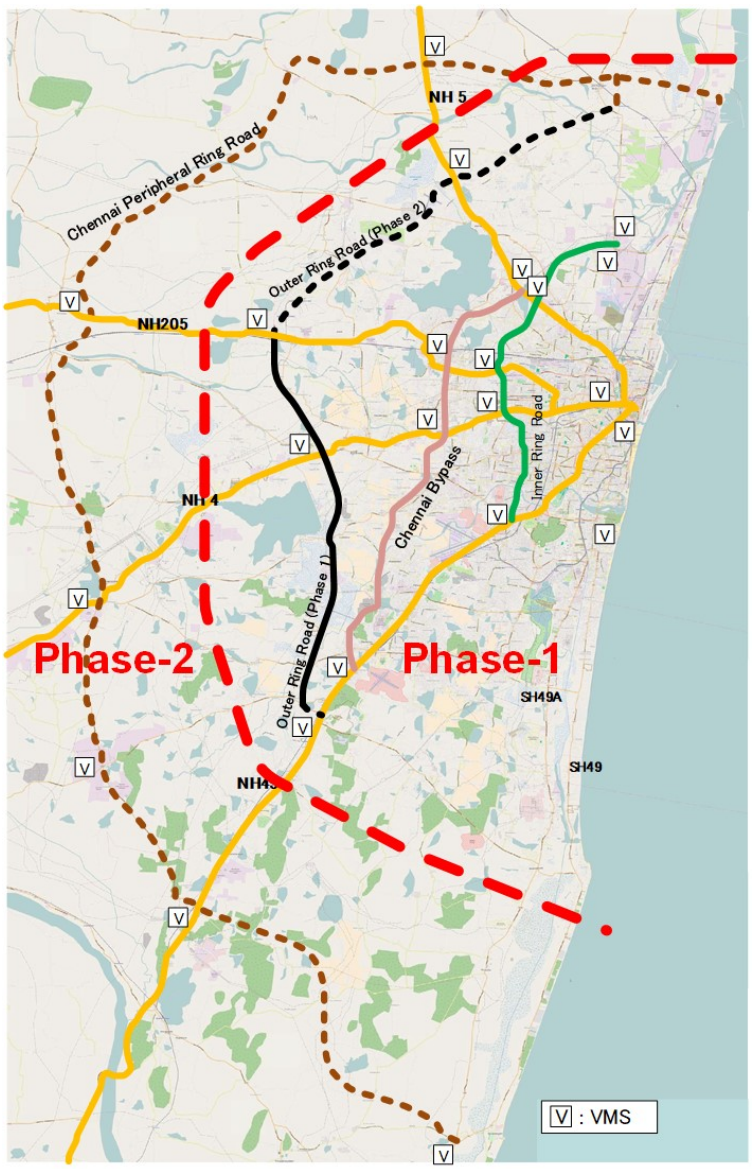
1) City Bus System, Chennai Traffic Information System, and CCTV/VMS under the Traffic Management System

One of the major purposes of the City ITS is to disperse the traffic by guiding the users to the optimal routes by providing congestion information/alternative route information. The Chennai Traffic Information System will generate and provide the information. It is systematically linked with the City Bus System and VMS System under the Traffic Management System to function, as described in Clause 3.1.2 (1) 'City ITS, 1) Requisites for the Systems' to function. Therefore, these systems shall be introduced together.

More details are shown in Table 3.2.1. The central system of the City Bus System, which is linked to the Bus Monitoring System, needs to be completed before completion of the central system of the Chennai Traffic Information System. Further, the central system of the Chennai Traffic Information System needs to be completed before completion of the Variable Message Sign System.

2) Variable Message Sign (VMS) Board

The VMS board will be installed at the upstream location of the main Radial Road and Ring Road junctions for road users to be able to choose alternative route. Therefore, it is proposed to install at the locations inside CPRR at the time of implemention of City ITS as the 1st phase; and outside CPRR together with construction of CPRR as the 2nd phase as shown in Figure 3.2.1.



Source: JICA Study Team

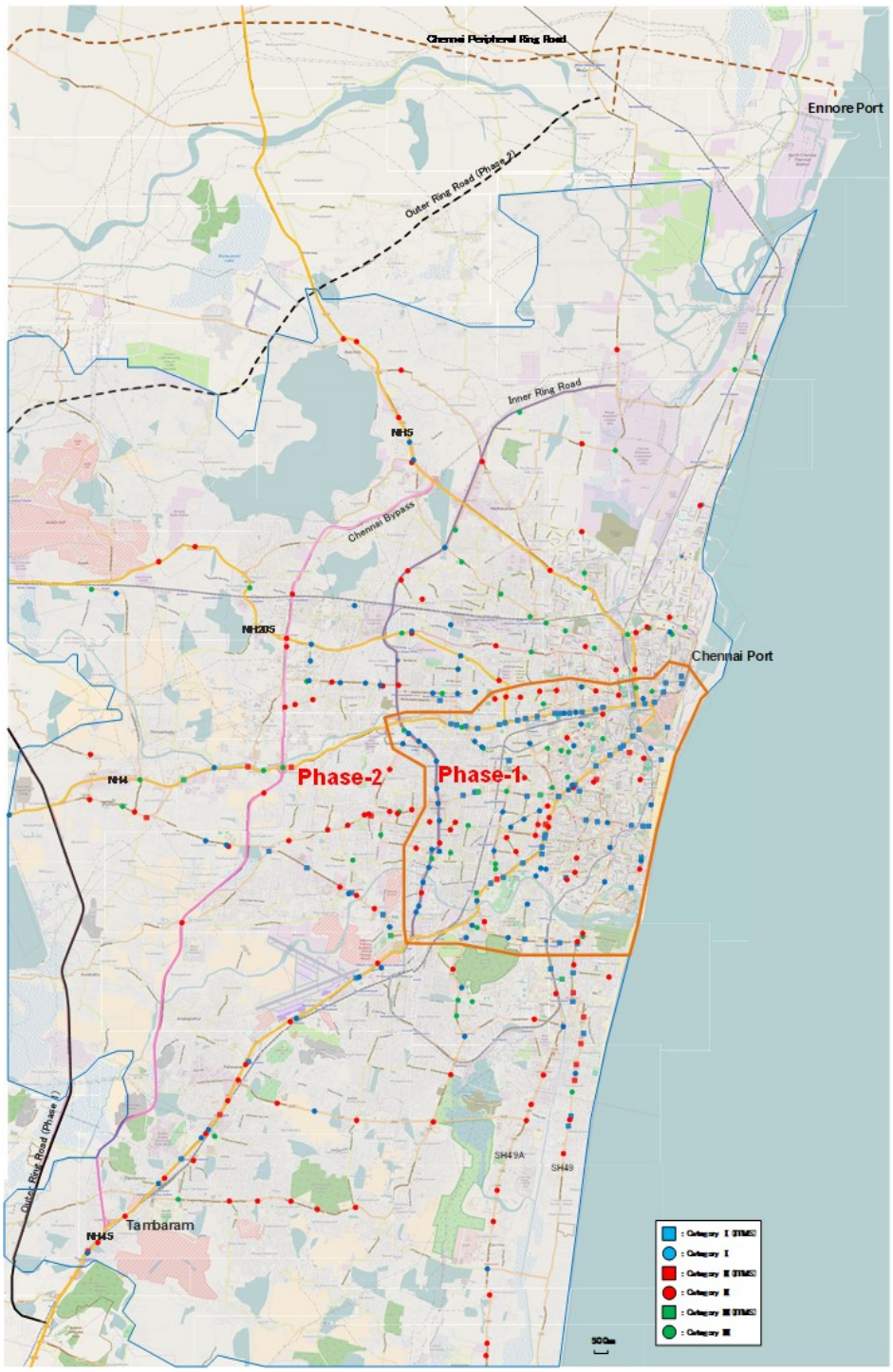
Figure 3.2.1 Proposed Locations of VMS Board by Phase

3) Area Traffic Signal Control System (ATCS)

The Area Traffic Signal Control System (ATCS) can be introduced independently from the above systems because it functions by itself.

In the 1st phase, the ATCS is proposed to be introduced to the core area of the city that is encircled by NH-4, Inner Ring Road (IRR) and Sardhar Vallabhai Patel Road. This is because the distance between the junctions is shorter, compared with other area and more effects can be expected by area-wise control. In the second phase, the ATCS is proposed to be introduced to other area.

The proposed locations of the ATCS by phase are shown in Figure 3.2.2 and Figure 3.2.3.



Source: JICA Study Team

Figure 3.2.2 Proposed Locations of Area Traffic Signal Control System by Phase

Source: JICA Study Team

Figure 3.2.3 Proposed Locations of Area Traffic Signal Control System in Phase-1

3.3 Consulting Services for the Prioritized Project

3.3.1 Chennai City ITS

(1) Mode of Contract Scheme

The 'Design Build', i.e., design, supply, and installation, in which the Employer prescribes the requirement of the systems and performance while the Contractor carries out the detailed design, best suits the project because of ITS Project, which is mainly composed of the systems and equipment.

The Design Build is adopted to other public projects of ITS in India. The major examples are 'MITRA Project' of City Bus Monitoring and Passenger Information System in Mysore, Karnataka State (World Bank), 'KSRTC Project' of Inter-City Bus Monitoring and Passenger Information System in Karnataka State (State Budget) and 'B-TRAC Project' of Traffic Management System of Bengaluru Traffic Police in Karnataka State (State Budget).

'Procurement of Plant Design, Supply and Installation' of '(JICA) Standard Bidding Documents Under Japanese ODA Loans (SBD)' is recommended to be used for Japanese ODA Loan Project. This SBD is prepared for the Design Build Project and has been used for several ITS projects under the Japanese ODA loan in India and other countries. This SBD has been made based on FIDIC 'Yellow Book' (Plant and Design-Build).

(2) Tender Method of Consultant Procurement

It is very important that the requirements be clearly defined/prescribed so that the bidders can properly reflect the requirements on their proposals particularly because of the ITS Project that utilizes advanced technology. This is a different method from 'Turn Key Project', or Engineering Procurement and Construction (EPC) where the Contractor takes almost the entire responsibilities on the design and construction. In particular, the Indian local contractors do not have sufficient experiences of ITS projects yet. Under such situation, ensuring the quality throughout the project, particularly the upper stage, i.e., basic design and contractor procurement, is very important because the quality of the upper stage will affect the entire project including the stages of implementation, operation and maintenance. Therefore, procuring the consultant through an international competitive bidding including the stages of basic design and contractor procurement is recommended.

(3) Selection Method of Contractor Procurement: Quality and Cost Based Selection (QCBS)

ITS facilities such as emergency call box, traffic counter, CCTV, weather monitoring facility, VMS and center system are obligated to be installed on national highways under the jurisdiction of NHAI in India where a certain level of traffic volume is expected (more than 40,000 daily traffic volume). However, currently, there is no road where these facilities have been installed correctly and actually no information is provided. As for City ITS in India, Ahmadabad in Gujarat State is the only city that provides dynamic traffic information in real time by Traffic Information System installed (The system was introduced by Japanese company under the Scheme of Support for Japanese Small and Medium Enterprise Overseas Business Development by JICA).

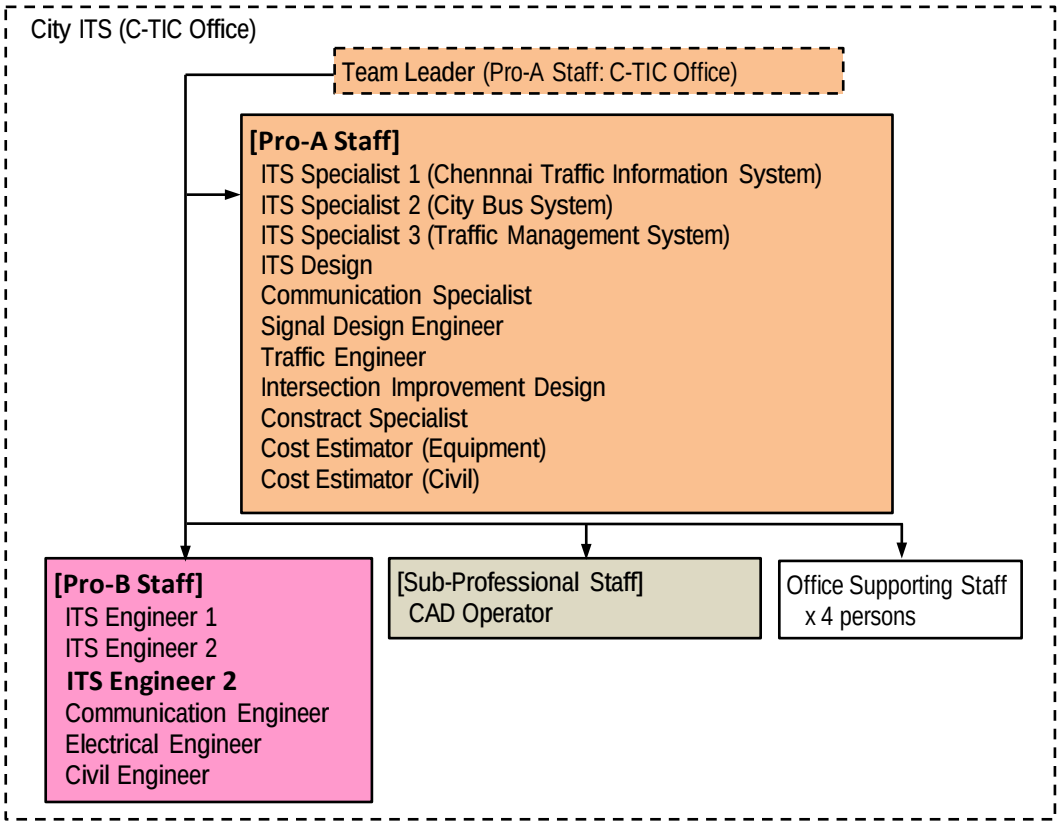
It is considered that the above situation of ITS in India has been caused by the fact that contractors who have sufficient technical capabilities for developing and handling the advanced system were not selected, and the selection method of the contractor procurement is considered one of the predominant factors behind the failure. ITS consists of several subsystems where technical aspects are vitally important such as software processing method, interface between subsystems or external systems and integration of systems. Therefore, selecting a contractor who holds enough technical capabilities determines the success of a project. To properly evaluate the technical capabilities of the bidders and select an appropriate contractor, adopting the Quality and Cost Based Selection (QCBS), an evaluation point of technical evaluation is reflected in addition to the financial evaluation, is strongly recommended.

The Smart City Mission, which will develop 100 smart cities, is the case in India that the selection method was altered from the conventional cost-based selection to QCBS. The first several cities such as Mumbai and Surat adopted cost-based selection for cost saving. But those cities fell into a situation that the integration of system could not be achieved because the contractor did not have enough technical capabilities. In the light of this fact, it was decided to adopt QCBS for the project of Smart City Mission. For example, the ratio of technical evaluation and financial evaluation for QCBS is 8:2 in Agra and 7:3 in Jabalpur and Lucknow.

Furthermore, QCBS was used for the project of city bus system in Mysore, Karnataka State financed by World Bank to select a contractor. The ratio of technical evaluation and financial evaluation was 6:4. The system has already been in operation and the project earned a high reputation for one of the successful ITS projects in India.

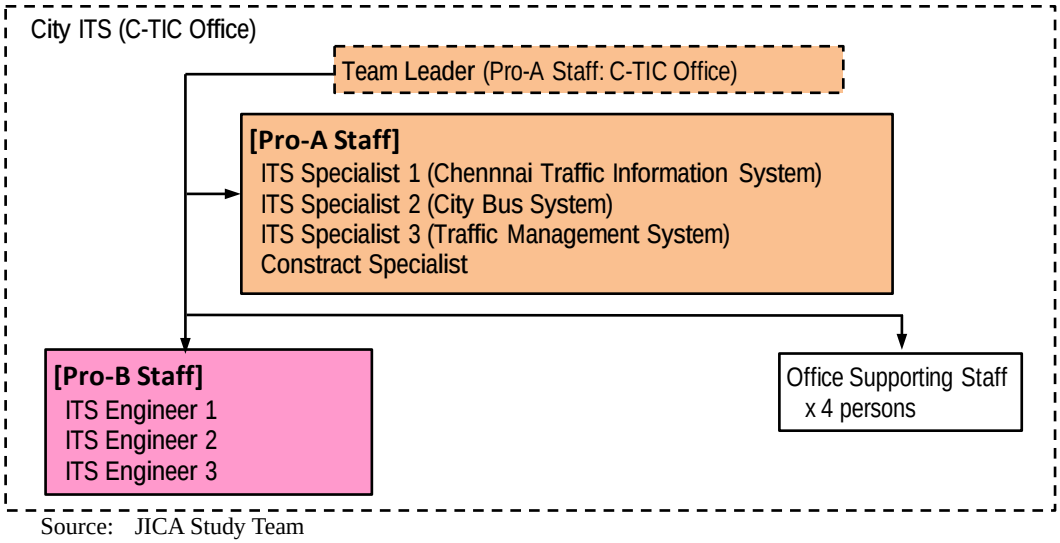
(4) Proposed Organization of Consultant

The following charts are proposed organizations of consultant for City ITS:



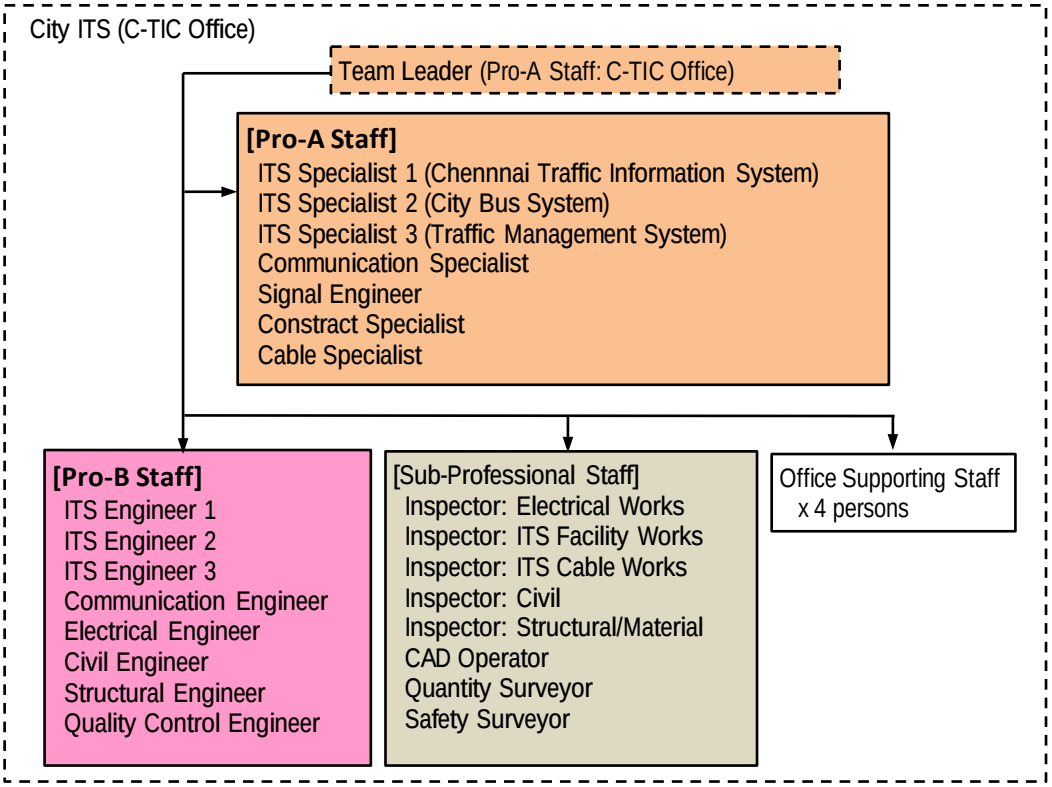
Source: JICA Study Team

Figure 3.3.1 Proposed Organization Structure of ITS Consultant (City ITS: B/D)



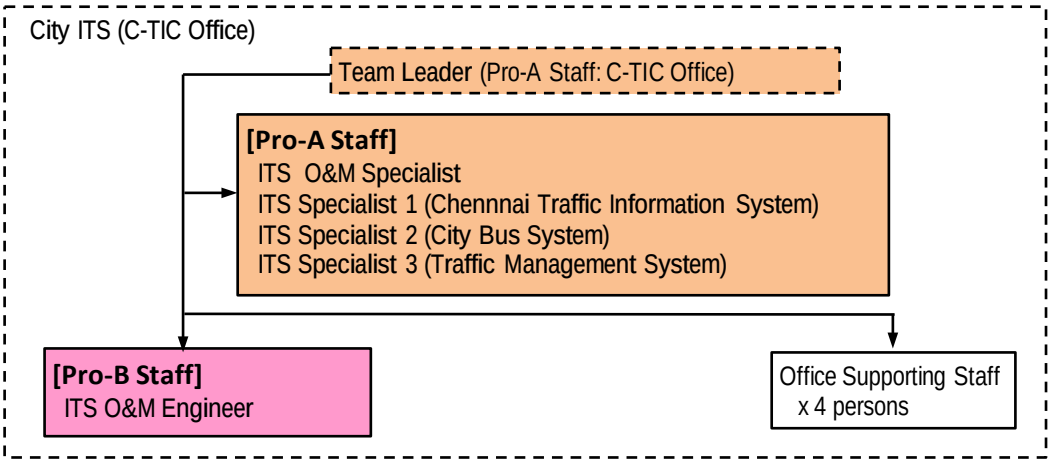
Source: JICA Study Team

Figure 3.3.2 Proposed Organization Structure of ITS Consultant (City ITS: T/A)



Source: JICA Study Team

Figure 3.3.3 Proposed Organization Structure of ITS Consultant (City ITS: C/S)



Source: JICA Study Team

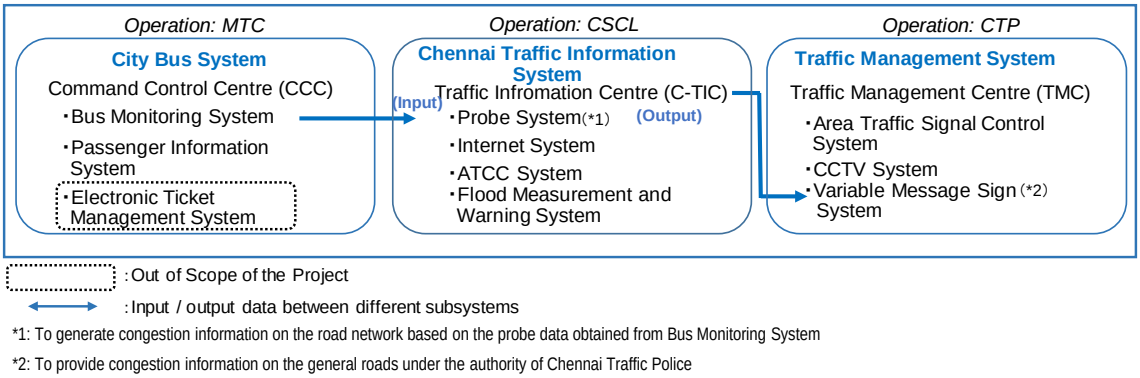
Figure 3.3.4 Proposed Organization Structure of ITS Consultant (City ITS: O/M)

CHAPTER 4 PRELIMINARY DESIGN OF CITY ITS

4.1 General

4.1.1 Scope and Objectives of Preliminary Design of City ITS

The scope of City ITS, which will be introduced to Chennai Metropolitan Area by the Japanese ODA loan, hereinafter referred to as the Project, was determined based on the studies carried out so far and discussions with Tamil Nadu government as shown in Figure 4.1.1. There are three components, i.e., Chennai Traffic Information System, Traffic Management System, and City Bus System. Each component is composed of some subsystems. The preliminary design of these components, including identifying quantity of equipment and cost estimation, was carried out for the formulation of Japanese ODA Loan Project.



Source: JICA Study Team

Figure 4.1.1 Scope of City ITS for the Project

4.1.2 Outline of City ITS

(1) Purpose of ITS Components

The purposes of three ITS components are shown in Table 4.1.1.

Table 4.1.1 Purpose of ITS Components

ITS Component	Purpose
Chennai Traffic Information System	・ Generating dynamic traffic information such as congestion, road closure, etc., based on collected data/information from roadside equipment, city bus system and related government organizations. ・ Transmitting the generated traffic information to Traffic Management System. ・ Storing quantitative data and information on traffic to be utilized for planning such as road maintenance/construction, traffic management, transport planning, etc. ・ Monitoring the operation status of the equipment and system
Traffic Management System	・ Providing a dynamic information on traffic, received from Chennai Traffic Information System, by VMS boards to the road users. ・ Displaying necessary messages on the message line of VMS manually inputted at the center. ・ Controlling the traffic by Area Traffic Signal Control System (ATCS). ・ Monitoring the traffic situation at site by CCTV. ・ Monitoring the operation status of equipment and system.
City Bus System	・ Managing the bus operation using the Bus Monitoring System. ・ Providing the real time bus arrival/departure information through information boards at bus terminals by the Passenger Information System. ・ Transmitting bus probe data to Chennai Traffic Information System. ・ Monitoring the operation status of equipment and system.

Source: JICA Study Team

(2) Coverage Area of City ITS and Location of Centers

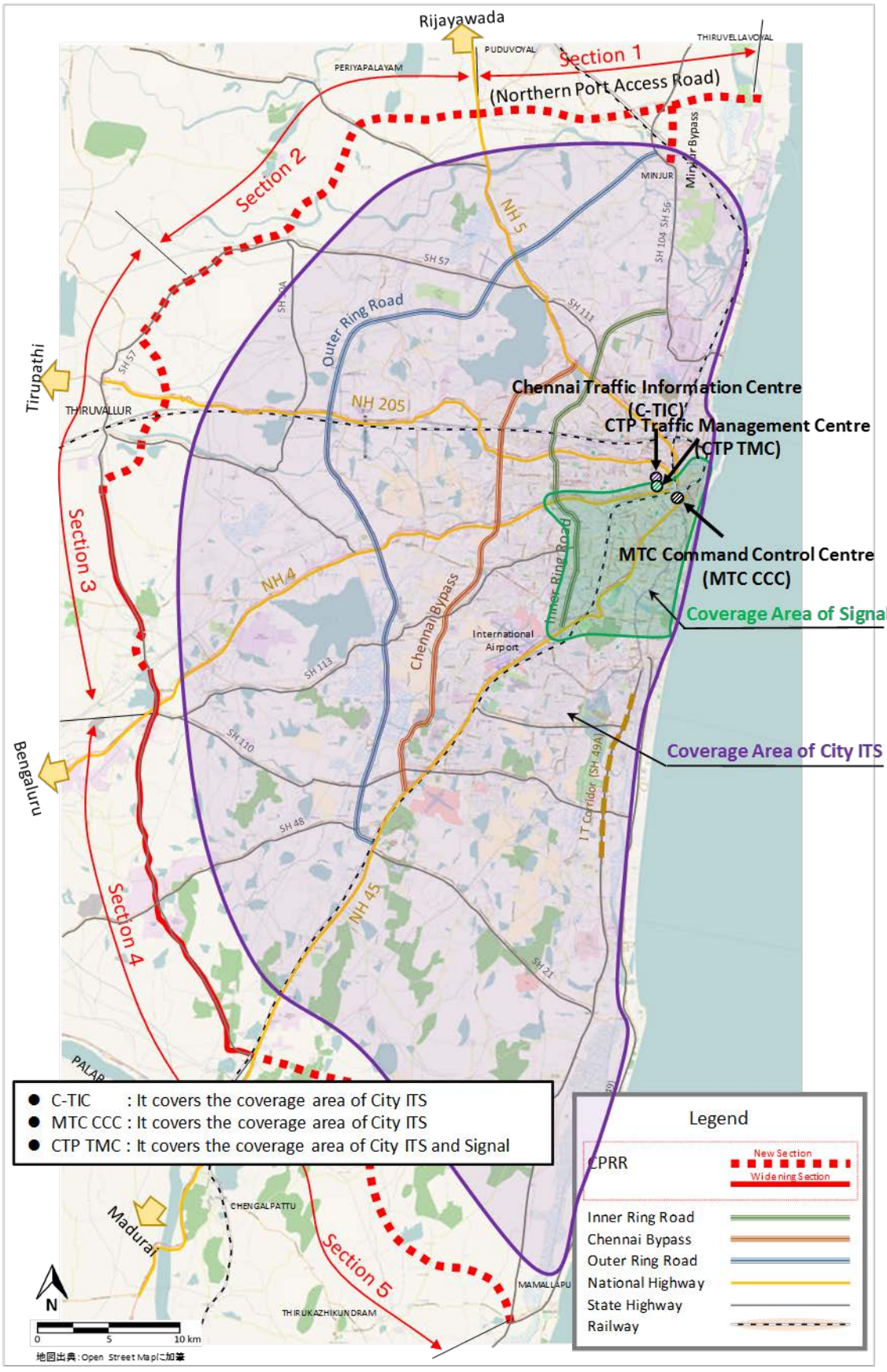
The City ITS components are planned to be developed in two phases. In the first phase, it will be developed covering the area inside Chennai Peripheral Ring Road (CPRR). While the second phase, the coverage area will be expanded to outside CPRR. The project of the Japanese ODA loan that this report discusses is the first phase. The ITS components in the second phase will be developed later together with the construction of CPRR and traffic information including CPRR, which will be provided to the road users.

The purple-colored in Figure 4.1.2 shows the coverage area of City ITS in the first phase. The green-colored in Figure 4.1.2 shows the coverage of Area Traffic Signal Control System in the first phase to cover the core area of the city.

The following three centers will be developed to realize the purposes described in Table 4.1.1 above.

- Center of Chennai Traffic Information System (C-TIC)
- Center of Traffic Management System (CTP TMC)
- Command Control Center of City Bus System (MTC CCC)

C-TIC and CTP TMC will be established in the headquarters of Chennai Traffic Police. MTC CCC will be established in the headquarters of MTC. The locations and coverage area of these centers are also indicated in Figure 4.1.2.

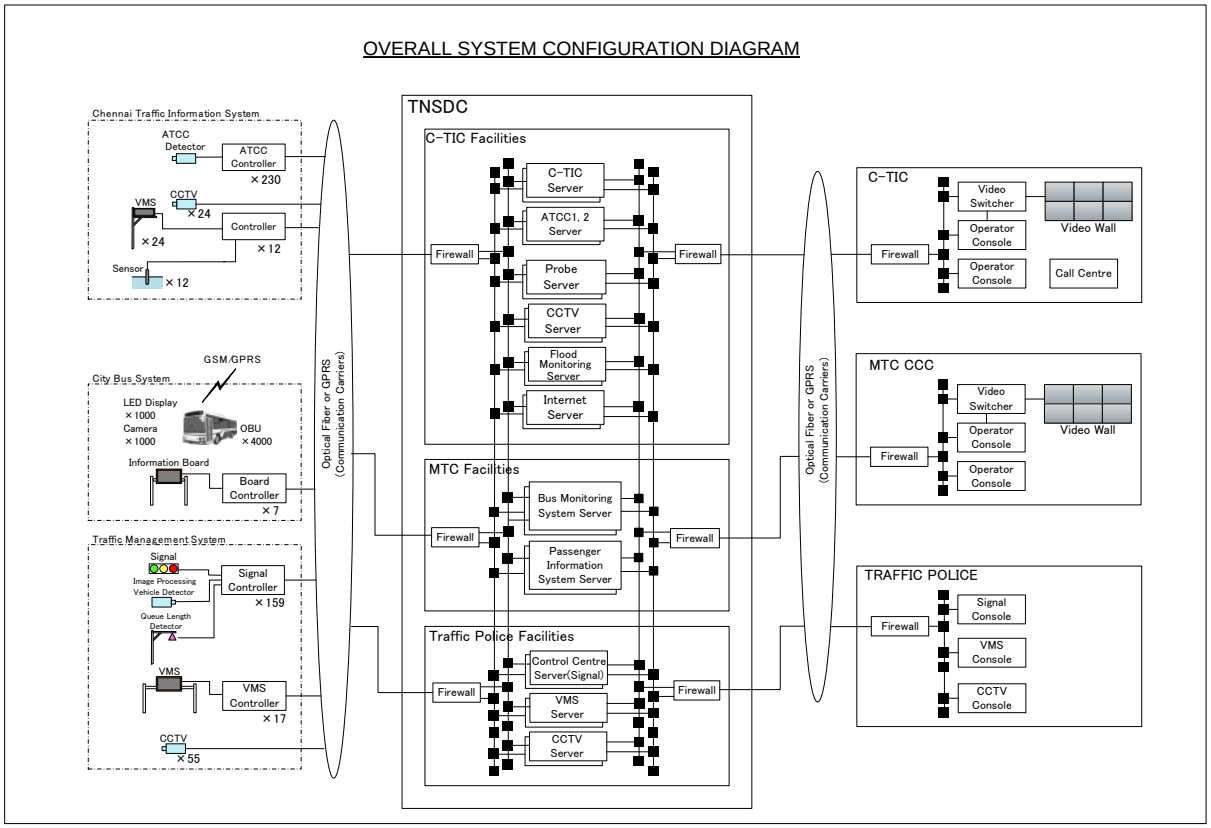


Source: JICA Study Team

Figure 4.1.2 Location Map of Coverage Area and Centers of City ITS

(3) Overall System Configuration of ITS Components

ITS components are basically composed of the center system and roadside equipment. The servers of the center systems will be located in Tamil Nadu State Data Center (TNSDC). The overall system configuration of ITS components is shown Figure 4.1.3.

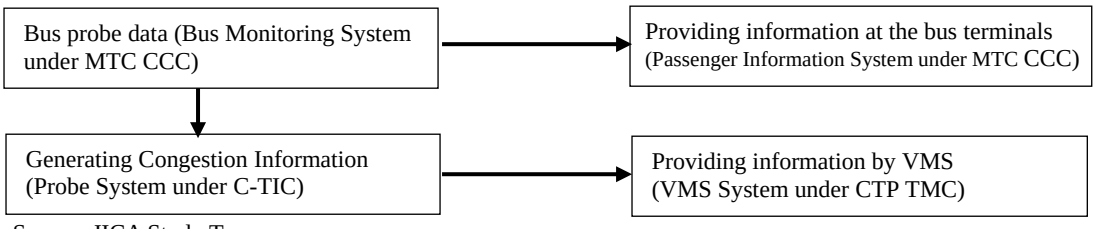


Source: JICA Study Team

Figure 4.1.3 Overall System Configuration of ITS Components

(4) Data Linkage among Subsystems

Many of the subsystems of ITS components will be linked. Figure 4.1.4 shows one of the typical examples of the data linkage among the subsystems of different ITS components.



Source: JICA Study Team

Figure 4.1.4 Major Example of Data Linkage among Subsystems of Different ITS Components

4.2 Design Concept of Chennai Traffic Information System

4.2.1 Major Roles of Subsystems

Table 4.2.1 shows the subsystems and their major roles of the Chennai Traffic Information System.

Table 4.2.1 Major Roles of Subsystem of Chennai Traffic Information System

Subsystem	Major Roles
Center System	・ Displaying the information of the current traffic situation on the video wall, plotting on the schematic image of the road network in Chennai and share the information with the personnel working in C-TIC ・ Storing the processed data for a certain period ・ Controlling the displaying image of the video wall ・ Monitoring the operation status of all subsystems ・ Monitoring the operation status of the network
ATCC System	・ Detecting the vehicle speed and traffic volume categorizing into at least two classes on the sensing area by image processing ・ Storing the data collected from the roadside equipment
Probe System	・ Generating the congestion information based on the bus probe data received from the Bus Monitoring System under MTC CCC and the traffic data collected by ATCC System and updating every five minutes ・ Storing the processed data for a certain period
Internet System	・ Displaying the congestion level information on the road network image on the internet based on the information generated by the Probe System
Flood Measurement and Warning System	・ Detecting the water-logging status of underpass roads ・ Capturing the image of CCTV installed at the entries of the underpass in both directions and storing the captured image for a certain period ・ Displaying the road closure information on VMS installed at the entries of the underpass in both directions when water-logging reaches the threshold level ・ Storing the measured water-logging data for a certain period

Source: JICA Study Team

4.2.2 Functions, Quantity, and Location of Roadside Equipment

(1) ATCC System

ATCC system adopts two different types of Automatic Traffic Counter-cum-classifier (ATCC), i.e., ATCC-1 and ATCC-2.

The purpose of ATCC-1 is to collect the speed data of the vehicles on the roads where MTC city buses are not operated. These roads are Chennai Bypass and Outer Ring Road. The data collected by the system will be used to supplement to Probe System to calculate the congestion level on these roads. ATCC-1 will be installed on the both directions of Chennai Bypass and Outer Ring Road at two-kilometer interval.

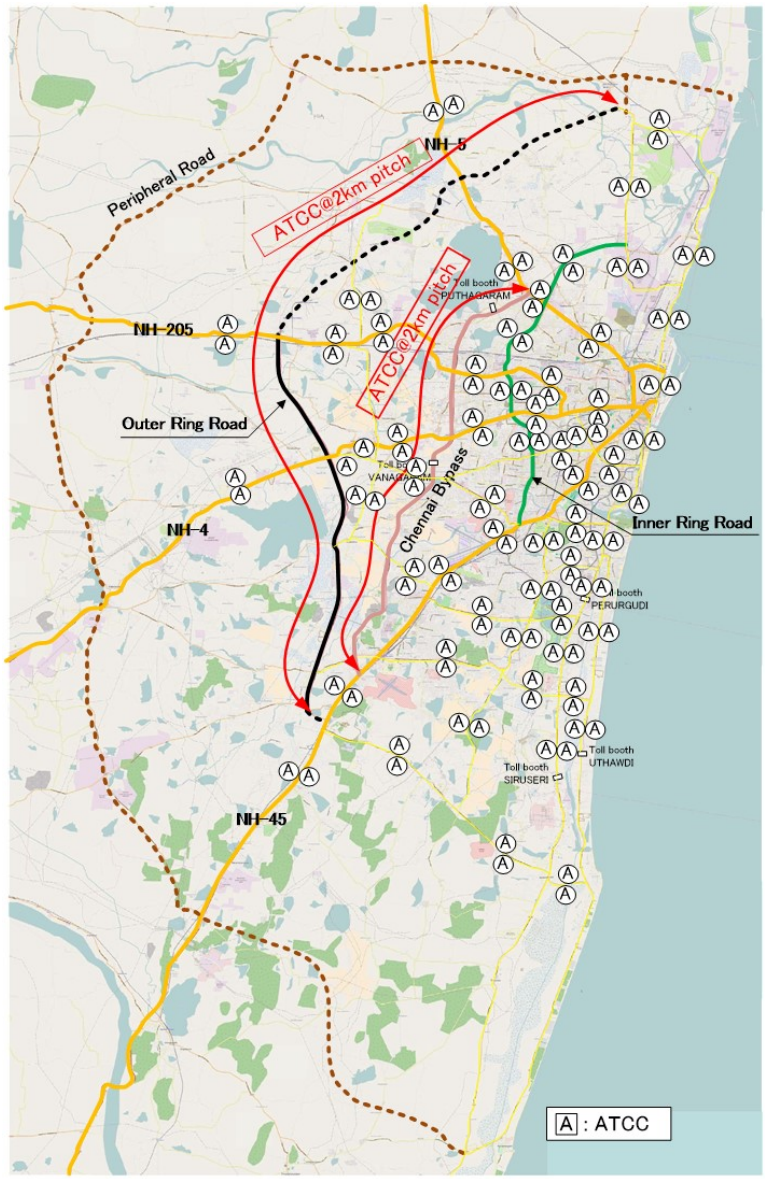
The purpose of ATCC-2 is to collect the traffic volume data categorizing into at least two different classes, large and small-sized vehicles, on the arterial roads. The collected data will be used for the road and traffic management purposes. They will be installed at the locations of mid-point between major junctions.

Eight units of ATCC-2 at four locations on the national highways outside CPRR will be additionally installed in the second phase.

The number of ATCC to be installed in the first phase is:

- ATCC-1: 102 units (on Chennai Bypass and Outer Ring Road at two-kilometer interval)
- ATCC-2: 128 units (on the locations of mid-point between major junctions of arterial roads)

The locations of ATCC are shown in Figure 4.2.1.



Source: JICA Study Team

Figure 4.2.1 Locations of ATCC (ATCC1 and ATCC2)

(2) Flood Measurement and Warning System

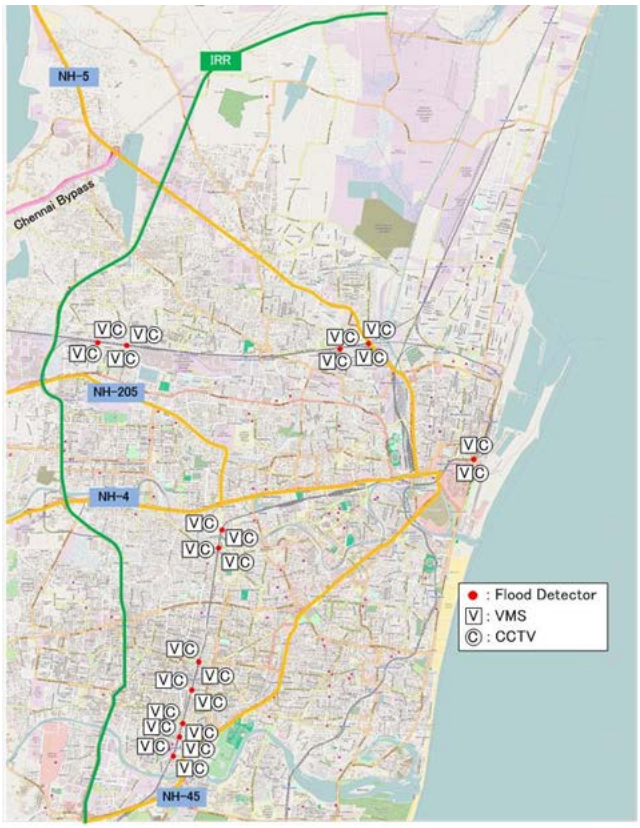
The roadside equipment of the Flood Measurement and Warning System are composed of waterlogging level detection sensor, CCTV camera, and VMS. They will be installed at both sides of the underpasses in the city. When the waterlogging level detection sensor detects that the water level has reached the threshold level, the alarm will be issued at C-TIC and the warning messages such as road closure will be displayed on VMS. The operator in C-TIC observes the condition of the waterlogging by the pictures captured by CCTV camera.

The reference threshold levels of waterlogging and the number of the roadside equipment are:

- Level 1: Around 150 mm water-depth that the water level may reach the exhaust pipe of small-sized vehicle, and
- Level 2: Around 300 mm water-depth that the water level may reach the exhaust pipe of large-sized vehicle.

- Number of Roadside Equipment of Flood Measurement and Warning System: 12 sets

The locations of the roadside equipment of Flood Measurement and Warning System are shown in Figure 4.2.2.



Source: JICA Study Team

Figure 4.2.2 Locations of Roadside Equipment of Flood Monitoring and Warning System

4.3 Design Concept of Traffic Management System

4.3.1 Major Roles of Subsystems

The Traffic Management System is composed of three subsystems, namely: Variable Message Sign (VMS) System, Area Traffic Signal Control System (ATCS), and CCTV System. Their major roles are shown in Table 4.3.1.

Table 4.3.1 Major Roles of Subsystem of Traffic Management System

Subsystem	Major Roles
Variable Message Sign (VMS) System	・ Receiving the traffic information generated by probe server of Chennai Traffic Information System. ・ Providing the received traffic information through VMS boards to the road users. ・ Providing the messages on the message line of VMS boards, which are manually inputted by the operators at the console terminal. ・ Storing the data on the provided messages for a certain period. ・ Monitoring the operation status of the equipment and system.
Area Traffic Signal Control System (ATCS)	・ Controlling the signals to coordinate the neighboring signals by control algorism through the center, based on the data measured by the roadside sensors. ・ Controlling the signals on time-basis through the center when required. ・ Controlling the signals on manual-basis at site when required. ・ Controlling the pedestrian signals. ・ Storing the data such as measured data by the roadside sensors, applied signal parameters, etc. for a certain period.

	・ Monitoring the operational status of the equipment and system
CCTV System	・ Capturing the image of the traffic conditions at site where CCTV is installed. ・ Showing the captured image on the console at CTP TMC to monitor the site condition by the operator. ・ Storing the captured image data for a certain period. ・ Monitoring the operation status of the equipment and system.

Source: JICA Study Team

4.3.2 Functions, Quantity, and Location of Roadside Equipment

(1) Variable Message Sign (VMS) System

The VMS System provides the traffic information such as congestion level, expected time to the major destinations, road work, road closure, etc., to the road users. It aims to enable them to select the alternative route or encourage them to change their travel plan, notifying such information in advance.

The VMS boards will be installed at the locations before the major junctions of the arterial roads where drivers are able to make judgement on the routes.

The installation area of the VMS boards in the first phase is up to the outside of the Outer Ring Road. Additional VMS boards will be installed outside CPRR on the arterial roads in the second phase.

The number of VMS boards to be installed in the first phase is 17 units.

The locations of VMS boards in the first phase are shown in Figure 4.3.1.

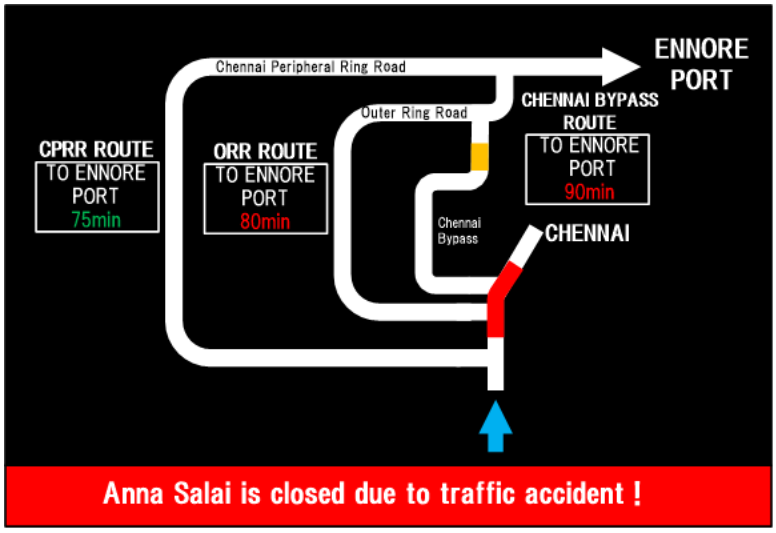
Source: JICA Study Team

Figure 4.3.1 Locations of VMS Boards

An example of one of the VMS board displayed images is shown in Figure 4.3.2.

The congestion level based on its severity is shown in different colors and expected time of arrival to the major destinations ahead of the locations of the VMS boards will be displayed on the schematic image of the road network. The messages which are manually inputted by the operators on the console at CTP TMC will also be displayed on the message line at the bottom of the VMS board.

The displayed image of each VMS board will be different, depending on the locations of VMS boards and the direction of the vehicles. The design of each VMS board will be finalized during the basic design phase of the Project.



Source: JICA Study Team

Figure 4.3.2 Example of VMS Board Displayed Image

(2) Variable Message Sign (VMS) System

ATCS will be introduced to optimize the traffic flow in the city, controlling the traffic signals in area-wise. The signals will be controlled by sub-area, a minimum unit of signal control, where the traffic patterns are basically identical, and the same cycle time is applied so that the offset is defined between the signals in the same sub-area. The sub-area is combined together or separated to form a larger or smaller control area where the same control is applied depending on the time of day.

The signal controlling parameters, i.e., cycle, split, and offset, are determined based on the data collected from the roadside sensors to optimize the signal pattern according to the traffic condition. The functions of fixed time of a day and manual mode will also be equipped. The pedestrian signal will be under the control of this system as well.

The target area for installing the signals of ATCS is the core area of Chennai because the number of junctions is large and the distance between junctions is short, and therefore more beneficial effects of ATCS can be expected.

The number of the junctions where the signals will be installed is 159 junctions.

The locations of the signals of ATCS are shown in Figure 4.3.3.

Source: JICA Study Team

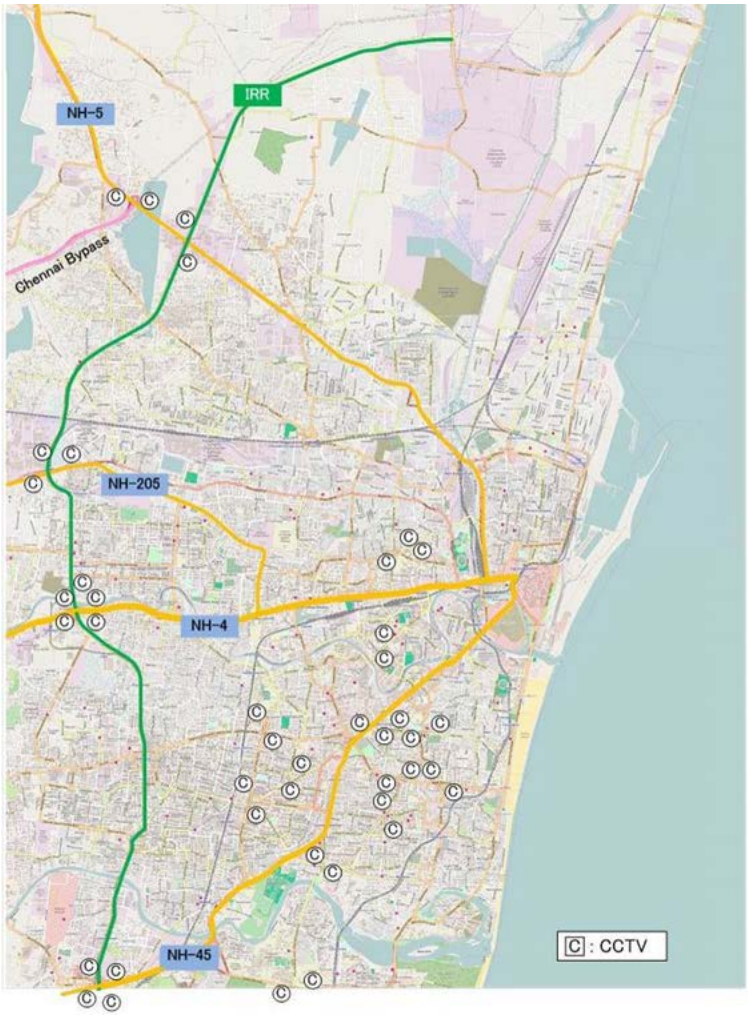
Figure 4.3.3 Locations of Signals of Area Traffic Signal Control System (ATCS)

(3) CCTV System

The CCTV System will be introduced to monitor the traffic situation at site. There is a plan to install CCTVs at a large number of junctions in Chennai by Chennai Traffic Police. Therefore, it was determined that CCTV in the Japanese ODA Loan Project will be installed at the margining points of grade separate roads in the city, where there is a high possibility of accident.

The number of CCTV cameras to be installed is 55 units.

The locations of CCTV camera are shown in Figure 4.3.4.



Source: JICA Study Team

Figure 4.3.4 Locations of CCTV Camera

4.4 Design Concept of City Bus System

4.4.1 Major Roles of Subsystems

The City Bus System is composed of two subsystems, namely: Bus Monitoring System and Passenger Information System. Their major roles are shown in Table 4.4.1.

Table 4.4.1 Major Roles of Subsystem of City Bus System

Subsystem	Major Roles
Bus Monitoring System	・ Tracking the locations of running buses for monitoring the bus operation based on the bus probe data collected from GPS devices installed on the buses ・ Displaying the information of bus location and others necessary information on the video wall in the Command Control Center of MTC ・ Assisting the operators to instruct the bus drivers on such occasion as unnecessary stop on the road, deviation of bus route, accident, etc. ・ Measuring the congestion level of passengers inside the buses through in-bus camera ・ Assisting MTC to plan optimum bus route and dispatching schedule by analysis based on the data measured by the in-bus camera and GPS devices ・ Storing the collected data and bus operation data for a certain period ・ Monitoring the operation status of the equipment and system
Passenger Information System	・ Generating the information on the expected arrival and departure time of the city buses at/from the bus terminals based on the data collected by the Bus Monitoring System ・ Providing the above generated information through information boards at the major bus terminals ・ Displaying the next bus stop by the in-bus display board ・ Controlling the display contents of the information boards ・ Storing the above data for a certain period ・ Monitoring the operation status of the equipment and system

Source: JICA Study Team

4.4.2 Functions, Quantity and Location of Roadside Equipment

(1) Bus Monitoring System

The Bus Monitoring System will be introduced to assist MTC for efficient management of city buses. It is composed of the center system and in-bus equipment which are GPS devices and in-bus cameras.

The data collected from the GPS devices will be used for tacking the movement of the city buses. It will also be used for generating the congestion information, transmitted to the Probe System of Chennai Traffic Information System.

The system also analyzes for the improvement of optimum bus route and dispatching schedule based on the congestion level of the passengers inside the bus obtained through the in-bus cameras and GPS location data.

There are approximately 3,800 MTC buses in operation. The GPS devices will be installed in all buses. In-bus cameras will be installed in 1,000 buses by the Project as an initial start and additionally increased in later stage.

The number of in-bus equipment is:

- GPS device: 4,000 units for all MTC city buses (the number of units includes some spares)
- In-bus camera: 1,000 units for 1,000 MTC city buses (to be introduced as initial start by the Project and will add later)

(2) Passenger Information System

The Passenger Information System is composed of center system, information boards installed at the major bus terminals, and in-bus LED boards installed inside the bus vehicles. The information boards at the major

bus terminals provide information of the expected time of arrival and departure of MTC buses. The in-bus LED boards inside the bus vehicle provide the information of the next bus stop.

There are 31 bus terminals in Chennai. Out of these, seven bus terminals were selected for installation of the information board considering the number of passengers and effect of providing information accordingly.

The numbers of the information boards and in-bus LED boards are:

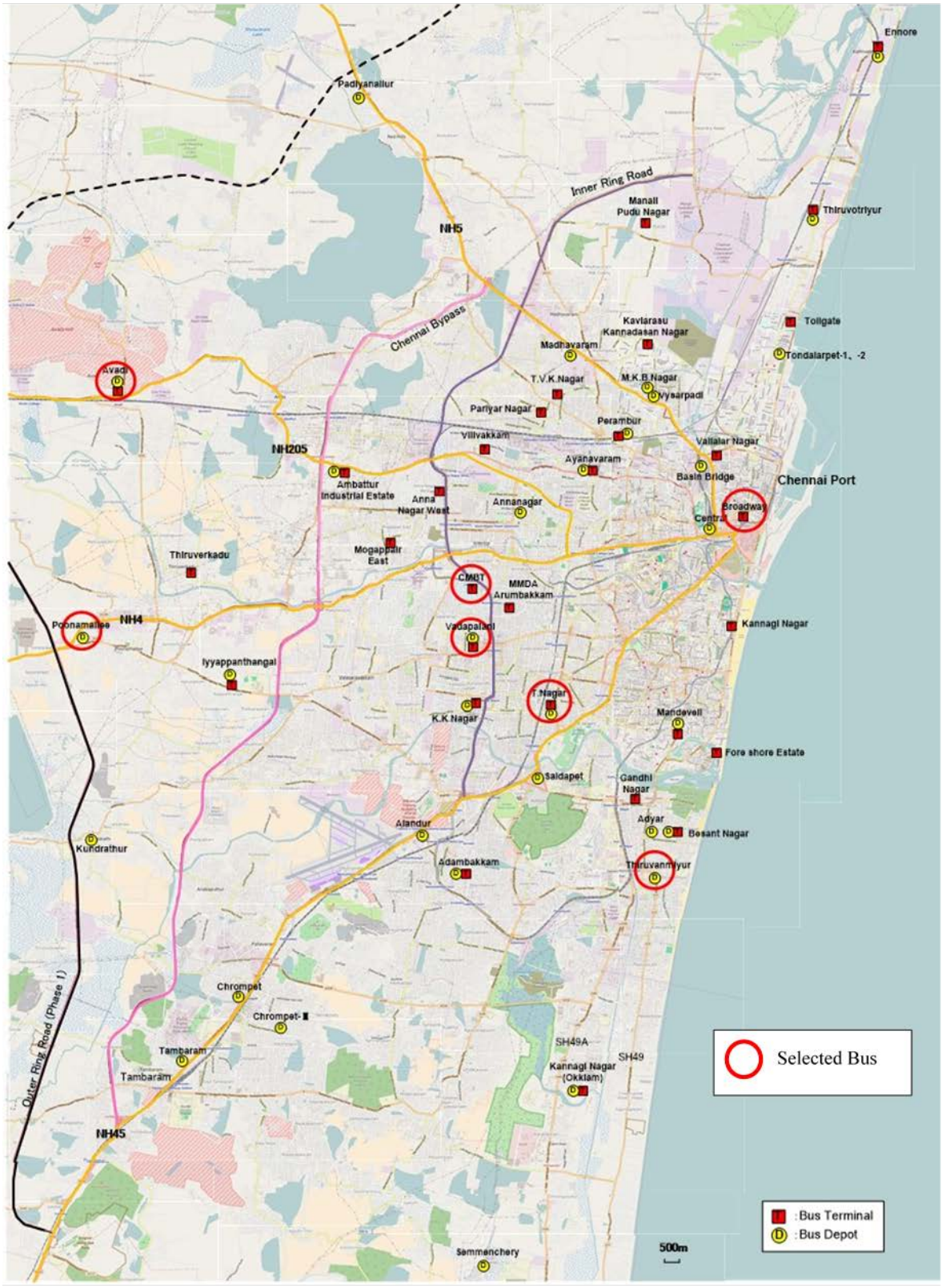
- Information board: 8 information boards at seven bus terminals
- In-bus LED board: 1,000 units for 1,000 buses (to be introduced in the initial start by the Project and will add later)

The selected bus terminals for the information boards are:

- Broadway Bus Terminal
- Avadi Bus Terminal
- Poonamalee Bus Terminal
- Thiruvanmiyur Bus Terminal
- Vadapalani Bus Terminal
- T.Nagar Bus Terminal
- CMBT Bus Terminal

One LED large-size information board will be installed in the field of each bus terminal where a maximum number of passengers can view, except CMBT Bus Terminal. Two large-sized LCD information boards will be installed in CMBT, one inside the building and the other outside the building of CMBT.

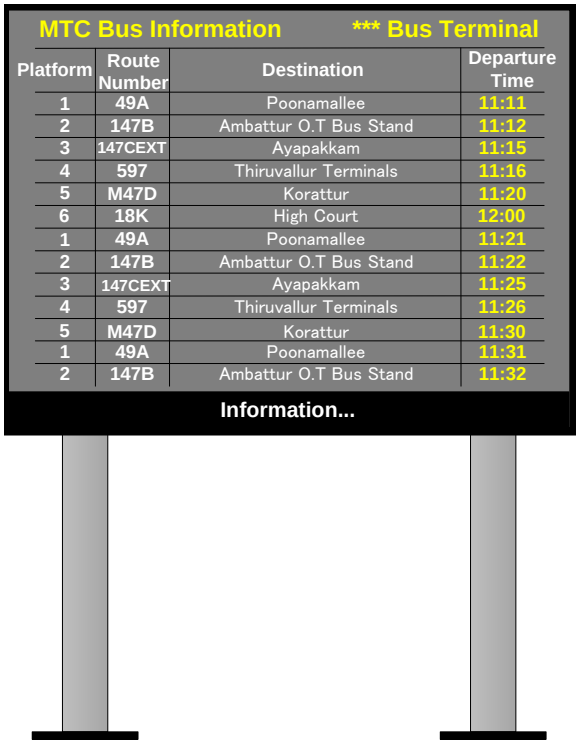
The selected bus terminals for the information board are shown in Figure 4.4.1 and the typical image of an information board installed in the field of bus terminal is shown in Figure 4.4.2.



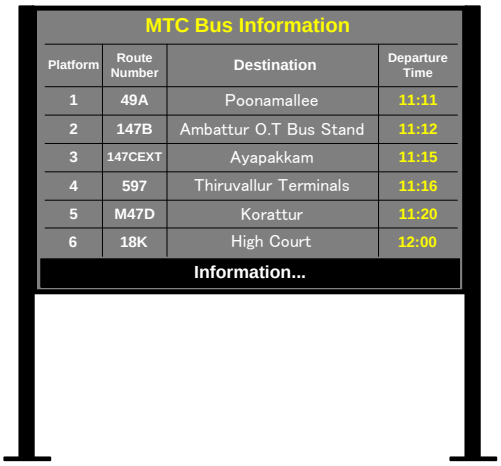
Source: JICA Study Team

Figure 4.4.1 Locations of Information Board of Passenger Information System

LED Type for Bus Terminals



LCD Type for CMBT Bus Terminal



Source: JICA Study Team

Figure 4.4.2 Typical Image of Information Board at Bus Terminal

CHAPTER 5 IMPLEMENTATION ORGANIZATION FOR CITY ITS

5.1 Demarcation of Responsibility of Related Organizations

The responsibilities of related organizations for City ITS are demarcated as shown in Table 5.1.1.

The Chennai Smart City Limited (CSCL) is the executing agency of the Project and will be responsible for the procurement and installation for all components of City ITS. The maintenance and evaluation of Service Level Availability (SLA) will also be executed under the responsibility of CSCL. The operation of each component will be carried out by the respective organizations, i.e., CSCL for Chennai Traffic Information System, CTP for Traffic Management System, and MTC for City Bus System. The ownership of the system and equipment of components will belong to these organizations respectively as shown in Table 5.1.1.

Table 5.1.1 Demarcation of Responsibility of Related Organizations for City ITS

System	Subsystem	Responsible Organization by Project Stage			
		Procurement and Installation	Operation	Maintenance (*1)	Ownership of System and Equipment
Chennai Traffic Information System	Chennai Traffic Information Centre (C-TIC)	CSCL	CSCL	CSCL	CSCL
	Probe System / Internet System				
	Automatic Traffic Counter-cum-classifier (ATCC) System				
	Flood Measurement and Warning System				
Traffic Management System	Traffic Management Center (TMC)	CSCL	CTP	CSCL	CTP
	Area Traffic Signal Control System (ATCS)				
	Variable Message Sign (VMS) System				
	CCTV Traffic Monitoring System				
City Bus System	Bus Tracking System (BTS)	CSCL	MTC	CSCL	MTC
	Passenger Information System (PIS)				

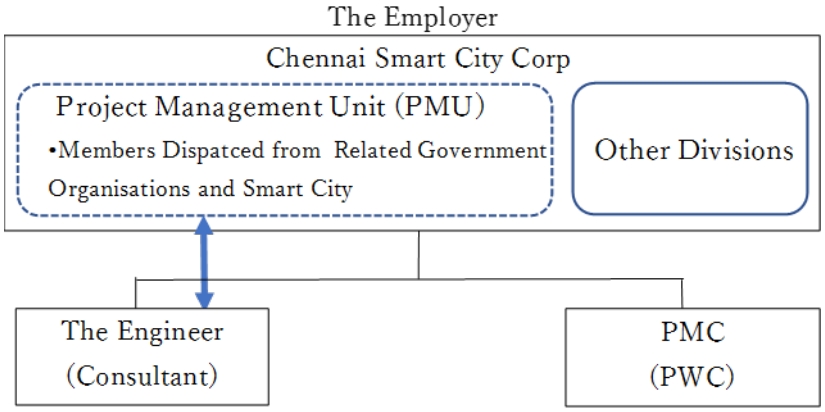
Source: JICA Study Team

CSCL: Chennai Smart City Limited, CTP: Chennai Traffic Police, MTC: Metropolitan Transport Corporation
(*1): The responsible organization for maintenance will be in charge of the evaluation of the Service Level Agreement (SLA) and O&M payment accordingly.

5.2 Implementation Organization (CSCL) for City ITS

5.2.1 Organization Structure of CSCL for Implementation of City ITS

The Project Management Unit (PMU), which will take the full responsibility, will be established in CSCL to assure smooth implementation of the Project. A number of matters that require coordination with the organizations involved in the Project are expected to arise during the the Project. Thus, the secondees will be dispatched to PMU from GCC, CTP, and MTC. The organization structure is shown in Figure 5.2.1.



Source: JICA Study Team

Figure 5.2.1 Organization Structure of PMU of CSCL

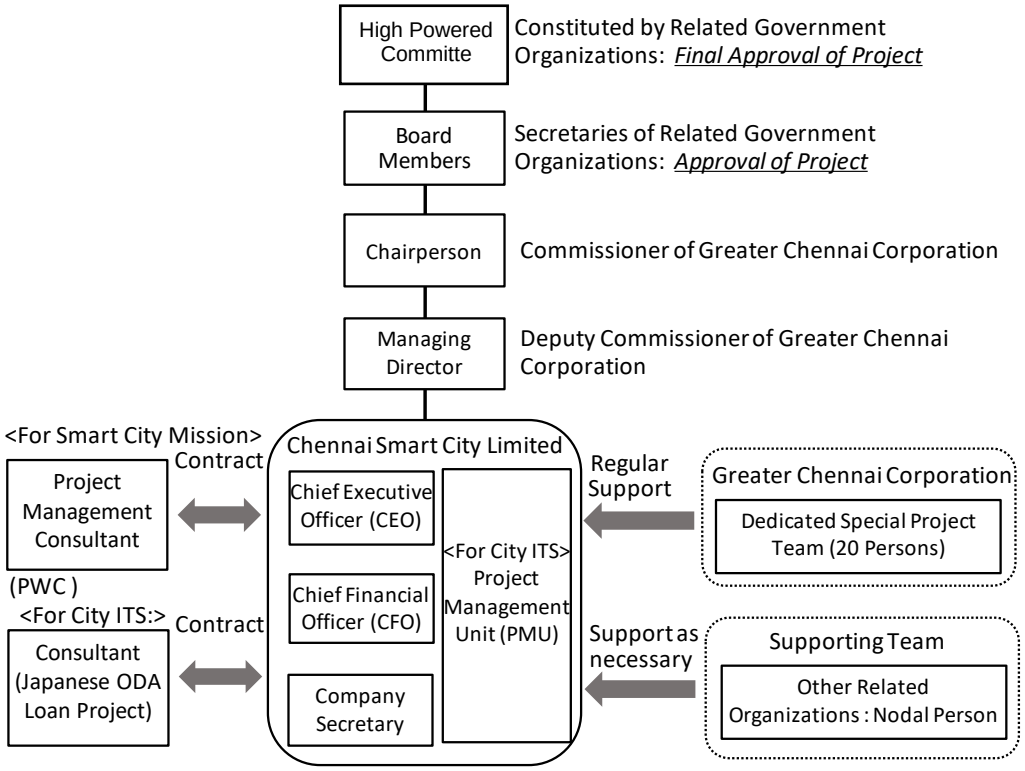
The members of PMU are as follows:

- Project Director: to supervise and monitor the whole Project
- Superintending Engineer: to be assigned exclusively for the Project
- Contract Manager: to deal with the legal matters related to the Project as a legal expert
- Instrumentation Engineer
- Project Accountant
- Coordinator from GCC (Chennai City)
- Operational Engineer from CTP
- Operational Engineer from MTC
- Supporting Staff

CSCL contracted PricewaterhouseCoopers (PWC) as the Project Management Consultant (PMC) for the implementation of Chennai Smart City Mission.

5.2.2 Flow of Making Decision on the Implementation of City ITS

The entire organization structure of CSCL is shown in Figure 5.2.2.



Source: JICA Study Team

Figure 5.2.2 Entire Organization Structure of CSCL

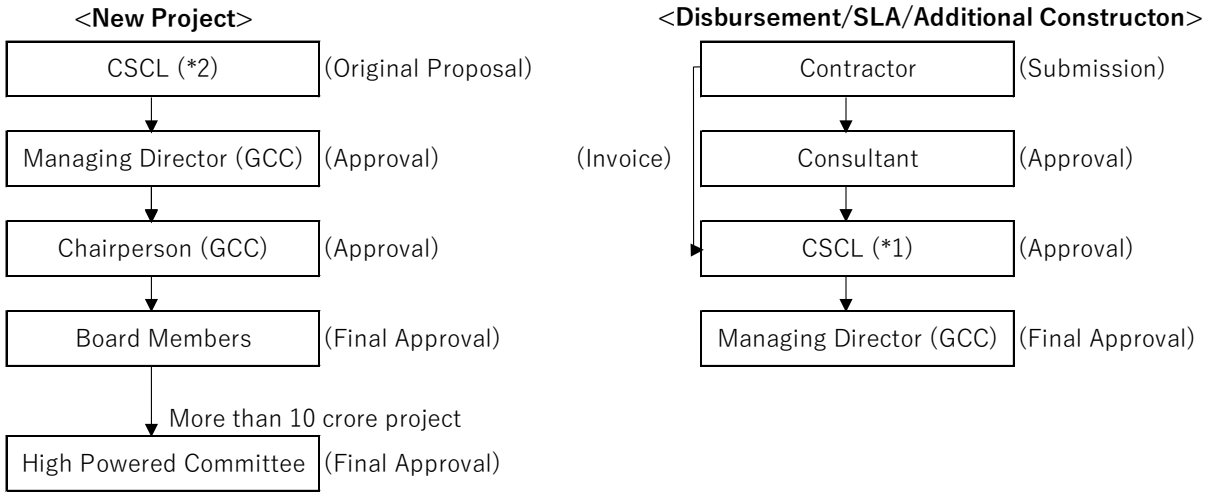
Figure 5.2.3 shows the decision -making flows on the new project and disbursement, SLA evaluation and additional construction during the project implementation, respectively.

During the project implementation, the Contractor will submit the invoice for disbursement to the Employer, i.e., CSCL. Meanwhile the Consultant will supervise and approve the performance made by the Contractor, if judged successfully performed. CSCL will approve the disbursement based on the report made by the Consultant and invoice submitted by the Contractor. The Managing Director will make the final approval on the disbursement.

During the O&M period of the project implementation, the decision on evaluation of SLA and disbursement will also be made according to this decision-making flow. If it is judged that additional construction such as additional function, expansion of coverage area, etc., is necessary during the implementation of the Project, the same flow on the approval will be taken.

In the case of additional construction, the Managing Director will make judgement on whether it shall be made under the same project or as a new project, i.e., procuring a new contractor. If it is judged as a new project, the flow shown on the left in the figure below will be taken.

In the case of a new project, the original proposal will be made by CSCL. The approval will be made following the sequence from Managing Director to Chairperson, and the Board Members will make the final decision. If the project cost exceeds 10 crores, the decision will be upgraded to the level of High-powered Committee for the final approval.



Source: JICA Study Team

(*1): The members of PMU established in CSCL will confirm the performance of the Contractor based on the report made by the Consultant and the approval as CSCL will be made by CEO of CSCL during the implementation of the Project.
(*2): The members of PMU established in CSCL will make necessary coordination with the involved organizations and the proposal will be finalized by CEO of CSCL.

Figure 5.2.3 Decision-making Flow

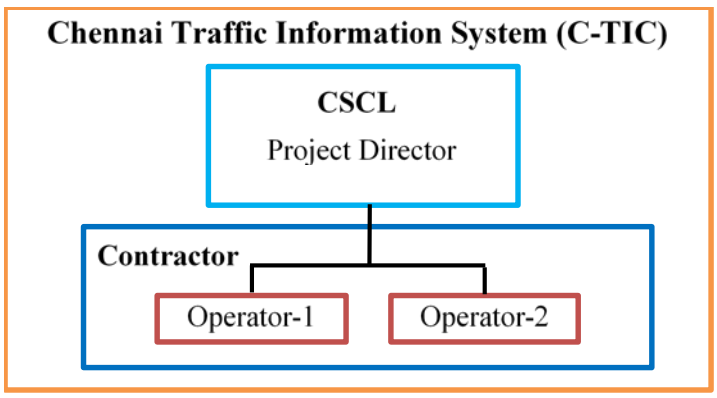
5.3 Operation and Maintenance Plan

The required organization structure, roles of staff, required qualification of the staff, and shift arrangement for operation and maintenance of the following three components of City ITS are proposed in the following clauses:

5.3.1 Operation of Chennai Traffic Information System

(1) Required Organization Structure and Roles of Staff for Operation of Chennai Traffic Information System (C-TIC)

The Chennai Traffic Information System (C-TIC) will be operated and maintained under the supervision of CSCL. Therefore, one Project Director shall be posted from CSCL. Two operators are required to be deployed under the Project Director. These operators will serve as staff of the Operation and Maintenance Contractor. The required organization structure is shown in Figure 5.3.1 and the roles of the staff are shown in Table 5.3.1.



Source: JICA Study Team

Figure 5.3.1 Organization Structure for Operation of Chennai Traffic Information System(C-TIC)

Table 5.3.1 Roles of Staff in the Center of Chennai Traffic Information System (C-TIC)

Position	Roles	Working Hours
Project Director (CSCL)	• Responsible for supervising and controlling all activities of the Center of Chennai Traffic Information System • Coordinating with related government agencies especially MTC and Chennai Traffic Police as required • Checking the reports generated by the systems • Analyzing and compiling the processed data/information and providing it to related government agencies if requested • Informing the Maintenance Team of the malfunctions of the equipment/system when it occurs • Making an order of system upgrade or maintenance work to the Contractor as necessary • Responsible for maintaining the spare parts • Informing related government agencies of the dangerous condition of underpass due to flood if the alarm of critical water level is issued by the Flood Measurement and Warning System	Daytime only
Operator-1	• Receiving and answering enquiries from the public and/or related government agencies • Informing related government agencies of the necessary information as required • Requesting related government agencies to provide information as necessary • Monitoring the condition of the underpass by the Flood Measurement and Warning System during heavy rain. If the water level becomes close to the dangerous level, informing the Project Director to contact related government agencies • Taking charge of the works of Operator-2 in his absence	Daytime with two shifts
Operator-2	• Checking the operation status of ATCC System and Flood Measurement and Warning System • Monitoring the traffic condition displayed on the schematic map of the video wall • Informing the Project Director of the malfunction of equipment and systems when it occurs • Requesting the Project Director to contact the Contractor for upgrade or maintenance of the system as required • Checking the discrepancies of the information displayed on VMS and probe server • Taking charge of the work of Operator-1 in his absence	Daytime with two shifts

Source: JICA Study Team

(2) Required Qualification of Operators of Chennai Traffic Information System (C-TIC)

Table 5.3.2 shows the required qualifications of the operators of Chennai Traffic Information System (C-TIC).

Table 5.3.2 Required Qualification of Operators of Chennai Traffic Information System (C-TIC)

Position	Qualification
Operator-1 and Operator-2	• Education: University/College graduate or similar • Total Work Experience: 5 years • Similar Work Experience: 3 years • Language Capability: Fluent in English, Tamil, and Hindi

Source: JICA Study Team

(3) Shift Arrangement for Operation of Chennai Traffic Information System (C-TIC)

The system will be operated for 24 hours a day and 7 days a week. But it will run unmanned from 10:00 pm until 6:00 am. Therefore, the operators will station in the center from 6:00 am until 10:00 pm, totaling to 16 hours a day in two-shift. One extra shift shall be organized. Thus, three-shift in total is required.

Table 5.3.3 shows an example of shift arrangement for the operation of Chennai Traffic Information System.

Table 5.3.3 Example of Shift Arrangement for the Operation of Chennai Traffic Information System (C-TIC)

	Shift-1 06:00 am - 02:15 pm (*1)	**Shift-2** 02:00 pm - 10:00 pm (*1)	**Remarks**
Party 1	On-duty	Off-duty	
Party 2	Off-duty	On-duty	
Party 3	Off-duty	Off-duty	Stand By

Source: JICA Study Team

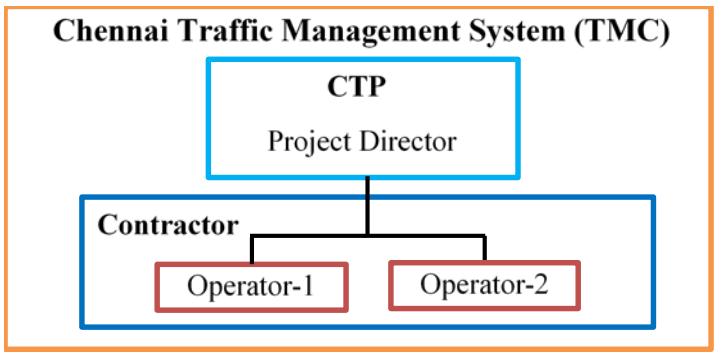
(*1) The time from 2:00 pm to 2:15 pm will be spent for the information handover meeting between the first and second shifts.

5.3.2 Operation of Traffic Management System

(1) Required Organization Structure and Roles of Staff for the Operation of Center of Traffic Management System

The Traffic Management System will be operated under the supervision of CTP. Therefore, at least one (1) Project Director shall be posted from CTP. Two operators are required to be deployed under the Project Director. These operators will be the staff of Operation and Maintenance Contractor. The maintenance works will be handled by the Maintenance Team of the Contractor.

The required organization structure is shown in Figure 5.3.2 and the roles of the staff in Table 5.3.4.



Source: JICA Study Team

Figure 5.3.2 Organization Structure for Operation of Traffic Management System (TMC)

Table 5.3.4 Roles of Staff in the Center of Traffic Management System

Position	Roles	Working Hours
Project Director (Chennai Traffic Police)	• Responsible for supervising and controlling all activities of the Center of Traffic Management System • Coordinating with the C-TIC and related government agencies as required • Checking the reports generated by the systems • Analyzing and compiling the processed data/information and providing it to related government agencies if requested • Informing the Maintenance Team of the malfunctions of the equipment/system when it occurs • Making an order of system upgrade or maintenance work of the system to the Contractor as necessary • Checking the spare parts inventory • Instructing the Operator-1 to provide warning message through VMS as required • Instructing the Operator-2 to change the signal parameters as required • Responsible for maintaining the spare parts	Daytime only
Operator-1 (VMS, CCTV)	• Monitoring and manipulating VMS and CCTV • Informing the Manager of the Contractor on the malfunction of VMS and CCTV system when it occurs • Taking charge of the work of Operator-2 in his absence	Two Shifts
Operator-2 (ATCS)	• Monitoring the signal • Manipulating the signal as per the instruction of the Project Director • Requesting to the Manager of the Contractor to change the signal parameter as per the instruction of the Project Director • Informing the Manager of the Contractor on the malfunction of ATCS system/equipment when it occurs • Taking charge of the work of the Operator-1 in his absence	Two Shifts

Source: JICA Study Team

(2) Required Qualification of Operators of Traffic Management System (TMC)

Table 5.3.5 shows the required qualifications of the operators of Traffic Management System (TMC).

Table 5.3.5 Required Qualification of Operators of Traffic Management System (TMC)

Position	Qualification
Operator-1 and Operator-2	• Education: University/College graduate or similar • Total Work Experience: 5 years • Similar Work Experience: 3 years • Language Capability: Fluent in English, Tamil, and Hindi

(3) Shift Arrangement for Operation of Traffic Management System (TMC)

The system will be operated for 24 hours a day and 7 days a week. But it will run unmanned from 10:00 pm until 6:00 am. Therefore, the operators will station in the center from 6:00 am until 10:00 pm, totaling to 16 hours a day in two-shift. One extra shift shall be organized. Thus three-shift in total is required.

Table 5.3.6 shows an example of shift arrangement for the operation of Traffic Management System.

Table 5.3.6 Example of Shift Arrangement for Operation of Traffic Management System (TMC)

	Shift-1 06:00 am -02:15 pm (*1)	**Shift-2** 02:00 pm - 10:00 pm (*1)	**Remarks**
Party 1	On-duty	Off-duty	
Party 2	Off-duty	On-duty	
Party 3	Off-duty	Off-duty	Stand By

Source: JICA Study Team

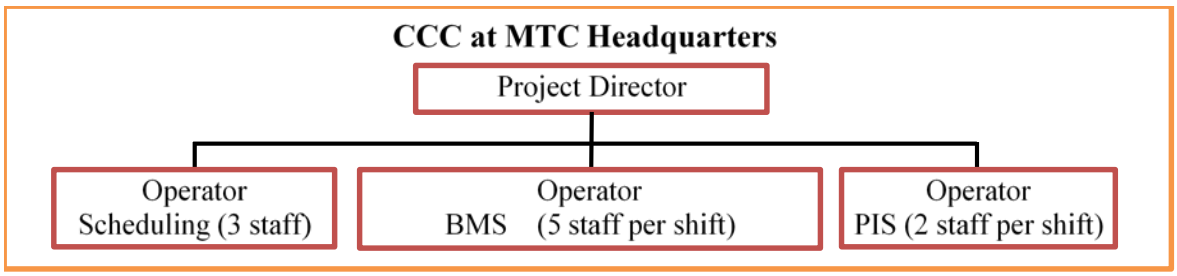
(*1) The time from 2:00 pm to 2:15 pm will be spent for the information handover meeting between the first and second shifts.

5.3.3 Operation of City Bus System

(1) Required Organization Structure and Roles of Staff for Operation of Command Control Center (CCC) of City Bus System

The City Bus System will be operated for 24 hours a day and 7 days a week under the supervision of MTC. Therefore, one Project Director shall be posted from MTC. MTC employees shall also be posted for operation. Five operators for each shift are required for Bus Monitoring System (BMS) and two operators for each shift for Passenger Information System (PIS). More employees are also required for handling the bus scheduling during day-time work. One employee needs to be deployed for all bus depots as well.

The required organization structure is shown in Figure 5.3.3 and the roles of the staff in Table 5.3.7.



Source: JICA Study Team

Figure 5.3.3 Organization Structure for Operation of CCC of City Bus System

Table 5.3.7 Roles of Staff in the CCC of City Bus System

Position	Roles and Responsibilities	Working Hours
Project Director	• Responsible for supervising all the activities of Command Control Center • Coordinating with related government agencies especially C-TIC and Chennai Traffic Police as required • Checking the reports generated by the systems • Analyzing and compiling the processed data/information and providing it to related government agencies if requested • Informing the Maintenance Team of the malfunctions of the equipment/system when it occurs • Making an order of system upgrade or maintenance work of the system to the Contractor as necessary • Responsible for maintaining the spare parts	Daytime only
Operator for Bus Scheduling (3 staff)	• Making/changing dispatch schedule of MTC buses • Informing the Project Director of the malfunction of dispatching system when it occurs	Daytime only
Operator for BMS (5 staff for 1 shift)	• Monitoring the bus operation status, e.g., departure time, arrival time, route deviation, skipping bus stops, etc. • Instructing the bus drivers as necessary • Checking the data collected by the system • Informing the Project Director of the malfunction of Bus Monitoring System when it occurs (Each operator monitors the buses by bus depot basis and maximum number of bus depot for one operator shall not be more than ten)	Three Shifts
Operator for PIS (2 staff for 1 shift)	• Monitoring the operation status of information boards at the bus terminals • Confirming the information displayed on the information board such that whether the displayed information is correct with the system, etc. • Informing the Project Director if the displayed information is not correct • Informing the Project Director of the malfunction of Passenger Information System when it occurs	Three Shifts

Source: JICA Study Team

(2) Shift Arrangement for Operation of CCC of City Bus System

The working hours of the operators need to cover the service time of city buses, i.e., from 5:00 am to 11:00 pm. Therefore, the operators need to work from 4:30 am to 11:30 pm. Three shifts are required because the maximum working hours are usually 8 hours. One extra shift shall also be organized. Thus, four-shift in total is required.

Table 5.3.8 shows an example of shift arrangement for the operation of CCC of the City Bus System.

Table 5.3.8 Example of Shift Arrangement for Operation of CCC of City Bus System

	Shift-1 04:30 am -11:15 am (*1)	**Shift-2** 11:00 am - 17:45 pm (*1)	**Shift-3** 17:30 pm - 11:30 pm (*1)	**Remarks**
Party 1	On-duty	Off-duty	Off-duty	
Party 2	Off-duty	On-duty	Off-duty	
Party 3	Off-duty	Off-duty	On-duty	
Party 4	Off-duty	Off-duty	Off-duty	Stand By

Source: JICA Study Team

(*1) At least 15 minutes at every shift change shall be ensured for the information handover meeting.

5.3.4 Maintenance of City ITS

The Maintenance Team shall be functional for all three components of City ITS, namely: Chennai Traffic Information System, Traffic Management System, and City Bus System. It is recommended to organize one Maintenance Team in the center of Chennai Traffic Information System (C-TIC) and it takes care of both systems, i.e.; Chennai Traffic Information System and Traffic Management System because the centers of these systems will be located at the same building, i.e., headquarters of Chennai Traffic Police. Another one Maintenance Team shall be organized in the center of the City Bus System in the headquarters of MTC.

(1) Major Activities of Maintenance Team for City ITS

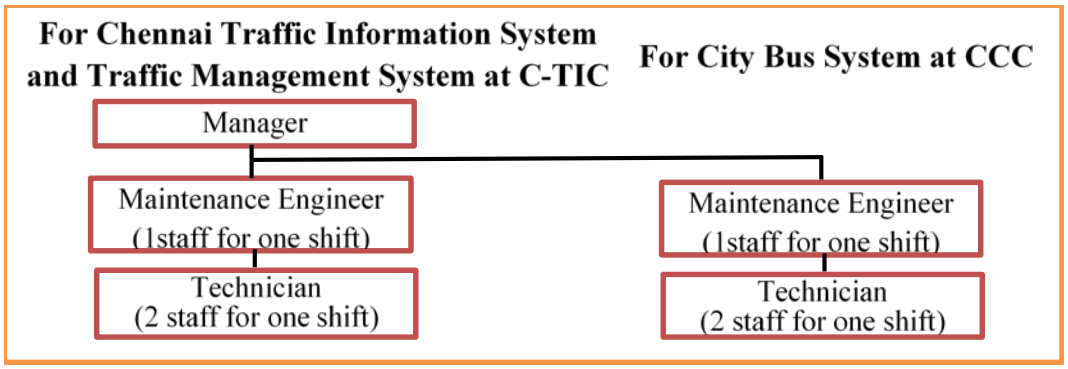
If any failures of system or equipment are found, the operator or Project Director in the center will contact the Manager or Engineers of O&M Contractor and request prompt troubleshooting. The Engineers and Technicians shall analyze the failure and be dispatched to the site for repair works if the site work is judged necessary. The Manager shall station in C-TIC and be responsible for all contractor's work including both operation and maintenance.

The major activities of the Maintenance Team are:

- Submit preventive inspection work plan and carry out as per plan,
- Submit necessary reports after checking and/or repairing the system,
- Carry out repair works for equipment and system,
- Carry out upgrade and maintenance of system/equipment, and
- Maintain spare parts.

The time from receiving notification of failure to completing the permanent or temporary remedial measure for all three components of City ITS shall be less than 24 hours except for cases of collision accident and other causes by force majeure.

(2) Required Organization Structure and Roles of Staff of Maintenance Team for City ITS



Source: JICA Study Team

Figure 5.3.4 Organization Structure for Maintenance Team for City ITS

Table 5.3.9 Roles of Staff of Maintenance Team for City ITS

Positions	Roles and Responsibilities	Working Hours
Manager (1 Staff) Stationed in C-TIC	• Responsible for the operation and maintenance of Chennai Traffic Information System • Supervising and controlling the Operation and Maintenance Team of Chennai Traffic Information System • Supervising and controlling the Maintenance Team of Traffic Management System and City Bus System • Responding and taking actions for system failures • Receiving and answering the enquiries from the Employer • Preparing and submitting necessary reports to the Project Directors of the centers of Chennai Traffic Information System, Traffic Management System and City Bus System as necessary • Checking the working condition and ensuring the performance of the operators of the three centers and the maintenance teams, frequently visiting the three centers • Corresponding to the requests made by the Employer such as system upgrade, etc. • Handling by contacting the suppliers of the system/equipment in case that resolving the failures/malfunctions of the system/equipment is beyond the capability of the Contractor	Daytime and On Call During Night Time
Maintenance Engineer (2 Teams) One Team Stationed in C-TIC and Another One Team in CCC	• Preparing the periodical inspection plan and carrying out the maintenance work • Instructing and supervising the technicians • Making report on the maintenance work and works for the resolution of failures and submitting it to the Manager • Checking the spare parts inventory	By Shift
Technician (2 Teams: 2 Staff for Each Shift for Each Team)	• Carrying out the maintenance work under the supervision of the Maintenance Engineer • Checking the equipment condition and making patrol at the site • Carrying out the regular inspection of City Bus System	By Shift

Source: JICA Study Team

(3) Required Qualification of Staff of Maintenance Team for City ITS

Table 5.3.10 shows the required qualifications of the staff of the Maintenance Team for City ITS.

Table 5.3.10 Required Qualification of Staff of Maintenance Team for City ITS

Position	Qualification
Manager	• Education: University/College graduate or similar • Total Work Experience: 15 years • Similar Work Experience in Total: 7 years • Similar Work Experience as a Manager: 3 years
Maintenance Engineer	• Education: College graduate of Electrical or System Engineering or similar • Total Work Experience: 10 years • Similar Work Experience: 5 years
Technicians	• Education: College graduate of Electrical or System Engineering or similar • Total Work Experience: 5 years • Similar Work Experience: 3 years

Source: JICA Study Team

(4) Shift Arrangement for Maintenance Team for City ITS

The system will be operated for 24 hours a day and 7 days a week. The Maintenance Team shall be arranged for four-shift to deal with a round-the-clock service. The Manager works only during daytime, but she/he needs to be contacted for 24 hours to cope with incident occurred during night time.

Four parties of the Maintenance Team shall be organized. They will take care of preventive maintenance, repair work for fault, recovery work on the occasions of malfunction, system modifications as necessary and manage the spare parts inventory.

Table 5.3.11 shows the example of shift arrangement for the Maintenance Team for City ITS.

Table 5.3.11 Example of Shift Arrangement for Maintenance Team for City ITS

	Shift-1 06:00 am -02:15 pm	**Shift-2** 02:00 pm - 10:15 pm	**Shift-3** 10:00 pm - 06:15 am	**Remarks**
Party 1	On-duty	Off-duty	Off-duty	
Party 2	Off-duty	On-duty	Off-duty	
Party 3	Off-duty	Off-duty	On-duty	
Party 4	Off-duty	Off-duty	Off-duty	Stand By

Source: JICA Study Team

(*1) At least 15 minutes in every shift change shall be ensured for information handover meeting.

The Maintenance Team shall ensure the functional condition of all systems/equipment of City ITS. One Maintenance Team shall station at C-TIC to take care of both Chennai Traffic Information System and Traffic Management System by three shifts. Another one Maintenance Team shall station in the center of MTC to take care of the City Bus System by three shifts.

CHAPTER 6 PROCUREMENT PLAN, CONSTRUCTION PLAN AND COST ESTIMATES

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CHAPTER 7 TENTATIVE IMPLEMENTATION SCHEDULE

The implementation schedule in consideration of the whole project stage from basic design to operation and maintenance period is considered and already presented in Table 3.2.1.

CHAPTER 8 PROJECT EVALUATION

8.1 Methodology

8.1.1 Economic Analysis

(1) General

The main objective of the economic analysis is to examine the investment efficiency of the project from the viewpoint of national economy using cost-benefit analysis, in case where it can be applied. Market prices are converted to economic ones where the influence of market distortion is removed (shadow prices). Opportunity costs are used for the costs of goods and services if their markets do not exist. Economic internal rate of return (EIRR) is used as an indicator of efficiency of project investment.

(2) Preconditions

The following preconditions are assumed in the economic evaluation. Additional preconditions will be clarified as necessary.

1) With-project and Without-project

For CPRR, with-project is the case where only the target section of the highway is constructed in the road network system with Section 4, which will start to be used as planned. While without-project is the case where any section of the highway is not constructed in the road network system except Section 4, which will start to be used as planned. For City ITS, the former is the ITS system which will be constructed while the latter one will not be constructed.

2) Evaluation Period

Evaluation period covers the whole project life from preparation of construction. It is decided that the project starts from 2018 to 2048 (25 years after the highway will start to be used) for CPRR and 2018 to 2036 (15 years after the system will start to be used) for ITS.

3) Conversion to Economic Prices

Market prices are converted to economic ones by multiplying 0.9, which is used in the economic analysis of the "Detailed Project Report." In addition, land prices are discounted by 50% because these include the "Solatium" to the land owners as 100% of the market value in accordance with the Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013.

4) Discount Rate

A 12% discount rate is employed here, which is used in the economic analysis of the "Detailed Project Report." It is used as the criteria for economic evaluation.

5) Price Level

Price level is set at 2017. Price data which are not at 2017 level are adjusted to 2017 level applying inflation rate (gross domestic product (GDP) deflator).

(3) Project Benefit

Incremental benefits are included in the evaluation by comparing with-project case and without-project case. The benefits are calculated in the form of cash inflow of each year during the evaluation period. Benefits of both Chennai Peripheral Ring Road (CPRR) and City ITS projects include the reduction of vehicle operation cost (VOC) and that of travel time cost (TTC).

1) Vehicle Operation Cost (VOC)

VOC per unit distance is estimated by type of vehicle. These are 2-wheeler (TW), car, 3-wheeler (auto), bus, light commercial vehicle (LCV), truck and multi-axe heavy commercial vehicle (MAV). The VOC is composed of a) fuel cost, b) tire cost, c) engine oil cost, d) other oil cost, e) greasing cost, f) spare parts cost g) maintenance cost, h) fixed cost, and i) passenger cost.

Manual on Economic Evaluation of Highway Projects in India, Indian Road Congress (2009) presents the

baseline value of VOC at free flow speed of 40 km/h by vehicle type, incorporating those above components as of 2009. In addition, the JICA Study on ITS Master Plan for Bengaluru Metropolitan Area, estimated VOC at other speed in 2014 prices. Thus, VOCs in 2009 and 2014 prices are converted to 2017 prices by applying GDP deflator as shown below.

Table 8.1.1 VOC by Type of Vehicle in 2009

Unit: INR per veh-km

	TW	Car	Auto	Bus	LCV	Truck	MAV
Free Flow Speed (40 km/h)	1.86	5.81	3.95	15.05	10.01	11.23	18.32

Source: Indian Road Congress, *Manual on Economic Evaluation of Highway Projects in India*, 2009

Table 8.1.2 VOC by Velocity and Type of Vehicle in 2017

Unit: INR per veh-km

Velocity (km/h)	TW	Car	Auto	Bus	LCV	Truck	MAV
5	6.51	39.88	6.51	69.99	53.16	54.65	89.15
10	4.53	22.83	4.53	46.15	35.49	37.51	61.19
15	3.81	17.09	3.81	37.08	28.36	30.51	49.78
20	3.43	14.18	3.43	31.73	23.87	26.08	42.54
25	3.27	12.58	3.27	29.21	21.31	23.43	38.23
30	3.11	11.17	3.11	26.89	19.03	21.06	34.36
35	2.96	9.92	2.96	24.76	16.99	18.93	30.88
40	2.82	8.80	2.82	22.80	15.16	17.01	27.75
45	2.83	8.85	2.83	22.91	15.23	17.09	27.88
50	2.86	8.93	2.86	23.13	15.38	17.25	28.14
55	2.90	9.06	2.90	23.46	15.60	17.50	28.55
60	2.96	9.23	2.96	23.90	15.90	17.83	29.08
65	3.03	9.45	3.03	24.48	16.28	18.26	29.78
70	3.12	9.73	3.12	25.18	16.75	18.78	30.64
75	3.22	10.05	3.22	26.01	17.30	19.41	31.66
80	3.34	10.43	3.34	27.01	17.96	20.15	32.87

Source: JICA Study Team based on the JICA Study on ITS Master Plan for Bengaluru Metropolitan Area, 2014

Table 8.1.3 GDP Deflator

2009	2010	2011	2012	2013	2014	2015	2016	2017*
6.06%	8.98%	8.54%	7.93%	6.19%	3.05%	1.79%	3.61%	2.81%

Note *: Data for 2017 is the geometric mean of 2014 to 2016.
Source: Website of the World Bank, https://data.worldbank.org/country/india?view=chart

Formula of the Benefit from the Reduction of VOC

Formula of the benefit from the reduction of VOC is shown below. Source is *the Manual for Cost-Benefit Analysis*, Ministry of Land, Infrastructure, Transport and Tourism, Japan (2008), with minor modification by the JICA Study Team.

Benefit from the reduction of VOC: $BR = BR_O - BR_W$

Total VOC: $BR_i = \sum_j \sum_i (Q_{ijl} \times L_l \times \beta_{jv}) \times 365$

Where,

BR : Benefit from the reduction of VOC (INR/year)

BR_i : Total VOC where the project *i* is implemented (INR/year)

Q_{ijl} : Traffic volume of vehicle type *j* at link *l* where the project *i* is implemented (vehicles/day)

L_l : Length of link *l* (km)

β_{jv} : VOC of vehicle type *j* (INR/vehicle per km) at an average velocity *v* (km/h)

i : *W* in case of implementation, *O* in case of no implementation

j : Vehicle type

l : Link number

v ; Average velocity of vehicle

2) Travel Time Cost (TTC)

The TTC by type of vehicle has been estimated in the JICA Study on ITS Master Plan for Bengaluru Metropolitan Area (JICA study). TTCs of 2-wheeler, 3-wheeler (auto), car and truck were estimated based on the result of opinion survey carried out by the JICA study. These were calculated by referring to the average salary (INR. /month) of drivers. TTC of bus was estimated, considering the average revenue and passenger volume per hour, based on information obtained from the counterpart agency. As the JICA study did not estimated TTC for LCV and MAV, those of auto and truck are used respectively. In addition, as these were estimated in 2014 prices, and converted to 2017 prices by applying GDP deflator.

Table 8.1.4 Travel Time Cost (2017)

Unit: INR per veh-min

TW	Car	Auto	Bus	LCV	Truck	MAV
1.77	3.64	1.77	21.69	1.77	1.55	1.55

Source: JICA Study Team based on the JICA Study on ITS Master Plan for Bengaluru Metropolitan Area, 2014

Formula of the Benefit from the Reduction of TTC

Formula of the benefit from the reduction of TTC is shown below. Source is *the Manual for Cost-Benefit Analysis*, Ministry of Land, Infrastructure, Transport and Tourism, Japan (2008)

Benefit from the reduction of TTC: $BT = BT_O - BT_W$

Total TTC: $BT_i = \sum_j \sum_i (Q_{ijl} \times T_{ijl} \times \alpha_j) \times 365$

Where,

BT : Benefit from the reduction of TTC (INR /year)

BT_i : Total TTC where the project *i* is implemented (INR /year)

Q_{ijl} : Traffic volume of vehicle type *j* at link *l* where the project *i* is implemented (vehicles/day)

T_{ijl} : Travel time of vehicle type *j* at link *l* where the project *i* is implemented (min)

α_j : TTC of vehicle type *j* (INR /min per vehicle)

i : *W* in case of implementation, *O* in case of no implementation

j : Vehicle type

l : Link number

(4) Project Cost

Incremental costs are included in the evaluation by comparing with-project and without-project. The costs are calculated in the form of cash outflow of each year during the evaluation period. The following cost items are considered.

1) Initial Cost

Initial cost includes costs of construction of the facility and equipment, and consulting services. Economic evaluation includes physical contingencies but excludes price escalations.

2) Operation and Maintenance (O&M) Cost

Operation and maintenance cost for each year is included. Price escalation is not included.

3) Depreciation

Since the money allocated and subject to depreciation is not actually spent at that time, it is not included in the cost items from the viewpoint of cash flow.

8.1.2 Financial Analysis

Benefit of the project is assumed to be toll revenue and it is impossible to collect tolls for the City ITS System. Therefore, the financial analysis is not conducted for the City ITS Project.

8.2 Project Evaluation on City ITS

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CHAPTER 9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Necessity and Effect of the Chennai City ITS Project

The economic validity of Chennai City ITS Project was also examined and evaluated taking into account the traffic situation in 2017. Sensitivity analysis is carried out in several cases such as changes in the benefit and/or cost as summarized below. The economic internal rate of return (EIRR) in the original case is so high that it is robust to some extent against unfavorable situations (benefit decreasing, cost increasing, or both cases) in principle. As a result of economic analysis, the EIRR of Chennai City ITS Project is 15.27% under most severe case as shown in Table 9.1.1. It was confirmed that this Project also contributes to economic development of Chennai Metropolitan Area.

Table 9.1.1 Sensitivity Analysis of EIRR

	No Change in Cost	Increase in Cost by 10%
No Change in Benefit	20.16%	17.83%
Decrease in Benefit by 10%	17.58%	15.27%

Source: JICA Study Team

9.2 Confirmation of Appropriateness of the City ITS Project Components

9.2.1 Demarcation of Responsibility of Related Organizations

The responsibilities of the related organizations for City ITS are demarcated as shown in Table 9.2.1.

The CSCL is the executing agency of the Project and will be responsible for the procurement and installation of all components of City ITS. The maintenance and evaluation of Service Level Availability (SLA) will also be executed under the responsibility of CSCL. The operation of each component will be carried out by the respective organizations, i.e., CSCL for Chennai Traffic Information System, CTP for Traffic Management System, and MTC for City Bus System. The ownership of the system and equipment of the components will belong to these organizations, respectively, as shown in Table 9.2.1.

Table 9.2.1 Demarcation of Responsibility of Related Organizations for City ITS

System	Subsystem	Responsible Organization by Project Stage			
		Procurement and Installation	Operation	Maintenance (*1)	Ownership of System and Equipment
Chennai Traffic Information System	Chennai Traffic Information Centre (C-TIC)	CSCL	CSCL	CSCL	CSCL
	Probe System / Internet System				
	Automatic Traffic Counter-cum-classifier (ATCC) System				
	Flood Measurement and Warning System				
Traffic Management System	Traffic Management Center (TMC)	CSCL	CTP	CSCL	CTP
	Area Traffic Signal Control System (ATCS)				
	Variable Message Sign (VMS) System				
	CCTV Traffic Monitoring System				
City Bus System	Bus Tracking System (BTS)	CSCL	MTC	CSCL	MTC
	Passenger Information System (PIS)				

Source: JICA Study Team

CSCL: Chennai Smart City Limited, CTP: Chennai Traffic Police, MTC: Metropolitan Transport Corporation
(*1): The responsible organization for maintenance will be in charge of evaluation of SLA (Service Level Agreement) and O&M payment accordingly.

9.2.2 Procurement Plan

Some specialized ITS equipment of servers and softwares are difficult to procure in India, so import from abroad is assumed. The table below summarizes the main equipment procurement categories.

Table 9.2.2 Procurement of ITS Equipment

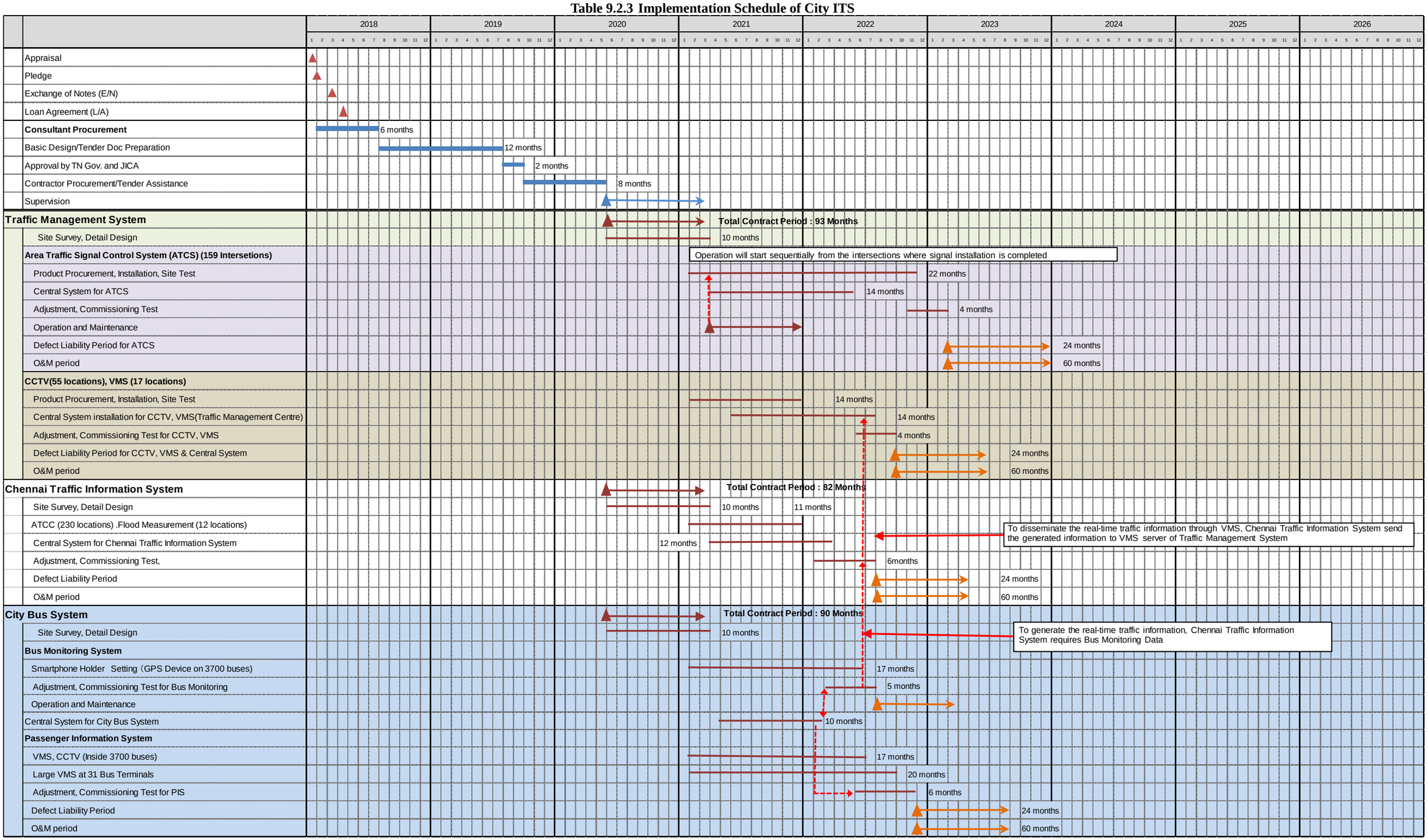
ITS Component		Domestic	Import
Chennai Traffic Information System (C-TIC)			
	Center System (including Probe System, Internet System)	All items except listed at the right	Probe server ATCC2 server software
	Automatic Traffic Counters-cum-classifier (ATCC) System	All items	-
	Flood Measurement and Warning System	All items	-
City Bus System (MTC)			
	Bus Monitoring System	All items except listed at the right	Monitoring server software
	Passenger Information System	All items except listed at the right	Passenger information software
Traffic Management System (Chennai Traffic Police)			
	Traffic Management Center	All items except listed at the right	Signal control system server Signal control system server software
	Area Traffic Signal Control System	All items except listed at the right	Signal control database Signal controller
	CCTV Traffic Monitoring System	All items	-
	Variable Message Sign (VMS) System	All items	-

Source: JICA Study Team

9.2.3 Project Implementation Schedule

Implementation schedule in consideration of the whole project stage from basic design to operation and maintenance period is considered and tabulated in Table 9.2.3.

Table 9.2.3 Implementation Schedule of City ITS



Source: JICA Study Team

Appendix-1: Minutes of Meeting with Concerned Agencies

Consulting Services for
Preparatory Study for Chennai Peripheral Ring Road Development in India
NIPPON KOEI CO., LTD. / EAST NIPPON EXPRESSWAY CO., LTD. / CTI ENGINEERING INTERNATIONAL CO., LTD. / PADECO CO., LTD.

Project Office

Tel. :
Fax. :

Ref. No. :CPRR-L-HMPD-01
Date :July 24, 2017

Mr. G.R. RAJENDRAN,
Chief Engineer (H), Construction and Maintenance,
Integrated Chief Engineers' office,
HRS Campus, 76 Sardar Patel Road, Guindy,
Chennai - 600 025.
E-mail: dcehplanning@gmail.com

Subject: Minutes of Kick-off Meeting for Preparatory Study for Chennai Peripheral Ring Road Development in India

Dear Sir,

JICA Study Team sincerely appreciate you for sharing your valuable time for the kick-off meeting held on 19th July 2017. We would like to submit the minutes of the kick-off meeting.

With regard to the following our requests made at the meeting that affect schedule of this study as well as appraisal work for the loan assistance, we would like you to kindly respond the requests urgently.

1. Provision of full set of the DPR reports
2. Provision / Introduction of office space inside or near HMPD or TNIDB (for 20 staffs)

As for the organizational structure for consensus building and decision making of the project, we discussed this matter at the kick-off meeting with TNIDB held on 20th July 2017. As a result, the Empowered Committee is recommended to be established after approval of the project by state and the Steering Committee is more suitable to accelerate the consensus building and decision-making at this stage. It was further confirmed with TNIDB that one Steering Committee for the matters of both CPRR and ITS will be established.

Therefore, we would like to propose the members of the Steering Committee as attached for your review and comment.

Your kind attention on the above would be highly appreciated.

Sincerely yours,

Takayasu NAGAI
Team Leader of the JICA Study Team
The Preparatory Study for Chennai Peripheral Ring Road Development in India

Attachment:

1. Minutes of Kick-off Meeting (HMPD)
2. Minutes of Kick-off Meeting (TNIDB)
3. Proposed Members of Steering Committee

c.c.

1) Mr. Rajeev Ranjan I.A.S, Additional Chief Secretary, HMPD (E-mail: hwaysec@tn.gov.in)
2) Mr. S. Krishnan I.A.S, Principal Secretary (Planning and Development), CEO- TNIDB (E-mail: plansec@tn.gov.in, Tel: 44-25674310)
3) Ms.Pooja Kulkarni I.A.S, Additional Secretary, Finance Department.
4) Mr. P. T. Mohan, Assistant Chief Engineer, HMPD, (E-mail: ptmohan1973@gmail.com, j.rammawia@nic.in, Tel: 9444476854)
5) Mr. K. S. Sadananda, Assistant Chief Engineer, HMPD (Tel:9884254774)
6) Mr. H. Ramesh, Divisional Engineer (Div-4), Chengalpattu, HMPD (Tel: 9677039979)
7) Mr. Hidenobu Fujiwara, South Asia Dept., JICA Head Office (E-mail: Fujiwara.Hidenobu@jica.go.jp)
8) Office Copy

Project Office

Tel. :
Fax. :

Ref. No. :CPRR-MOM-HMPD-01
Date :July 19, 2017

Annexure - 1

MEETING RECORD

Title	Kickoff Meeting			
Date	Wednesday 19 July 2017		**Time**	15:00 – 17:00
Venue	1st Floor, Conference Hall, Highways Research Station Campus, 76, Sardar Patel Road, Guindy (Opposite to Raj Bhavan)			
Participants	**No.**	**Name**	**Position**	**Phone Number**
HMPD	1	Palanivel	Chief Engineer	
	2	P.T.Mohan	Assistant Chief Engineer	9444476854
	3	H.Ramesh	Divisional Engineer (Div-4), Chengalpattu	9677039979
	4	K.S.Sadananda	Assistant Chief Engineer	9884254774
	5	K.Vanathi	Divisional Engineer, TNRDC	9444272519
	6	V.Pugazhendhi	Junior Engineer (Roads)	9952797229
	7	S.r.Prabakaran	Assistant Engineer (Roads)	9786438553
	8	R.Ramyasri	Assistant Engineer	9566143585
	9	R.Sathiya	Assistant Engineer	9444888781
	10	P.Madhan kumar	Assistant Engineer	9952075411
	11	G.Vijayalakshmi	Assistant Chief Engineer - Bridges	9442558793
DPR Consultant	1	N.j.Wesley	Team leader - STUP Consultant	9444020665
	2	Gobi k.	Sr. Designer - Highways- STUP Consultant	9884431161
	3	V.Krishnamoorthi	Sr. Consultant- STUP Consultant	9841184804
JICA	1	Hidenobu Fujiwara	South Asia division 1	9958295176
JICA Study Team	1	Takayasu Nagai	Team Leader / Road Planning	9786171898
	2	Ippei Iwamoto	Deputy Team Leader / Road Planning 2 / Road Design	
	3	Hiroya Totani	ITS Planning / Design 1	8978435175
	4	Noboru Kondo	ITS Planning / Design 2	8978435175
	5	Eiji Wakatsuki	ITS Operation	8586000395
	6	Kiyoshi Dachiku	Road Operation and Maintenance Planning	8588097983
	7	Kenichi Moritani	Natural Conditions Survey	
	8	Nawaz	Engineer	9840692739
	9	Rajesh	Secretary	9176646383
Others	1	Shinji Tsuboi	Nippon Koei India	9871248249
References		Inception Report (Draft)		

Agenda:

No.	Items for discussion	Conclusion – Agreement
1	**Self Introduction**	• The JICA Study team, STUP Consultants and members from HMPD were introduced to each other
2	**Explanation of Outline of the Study based on Inception Report (Draft)**	• TL gave a brief presentation on the objectives, schedule, members and work scope of this project. A copy of the inception report and presentation was shared with the members. • Same has been attached herewith for reference
2.1	Project to be subjected to the Study	• The details of the proposed study were explained to HMPD in detail.
2.2	Objective of the JICA Preparatory Survey	• The objectives of this study were discussed briefly.
2.3	Typical Process of the Loan Project	• The overall process of yen loan was explained by JICA expert. • Mr.Sadananda enquired if the project has been added in rolling plan 2017 ?. Representative of JICA replied that this project is not in rolling plan. However, decision for adding this project to the rolling plan 2017 by DEA is anticipated and envisaged date for this is around mid of August 2017. Also JICA appraisal mission is expected in December 2017.
2.4	Schedule of the JICA Preparatory Survey	• The schedule of the survey was shared with HMPD. It was also explained that this project takes about 6 months for submission of the draft report.
2.5	Member of JICA Study Team	• Members of the team were introduced. It was also informed that these members would be closely working with various stakeholders for successful completion of this study. • Members from HPDM informed that they will extended their full support for this study.
2.6	Work Scope for Mile Stone -1	• The miles stones- 1 of the project were explained in detailed and accepted.
2.7	Work Scope for Mile Stone -2	• The miles stones- 2 of the project were explained in detailed and accepted • It was also informed that Preliminary design, cost estimate and implementation plan preparation would be carried out by end of December 2017.
3	**Discussions**	
3.1	Proposal of Establishment of Steering Committee	• Mr.Sadananda suggested that empowerment committee may be formed with Minister of Highways, Finance Secretary, Highways Secretary, Project Director and other stakeholders related to this project. • Mr.Sadananda also suggested that steering committee may be formed with Chief Secretary, Finance Secretary, Highways Secretary, ,Project director and other stakeholders related to this project. • Mr.Sadananda requested the JICA Study Team to inform this matter to HMPD after consultation with TNIDB by letter.
4	**Others**	
4.1	Request for Office Space	• The TL requested HMPD for providing office space for the study team. HMPD informed JICA Study Team that it will consider the request and will inform about the availability within a week. They also requested JICA study team to discuss about this with Chief Executive Officer, TNIDB.
4.2	Request for sharing CPRR study reports	• The TL requested HMPD and STUP Consultants to share the reports and annexure related to CPRR Study. • It was decided that Mr.Sadananda, ACE-HMPD would

No.	Items for discussion	Conclusion – Agreement
		provide written confirmation to STUP Consultants to share the data within a week
4.3	Organizational framework for project implementation	• It was informed that organizational framework for project implementation would be decided as the survey proceeds further.
4.4	Assignment of Counterpart staff from HMPD	• TL requested HMPD to assign counterpart staff. • Mr. Ramesh, Divisional Engineer (Div-4), Chengalpattu was assigned for coordinating technical and implementation issues. • Mr.P.T.Mohan, ACE- HMPD informed that he may be contacted for all required support.
4.5	Permission for Traffic Surveys	• The JICA Survey Team explained HMPD that as a part of this study. It is required to conduct traffic surveys at few points to validate the traffic data. • HMPD informed that they will provide the necessary permissions for conducting the traffic surveys.
4.6	Status of the reports	• STUP consultants shared the status of the project as below. • It was informed that Detailed Project Report has been completed with estimates and drawings. • Land acquisition plan is also ready. • Preparation of major parts of the EIA reports have been completed. • JICA Survey team requested to share the reports for reviewing the same at the earliest.
4.7	Progress of works at CPRR	• The following updates were given by members of HMPD and STUP Consultants. • Public consultation has been done at all 5 sections as per the guidelines of Pollution Control Board. • Clearance from various departments have been initiated. • Approval for construction of Rail over bridge at the road and rail intersections have been obtained from Railways and Public Works Department. • Approval from forest department is awaited for section 3 & 5. • Costal regulation zone is not applicable in this project. • Other necessary approvals from various other departments would be obtained by concessioner or contractor at the later stages. • At Section 1 - Northern port access road, land acquisition is in progress. • Land acquisition for the section where construction has not been commenced in Section-4 has been initiated. Land acquisition is being carried by land revenue department. Land is acquired based on TamilNadu highways land acquisition act. Preliminary land acquisition notification has been issued, which will be followed by final notification to acquire the land.
4.8	Mode of implementation	• The mode of implementation i.e hybrid annuity or EPC or Item Rate would be decided after getting approval from the state government • Also the decision of introducing the toll plazas is government level decision and will be decided at the later stages.
4.9	Meeting with EIA Experts	• It was decided that Environmental expert from JICA Study team would meet the concerned EIA expert from STUP consultants. To discuss and understand the present status.
4.10	Section Prioritization	• JICA Survey Team enquired about the section prioritization they would be following in CPRR project. • HMPD replied that the prioritization would be in the

No.	Items for discussion	Conclusion – Agreement
		following order • Section 1 • Section 2 & 3 • Section 5 • And Section 4 (As road widening has been completed 90% already)

Attachment: Inception Report (Draft)

Project Office
Tel. :
Fax. :

Ref. No. :CPRR-MOM-TNIDB-01
Date :July 20, 2017

Annexure - 2

MEETING RECORD

Title	Kickoff Meeting			
Date	Thursday 20 July 2017		**Time**	15:00 – 15:45
Venue	Secretariat			
Participants	**No.**	**Name**	**Position**	
TNIDB	1	S. Krishnan I.A.S	Principle Secretary , CEO Finance Department	
	2	Pooja Kulkarni I.A.S	Additional Secretary, Finance Department	
	3	M.Raja	Deputy Secretary, TNIDB	
	4	N.Ganesan	Section Officer – Infra cell	
JICA	1	Hidenobu Fujiwara	South Asia Department	
JICA Study Team	1	Takayasu Nagai	Team Leader / Road Planning	
	2	Ippei Iwamoto	Deputy Team Leader / Road Planning 2 / Road Design	
	3	Hiroya Totani	ITS Planning / Design 1	
	4	Noboru Kondo	ITS Planning / Design 2	
	5	Eiji Wakatsuki	ITS Operation	
	6	Kiyoshi Dachiku	Road Operation and Maintenance Planning	
	7	Kenichi Moritani	Natural Conditions Survey	
	8	Nawaz	Engineer	
	9	Rajesh	Secretary	
Others	1	Dr. Sampath Kumar	Nippon Koei India	
	2	Raj Cherubal	CEO, Smart City Company	
References	Inception Report (Draft)			

Agenda:

No.	Items for discussion	Conclusion – Agreement
1	**Self Introduction**	• The JICA Study team was introduced to TNIDB. Many of the JICA Study Team members were familiar as they had worked in the previous study – Data collection survey for ITS in Chennai.
2	**Project to be subjected to the Study**	• Mr. Fujiwara, JICA explained that this preparatory survey is to review the CPRR & ITS project in detail and to formulate the implementation scheme for the loan project .
3	**Object of JICA Preparatory Survey**	• It was explained that the main objective of this preparatory survey is to review and update the DPR of CPRR and ITS. It was also explained that this project takes about 6 months for submission of the draft report.
4	**Process of the Loan Project (Tentative)**	• Mr. Fujiwara, JICA also explained that after update of the DPR based on suggestions and supplemental works by JICA Study Team, HMPD will appraise the results. After which Jica will conduct appraisal Mission for Loan Agreement with TN Government. This is expected to made by the end of December 2017.

No.	Items for discussion	Conclusion – Agreement
5	**Decision – Making Structure (Tentative)**	• Team Leader, JICA Survey Team gave a detailed presentation and CEO ,TNIDB gave the following suggestions, • CEO, TNIDB suggested that Empowerment committee may be formed at the implementation stages. For now it is suggested that a steering committee will be formed with finance secretary or Chief Secretary as chairman. This would expedite the process of getting various technical approvals at this planning stage of the study. • CEO, TNIDB suggested there is no need for separate committees for CPRR and ITS. They can be combined as one. • The empowered committee may be formed to get various financial approvals for the appraisal process of extending loan to the project and subsequent procedures. • CEO TNIDB requested Mr. Raj Cherubal CEO, Smart city Company – To monitor, co ordinate and share the plans related to ITS. It was decided that members from ITS Study Team would meet CEO, Smart City company & Project Management Consultants -PWC on 21st July 2017 at 2.00 pm to update on the status of smart city mission and various other plans related to ITS. • CEO, TNIDB suggested that the following members to be added to the steering committee 1) Transport Commissioner 2) Municipal Administrations and water supply department and 3) Tamil Nadu Infrastructure Financial Management company. • CEO TNIDB, informed the JICA Survey Team that the CPRR project has to go through MORTH where as the ITS project would be through MOUD. Hence he request the JICA Survey Team to explore the possibility of linking ITS project as a part of Tamil Nadu Investment promotion program- phase 2 which might expedite the implementation procedures as CPRR project has slowed down due to various reasons.
6	**Request of Important Facilities from Counterpart Side**	
	Request for Office Space	• The TL requested CEO, TNIDB for providing office space for the study team. CEO, TNIDB informed that they will consider the request and will inform about the availability shortly. • CEO, TNIDB will discuss regarding this issue with highways secretary
	Request for sharing CPRR study reports	• The TL requested CEO,TNIDB to co ordinate in getting complete set of study reports related to CPRR form HPMD. • CEO, TNIDB informed that he will discuss this issue with highways secretary.
	Discussions on ITS Components	• Mr.Totani briefed about the various objectives of this survey. It was explained that more detailed study would be conducted with various stakeholders and updates would be made to the detailed specifications

No.	Items for discussion	Conclusion – Agreement
		and estimates. Also the ITS components would be prioritized for implementation. • CEO, TNIDB will share the details about the agencies related to ITS implementation. • CEO, TNIDB requested JICA Survey Team to calculate the environmental benefits that would occur in shifting of private vehicle to public vehicles. • The present condition of ITS financing was enquired to CEO, TNIDB. It was informed that no financing has been tied up to any of the ITS components for implementation. And they are looking for the loan.

Attachment: Inception Report (Draft)

Annexure – 3

Proposed Members of the Steering Committee

No	Name of Organization
1	Highways & Minor Ports Department
2	Tamil Nadu Infrastructure Development Board
3	Municipal Administration and Water Supply Department
4	Housing & Urban Development Department
5	Chennai Metropolitan Development Authority
6	Chennai Traffic Police
7	Transport Department
8	Transport Commissioner
9	Greater Chennai Corporation
10	Chennai Smart City Corporation Limited
11	Tamil Nadu Road Development Corporation
12	Metropolitan Transport Corporation
13	Tamil Nadu State Data Centre
14	Chennai Metro Rail Limited
15	National Highway Authority of India
16	Tamil Nadu Infrastructure Finance Management Corporation
17	Tamil Nadu Urban Finance and Infrastructure Development Corporation Ltd.
18	Tamil Nadu Urban Infrastructure Financial Service Limited
19	Indian Institute of Technology, Madras
20	Anna University

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Preparatory Study for Chennai Peripheral Ring Road Development in India

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Project Office

Tel. :
Fax. :

Ref. No. :CPRR-MOM-NHAI-01
Date :July 24, 2017

Title	Meeting with Project Director- NHAI			
Date	Wednesday 24 July 2017		**Time**	11:00 – 12:00
Venue	Project Directors Office, 2 nd floor, Butt Road, SRI Tower, SP Industrial area, St. Thomas Mount, Chennai.			
Participants	**No.**	**Name**	**Position**	**Phone Number**
NHAI	1	Mr.Adhipadhi	Project Director – NHAI- Chennai	**9442527805**
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Noboru Kondo	ITS Planning / Design 2	8978435175
	3	Eiji Wakatsuki	ITS Operation	8586000395
	4	Nawaz	Engineer	9840692739
References				

No.	Items for discussion	Conclusion – Agreement
1	**Explanation of Outline of the Study based on Inception Report**	• The JICA Study team and NHAI were introduced to each other.
		• The Project Director, NHAI informed that the starting point of operational Stretches of NHAI starts from ▪ NH 45 – At Tambaram (At Km 28) ▪ NH 4 – At Maduravoil ▪ NH 205 – Poonamalle ▪ NH 5 – Madhavaram (At km 11) • The Project Director, NHAI informed that The roads within the city are maintained by State PWD (may not be all).
2	Toll Management.	The following information's were provided related to toll management. • The toll is being collected based of the National tolls act. • Car was charged .65 paisa per Km and now it's being charged at 1.54 per km. • These fares are fixed based on the wholesale price index. • There is no comprehensive smart card available for fare collection. FasTag is being used for this purpose. • NHAI informed that they are not planning to introduce any smart card fare payment system besides manual and FasTag system.
3	Visit to Toll Plaza	• NHAI would arrange a visit to the plaza at Sriperambadur on the request of study Team because IHMCL person is working there who should have a knowledge of FasTag system,
4	RFID working issues	• The miscommunication between antenna and tag happens often and it's more affected during the times of rain. • NHAI requested the study team to visit Mr. Palekar – (9871656694) Indian Highways Management Company Limited for information related to RFID. at Delhi

No.	Items for discussion	Conclusion – Agreement
5	FASTag System	The procedure for obtaining FASTag System is explained below • The documents required for obtaining FASTAG are ➢ Registration Certificate (RC) of the vehicle. ➢ Passport size photograph of the vehicle owner ➢ KYC documents as per the category of the vehicle owner • The registration fees for FAS Tag System is Rs.200 • FasTag to be obtained from various authorized banks (approx.10banks). • Net connectivity and Software issues. • Planning to have separate servers.
6	Installing ATCC along Chennai Bypass	• NHAI informed that ATCC may be installed at Chennai Bypass. Formal Government level approval might be required.
7	Toll fare collection at Radial Roads	NHAI informed that construction of CPRR will reduce the revenue of NHAI road Concessionaire which managing the roads are crossing CPRR. In order to avoid revenue reduction, NHAI want to relocate the plazas and modify the existing boundaries from inside of CPRR to outside the CPRR . However, road administrator of inside of CPRR need to change from NHAI to State road administrator.
8	Contact information.	• The Project Director, NHAI Shared his e mail id and phone number and informed that he may be contacted for further queries. ➢ Email : chennaipiu@gmail.com ➢ Mobile: 9442527805

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Project Office

Tel. :
Fax. :

Ref. No. :CPRR-MOM-CMRL-01
Date :July 25, 2017

MEETING RECORD

Date	Friday 25th July 2017		**Time**	14:00 – 15:00
Venue	CMRL Office, Koyembedu			
Participants	**No.**	**Name**	**Position**	**Phone Number**
CMRL	1.	Mr.Krishnan	GM- Technical	
	2.	Mr. Narendra	AGM – Technical	9445868247
	3	Mr. Ravi Maduraikannan	Manager - Technical	9445868308
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Nawaz	Engineer	9840692739
References		Questioner for meeting		

Agenda:

No.	Items for discussion	Conclusion – Agreement
1	**Self Introduction**	• The team was introduced to the CMRL.
2	**Progress and status of Chennai Metro project**	• Mr.Totani gave a brief explanation on the objectives, schedule, members and work scope of this project. • A copy of the questionnaire was shared with the officials and was requested for replies. CMRL officials gave the following replies :
	CMRL Operational Stretches	• The following stretches are currently operational o Airport to Little mount (Corridor 1) o St Thomas mount to Nehru park (Corridor 2)
	Ridership at airport stretch	• CMRL officials informed that the stretch from airport to little mount has been opened recently. • This stretch of corridor 1 is in partial operations and the ridership is slowly increasing.
	Completion of Metro Phase 1	• CMRL Officials informed that the Metro Phase 1- 45 Kms stretch including the underground stretch is expected to be completed by mid of 2018. • 98 % of tunneling work has been completed at all the stretches. • Small section of tunneling work at Gemini flyover is pending and it's expected to get completed shortly. • The construction work at Station is in different stages of completion and work is in progress.
	Approval of Mero phase 2	• Government of Tamil Nadu has approved Metro Phase 2 and approval from Central Government is pending.
	Intermodal connectivity	• CMRL informed that they are the SPV for implementation of metro rail. Where ever possible inter modal connectivity has been provided. • In phase1 of the metro all the major terminals have been connected (Intercity and Intra city Bus terminal, Rail network and Airport). • The connectivity with sub urban railways has been provided at St Thomas mount and Guindy.

No.	Items for discussion	Conclusion – Agreement
		• Parking facility for cars and Tw's has been provided at metro stations where ever land is available. • Feeder buses are being run from metro stations by MTC. Taxi operators such as Ola and Uber are also placed at important stations. Same strategy will be followed in the next phase of study also. • In Phase 2 of Metro DPR, a separate component (estimate) has been added for Multi Modal Integration. In the DPR, 2 % of the entire project cost has been added as the budget for Multi Modal Integration, Which will be used by CMRL for implementing various plans of Multi Modal Integration.
	Agencies responsible for Inter modal connectivity.	• CMRL informed that the agencies responsible for inter modal connectivity are GCC, MTC, CMDA and Highways.
	Punctuality of Metro Operations	• It was informed that metro rail runs on schedule and is 99 % punctual. • As a part of clean development mechanism a study is being carried out. The study would identify and measure the before and after benefits of introducing Metro. The Study would also calculate the carbon credits.
	Update on Common Mobility Card	• CMRL has introduced Metro Travel Card and they use both TYPE A and TYPE C – Felica Card. The card reader is capable of reading both TYPE A and TYPE C card. • Initially 3 Lakhs Type A cards was issued. Later 2 Lakh cards have been issued recently due to the shortage of TYPE A cards. • The collaboration between various stakeholders is still pending to arrive on a common platform for usage of the Common Mobility card. • MTC has to confirm to CMRL that the ETM is capable of reading both Type A and Type C Cards. • CMRL has started to issue Travel Cards and the usage of tokens has been reduced. It is estimated that 90% of the Payments are now through cards.
	Metro Travel Card for CPRR	• CMRL informed that clearing house of Metro is capable of handling 32 Operators. And hence the travel card can be programmed to be used at CPRR toll plazas for toll Collection (Touch and Go system). • As CMRL has already issued cards and a mechanism for operations, the toll operator may not introduce a new back end system or issue new cards. They may set up the card reading machine and start the operations.
	Reason to use Type A cards	• The technical requirements of the cards are accessed based on factors such as – Data security Measures and Card reading speed. • CMRL informed that TYPE –A (NXP) cards are Cheaper. • They are pick products which are not single source monopoly products.
	Banks role in Metro Cards	• Metro Travel cards are also issued through State Bank of India. • The State bank of India card which can be used as Debit card and Metro travel card.

Project Office
Tel. :
Fax. :

Ref. No. :CPRR-MOM-IHMCL-01
Date : August, 2nd , 2017

MEETING RECORD

Title	Meeting with Mr.Palekar – IHMCL – NHAI – New Delhi			
Date	2nd August 2017		**Time**	15:00 – 17:30
Venue	Mr. Palekars Cabin, IHMCL office, New Delhi			
Participants	**No.**	**Name**	**Position**	**Phone Number**
IHMCL	1	Mr. Palekar	Project Director - IHMCL	
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Mr. Okuda		
	3	Varun Agarwal	ITS Operation	8586000395
	4	Nawaz	Engineer	9840692739
References		Questioner		

Agenda:

No.	Items for discussion	Conclusion – Agreement
1	**Self Introduction**	• The Study team was introduced to Mr. Palekar, it was also informed that the formal study by JICA has not been commenced yet and the team is here to collect preliminary information for the study.
2	**FASTAG Card System**	Mr. Palekar gave the following updates: A. Dissemination ratio is around 13 to 14 %. B. The issuer and acquirer of FASTag cards are banks. C. There are around 400 Toll Plazas operating FASTag card system. **<u>Business Model Prior to April 2015:</u>** D. Prior to April 2015, ICICI bank (Single entity) was the only acquirer and issuer for the FASTag card system. They issued around 7000 FASTag tags. **<u>The business model from May 2015:</u>** E. From May 2015 the number of issuers and acquirers has been increased. Issuer banks are nearly 10 Nos and acquirer banks are almost 7 Nos. F. SBI and ICICI Bank are the most active players in the business. G. The percentage share of handing the FASTag is ➢ 80% by ICICI ➢ 10 % by SBI (State Bank of India) ➢ And 10 % other banks. H. Around .5 Million Tags have been issued till date by various issuer banks.
3	**How the current**	• NPCI (National Payments Corporation of India) is the body formed by

No.	Items for discussion	Conclusion – Agreement
	business model works?	under Reserve Bank of India for handling e payments at the National level. This acts as National Clearing House. • All toll Plazas are connected to acquiring entities (which are banks) • One plaza will connect with one bank only. • The acquirer has the business rules (which are toll rates basically). • When a user uses the FASTag system. The tag reader at the toll plaza reads the detail and the information is sent to the acquirer. The Acquire gets transaction details to the server and sends to NPCI for settlement. • The acquiring bank has the traffic table (Business rules) which are provided by the governor of the toll plazas. • NPCI will check card details and check the issuer bank. • An individual tag is connected to a single bank only. The respective amount of toll is debited online. • Within 24 hrs the amount is credited to the concessioner account. • The procedure is very similar to the credit & debit card.
4	**NPCI – Fees structure**	• With a vision to promote online payments, Government of India is providing subsidiary for the users. • <u>For example</u>: When a user pays Rs.100 at a toll plaza. The concessioner gets Rs.100 where as 4 % of it, which is Rs.4, is paid by Government as fees for online transfer and service charge. • The amount sharing of the 4 % is ▪ 1 % of IHMCL ▪ 1.5 % to issuer ▪ 1.25 to acquire ▪ .25 to NPCI • Gov is paying this 4% to NHAI and NHAI will pay to IHMCL. • IHMCL will give the money to NPCI.
5	**Incentive schemes**	• GOV is spending a lot to promote ETC. • The Government is providing cash back at the end of the month to the FASTag Users. ➢ April 2015 to March 2016 - 10 % cash back. ➢ April 2016 to March 2017 - 7.5% cash back. ➢ April 2017 to March 2017 - 5% cash back.
6	**Linking FASTag System to Common Mobility Card**	• Linking Common Mobility card with the FASTag system is possible, provided same architecture is used. • For CPRR to be connected with the FASTag scheme. Decision at government level has to be taken. Interoperability has to be decided. State government can send the request to all agencies within the state and decide on this. • If the smart card is issued by Chennai Metro. The time to pay the concessioner can be adjusted even to 48 Hrs as the decision is within the state government.

No.	Items for discussion	Conclusion – Agreement
7	**Using NHAI cards in State level plazas:**	• For the users to have seamless travel, NHAI is in touch with the various state-level agencies to standardize the card. Example: Madhya Pradesh. But there is no policy available with NHAI to standardize this. But may happen in future. • But for now, NHAI is focusing mainly on toll collections through various modes such as FASTag/ mobile wallets. • Locally available tags are being used at many state level toll plazas which are under the discretion of State Government. MORTH can request the state government be a part of FASTag program. • For any state level plaza to go with the FASTag system, the national level standard procedures have to be followed.

8	**Other details about the FASTag system:**	• Presently FASTag system has been tied up with PAYTM (Mobile Wallet for payments through QR codes).
		• There are 2 lanes available in the toll plazas.
		  • ETC lane only for vehicles with FAS TAG
		  • And Hybrid lanes are for payments through credit/debit card/cash/ mobile wallet.
		• When required to give some kind of discount to some categories of the vehicle. It can be provided through adjusting the business rules at the toll plazas (May be done at both state level and Central level). The backend system can be programmed as required.

9	**Types are tolling at plazas**	There are two types are tolling being followed: • **Open road tolling**: The user has to pay the entire fees when he crosses two specified points, which is irrespective of the distance. • **Closed road tolling**: Every exit and entry point will have toll plaza and the user are made to pay based on the distance.

10	**Exempted vehicles at toll plazas**	• Two kinds of exceptions are available at toll plazas. They are Person based and Vehicle based discounts.
		  o Person based vehicles: President of India, Chief Justice
		  o Vehicle-based: Fire Vehicle, Ambulance
		• Discounts on a monthly basis for locals are being provided at toll plazas.

11	**Data Flow in BOT or EPC projects:**	• The data Flow in BOT or EPC procedure is same. The standards and equipment to be placed at the toll booths have been defined. i.e Tags& Readers • The only difference is in BOT the bank account number is same for the entire project, Whereas in EPC project every year the operator changes and hence the bank account number changes.
12	**Non-ETC vehicle entering an ETC lane.**	Ejection lanes are not possible because of the vehicular system in the toll plazas. NHAI is planning to increase dedicated lanes. It has also been planned to introduce an ETC reader in the non ETC lane so that when an ETC vehicle enters the non etc lane. The reader can read it easily. The idea is to increase the number of ETC lanes basically. NHAI is also planning for penalizing normal vehicles entering into the ETC lanes.
13	**Technical details**	• The basic specification (Data structure, security aspects, and

No.	Items for discussion	Conclusion – Agreement
		encryptions) of the FASTag has been continuously updated based on the experience. Mr. Palekar informed he will share the latest details.
14	**Design scope for road administrators:**	• The ETC information is presently sent in batches. It has been planned to make it online as and when a transaction happens. It is possible with strong data backing. As many plazas are in the remote area. The government is working on improving the connectivity which will, in turn, make the system work in online mode.
15	**Data base of Black listed vehicles:**	• The issuer banks create and store the information related to the defaulters and blacklisted users. The blacklisted categories includes users with wrong class of vehicles, cloned cards cases etc • The ticket created by toll is sent to NPCI and the information sent is checked and verified by NPCI. And if found guilty the user is added to the blacklist and the information is shared to all the toll plazas at the national level.
16	**Linking Vehicular data Base to the Toll Plazas:**	• The Vehicle data base which is available at the state level is not linked to the toll systems for now. But will be done at the later stages. • Vaahan – Online vehicle data base is available under MORTH and its standalone system.
		• Mr. Palekar informed he may be contacted in future for more queries.

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Project Office :
2nd Floor, Sri Ramani Residency
No 8, Maharaja Surya Road, Alwarpet, Chennai - 600018
Tel. : 044 - 48568363
Fax. :

Ref. No. :CPRR-MOM-TRAFFIC POLICE-01
Date :August 3, 2017

MEETING RECORD

Title	Meeting with Commissioner of Police			
Date	Wednesday 3rd August 2017		**Time**	11:00 – 14:00
Venue	Office of Commissioner of Police, Vepery, Chennai			
Participants	**No.**	**Name**	**Position**	**Phone Number**
Police Department	1	Dr.A.K.Viswanathan IPS	Commissioner of Police	
	2	Mr. K.Periaiyah IPS	Additional Commissioner of Police-Traffic	9443388003
	3	Mr.Jayakumar	Deputy Commissioner - Planning	
	4	Mr.Julius Christopher	Assistant Commissioner of Police - Traffic (Planning)	
	5	Mr.Najmul Hoda	Joint commissioner of Police- North	
	6	Mr.Michel	Pa to DC Planning	9444330046
JICA Study Team	1	Takayasu Nagai	Team Leader	
	2	Hiroya Totani	ITS Planning / Design 1	8978435175
	3	Noboru Kondo	ITS Planning / Design 2	8978435175
	4	Eiji Wakatsuki	ITS Operation	8586000395
	5	Nawaz	Engineer	9840692739
References		Questioner for Traffic Police		

Agenda:

No.	Items for discussion	Conclusion – Agreement
1	Self Introduction	• The JICA Study team was introduced to the officials of Police Department.
2	Explanation of Outline of the Study based on Inception Report (Draft)	• TL gave a brief presentation on the objectives, schedule, and work scope of this project. A copy of questioner was circulated and answers were obtained on various subjects. • Same has been attached herewith for reference
3	E Challan System	• It was informed that there are 33 different sections under which the traffic police are charging the public for their traffic offences. Some of them are drunk and drive, over Speeding, driving without a valid license etc. • Fine amount varies as per the offence made. • At Present 409 E- Challan Machines are being used for collection of fines. • Also card swiping machines have been newly introduced with which the offenders can pay their fine with their credit or debit cards. • Total Fine amount of 12 Crores and 59 Lakhs has been collected this year.
4	Intelligent Traffic Management System	• It was informed that ITMS tender was awarded to Purple Info Tech Ltd and later terminated as project was not completed on time. • The matter is under litigation in court and is pending for disposal.

<table>
<tr><th>No.</th><th>Items for discussion</th><th>Conclusion – Agreement</th></tr>
<tr><td>5</td><td>Area Traffic Information System</td><td>• A pilot project has been done by IIT and after successful implementation; the project has been handed over to traffic police.</td></tr>
<tr><td>6</td><td>Other ITS components in Use</td><td>The following updates were provided to the study team
• No vehicle detectors or other road side equipment is being used.</td></tr>
<tr><td>7</td><td>Visit to traffic Control Room</td><td>• The traffic control room was visited. The control room serves for north and south portion of Chennai.
• The control room operates various toll free help line numbers. Some of them are
<table>
<tr><td>Police</td><td>100</td></tr>
<tr><td>Traffic Police</td><td>103</td></tr>
<tr><td>Child Line</td><td>1098</td></tr>
<tr><td>Women Help Line</td><td>1091</td></tr>
<tr><td>Senior Citizens help line</td><td>1253</td></tr>
</table>
• Police are using walky talky to communicate with each other.
• The updates on traffic are provided to public through Face book and Twitter.</td></tr>
<tr><td>8</td><td>Traffic Signal System</td><td>• There are 385 signals in Chennai. The lists of signals were provided as annexure.
• The traffic signals have separate controllers and the signals are stand alone signals.
• There is no signal co ordination system available. The existing signals are being operated manually by traffic constable available at the location.
• The Annual Maintenance Contract is usually for 12 months.
• The major player for signal installation are M/s CMS and M/S Analog systems Pvt Ltd.
• The cost of each signal is about 6 lakh rupees. Currently Traffic police are spending 8 to 10 % of the purchase amount as AMC amount.</td></tr>
<tr><td>9</td><td>VMS system</td><td>• The list of locations which have installed VMS was provided.
• Currently VMS boards are used to display traffic awareness messages and traffic diversions information to the general public.
• Messages are displayed in English and Tamil.</td></tr>
<tr><td>10</td><td>Judistriction of Chennai Traffic Police.</td><td>• It was explained that CPRR falls under the judistriction boundary of 3 districts. They are

Chennai,
Kanchipuram and
Chengalpattu.

• Additional Police Commissioner gave the following divisional demarcation of various sections of CPRR
<table>
<tr><th>Sections in CPRR</th><th>Location</th><th>Within the Administrative boundary of</th></tr>
<tr><td>Section 1</td><td>Ennore</td><td>Chennai Police</td></tr>
<tr><td>Section 2</td><td>Tathchur</td><td>Tiruvallur</td></tr>
<tr><td>Section 3</td><td>Tatchur to Tiruvallur Bypass</td><td>Tiruvallur and Kanchipuram</td></tr>
<tr><td>Section 4</td><td>Sriperambudur to Singaperumal Koil</td><td>Kanchipuram</td></tr>
<tr><td>Section 5</td><td>Singaperumal Koil to Mahaballipuram</td><td>Kanchipuram</td></tr>
</table>
• The list of signals will be prepared in an image format and shared.
• The judistriction map was shown and photos of the same were documented.</td></tr>
<tr><td>11</td><td>Suggestions from Commissioner of Police.</td><td>Commissioner of police gave the following inputs after discussions with JICA study Team.
1) The study team to be updated with the plans related to Smart city proposal of Chennai.</td></tr>
</table>

No.	Items for discussion	Conclusion – Agreement
		2) It has been proposed by police to install 3200 cameras in the city. Fund for procuring the same has been allotted (Approximately 100 Crores). Now tender has to be invited for implementation of the same. The JICA study team can look on this. 3) JICA study team can look on how to add the intelligence components to the cameras. 4) Good network of signals to be introduced.It was recommended that a pilot project for signal co ordination may be tried before the actual implementation of the bigger project. The Stretch from Muthusamy point to Poonamallie may be tried. 5) JICA study team was requested to meet Mr.Amresh Pujari (9442223377) ADGP – State Traffic Planning Cell for information regarding all the districts related plans.

Attachment: Reply to Questioners.

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Ref. No. :CPRR-MOM-MTC-01
Date :September 05, 2017

Title	Meeting with Managing Director of Metropolitan Transport Corporation (MTC)			
Date	5 (Tuesday) September 2017		**Time**	11.00 – 12:30
Venue	Metropolitan Transport Corporation, HQ			
Participants	**No.**	**Name**	**Position**	**Phone Number**
MTC	1	Thiru V.Krishnamoorthy	Managing Director	
		Other many MTC personals		
SMART CITY Limited	1	Mr. Raj Cherubal	CEO, Smart City Corporation	
	2	Mr. Daniel Robinson	Consultant - C40 - NGO	9940652815
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Noboru Kondo	ITS Planning / Design 2	8978435175
	3	Eiji Wakatsuki	ITS Operation	8586000395
References		Discussion Paper of Bus System, Common Mobility Card and Schedule		

No.	Items for discussion	Conclusion – Agreement
1	Confirming procurement methodology of Bus ITS projects	• Mr. Raj Cherubal mentioned that some of the high level of T.N. government has following opinions. ✓ Both Bus Monitoring System and Passenger Information System should be implemented by one contractor as JICA ITS project rather than a pilot basis. ✓ All the systems of smart city should be implemented by single contractor. ✓ As the project funded by JICA takes time to implement, T.N.State procured contractor first and JICA's fund will be put in later. . • JICA Study Team explained followings. ✓ JICA aims to contribute to solve traffic problems in this ODA loan project. For this reason, it is impossible to fund all required systems for Smart City. ✓ JICA can fund only projects which follows JICA guidelines, but it is impossible to fund prior project.

No.	Items for discussion	Conclusion – Agreement
2	Confirming current status of MTC ITS project	• MTC is considering to use smartphone for GPS device instead of installing dedicated GPS device on the bus. • If these smartphones will be installed on bus for collecting location data, it matches the purpose of JICA ODA. • MTC prepared RFP for both Bus Monitoring System and Passenger Information System. So MTC requested to check the content of RFP. • MTC need advices from JICA Study Team like what kinds of information need to be collected for Bus Monitoring System. • JICA Study Team agreed to advise to MTC.
3	Current status of electronic ticket management system	• MTC introduced electronic ticket management system three years back for all MTC buses already. Now, MTC has 8000 numbers of handy electronic ticketing devices. • These devices are interoperable with Chennai Metro Card since it can read Type A card but not Felica card. (CMRL issued two million of Felica card already.)※ • JICA Study Team explained necessity of establishment of new state government organisation which will manage the clearing house and common mobility cards between MTC, CMRL and other public transportations.
4	Procurement schedule	• Time schedule of JICA ITS Project is too long. In order to shorten the project, we should discuss with TNRDB. • Since Specification and RFP were already made, we should utilize these documentations to shorten the schedule. In order to utilize these documentations, MTC & CSCL requested JICA Study Team to confirm the content of these documentations and give the necessary advices. • JICA Study Team agreed to check these documentations.
5	Necessary materials	• MTC will provide RFP and technical specifications (Bus Monitoring System, Passenger Information System, and Electronic Ticket Management System) to JICA Study Team. • In order to offer the materials to MTC, JICA Study Team need to send a letter to Mr. Davidar (Additional Chief Secretary, Transport Department) and cc. to Managing Director MTC.

Note: ※ JICA Study Team confirmed the current status of MTC Electronic Ticket Management System to Sony (Felica Manufacture).

- Handy devices which MTC introduced does not have a read/write function of IC card.
- However, it will be functional for read/write of both Mifare and Felica card by installing software and key, since antenna and chip for read/write are embedded.
- This software need to develop. Probably Nippon Signal will be selected to develop the software, since Nippon Signal is the contractor of CMRL ticketing system.
- In this case, asset of software will be belonged CMRL. So, the cost of development of software (or cost of license) need to coordinate between MTC and CMRL.
- Several years ago, Sony demonstrated whether Handy device would be functional for CMRL Mifare card to MTC by installing software.

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Ref. No. :CPRR-MOM-Smart City-01
Date :September 05, 2017

Title	Meeting with CEO of Chennai Smart City Limited			
Date	5 (Tuesday) September 2017		**Time**	12.00 – 12:30
Venue	Metropolitan Transport Corporation, HQ			
Participants	**No.**	**Name**	**Position**	**Phone Number**
SMART CITY Limited	1	Mr. Raj Cherubal	CEO, Smart City Corporation	
	2	Mr. Daniel Robinson	Consultant - C40 - NGO	9940652815
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Noboru Kondo	ITS Planning / Design 2	8978435175
	3	Eiji Wakatsuki	ITS Operation	8586000395
References				

No.	Items for discussion	Conclusion – Agreement
1	Confirming responsible organization for each project stage of JICA ITS project	• JICA Study Team requested to clarify the responsible organization for Chennai Traffic Information Centre (C-TIC) • Mr. Raj explained that Chennai Smart City Limited (CSCL) is the most suitable organization for taking charge of JICA ITS project, since ITS project will relate to various organizations. And CSCL is the only organization enable to traverse various organizations. • O&M period is five years and CSCL is also responsible for this stage. • However, we need to discuss with high level officers of T.N. state. • A High Powered Committee which compose of executives of related Gov. organizations, is formed above the CSCL. The role of High Powered Committee is to decide important matters.
2	Jurisdiction of Flood Monitoring System	• JICA study team asked the jurisdiction of Flood Monitoring system since Tamil Nadu Urban Finance and Infrastructure Development Corporation (TUFIDCO) is planning to install flood monitoring system. JICA study team explained that the Flood Monitoring System of JICA ITS project is to monitor the underpass and warn the vehicles not to pass through.

No.	Items for discussion	Conclusion – Agreement
		• Mr. Raj Cherubal said if the difference of both systems are clear, JICA ITS project should cover your Flood Monitoring System. The Flood Monitoring System what TUFIDCO is planning is to monitor wide flooding area. • CSCL will confirm what kinds of system is TUFIDCO planning and inform the result.
3	Future meeting with Chennai Traffic Police (CTP)	• Whenever JICA study Team need to discuss with .CTP, CSCL will attend with JICA team. Following is a key person of CTP for ITS. Mr. Ren, Joint Commissioner of Chennai Traffic Police: North Section Mobile No.; 9940113111

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Ref. No. :CPRR-MOM-TRAFFIC POLICE–02
Date :September 15, 2017

MEETING RECORD

Title	Meeting with Commissioner of Police			
Date	Friday 15 September 2017		**Time**	15:00 – 17:00
Venue	Office of Additional Commissioner of Police, Vepery, Chennai			
Participants	**No.**	**Name**	**Position**	**Phone Number**
Police Department	1	Mr. K.Periaiyah IPS	Additional Commissioner of Police- Traffic	9443388003
		Many other Polie Officer		
	3	Mr.Jayakumar	Deputy Commissioner - Planning	
	4	Mr.Julius Christopher	Assistant Commissioner of Police -Traffic (Planning)	
	5	Mr.Najmul Hoda	Joint commissioner of Police- North	
	6	Mr.Michel	Pa to DC Planning	9444330046
Smart City	1	Mr. Raj	CEO	
PWC	2	Mr. Arun		
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Noboru Kondo	ITS Planning / Design 2	8978435175
	3	Eiji Wakatsuki	ITS Operation	8586000395
References		- Questioner for Traffic Police - Discussion Paper 002 Responsible Organisation for VMS - Discussion Paper 006 Area Traffic Signal Control System		

Agenda:

No.	Items for discussion	Conclusion – Agreement
1	Coverage area of signal system for JICA ITS Project	• Time schedule of JICA ITS Project is too long. • ITMS project to implement camera monitoring system and signal system will resume soon. This project is planning to cover signals at 100 junctions. • Locations of 100 targeted junctions are still adjustable presently. • In particular, junctions on NH-4, NH-45, and OMR need to be installed at early stage. • According to the ITMS Contractor, service can be started within one year. →Based on above, Traffic Police want to proceed 100 junctions which locate in core area by ITMS. JICA Study Team requested CTP to specify the core area.
2	Center location for both CTP and C-TIC (JICA ITS Project)	• CTP recommended to establish the both C-TIC and Traffic Management System at 7 the floor of CTP HQ since there is a big empty space. • JICA Study Team will measure the exact size of above empty space later. • Call center and ITMS center for CTP are already established same floor. Thus, all information can gather same floor. In addition to this, the Contractor can reduce the number of employer for O&M.
3	Jurisdiction of Variable Message Sign (VMS)	• Some VMS which JICA Study Team is planning will place outside of CTP's jurisdiction. • CTP has a strong will to manage all VMS, since CTP is normally coordinate various matters with neighbouring Traffic Police. • Thus, CTP can handle necessary management even O&M stage.

No.	Items for discussion	Conclusion – Agreement
4	Traffic enforcement	• Major missions of Traffic Police are Traffic Management and Traffic Enforcement. • The targets for Traffic Enforcement are signal jumping, over speed, mobile talking etc. CTP demands the systems can handle these violated vehicles. Automatic Number Plate Recognition System (ANPR) is one of the major system for Traffic Enforcement. Thus, CTP requested to JICA Study Team to consider introducing ANPR for CTP.
5	Others	• CTP also consider that announcement function for pedestrians to inform green phase is very important. This system is not necessary for all junctions but required for key junctions.

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Ref. No. :CPRR-MOM-Smart City-02
Date :September 18, 2017

Title	Meeting with CEO of Chennai Smart City Limited			
Date	18 (Monday) September 2017		**Time**	14:30 – 15:30
Venue	Metropolitan Transport Corporation, HQ			
Participants	**No.**	**Name**	**Position**	**Phone Number**
SMART CITY Limited	1	Mr. Raj Cherubal	CEO, Smart City Corporation	
	2	Mr. Arun	PMC (PWC)	
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Noboru Kondo	ITS Planning / Design 2	8978435175
	3	Eiji Wakatsuki	ITS Operation	8586000395
References				

No.	Items for discussion	Conclusion – Agreement
1	Confirming role of Chennai Smart City Limited (CSCL) during ITS project	• CDCL currently has 59 projects. (Including concept). Among them, Contractors were selected for 2 projects, 8 projects are bidding stage, 20 projects were under making DPR, and others were under DPR preparation. • CSCL was established for taking care of Smart City Projects from planning, implementation to O&M. • Currently, CSCL has six divisions under CEO. Among them, PMC is responsible for everystages from bidding to implementation. • Currently, PricewaterhouseCooper (PWC) has a contract with CSCL by winning the bid and contract period is four years. Five members are working as PMC at CSCL office. ✓ (Leader（Mr.Arun） ✓ Transport Expert ✓ Urban Expert . ✓ Financial Expert ✓ Procurement Expert Organization Chart is attached this MoM. • PMC explained followings ✓ When JICA ITS project start, a consultant for JICA ITS Project will be placed under PMC and PMC will be the counterpart ✓ Procurement, Implementation and O&M of JICA ITS Projects (Chennai Traffic Information System, Traffic

No.	Items for discussion	Conclusion – Agreement
		Management System and Bus System) will be under jurisdiction of CSCL ✓ The asset of both Traffic Management System and Bus System will be handed over to CTP and MTC after completion of acceptance test. ✓ However, payment and confirming Service Level Agreement (SLA) will be carried out by CSCL during O&M stage.
2	High Powered Committee	• High Powered Committee consists of Principle Secretaries of various related department. Chairman is a commissioner of GCC and MD is a Deputy Commissioner of GCC. Board Member list will be sent later. (Act Paper when Smart City's SPV is established) ※
3	Definition of ITMS	• ITMS is an abbreviation of Integrated Traffic Management System. CSCL and related organizations are using this name for all transported system for Chennai Smart City.

Note: ※ This Act does not shows any member list. JICA Study Team is keep requesting to provide necessary materials to CSCL.

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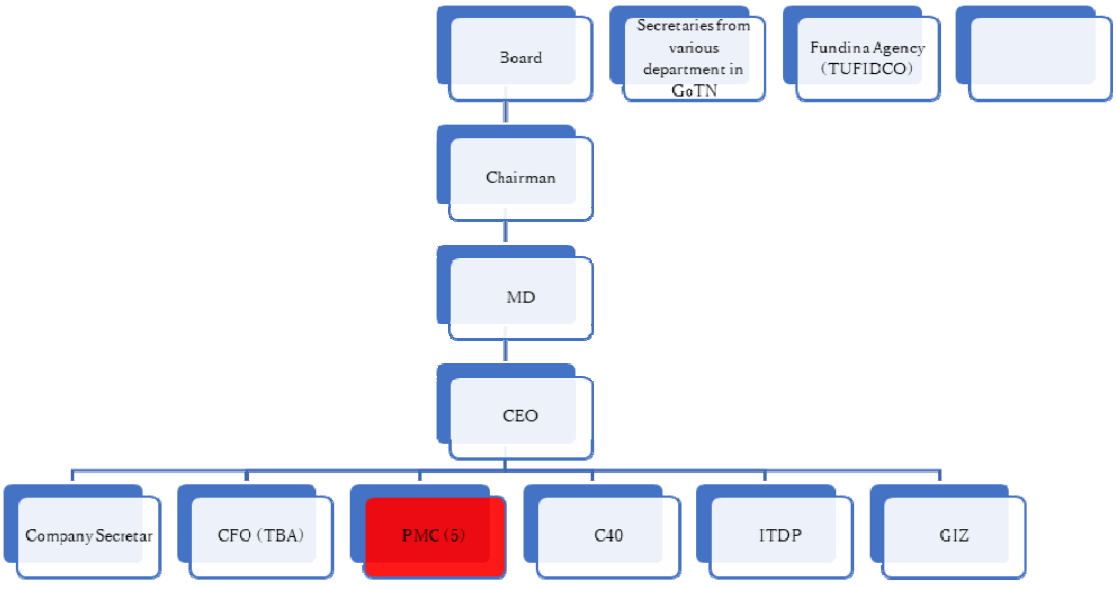

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Ref. No. :CPRR-MOM-Transport Dept -01
Date :September 26, 2017

Title	Meeting with P.W.C Davidar, IAS, Additional Chief Secretary to Government – Transport Department			
Date	26 (Monday) September 2017		**Time**	15.00 – 16:00
Venue	Transport Secretary Cabin, Secretariat, 4th Floor, Chennai.			
Participants	**No.**	**Name**	**Position**	**Phone Number**
Transport Department	1	P.W.C Davidar, IAS	Additional Chief Secretary to Government – Transport Secretary	
SMART CITY	1	Mr. Raj Cherubal	CEO, Smart City Corporation	
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Noboru Kondo	ITS Planning / Design 2	8978435175
	3	Eiji Wakatsuki	ITS Operation	8586000395
	4	Nawaz	Engineer	9840692739
References		Discussion Paper on Bus Tracking System, Common Mobility Card, VMS boards location information.		

No.	Items for discussion	Conclusion – Agreement
1	Reporting to Mr. Davidar on the study activities carried out so far and sharing major points raised	• Mr. Raj Cherubal briefed Mr.Davidar that the JICA Study Team has been closely working with MTC and Smart City Company and has prepared the implementation plan and various discussion papers. • JICA Study Team shared the proposed implementation schedule for Chennai City ITS and explained them in detail. • It was explained that the three components that have been finalized related to bus systems are o Bus Monitoring System o Passenger Information System o Bus ticketing System ❖ **Bus Monitoring System:** This system shows the current location of the Bus. The tracking is carried out either with a GPS Device or a GPS enabled Smart Phone. ❖ **Passenger Information System**: It is to display the information to the road users through Variable Message sign board. The Information can also be provided in a mobile app format. ❖ **Bus ticketing System:** Bus Tickets are provided using a electronic Ticketing machine.

No.	Items for discussion	Conclusion – Agreement
2	Current Condition of MTC	• Currently MTC is using electronic Ticketing machine to issue Tickets. MTC is paying 13.3 paisa as transaction fees to the vendor for every ticket they are issuing. • 95 % of the Electronic Ticketing machines are operational now. • Mr. Davidar informed that in the past 12 years MTC has revised its Bus Travel fare only 2 times where as BMTC has revised its fare 11 times. • MTC has plans of adding 2000 electric buses to the fleet.
3	Necessity of Expediting Project Implementation	• Mr. Davidar informed that he will retire by October 2018 and he has to bring some system in place before that as the successor might not be interested. • He also informed that the JICA Timeline may be a problem he has to show immediate results.
4	Development plans of Transport Secretary	• There are around 4000 buses in Chennai and around 18000 buses in other cities of TamilNadu. • Mr. Davidar informed that his vision is to replicate the same business model and technology (software) which will be adopted for MTC in the other smart cities of TamilNadu. Some of the other smart cities include Coimbatore, Thirunelveli, Madurai, Tirchy and Tanjore. • Mr. Davidar suggested that they are looking for a system which will develop Bus Monitoring software at a particular region and that can be used for other cities as well. This will solve the recurring licensing fees issues and duplication of the work. The idea is to make the software open source saving a huge amount of development and licensing fees. Where as they are ready to invest in devices.
5	Action Plans of Transport Secretary	• Mr. Davidar informed that he is happy to have a mobile application which provides the expected arrival time of the bus. He also informed that he is in discussion with local companies which are ready to provide solution for Passenger Information System. • Mr. Davidar also informed that a company has provided them with a quote of Rs.5 Crores for Bus Monitoring System and Passenger Information System (App Based) with operation and maintenance for 4 Years and 1 Cr per year after that as Maintenance and operational charge. • Companies like Map Unity are providing the framework required as open source. The data input for this system has to be provided. (http://ctis.in/)

No.	Items for discussion	Conclusion – Agreement
		• Mr. Davidar also indicated that given a budget of Rs.10cr with an estimate of Rs.4000 per bus, all the buses in the Tamilnadu can be provided with GPS units. • Mr. Davidar (Additional Chief Secretary Transport) informed that his plan is to commence the app based Passenger Information System by the end of January 2018.
6	Common card issues.	• Mr. Davidar (Additional Chief Secretary Transport), informed JICA Study Team that he has meeting with MD, CMRL and it was decided that all the issues related to common mobility card would be discussed and concluded in the table as they both want the end users to benefit.
7	Conclusion	• It was decided that Bus Monitoring System can be done by JICA in a larger scale where as App based Passenger Information System will be done by MTC immediately.

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Ref. No. :CPRR-MOM-TNIDB-02
Date :September 27, 2017

Title	Meeting with Mr. Krishnan IAS – Principle Secretary – Planning and Development			
Date	Tuesday 27 September 2017		**Time**	11:30 – 12:00
Venue	Conference Hall, Secretariat, 2nd Floor, Chennai			
Participants	**No.**	**Name**	**Position**	**Phone Number**
TNIDB	1	Mr.Krishnan IAS	CEO- TNIDB	
	2	Ms.Pooja Kulkarni IAS	Additional Secretary - Finance	
SMART CITY	1	Mr. Raj Cherubal	CEO	
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Noboru Kondo	ITS Planning / Design 2	8978435175
	3	Eiji Wakatsuki	ITS Operation	8586000395
	4	Nawaz	Engineer	9840692739
References		Discussion Paper on Bus Tracking System, Variable Message Board, Organization for ATCC,Common Mobility Card, Area Traffic Signal Control System and Proposed Implementation Schedule.		

No.	Items for discussion	Conclusion – Agreement
1	**Background of the study**	• Mr. Raj Cherubal briefed Mr.Krishnan that the JICA Study Team has met various stakeholders and has prepared an implementation plan and various discussion papers. • JICA Study Team (JST) shared the proposed implementation schedule for Chennai City ITS.
2	Mr.Krishnan gave the following informations	• Mr.Krishnan indicated that they are very keen on starting the project at the earliest. • Chennai Smart city Limited has some budgetary allocations and is planning to implement few projects by themselves. • Mr.Krishnan requested JICA study team to request JICA to expedite the loan process. • Mr.krishnan suggested that the bid documents for project implementation to be ready in advance for project implementation and it is not necessary to wait till loan agreement is signed. This will expedite the implementation process.
3	Mr.Krishnan gave the following suggestions to Mr.Raj and Ms.Pooja	• Mr.Krishnan requested Ms.Pooja Kulkarni, Additional Secretary, Finance department to write a formal letter

No.	Items for discussion	Conclusion – Agreement
	Kulkarni.	requesting JICA for faster approvals. • Mr.Krishnan requested Mr. Raj to share the documents prepared by smart city with JICA for review of the save. This would in turn save time and duplication of work. • The junction improvements to be done in a phased manner as doing all together is not possible. • Consultant procurement may be planned well in advance. The budget for preparatory studies may be funded through smart city funds if necessary. • The actual site implementation to be taken in the year 2018 – 2019
4	Conclusion	• A meeting with members from JICA, GCC, MTC and Traffic Police will be convened to finalize on the plan. Raj to internally discuss and clear all approvals necessary from TNIDB
		• JICA study Team also requested Mr. Krishna to find out if funding is necessary for any projects related to transportation. • JST informed Mr.Krishnan that JICA is planning to meet him on October 2017.

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Ref. No. :CPRR-MOM-BMTC-01
Date :November 30, 2017

Title	Meeting with Chief System Manager of Bengaluru Metropolitan Transport Corporation （BMTC）			
Date	30 (Thursday) November 2017		**Time**	15:50– 16：20
Venue	Bengaluru Metropolitan Transport Corporation, HQ			
Participants	**No.**	**Name**	**Position**	**Phone Number**
BMTC	1	Mr. Nagendra	Chief System Manager	
JICA Study Team	1	Noboru Kondo	ITS Planning / Design 2	8978435175
References				

No.	Items for discussion	Conclusion – Agreement
1	Organization Structure of BMTC for Operation of City Bus System (Bus Monitoring system, Passenger Information System and Electronic Ticketing System)	• Over all responsible position of BMTC ITS project is Chief Traffic Manager and responsible position for technical part of project is Chief System Manager (Mr.Nagendra). • BMTC center carries out bus operation management. • BMTC buses are operated for 24 hours a day (the number of buses operated at night becomes small). • All operators working in BMTC center are permanent employees of BMTC. • The operation service is offered for 24 hours a day and 7 days a week, covered by 3 shifting arrangement per day. • Two-shift covers day-time shift and one shift consists of 11 operators. One shift covers night time and it consists of 4 operators. In total, 26 operators work for 24 hours by 3 shifts. • Each operator is in charge of 4 bus depots (Total number of depots is 43). In the night shift, 4 operators are in charge of all depots. • Shift timing ✓ Day shift 1 (6：00AM～2：00PM) ✓ Day shift 2 (2：00PM～10：00PM) ✓ Night shift (10：00PM～6：00AM) • Beside operators, 9 BMTC employees are working in BMTC center. Among them, 5 employees are in charge of handling bus schedule and remaining 4 employees are supervisor. • Total number of monitors is 20 and 1 operator uses one monitor. • The roles of employees working in BMTC center are

No.	Items for discussion	Conclusion – Agreement
		✓ Operator : Monitoring bus operation such as deviation from predetermined bus route, skipping bus stop, departing time, arriving time, reporting etc. ✓ 5 employees for day work: Handling bus schedule ✓ 4 supervisors: Supervising performance and instruction of employees in BMTC center. • 43 depots also have one ITS personnel in charge respectively. The job at the depot are mainly for ETM (Electric Ticketing Machine). The depot also has a 3-shift arrangement.
2	Maintenance works	• When failure of equipment happens, ITS personnel in charge or operator in BMTC center contact to contractor (TRIMAX). • TRIMAX is deploying two staff in BMTC center for 24 hours by 3 shifts. • One system engineer of TRIMAX stations in BMTC center on day time basis. • Major roles of TRIMAX are maintenance work for equipment/system and development of applications. • TRIMAX carries out periodic inspection for weekly basis. • Responsibility of system of TRIMAX is UPS to system • TRIMAX regularly staying in BMTC center. In case of handling system failure found remotely, TRIMAX staff is dispatched to the site. • BMTC will send SLA documents to JICA study team later.
3	Others	• LED boards are installed in BMTC buses but this is not the part of ITS project. • Next bus stop which LED boards shows are controlled by geofence. • All related technical specifications for bus ITS are available through internet (Website of MOUD: UBS2)

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Ref. No. :CPRR-MOM-BMTC-01
Date :December 06, 2017

Title	Meeting with Manager Contracts (Smart World & Communication) of Larsen & Toubro Construction			
Date	6 (Wednesday) December 2017		**Time**	14:15– 16 : 00
Venue	Larsen & Toubro Construction, HQ			
Participants	**No.**	**Name**	**Position**	**Phone Number**
L&T	1	Mr. Kathikeyan	Contracts Manager	
JICA Study Team	1	Mr. Noboru Kondo	ITS Planning / Design 2	8978435175
	2	Mr. Eiji Wakatsuki	ITS Operation	
References				

No.	Items for discussion	Conclusion – Agreement
1	O&M for Chennai City ITS	• 5 years of O&M term for ITS projects is common practice in India. • Cost estimation of O&M staff will be shared soon.
2	Signal	• L&T does not have an experience of introducing the wireless signal communication system at junction, but this method has increasingly become common as pilot basis in India. • The reason is that the Employer intends to avoid road works as much as possible. • However OFC network is usually used for communication between junction (controller) and sensors or junctions (controller) and center. • OFC covers almost entire area. The aerial wiring is not used for the communication between junctions (controllers) or between junction (controller) and center. • ZIGBEE protocol, not the Wi-Fi, is adopted for the communication in junction. • The communication between junction to junction and between the center to the junction is based on the optical cable and becomes a contract with MPLS Link.
3	Solar power source	• The solar power is popular practice for signal power supply in India due to the reason that the Employer wishes to avoid road works, similar to the case of wireless communication at junction. • In case of introducing solar power source, the capacity of the accumulator battery depends on the load of signal. It depends

No.	Items for discussion	Conclusion – Agreement
		on the adopted signal system. The capacity of controller is usually 600 VA to 800 VA at a maximum of 1000 VA, and the traffic light is 50 VA to 100 VA. • The life of the accumulator battery is up to 2 years. It becomes shorter depending on various conditions such as weather.
4	Automated Number Plate Recognition System （ANPR）	• The accuracy of ANPR is usually 80 to 85% in the daytime and 70% or more in the night-time. In the specification, it is usually described as 90% or more. • L&T uses a system with a normal camera in the daytime and an infrared camera in the night-time, with two cameras installed in one console (one lens).
5.	Installation cost	• Approximately, the cost of signal system is around 20～25Lahk per junction. • The approx. prices of ANPR are as follows (Note: it varies, depending on the quantity) ✓ Software :5 Lahk per unit ✓ Normal camera : Rs 50,000 ✓ Infrared camera : Rs 30,000
6	City bus system	• L&T won the Hubli BRT system in Karnataka State (bid price: 100 Cr., NEC 112 Cr) for 440 buses. • ITS components of Hubli BRT are: ✓ GPS/OBU+Inbus camera ✓ Central software ✓ PIS ✓ Dept/Transit Management System (PTS, Human Resource, Finance, 等) ✓ ERP (SAP) * ERP（Enterprise Resource Planning）is a package system that centrally manages the resources and information to support the administrative activities of company. It manages such items as order management / sales management, stock management, production management, financial accounting, etc., personnel salary, expense adjustment, fixed assets, project management, management accounting, customer management, budget management and so on. * SAPERP SAP SAP Inc.is one of the famous packages of ERP.
7.	Others related to ITS	• The vehicle count data is considered more important than categorizing vehicle type (as an opinion of L&T). • It would be better to adopt deep learning for Predictive

No.	Items for discussion	Conclusion – Agreement
		Analysis of traffic flow in the city (Traffic Pattern). • If the camera has capability to count up to 3 lanes, a cantilever type should be sufficient, not a gantry. • L&T has a strong intension to join tender of Chennai City ITS.
8	Others（Contract）	• L&T is currently preparing for re-bidding of the introduction of signal system for 353 junctions in Pune. In first bid, only IBI and L&T remained after PQ, But, the employer decided to carry out re-bid by some political reason. • The comprehensive evaluation method is adopted to this tender. • Order books can be found by searching ATCS on the Pune Municipal Corp. or Pune Smart City website.

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Ref. No. :CPRR-MOM-Smart City-04
Date :December 13, 2017

Title	Meeting with CEO of Chennai Smart City Limited			
Date	13 (Wednesday) December 2017		**Time**	17:30 – 19 : 00
Venue	JICA Study Team Office			
Participants	**No.**	**Name**	**Position**	**Phone Number**
SMART CITY Limited	1	Mr. Raj Cherubal	CEO, Smart City Corporation	
JICA Study Team	1	Hiroya Totani	ITS Planning / Design 1	8978435175
	2	Noboru Kondo	ITS Planning / Design 2	8978435175
	3	Eiji Wakatsuki	ITS Operation	8586000395
	4	Nawaz	Engineer	9840692739
References				

No.	Items for discussion	Conclusion – Agreement
1	Confirmation of demarcation of the related organizations for City ITS	• CSCL(Chennai Smart City Corp.) will be the responsible organization for JICA City ITS project for procurement and installation stage. • In O&M stage, CSCL will be the responsible for maintenance of all systems but operation will be managed by following organizations. ✓ Chennai Traffic Information System: CSCL ✓ Traffic Management System: Chennai Traffic Police (CTP) ✓ City Bus System: Metropolitan Transport Corp. (MTC) • The ownership of each system will be the same as above. • Regarding the responsible organization of O&M and ownership of city ITS after the completion of contract term of City ITS system integrator, T.N.State Gov. will make a decision.
2	High Powered Committee	• There are two different High-Powered Committees. • One of them is responsible for approval of project in case of large size project, of which project cost exceeds 10 crores. • The other is responsible for coordination across the related organizations.
3	Confirmation of decision making flow of the project	• The decision-making flow for requesting budget, making payment, procuring new project, system upgrade for the on-going project, etc. were confirmed.

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Ref No: CPRR-MOM-TRAFFIC POLICE - 6

MEETING RECORD

Title	Meeting with Additional Commissioner of Police- Traffic				
Date	Wednesday 19th December 2017			Time	11:00 – 12:00
Venue	Office of Commissioner of Police, Vepery, Chennai				
Participants	No.	Name	Position		
Chennai Traffic Police	1	Mr. A.Arun IPS	Additional Commissioner of Police- Traffic		
	2	Mr.Prem Anandh Sinha	Joint Commissioner - Traffic		
	3	Mr.Jayakumar	Deputy Commissioner - Planning		
	4	Mr.Julius Christopher	Assistant Commissioner of Police -Traffic (Planning)		
	5	Mr.Najmul Hoda	Joint commissioner of Police- Traffic		
	6	Ms.Shanmuga Priya	Joint commissioner		
	7	Mr.Eshwaran	Joint commissioner		
JICA Study Team	1	Mr.Takayasu Nagai	Team Leader		
	2	Mr.Hiroya Totani	ITS Planning / Design 1		
	3	Mr.Noboru Kondo	ITS Planning / Design 2		
	4	Mr.Eiji Wakatsuki	ITS Operation		
	5	Mr.Nawaz	Engineer		
JICA	1 2	Mr.Kenji Isomoto Mr.Fujiwara			
Smart City	1 2	Mr.Raj Cherubal Mr.Yashyeshwini, Smart City	CEO Associate		
PWC Consultants	1	Mr.Gowind Agarwal	Consultant		

Agenda:

No.	Items for discussion	Conclusion – Agreement
1	Introduction and phasing of the project	• Mr.Prem Anandh Sinha made a brief presentation on the list of signals that are currently available in Chennai. The total signals were categorized into three phases and it was presented that the implementation of these signals may be carried out in phases. The details are as follows ✓ Phase I to include 160 junctions in the core city area. ✓ Phase II to include 101 junctions. ✓ 174 junctions to be included in Phase III of which 132 are from Chennai District (Western, Northern, Southern suburbs) and 42 junctions from Kancheepuram District.
2	Coverage Area	• JICA Study Team mentioned that ECR & OMR cannot be included in Phase I as it is designed for core city. JICA study team also commented that the distance between signals shall be less than 500 meters for signal synchronization.
3	Additional Facilities at Junctions	• Additional Commissioner of Police-Traffic suggested placing Emergency Call Box at Traffic Signals. Mr. Raj Cherubal (CSCL) agreed and informed that it is under

No.	Items for discussion	Conclusion – Agreement
		planning at some locations/ signals already under Smart City Initiative and these will be implemented by Smart City Mission Project, not JICA project.
4	Relocation of the signals for assuring visibility	• JICA Study Team observed that the existing traffic signals are not visible at many junctions because of the trees and landscape. • JICA Study Team suggested that trees may need to be cut or relocation of the signals may be needed. Chennai Traffic police informed that cutting trees are not permitted as it involves necessity of obtaining the permission from other departments. • Additional Commissioner of Police-Traffic requested to consider the design avoiding cutting trees. However, he agreed that trees could be pruned for the sake of placing signals. Mr. Raj Cherubal added that depending on the design, JICA may consider installing the signals at appropriate locations avoiding cutting the trees as much as possible.
5	Wire-based Communication for Signal	• JICA Study Team informed that the wire-based communication is better than wireless communication for the signal. JICA Study Team requested to adopt the duct based wiring at the junctions instead of wireless communication due to technical reason. Chennai Traffic Police agreed to the suggestion. • Mr. Raj Cherubal suggested that pipe jacking could also be considered as an option. It was agreed that this issue will be finalized in the basic design stage. • Chennai Traffic Police assured that once the Implementation plan is finalized, Chennai Traffic Police will accord approval for cutting the roads for laying cables, if necessary.
6	Available Space for Center	• JICA Study Team provided a layout plan for Chennai Traffic Command Centre and requested to provide the additional 50% of the existing floor area or one more another floor. • Mr. Raj Cherubal informed that the layout plan for the Chennai Traffic Command Centre will be done by the system Integrators of the project. • JICA Study Team recommended to have a space for the meeting in the center and pointed out that the present Traffic Command Centre does not have such spaces. Chennai Traffic Police assured that it can be worked out according to the plan.
7	Number of signals to be taken for Phase 1 of the project	• Additional Commissioner of Police-Traffic informed that M/S Purple Infotech has already initiated the ITMS project and has set up traffic monitoring cameras at 10 junctions. Due to some issues between Chennai Traffic Police and M/s Purple Technologies, the project has been put on hold and a case has been filed at court. • Additional Commissioner of Police-Traffic informed that they are trying to sort the issues with M/S Purple InfoTech on ITMS project and start the implementation of the project as soon as possible. It was also informed that the decision on this issue will be taken in a month. • Additional Commissioner of Police-Traffic informed that they will try to replace the 100 ITMS locations provided to M/S Purple InfoTech from within the city to outside the city limits. • Additional Commissioner of Police-Traffic suggested that ITMS Project by Purple

No.	Items for discussion	Conclusion – Agreement
		Technologies and Project by JICA must be integrated. JICA Study Team explained that the signal systems by different projects, i.e. ITMS project and JICA project, will not be integrated and Chennai Traffic Police understood.
8	CCTV Cameras at Junctions	• JICA Study Team stated that the identified 159 junctions will include improvement of Traffic Signals and Sensors. • JICA Study Team suggested that the CCTV cameras for these areas be taken up by Chennai Police. Chennai Police stated that 200 CCTV cameras are to be installed under Nirbhaya Scheme – (A Scheme by Government of India for ensuring safety of women). • Mr. Raj Cherubal added that it has been planned by Chennai Smart City Limited to install 50 Cameras under the Surveillance plan of Chennai Smart City.

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Ref No: CPRR-MOM-MTC - 7

MEETING RECORD

Title	Meeting with MTC				
Date	Wednesday 19th December 2017			Time	15:00 – 15:30
Venue	MTC Head Quarters, Pallavan House, Anna Salai				
Participants	No.	Name	Position		
MTC	1	Mr.Thanigailingam	Joint Managing Director		
	2	Mr.Neduncheliyan	Deputy Manager – Commercial		
	3	Mr.Swaminathan	Assistant Manager – Pallavan Transport Consultancy Services		
	4	Mr.Prakasam	Project Officer, Pallavan Transport Consultancy Services		
	5	Mr.Bennet Rajan	Assistant Manager , Planning & Development		
	6	Mr.Manikkam	Assistant Manager , EDP		
	7	Mr.Manivannan	IT Manager, Electronic Data Processing		
JICA Study Team	1	Mr.Takayasu Nagai	Team Leader		
	2	Mr.Hiroya Totani	ITS Planning / Design 1		
	3	Mr.Noboru Kondo	ITS Planning / Design 2		
	4	Mr.Eiji Wakatsuki	ITS Operation		
	5	Mr.Nawaz	Engineer		
JICA	1 2	Mr Kenji Isomoto Mr.Fujiwara			
Smart City	1	Mr.Raj Cherubal	CEO		

Agenda:

No.	Items for discussion	Conclusion – Agreement
1	Confirmation on the Number of Buses	• MTC confirmed the following ✓ 3,774 (total number of MTC buses) ✓ 3,475 (in operation) • MTC also confirmed that the number of MTC buses is planned to be increased.
2	Large Bus Terminals	• MTC informed the Large Bus Terminals where the information boards are required to be installed are 1)Broadway 2)Avadi 3)Thiruvanmiyur 4)Tambaram 5) Poonamalle 6)CMBT • MTC confirmed that Tambaram & Poonamalle bus terminals are being maintained by Local Municipality. MTC confirmed that when VMS boards are installed in these Bus terminals, it will be owned by MTC. • JICA Study Team suggested that the Bus Bay Terminals such as Tambaram shall

No.	Items for discussion	Conclusion – Agreement
		not be included in the Project due to the reason that there is not proper locations for installation of information board. • It was agreed that the following bus terminals will be included for installation of the information board by the Project 1) Broadway 2) Avadi 3)Thiruvanmiyur 4) Poonamalle 5) T. Nagar 6) CMBT 7) Vadapalani • It was agreed that; ✓ One large information board will be installed at one bus terminal of above except CMBT ✓ Two large information boards will be installed at CMBT ✓ Small information boards at each plat form of the bus terminal will not be installed
3	Confirmation on the Number of Equipment	• It was agreed as follows: ✓ GPS Devices – 4000 Buses ✓ In Vehicle Camera- 1000 Buses ✓ In Vehicle LED Display – 1000 Buses • JICA suggested and MTC agreed that depending on the feedback from public, the number of in vehicle cameras, LED Displays will be increased at later stage. At first stage, MTC evaluates the effect of in-vehicle camera and LED board.
4	Mobile Application Development.	• MTC requested that a mobile application shall be developed by JICA project for the passengers to provide the expected arrival time of the bus at bus stops. JICA informed that it has not been considered as a part of this study. Smart city informed that it will consider with their own funds.
5	Data Storage and Hosting	• CSCL informed that the big data collected shall be stored in the cloud. JICA study team commented that TNSDC is proposed for data storage. CSCL mentioned comparing cost is important and will be finalized in the basic design stage.
6	Space for Control Center	• MTC confirmed the available space for Control Center. The space was inspected by JICA Study Team and required minor renovations were discussed. MTC also informed that if more space is required, it will be arranged. • Both parties agreed that the existing two rooms will be renovated to make it one large room for the command control center of city bus system.

Appendix-2: Correlationship of Concerned Organizations

Ministries and Related Organisations