Draft Specifications for ITS Components

27 January, 2015

JICA ITS Study Team

(Source: JICA Study Team)

Draft Specification for ITS Components

- Draft specifications, which present technical requirements for system, equipment and software comprising ITS component, have been prepared as the Study output.
- They will be a part of Tender Documents when a contractor for the supply and installation of ITS component is procured.

(Source: JICA Study Team)

ITS components proposed (1)

Draft specifications were prepared for the following four (4) ITS components:

- B-TIC system.
  - B-TIC centre system including software
  - Automatic traffic counter-cum-classifier system
  - Probe car system
  - Queue length measurement system
  - Variable message sign system
- Traffic signal system.
  - Control centre system including software
  - Intersection signal
  - Video vehicle detector

(Source: JICA Study Team)

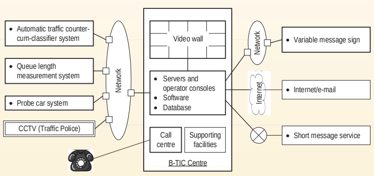
ITS components proposed (2)

- PRR toll management system (TMS)
  - Toll management centre system including software
  - Toll plaza system
  - Lane equipment including toll collection procedure
  - CCTV camera system
- PRR highway traffic management (HTMS) system
  - Control centre system including software
  - CCTV camera
  - Automatic traffic counter-cum-classifier (ATCC)
  - Variable message sign (VMS) system
  - Digital transmission system

(Source: JICA Study Team)

B-TIC System

- The system is composed of the following sub-systems
  - B-TIC centre system including software
  - Automatic traffic counter-cum-classifier (ATCC) system
  - Queue length measurement system
  - Probe car system
  - Variable message sign (VMS) system



(Source: JICA Study Team)

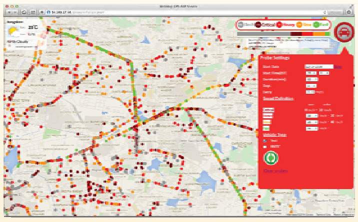
B-TIC ATCC System

- ATCC system collects traffic volume and speed data.

(Source: JICA Study Team)

Probe car system

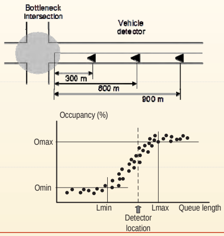
- Probe car system obtains bus location data from BMTC.
- After map matching process, the system calculate average section speed based on the bus movement data.



(Source: JICA Study Team)

Queue length measurement system

- Vehicle detector is installed at 300 m, 600 m, and 900 m from bottleneck intersection
- Existence of queue is judged on occupancy data collected by vehicle detector.
- Detectors are installed at approach where queue is created.



(Source: JICA Study Team)

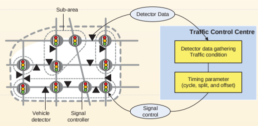
Variable message sign (VMS) system

- Road and traffic information is provided to road users through VMS.
- VMSs are installed in principle on radial roads at Outer Ring Road.

(Source: JICA Study Team)

Traffic Signal System

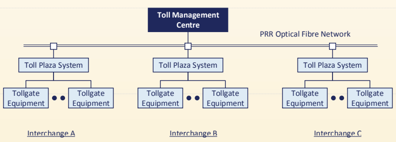
- New traffic responsive signal system that adjust signal timing based on the traffic data gathered by vehicle detector, will be introduced.
- System will be installed in three phases.



(Source: JICA Study Team)

PRR Toll Management System

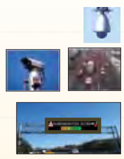
- Distance based toll (closed system) with tollgate at entry and exit.
- Toll payment method:
  - Cash
  - Touch and Go (with common mobility card)
  - ETC (DSRC with common mobility card)

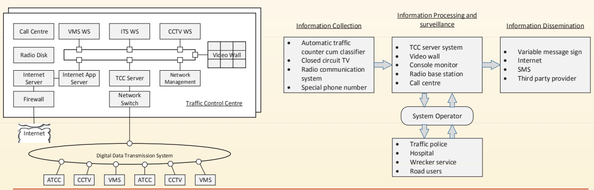


(Source: JICA Study Team)

PRR Highway Traffic Management System

- The system is composed of:
  - CCTV system
  - Automatic vehicle counter-cum-classifier
  - Variable message sign system
  - Digital transmission system





(Source: JICA Study Team)

Tender Documents

- Standard structure of tender documents
  1. Invitation for tender
  2. Instructions to tenderers
  3. Form of tender
  4. Pricing documents
  5. General conditions of contract
  6. Conditions of particular applications
  7. Employer's requirements Part A: General technical specifications
  8. Employer's requirements Part B: Particular technical specifications
  9. Employer's requirements Part C: Maintenance specifications
  10. Employer's requirements Part D: Drawings

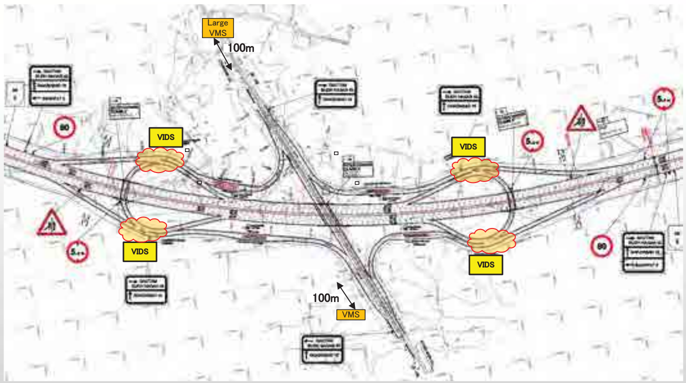
(Source: JICA Study Team)

ITS Master Plan
for
Bengaluru Metropolitan Area
(Coordination between Civil and ITS)

April 2015

JICA Study Team

2. Example of Wrong Design

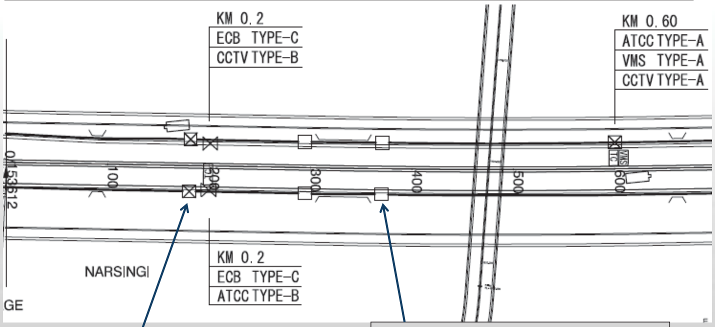


2. Example of Wrong Design

3. Examples of Problems during Civil Construction

Location of cable ducts and junction boxes

➢Cable ducts and junction boxes are important facilities to protect electronic and communication cables.

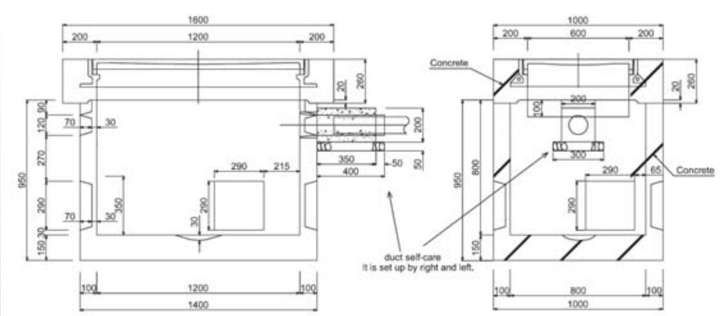


Junction Box with connection of cable

Junction Box without connection of cable

3. Examples of Problems during Civil Construction

Junction Box



3. Examples of Problems during Civil Construction

Cable duct in ground work section

➢Cable ducts should be properly buried under the ground surface at shoulder.

3. Examples of Problems during Civil Construction

Cable duct at bridge joint

➢Cable duct in hand rail should be connected by flexible joint duct so that it can move with bridge girder's movement.

Inflexible

Different height and impossible to connect

Flexible

(Source: JICA Study Team)

3. Examples of Problems during Civil Construction

Cable duct at end of bridge

➢Cable ducts need to be connected properly from handrail to ground.

Duct is exposed on water drain

Interrupted by support of light pole and impossible to connect

(Source: JICA Study Team)

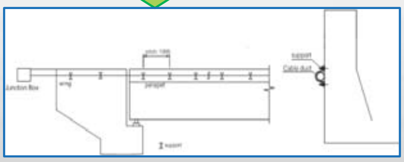
Connected properly by using flexible duct

3. Examples of Problems during Civil Construction

Cable duct

Duct is left up in the air

Cable duct was crushed



 (Source: JICA Study Team)

Thank You

 (Source: JICA Study Team)

ITS Master Plan for Bengaluru Metropolitan Area

(Outline of TMS for PRR)

April 2015

JICA Study Team

(Source: JICA Study Team)

1. Basic Concept of Toll Management System

1. **Closed System**
2. **Distance Based Toll**
3. **Three Collection Method**
   - Touch & Go system using prepaid smartcard
   - Electronic Toll Collection (ETC) system using OBU and prepaid smartcard
   - Cash using smartcard as transit card
4. **Toll Lane Type**
   - Manual and T&G lane
   - ETC Lane
5. **Restricted Vehicle Type to Enter PRR**
   - 2 Wheeler
   - Auto Rickshaw

 (Source: JICA Study Team)

2. Vehicle Classification

- Vehicle will be classified into 5 types and each class is defined by AVC which can measure physical properties such as
  - Number of axles
  - Vehicle height at first axle

Class	Vehicle Type
1	Car, Jeep, Van or Light motor vehicle
2	Light commercial vehicle, Light good vehicle, or Mini bus
3	Truck or Bus
4	Multi-axle vehicle (3 to 6 axles)
5	Oversized vehicle (7 or more axcls)

 (Source: JICA Study Team)

3. Exemption of Toll

VIP, Military Convoy, Patrol and Maintenance Vehicle for PRR, Police Vehicle, Ambulance will be exempted from toll payment.

VIP, Military Convoy

- IC receives the information about arrival of VIP or Military convoy in advance
- Toll gate will be opened manually under supervision of supervisor
- No data will be collected

Patrol/Maintenance Vehicle of PRR, Police Vehicle, Ambulance

- Special smartcard will be issued for these for vehicle on PRR from smart card management agency.
- Card can be used as ordinary smartcard but no toll is charged
- Smartcard cannot use for other purpose

Exempt vehicle image will be taken by CCTV and kept for verification

 (Source: JICA Study Team)

4. Trouble Handling

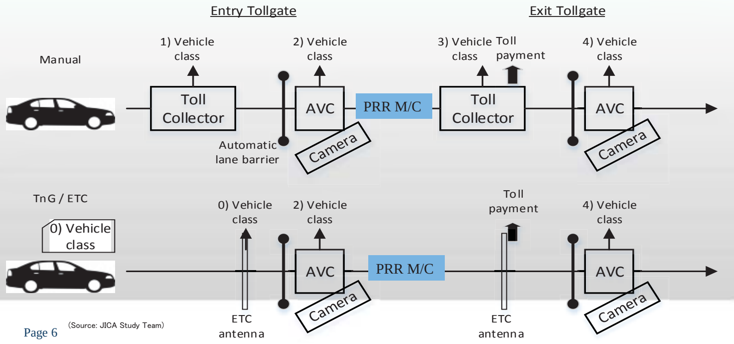
	Incident	Action
1	Transit card lost while on PRR	Toll from furthest IC is charged
2	Exit at entry IC	Toll from furthest IC is charged
3	Trip from downstream IC to upstream IC	Toll from furthest IC is charged
4	Excessive trip time	Toll from furthest IC is charged
5	Not enough cash at exit	Processed at office
6	Invalid/black listed card at entry (T&G, ETC)	Use manual system Check card at office if not blacklisted
7	Transit card read error at exit	Toll from entry IC claimed by driver if card is not damaged purposefully. Otherwise, toll from furthest IC is charged
8	T&G card read/write error at entry	Use manual system , Check card at office
9	T&G card read/write error at exit	Toll is settled with entry IC claimed by driver Check card at office
10	ETC read/write error at entry	Use manual system , Check OBU and card at office
11	ETC read/write error at exit	Toll is settled with entry IC claimed by driver Check OBU and card at office
12	Not enough balance in card at exit (T&G and ETC)	Pay in cash at lane or at office
13	Vehicle class discrepancy	*Next Sheet*

(Source: JICA Study Team)

5. Vehicle Class Discrepancy

Vehicle class is judged at several occasions by the TMS as listed below

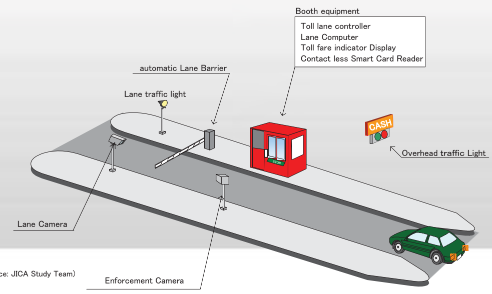
0) Vehicle class recorded in smart card (T&G, ETC)
1) Vehicle class judged by toll collector at entry (manual system)
2) Vehicle class judged by AVC at entry (manual, T&G, ETC)
3) Vehicle class judged by toll collector at exit (manual system)
4) Vehicle class judged by AVC at exit (manual, T&G, ETC)



 (Source: JICA Study Team)

5. Vehicle Class Discrepancy — Manual System

- 4 vehicle class data, two at entry and two at exit.
- If discrepancy is found among first 3 data (manual at entry, AVC at entry and manual at exit), vehicle class identified by toll collector at exit is used for toll payment.
- Any discrepancy among the vehicle class data including class identified by AVC at exit, is recorded in the transaction database together with the identification of toll collector at entry and exit and image of vehicle taken by CCTV. The data is used to review the classification reliability of AVC and performance of toll collector.



(Source: JICA Study Team)

5. Vehicle Class Discrepancy — T&G, ETC System

- T&G and ETC uses 3 class data (class in smart card, AVC at entry and AVC at exit).
- The action to be taken in case of discrepancy is:

A) Discrepancy between class in card and class by AVC at entry

No action is taken at entry as vehicle class is judged by AVC after automatic lane barrier. However, discrepancy is recorded and reported to the Centre together with image of vehicle taken by CCTV for investigation.

B) Discrepancy between class by AVC at exit and other data

Vehicle will be charged with the class recorded in the smart card. The discrepancy is recorded and reported to the Centre together with image of vehicle taken by CCTV for investigation.

C) Investigation at Centre

At Centre, number plate of the vehicle that caused discrepancy is identified based on the image taken by the CCTV and registration data of the vehicle is retrieved. If discrepancy is caused by the use of smartcard of different vehicle class from the vehicle that actually used the card, the card is blacklisted and blocked from further use.

(Source: JICA Study Team)

6. Smartcard

T&G ETC smartcard

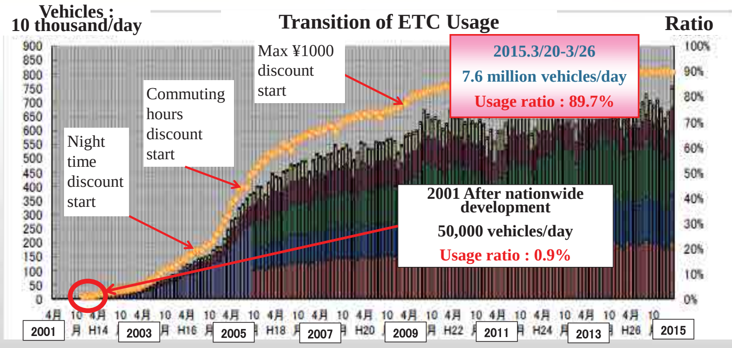
- Smartcard for T&G and ETC will be compatible with the common smartcard in State.
- Purchase of card and recharge of pre-paid amount will be prepared at IC office.

Transit Card

- Transit card also uses smartcard but much simpler data structure inside the card
- It is reusable around 5 lakh times

(Source: JICA Study Team)

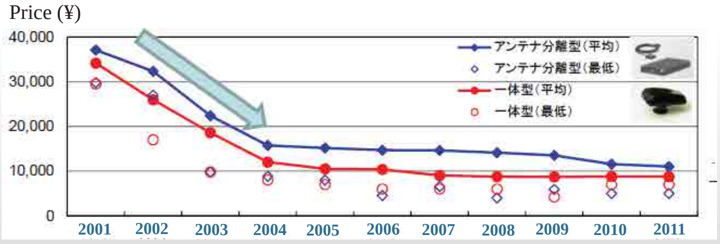
7. Transition of ETC Usage



(Source: JICA Study Team)

7. Transition of ETC Usage

OBU Price



(Source: JICA Study Team)

7. Transition of ETC Usage

	1月	2月	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月
2001	—	—	—	7,200	8,000	9,500	10,200	14,100	18,700	19,800	23,700	51,600
	—	—	—	—	—	—	—	—	—	—	—	0.9%
2002	58,000	75,700	92,800	114,600	130,700	147,900	171,600	185,200	198,300	212,700	230,200	235,000
	1.1%	1.4%	1.6%	2.0%	2.2%	2.5%	2.8%	2.9%	3.2%	3.4%	3.6%	3.8%
2003	240,000	270,300	[illegible]	[illegible]	402,000	451,500	530,400	603,600	676,100	733,600	794,000	872,700
	4.2%	4.4%	4.7%	5.6%	6.4%	7.2%	8.1%	8.9%	10.4%	11.4%	12.2%	12.7%
2004	990,700	1,019,300	1,357,000	1,237,600	1,238,600		1,440,600	1,470,600	1,537,300	1,578,800	1,828,700	1,862,300
	13.8%	14.8%	15.8%	17.1%	18.6%	18.9%	19.2%	19.0%	20.9%	21.7%	23.0%	25.5%
2005	1,872,100	2,163,200	2,484,200	2,815,500	2,393,200	3,254,500	3,383,300	3,598,700	3,732,000	3,815,500	[illegible]	4,014,600
	27.8%	31.0%	32.9%	37.9%	39.5%	43.9%	44.1%	44.1%	48.8%	50.0%	52.4%	54.2%
2006	3,735,100	4,173,600	4,485,000	4,383,200	4,327,400	4,550,300	4,809,600	4,304,600	4,775,200	4,815,700	4,939,100	4,903,600
	54.5%	57.4%	67.0%	58.7%	58.5%	61.6%	60.6%	56.0%	62.8%	63.1%	64.1%	64.7%
2007	4,546,200	4,981,400	5,192,900	5,087,800	5,028,000	5,167,100	5,198,000	5,502,000	5,291,000	5,382,000	5,506,000	5,332,000
	64.7%	66.3%	68.1%	66.8%	66.7%	68.3%	68.1%	68.4%	68.9%	70.1%	70.7%	71.0%
2008	4,983,000	5,249,600	5,612,000	5,529,000	5,381,000	5,253,000	5,820,000	5,583,000	5,585,000	5,670,000	5,742,000	5,631,000
	71.3%	73.0%	71.9%	73.1%	72.4%	74.0%	73.5%	71.5%	73.8%	74.5%	74.8%	75.4%
2009	5,246,000	5,495,000	5,842,000	5,902,000	5,981,000	6,021,000	6,310,000	6,742,000	6,571,000	6,413,000	6,483,000	6,353,000
	75.8%	76.8%	77.0%	79.5%	80.2%	80.8%	81.0%	81.3%	82.3%	82.8%	83.0%	82.9%
2010	6,078,000	6,250,000	6,137,000	6,525,000	6,539,000	6,501,000	6,312,000	6,628,000	6,341,000	6,253,000	6,386,000	6,247,000
	83.9%	84.0%	83.7%	84.4%	84.6%	84.3%	85.5%	85.2%	85.8%	85.6%	86.1%	86.0%
2011	5,772,000	6,038,000	5,658,000	6,004,000	6,025,000	6,276,000	6,581,000	6,960,000	6,590,000	6,621,000	6,701,000	6,633,000
	86.6%	86.8%	86.2%	86.5%	87.0%	86.8%	85.3%	85.0%	85.9%	85.6%	86.0%	86.0%
2012	5,909,000	6,096,000	6,591,000	6,639,000	6,635,000	6,567,000	6,867,000	7,287,000	6,839,000	6,934,000	7,009,000	6,740,000
	86.9%	87.3%	86.9%	87.2%	87.4%	87.5%	87.3%	87.0%	87.6%	87.7%	88.0%	87.9%
2013	6,234,000	6,606,000	7,115,000	6,897,000	6,987,000	6,399,000	7,314,000	7,585,000	7,198,000	7,128,000	7,383,000	7,117,000
	89.3%	88.5%	88.2%	88.7%	88.8%	89.0%	88.8%	88.4%	89.0%	89.4%	89.4%	89.2%
2014	6,733,000	6,389,000	7,476,000	6,835,000	6,979,000	6,765,000	7,015,000	7,352,000	7,072,000	6,912,000	7,098,000	6,889,000
	89.6%	89.6%	89.7%	89.9%	89.9%	89.9%	89.7%	89.2%	89.6%	89.6%	89.7%	89.6%
2015	6,488,000	6,886,000										
	90.1%	90.0%										

(Source: JICA Study Team)

7. Transition of ETC Usage

Transition of Estimated Usage ratio of smartcard user for PRR

- **From Japanese practice, it may increase 2% naturally**
- **Big discount is not considered**
- **The price down of OBU is not considered**

	2021	2022	2023	2024	2025
ETC usage ratio (%)	2	2	2	2	2
①Accumulated total (ETC) (%)	2	4	6	8	10
T&G usage ratio (%)	8	3	3	3	3
②Accumulated total (T&G) (%)	8	11	14	17	20
Accumulated total of smartcard (%) ①+②	10	15	20	25	30

(Source: JICA Study Team)

8. Conceptual Design: PRR ITS

Toll Management System (TMS)

Purpose

To manage toll collection on PRR: Type of toll collection and capacity

- **ETC Lane (Over 800 vehicles/hr)**
- **T&G and Manual Lane**
  (T&G:230 v/hr) (Manual:230v/hr for entry, 100v/hr for exit)

ETC


Smartcard inserted into OBU

T&G


Holding smartcard over a card reader

(Source: JICA Study Team)

9. Estimation of required number of lanes(ETC, T&G, Manual)

Calculation Step

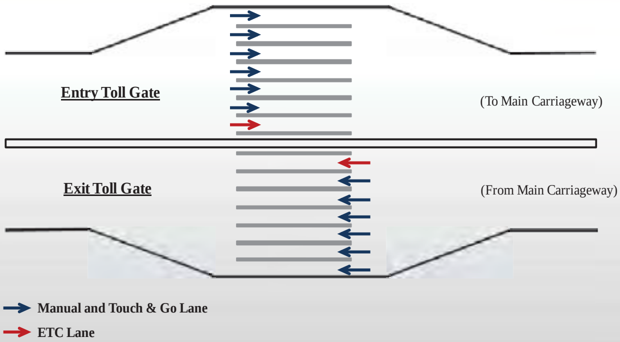
1. Find the peak hours traffic volume for each vehicle types
2. Decide the target year of maximum traffic volume
3. Decide the usage ratio of ETC and T&G
4. Decide the capacity of each toll collection method for both entry and exit
5. Decide the how much queue shall be accepted

- All lane width should be same, so it will be easy to increase the number of ETC lane in future.
- Island of ETC lane is 5m longer than manual lane, so required number of ETC lanes at target years should be estimated and construct same length.

(Source: JICA Study Team)

9. Estimation of number of ETC lanes

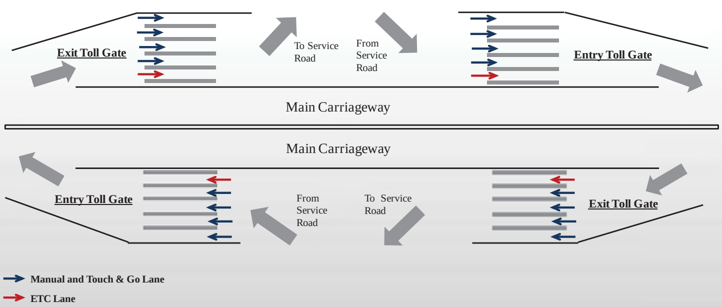
PRR TMS (Toll Barrier Type IC Structure)



(Source: JICA Study Team)

11. Organization Structure

PRR TMS (Diamond Type IC Structure)



(Source: JICA Study Team)

Thank You

(Source: JICA Study Team)

Appendix - 7

ITS Technical Tour

JICA COUNTERPART TRAINING FOR
" THE MASTER PLAN STUDY ON THE INTRODUCTION OF INTELLIGENT TRANSPORT SYSTEM IN BANGALORE AND MYSORE"

SINGAPORE AND JAPAN

2nd November to 13th November

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Background

The Directorate of Urban Land Transport (DULT) with the assistance from Japan International Cooperation Agency (JICA) is preparing the Intelligent Transport System (ITS) Master Plan for Bangalore and Mysore. For the purpose of preparation of ITS Master Plan and provide inputs to the master plan study team, a Technical Advisory Group (TAG) has been formed with representation from all the stakeholders. The scope of the ITS Master Plan also consists of building the capacity of stakeholders to implement the proposals from the ITS Master Plan. In this regard, a counterpart training at Singapore and Japan was organized by the JICA study team for selected members of the TAG.

1.2 Purpose of Counterpart Training

The purpose of the training was to expose the stakeholders of Bengaluru and Mysuru to some of the best practices of ITS in Singapore and Japan. The training was designed specifically to introduce the participants of the training to ERP, EPS, traffic control center, automated data sensing and collection system, ETC, and other urban transit systems.

1.3 Members in Counterpart Training

The list of the members who attended the counterpart training is provided in the table below.

No.	Name	Designation	Department

1	Mr. P.N.Nayak	Engineer Member	BDA
2	Mr. Hemantha Kumar L	Managing Director	DDUTTL
3	Mr. Ravikumar P	Joint Director	CDAC
4	Mr. Syed Afsar Pasha	Asst. Commissioner Police	BTP
5	Mr. Umashankar	Executive Engineer	BBMP
6	Mr. Basavaraj Kabade	Executive Engineer	BBMP
7	Mr. Shivananda K R	Deputy Chief Engineer	BMRCL
8	Mr. Nagendra	Divisional Traffic Officer	BMTC
9	Mr. S. Rajesh	Divisional Traffic Officer	KSRTC
10	Mr. R.P. Ashok	Police Inspector	MTP
11	Mr. Shamanth Kuchangi	Technical Head	DULT
12	Mr.Sivasubramaniam J	Transport Planner	DULT

1.4 Counterpart Training Itinerary

Date	Country	Place and Organization	Topics for Learning
Nov.3 (Mon)	Singapore	**MHI** Mitsubishi Heavy Industries Engine System Asia PTE LTD Traffic Control & Transportation Division	- State-of-Art Technology of Next Generation ERP - Electronic Parking Technology ERP and EPS Site visit - Actual Practice of EPR and EPS at Site - Components of ERP Facilities and Their Purposes
Nov.4 (Tue)		**Land Transport Authority** ITSC River Vally	- Outline, Roles and Activities of LTA - Traffic Management Policy of Congestion Charging - Outline of ERP System - Step-wise Implementation
Nov 6 (Thus)	Japan	**JICA Tokyo**	- Briefing by JICA Headquarters in Tokyo
		Nippon Koei, Tokyo	- Policy and Strategy of ITS in Japan - ITS Technology in Japan
Nov 7 (Fri)		**Tokyo Metropolitan Police**	- Facilities, Policies, Operation and Management of Traffic Control by
		VICS Center, Tokyo	- Police in Metropolitan Area - Scheme and Method of Vehicle Information and Communication System-

		Hitachi ,Tokyo	- Leading ITS Technology - Concept and Key Technologies of Smart City
DATE	Country	Place and Orginasation	Topics for Learning
Nov 8 (Sat)	Japan	**E-NEXCO** **Trans Tokyo-bay Aqua line**	- The points of planning and efficient Use of Road Infrastructure and Related Facilities
Nov 9 (Sun)		**Koyto**	Site visit
Nov 10 (Mon)		**Nagoya Electric Works Co., Ltd.** **Nagoya Guide way Bus Co. Ltd.**	- - Explanation of multi colore, multi display VMS - Facilities, Operation and Maintenance of BRT - Connectivity and Information Provision of Public Transport
Nov 11 (Tus)		MHI , Kobe	- Mechanism of Toll Collection System - Advantages of DSRC Technology - Differences in Technology e.g. RFID, DSRC, etc. - ERP and ETC test track - Followed with site vist to Akashi bridge
Nov 12 (Wed)		JICA ,Tokyo	- Outline and Key Concept of ITS ” by Institute of Industrial Science, The University of Tokyo - Signal Control and Traffic Management in Urban City - Wrap up meeting

2. ITS IN SINGAPORE

2.1 ERP System in Singapore

Singapore has adopted the Electronic Road Pricing (ERP) system, which is an automated congestion pricing scheme, to manage traffic demand on the roads. The system uses open road tolling, where-in the vehicles do not stop or slow down to pay tolls. The scheme consists of ERP gantries located at all roads linking leading into the Singapore's central business district. They are also located along the expressways and arterial roads with heavy traffic to discourage usage during peak hours. The gantry system consists of two gantries, with sensors and enforcement cameras on one gantry and another set of sensors on the second gantry. Automated NumberPlate Recognition (ANPR)cameras are used for enforcement of violators. Currentlythere are about 80 ERP gantries installed in Singapore.

ERP Gantry and IBU observed in Singapore

A device known as an In-vehicle Unit (IU) is affixed on the lower right corner of the front windscreen within sight of the driver, in which a stored-value card (cash card), is inserted for payment of the road usage charges. The second generation IU accepts contactless cash card and EZ-Link. The cost of an IU is S$150. It is mandatory for all Singapore-registered vehicles to be fitted with an IU if they wish to use the priced roads. When a vehicle equipped with an IU passes under an ERP gantry, a road usage charge is deducted from the cash card in the IU. Sensors installed on the gantries communicate with the IU via a dedicated short-range communication system (DSRC), and the deducted amount is displayed to the driver on an LCD screen of the IU. The charge for passing through a gantry depends on the location and time, the peak hours being the most expensive. If a vehicle owner does not have sufficient value in their cash card (or EZ-Link) when passing through an ERP, the owner receives a fine by post within two weeks. The violator must pay the ERP charges plus a $10 administration fee within two weeks of the notice. Online payment is allowed; listing just the Vehicle Registration Number is required. Otherwise, a penalty of S$70 is issued by registered post to the vehicle owner, which rises to S$1000, or one month in jail, if not settled within 30 days.

ERP pricing is subjected to revision every three months after analyzing the operating speeds on the roadway within the ERP zone. On expressways the ERP rates are increased when the average speed drops below 45kmph and rates are decreased when the average speed is above 65kmph. Similarly on other roads the rates are increased when the speed drops below 20kmph and rates decreased for speeds below 30kmph.

Singapore is also considering next generation ERP system, where the gantry-less GPRS systems is being experimented.

2.2 EPS System in Singapore

In Singapore, the IBU used for paying ERP is also used for off-street parking payment. Entry to the designated parking area is controlled by barriers. The DSRC antenna at the Entry Gate reads the Cash Card and records the time of entry to the parking area. The Exit gate DSRC antenna reads the Cash Card at exit and debits the parking charge based on the duration, time and class of vehicle. The Exit Gate barrier will open on payment of the parking fee. Provision for manually paying the parking fee also is provided at the Exit Gate. Advantage of using the ERP technology for the Electronic Parking is the usage of same cash card for both applications. A demonstration of EPS at MHI office was provided to the study team as shown in the figure below. Parking at undesignated parking places was almost non-existent due to strict enforcement.

EPS Demonstration at MHI, Singapore

2.3 Intelligent Transport System Centre (ITSC) in Singapore

The ITSC is housed in the Land Transport Authority (LTA) of Singapore and manages traffic flow on the roads and maintains the associate Intelligent Transport System (ITS) infrastructure. The ITS infrastructure spans over 161 km of expressways and road tunnel systems in Singapore.The Operation Control Centre (OCC) operates 24/7 and is responsible for collecting data, analysis and dissemination of information. The ITSC operates several modules as listed below to manage traffic in an effective manner.

- **Expressway Monitoring & Advisory System (EMAS)** to monitor traffic along expressways and alert motorists for any incidents.
- **Green Link Determining System (GLIDE)** to monitor and optimize green time to provide "green-wave" along main roads in response to changing traffic demand.
- **Junction Electronic Eyes** to consist of surveillance cameras to monitor traffic at major signalized junctions.
- **E-Traffic Scan** to use taxis equipped with Global Positioning System as probes.
- **Green Man+** to extend green time for elderly and pedestrians with disabilities to cross the road.
- **Your Speed Sign** to display the real time speed of vehicles and alerts motorists when they over-speed.
- **Parking Guidance System** to provide real-time information on available parking spaces.

3. ITS IN JAPAN

3.1 Lectures/Presentations

Several presentations were organized to share information on various ITS implementations in Japan.

Presentations by members of ITS Japan were provided on the overall focus of ITS in Japan, the role of ITS Japan as an organization and the interaction of private-government in effective implementation of ITS. It was explained in these presentations that the nine focus areas for ITS in Japan are:

1. Advances in Navigation System
2. Electronic Toll Collection System

3. Assistance for Safe Driving
4. Optimization of Traffic Management
5. Increasing Efficiency of Commercial Vehicle Operation
6. Support for Public Transport
7. Increasing Efficiency of Road Management
8. Support for Pedestrians
9. Support for Emergency Vehicle Operation

ITS Japan Presentations at Nippon Koei

Presentation on concepts and key technologies of Smart City was presented by Hitachi, which included concepts for advanced traffic control systems.

Other presentations included an outline and key concepts of ITS by Prof. Kamijyo, where basic concepts of ITS was elaborated and also the participants were exposed to the on-going research in ITS. Some concepts of signal control and traffic management in urban areas was presented by Mr. Yokoi.

These presentations were very useful to the training participants as it provided the requisite background to understand the workings of various ITS systems that were demonstrated.

3.2 Visits to Traffic Information/Control Centre

<u>Tokyo Traffic Control Centre</u>

Tokyo's Integrated Traffic Control Systems (ITCS) is a large-scale traffic management system that ensures safe and smooth road traffic in Tokyo region. This system realizes optimal traffic management for cities and environment by providing traffic information via various media and controlling signals based on the result of traffic information analysis collected by detectors on roads.

Tokyo's ITCS has three display boards - the Expressway Display Board, Central Display Board, and Information Display Board. The display boards depicts the traffic condition on the roadways by analyzing information collected from cameras, vehicle detectors, helicopters, police, citizen reports. The traffic condition on roads is displayed by color coded maps, where roads in red indicate congestion, while green indicates free-flow. Location, time and status of traffic accidents, road closures are also indicated on these maps.

The information analyzed in the traffic control center is disseminated to road users in various ways as follows.

- Variable Message Signs
- Preset Message Boards
- Car Information Display
- Parking Guidance System
- Roadside Radio Transmitter
- Telephonic Information Service
- etc.

Vehicle Information Communication System (VICS)

VICS provides detailed real-time traffic information to drivers. VICS information (on traffic congestion, road regulations etc) is edited and processed at the VICS Centre and is then transmitted in real time to car navigation systems where it is displayed in text and graphic form. VICS enables drivers to select the shortest, most convenient routes available, and ensures that traffic is distributed smoothly. Congestion and restriction information is collected by the highway operators and the local police as a part of their daily activity and the Japan Road Traffic Information Centre integrates the information provided by the respective agencies. Parking availability is collected by the individual parking operators.

Objectives:

Provision of accurate and timely real-time information in order to alleviate problems of congestion, traffic emissions and environmental degradation, increased travel times; navigation around cities, many of which have narrow and winding road networks and lack of parking facilities; and to make roads safer and more driver-friendly.

Technical details:

- Collection of accurate information – on congestion levels, restrictions, parking space availability, etc.
- Information processing – data is collected and integrated automatically by the seven national VICS centres.
- Information transmission – information is transmitted through three media: radio beacons on highways, light beacons on the major normal roads and FM multiplex broadcasts. Each of the radio beacons covers a 70 m zone, with a communication speed of 64 Kbps. A single round of information contains 8,000 characters, which is updated every 5 minutes.
- Infra-red light beacons double as vehicle censors to collect traffic information. They are located along major roads in the city area, covering a 3.5 m zone, with a communication speed of 1 Mbps. A single round of information contains 10,000 characters, which is also updated every 5 minutes. These can be customized for each location to provide area specific information. FM mutiplex broadcasts can provide

more generic information to wider areas. This uses FM radio broadcast facilities at NHK that covers 10-50 km radius within the transmission antenna. Data speed is 16Kbps, with 50,000 characters broadcasted continuously also updated every 5 minutes.

3.3 Industry Visits

Mitsubishi Heavy Industries Ltd (MHI).

The study team visited the MHI office and were presented with various ITS products and implementation of MHI in ERP and EPS systems. The study was taken a test course within the MHI campus to witness ERP test with DSRC and RFID. In these tests cars fitted with DSRC and RFID were driven at different speeds ranging from 10 km/hr to 40 km/hr and the time taken for toll gate to open on time was observed. The team observed at even at 40 km/hr speed, there was hardly any noticeable difference in toll operation speed between DSRC and RFID. The MHI informed that DSRC is more dependable compared to RFID in terms of recognition under real-time conditions.

Nagoya Electricals

The study team visited the Nagoya Electricals, a manufacturer of Variable Message Sign boards. The officials from Nagoya Electricals presented on various VMS sign boards that are manufactured in their industry, such as multi-color sign boards, custom designed sign boards, etc. The study team was also taken to the workshop where different sign boards were on display. First ever VMS to be manufactures was also on display at the workshop. The team also witnessed a simulated rain test that is usually carried out on VMS sign boards to ensure they withstand and work during stormy weather conditions.

3.4 Other Site Visits

<u>Trans-Tokyo-bay Aqua line</u>

The Tokyo Bay Aqua-Line also known as the Trans-Tokyo Bay Highway is a bridge–tunnel combination across Tokyo Bay in Japan. It connects the city of Kawasaki in Kanagawa Prefecture with the city of Kisarazu in Chiba Prefecture, and forms part of National Route 409. With an overall length of 14 km, it includes a 4.4 km bridge and 9.6 km tunnel underneath the bay—the fourth-longest underwater tunnel in the world.

At the bridge–tunnel crossover point, there is an artificial island called Umihotaru (literally meaning "sea firefly") with a rest area consisting of restaurants, shops and amusement facilities. Air is supplied to the tunnel by a distinctive tower in the middle of the tunnel, called the Kaze no To (the tower of wind), which uses the bay's almost-constant winds as a power source.

The road opened on December 18, 1997 after 23 years of planning and 9 years of construction at a cost of 1.44 trillion Yen (11.2 billion USD at the time of opening). The Tokyo Bay Aqua-Line reduced the drive between Chiba and Kanagawa, two important industrial regions, from 90 to 15 minutes and also contributed to cutting the travel time to the sea leisure area in the southern part of the Bōsō Peninsula from Tokyo and Kanagawa. Before the tunnel opened, one had to drive around about 100 km along the shores of Tokyo Bay and pass through downtown Tokyo.

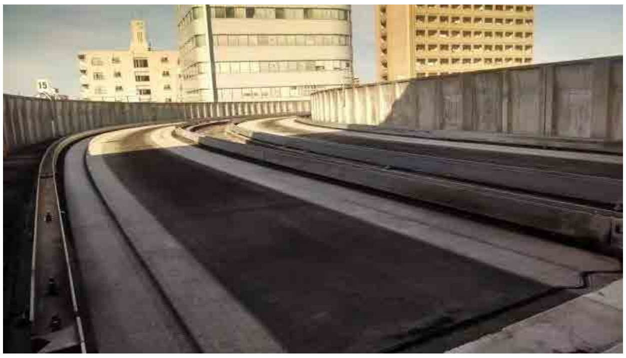
Akashi Kaikyo Bridge

The Akashi Kaikyo Suspension Bridge is the longest suspension bridge in the world. It took two million workers ten years to construct the bridge, 181,000 tonnes of steel and 1.4million cubic metres of concrete. It has six lanes and links the island of Awaji and the mainland city of Kobe, a distance of four miles. The concept of building a bridge across the Akashi Straits became urgent after a disaster in 1955. A ferry carrying over one hundred children sank after colliding with another ferry, in the busy shipping lane. One hundred and sixty eight children and adults died in the disaster. Political pressure for a bridge increased and in 1988 construction began.

The Akashi Straits is four miles wide at the bridge site with sea depths of one hundred metres and currents averaging fourteen kmph. The Akashi Straits is one of the busiest sea lanes in the world with over a thousand ships per day travelling through it. Furthermore, the bridge is in a typhoon region in which winds can reach speeds of 290 kmph. The construction of a suspension bridge involves the use of two main cables stretching between two towers. The roadway beneath these is suspended by more cables. To stop the towers, roadway and cables collapsing, they are held at either end by large anchor blocks (the Akashi anchor blocks weigh 350 000 tonnes).

<u>Nagoya Guided Busway System</u>

Yutorito Line is a bus rapid transit line in Nagoya, Aichi, Japan. The line is officially called Guideway Bus Shidami Line. Its official nickname, Yutorīto Line, is a portmanteau of yutori (relaxed) and street. The line is owned by Nagoya Guideway Bus. The whole line opened on March 23, 2001. The line consists of the guided bus segment on a viaduct dedicated track in central Nagoya and the ordinary bus segment on public road. Vehicles go directly between the two segments. The guided bus segment runs between Ozone, Higashi Ward and Obata Ryokuchi, Moriyama Ward. Nagoya Guideway Bus manages the guideway facilities and cars, while Nagoya Municipal Bus operates buses on the line. This is the only guided bus line in Japan. The line is legally considered as a sort of railway, like monorails or automated guideway transits in the country.



4 LESSONS LEARNT

This technical study tour provided a lot of insight to the participants. All the participants got a view first-hand the workings of ITS systems and also to see how these ITS systems have benefitted Singapore and cities in Japan in terms of improving mobility for their people and in effective traffic management. The presentations and lectures on various topics in ITS provided the participants with the necessary background in full understanding the ITS systems. The insights obtained in tour will be beneficial to all the participants to plan and implement ITS in an orderly manner in Bengaluru and Mysuru. In addition to the above learning, some specific observation derived from this study tour is detailed below.

- Importance ofa centralized decision making and planning for urban transport organization
  Visit to LTA in Singapore made the participants realize that an empowered centralized decision making and implementation organization was key to successful integration of various transport and related implementations.
- Importance of basic infrastructure
  The study team realized that for ITS implementations to be successfully in achieving the desired outcome, basic roadway infrastructure is essential. Some basic roadway infrastructure like good pavement, uniform cross-section of roadway, pedestrian infrastructure, pavement markings at junctions, proper provision of parking infrastructure, etc.

- Importance of Traffic Information and Control Centre:
  As cities grow, road networks within the city expands and managing traffic manually becomes impossible, an efficient traffic information and control Centre is a requirement. Such centers provide an opportunity to gather network-wide data, analyze the data

efficiently and disseminate as necessary. Such centers become a place for various agencies responsible for managing cities to come together and co-ordinate.

- Need for efficient mass transport systems with well-designed transfer facilities.

  Cities with well-designed mass transport systems result in less dependent on private vehicle usage and hence reduce congestion and air pollution in cities. In Japan the team experienced how seamless it was to travel across the cities using multiple mass transport systems due to well-designed transfers and frequent availability if trains to all destinations.

- Necessity of common Mobility Card:

  The members of the study team were provided with a common mobility card in Japan. The members of the team were amazed at the convenience that such a card could bring in improving travel experience. With the mobility card in hand, the team could seamlessly walk into any transit system, may it be heavy rail, metro, bus and travel without having to queue for purchase of tickets or being bothered about having the right amount to purchase tickets. When thirsty, the team was pleasantly surprised that they could quench their thirst with the same mobility card, the mobility card doubled as pre-paid cash card that could be used for shopping.

- Walking as a preferable mode for first and last mile connectivity:

  The team observed that most people walked to transit stations. Team walked 10-15 minutes to take metro from the JICA center at Tokyo to venture out into the city. Inter-connected underground paths, well maintained footpaths gave way ample opportunity for the team to walk many kilometers daily and all these walking seamed easy and tireless due to well-designed facilities for walking.

- People and their behavior.

  Last but not the least, the disciple of people whether driving on road, using the escalator, getting in and out of rail, following signage and markings is key to smooth functioning of any transport systems. Such disciplines behavior should be enforced.

5 ACKNOWLEDGEMENTS

The study team would like to acknowledge the Commissioner of DULT for her vision and spearheading the ITS Master Plan for Bengaluru and Mysuru and according permission for this training to happen as duly planned. The study would like to thank the JICA staff for extending their cooperation during this training and for organizing various useful presentations and site visits. The team also would like to thank the JICA study team housed in DULT for organizing and coordinating this training program and for all help in making necessary arrangements for the study team members during this program.

Appendix - 8

Photo

Photos Taken during study of ITS master Plan for Bengaluru and Mysore

Vehicle Accidents in Bengaluru:


(Source: JICA Study Team)


(Source: JICA Study Team)

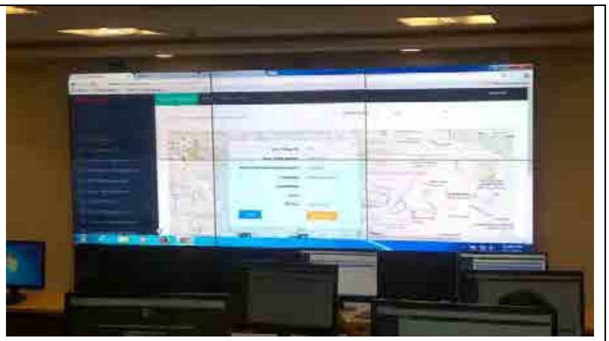
Bengaluru BMTC City Bus

(Source: JICA Study Team)


(Source: JICA Study Team)

BMTC Control Centre


(Source: JICA Study Team)


(Source: JICA Study Team)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Traffic Management Centre of Bengaluru Traffic Police


(Source: JICA Study Team)


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(Source: JICA Study Team)


(Source: JICA Study Team)


(Source: JICA Study Team)

Bicycle Sharing

(Source: JICA Study Team)


(Source: JICA Study Team)


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Bengaluru Metro


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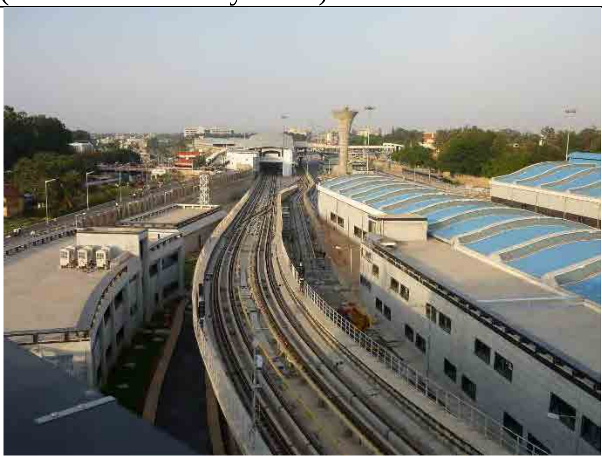
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Flooding of Bengaluru Roads When Rained

(Source: JICA Study Team)

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Footpaths in Bengaluru


(Source: JICA Study Team)


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Road Junctions in Bengaluru with Traffic Signal and CCTV


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On Road Parking in Bengaluru

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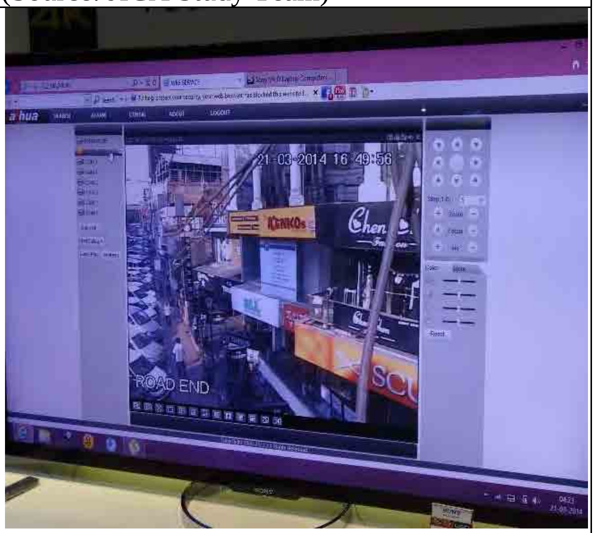
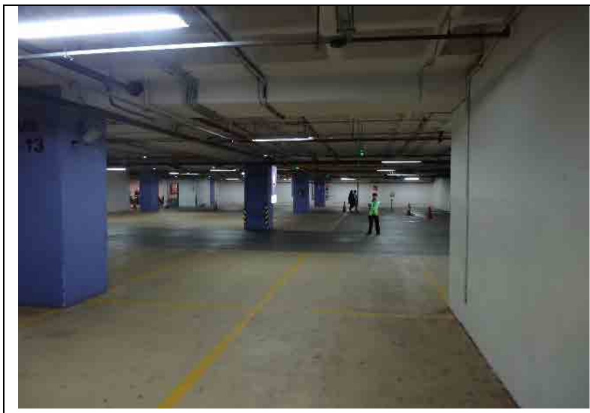
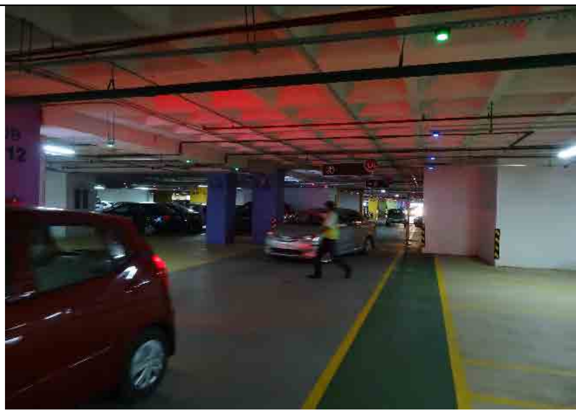


(Source: JICA Study Team)

Off Road Parking in Bengaluru

 (Source: JICA Study Team)	 (Source: JICA Study Team)
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Cycle Day in Bengaluru

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Auto Rickshaw

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Mysore KSRTC Buses, Passenger Information System

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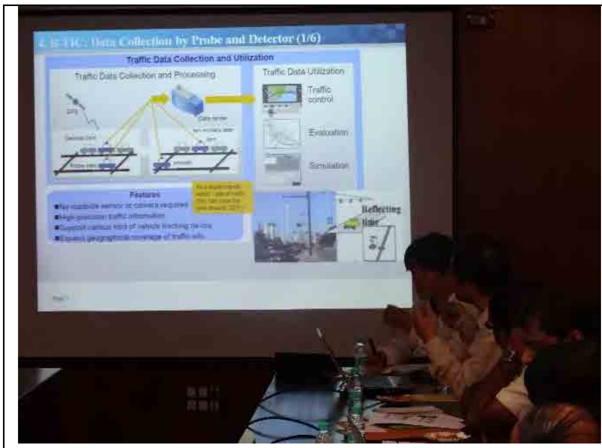
TAG Meeting Photos



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TAG ERP Meeting Photos

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