CHAPTER 17
METRO MANILA ROUTE GUIDANCE SYSTEM

17.1 INTRODUCTION

17.1.1 Background

With the pronouncement made by Chairman Tolentino way back September 2010 that "The internet is a good medium to effectively communicate with the public. We intend to make full use of all available technologies and resources to deliver on time and up-to-date information to the public."

MMDA in 2010 launched the twitter account, Facebook page and the Metro Manila Traffic Navigator.

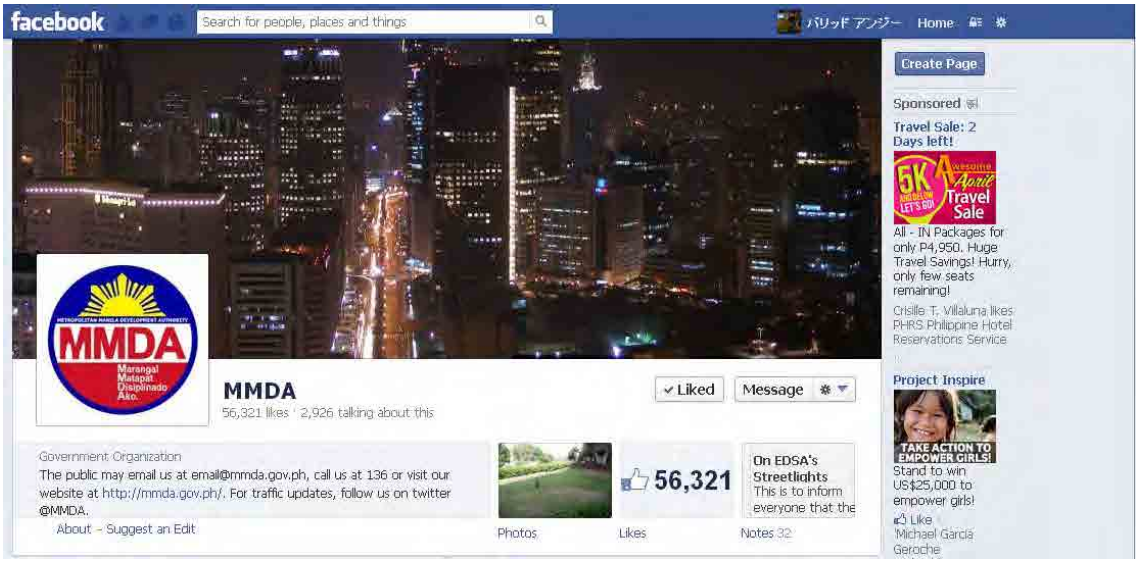
Source: MMDA ***http://www.mmda.gov.ph/***

FIGURE 17.1-1 OUTLINE OF TRAFFIC NAVIGATOR

As of April 2013, the MMDA twitter accounts have soared to 530,799 followers.
In the same manner the Facebook page got 56,321 likes.

Source: MMDA Twitter https://twitter.com/MMDA

FIGURE 17.1-2 "TWITTER" ACCOUNT OF TRAFFIC NAVIGATOR



Source: MMDA Facebook http://www.facebook.com/MMDAPH

FIGURE 17.1-3 "FACEBOOK" ACCOUNT OF TRAFFIC NAVIGATOR

The MMDA-TV5 Metro Manila Traffic Navigator which was launched just last year has considerably increased the numbers of downloads.

- For iOS which was released Sep. 2011 had 175,778 downloads.
- For Android which was released Nov. 2011 also had 54,742 downloads.
- For Blackberry which was released March 2012 had 45,786 downloads.

However, congestion is still occurring. In order to improve the traffic condition, MMDA is scheduled for the advancement of Traffic Navigator.

17.1.2 Objectives

In order to ease traffic congestion in Metro Manila while minimizing the impact on the current traffic demand and spending on infrastructure development, a method which promotes spatial dispersion of the traffic demand is effective. To achieve such spatial dispersion, “precise understanding of the traffic condition” and “effective sending of information on traffic condition” would be required.

One of the methods to obtain “precise understanding of the traffic condition” is to gather information on temporal-spatial migration of vehicles via GPS as represented by FCD (Floating Car Data). In order to ensure the credibility of spatiotemporal data, it is necessary to obtain many samples, and thus it is also crucial to develop a mechanism for obtaining a large number of samples. However, FCD alone is not sufficient to understand the entire situation. It should be noted that an appropriate setting in coordination with other information sources such as vehicle detectors and CCTV would be required.

As to “effective sending of information on traffic condition”, it is based on the data collected under the assumption of “precise understanding of the traffic condition”. The spatial dispersion of traffic demand is achieved by providing drivers an optimum route based on the comparison of real-time travel times of selected multiple routes according to their OD (Origin-Destination) request.

Furthermore, dispersion of the traffic demand is possible not only in terms of space but also time. However, temporal dispersion requires more than understanding and providing the current situation, that is, optimization of the departure time through provision of a series of situations with temporal continuity (including future situations).

In this discussion, we aim to provide traffic information which would ease traffic congestions through promoting temporal-spatial dispersion of the traffic based on inducing the traffic demand to less congested route/time.

17.2 TRAFFIC NAVIGATOR

17.2.1 Function of Traffic Navigator at Present

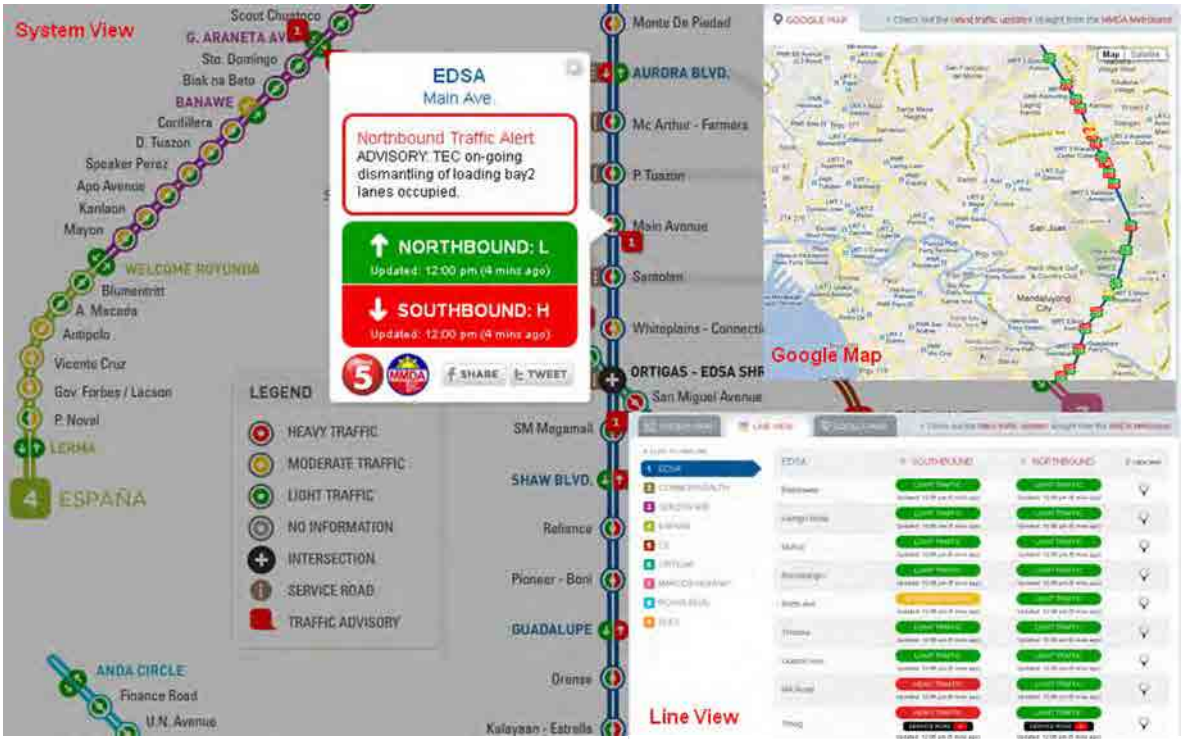
This Traffic Navigator consists of 9 lines which can be seen in three different views depending on preference.

1) System View
2) Line View, favorable to those who are familiar with the place, user could easily see the traffic status
3) Google Map, favorable to those who are not familiar with the place and has to rely solely in the map of his/her whereto, in this Google map view only 1 specific line can be seen.

The traffic condition is classified as heavy traffic represented on the map by flaming red color, moderate traffic represented by the orange color, light traffic represented by the green color, and no information is represented by the grey color.

Traffic Advisory is likewise indicated with a drop-down shout out stating any road construction, events, incidents, crashes, etc, that could create a heavy traffic congestion.

The present traffic navigator is doing well, but some more enhancements can be done to provide more accurate information.



Source: MMDA http://www.mmda.gov.ph/

FIGURE 17.2-1 VIEW SAMPLE OF TRAFFIC NAVIGATOR FOR PC

Source: MMDA http://www.mmda.gov.ph/

FIGURE 17.2-2 VIEW SAMPLE OF TRAFFIC NAVIGATOR FOR SMARTPHONE

Source: MMDA http://www.mmda.gov.ph/

FIGURE 17.2-3 SCREEN TRANSITION OF TRAFFIC NAVIGATOR FOR SMARTPHONE

17.2.2 Agendas of Traffic Navigator

The following challenges (issues to be solved) of the current Traffic Navigator has been identified in order to build an advanced Traffic Navigator.

(1) Segmentation of Digital Road Map

As to the display method, the PC version is designed by TV5 while the smartphone version is designed by MMDA, and there are discrepancies between the two versions. However, they have the same base for segmentation (location of nodes). Their display methods need to be standardized so that there would be no confusion for the users.

The location of nodes is based on the traffic condition. For example, even though the distance among Santolan－Main Avenue－P. Tuazon is very short, nodes are located because their traffic conditions may be different. We should pay attention to this point upon developing a DRM (Digital Road Map), and make sure to divide the link at all junctions and intersections for route searching.

Currently, Traffic Navigator utilizes Google Map as its map data. Since developing a DRM which also covers minor streets takes time, utilization of Google Map for the time being is reasonable. However, because Google Map is not precise in terms of the number of lanes and the width of roads, it would be difficult to meet the requirements for the advanced Traffic Navigator. MMDA has a plan to cover all roads, including minor streets, in the provision of traffic information. Therefore, it seems necessary for the government of the Philippines to develop its own DRM in the future in cooperation with organizations such as NAMRIA (National Mapping and Resource Information Authority), as the basic condition of realizing traffic information input on the layer image and GIS (Geographic Information System).

(2) Data Collection

Currently, collection of the data on traffic condition depends on subjective and fragmented information via Twitter as SNS (Social Networking Service), traffic enforcers and CCTV, and thus has not reached a sufficient level of data collection. In the future plan, such data collection will be replaced with objective and spatial data collection based on FCD from buses, taxis and logistics vendors. There is also a plan of FCD data collection via smartphones. Although the amount of such data will be limited for the time being, it is expected to increase steadily as utilization of FCD expands in the future. Appropriate collection of information not only through FCD but also in coordination with CCTV, SNS, and VD (Vehicle Detector) is also considered.

Currently, only the data collected by MMDA (including some expressway companies) is in use, and there is no coordination with other agencies. However, there is a plan to share incident information from other agencies including DPWH, Fire Department and LGU through a service called WebEOC (http://www.esi911.com/esi/), which could be the groundwork for developing an information layer function.

(3) Data Processing

Under the current Traffic Navigator, a subjective traffic condition definition is manually made and provided. In order for the users to search for an optimum route by themselves and to estimate a traffic condition, an objective and standardized definition rather than a subjective guessing and introduction of automatic judgment via a traffic control system would be required.

(4) Others

On the current interface screen, not all routes are displayed on the map. In a case of using multiple routes, a complicated navigation operation is required. A modification to display all routes in the same map would be necessary.

At the same time, routes covered for information provision are limited, and thus it is not possible to search an optimum route from multiple routes. Therefore, it is necessary to expand the coverage of routes available for information provision.

The provision of travel time information via VMS (Valuable Message Signboard) is a function requested by Chairman Tolentino, who actually observed it when he was in Japan. Although it is wished to provide travel time information from the position of VMS installation to a destination as well as the information on traffic congestion, searching for an optimum route as an objective decision-making indicator is not possible because the current data is not based on the required time. Therefore, improvement of this point is also expected. MMDA is willing to introduce real time simulation in the future for projection of traffic congestions. For this to happen, it is essential not only to collect quality and sufficient amount of traffic data but also to introduce a traffic control technology based on traffic engineering.

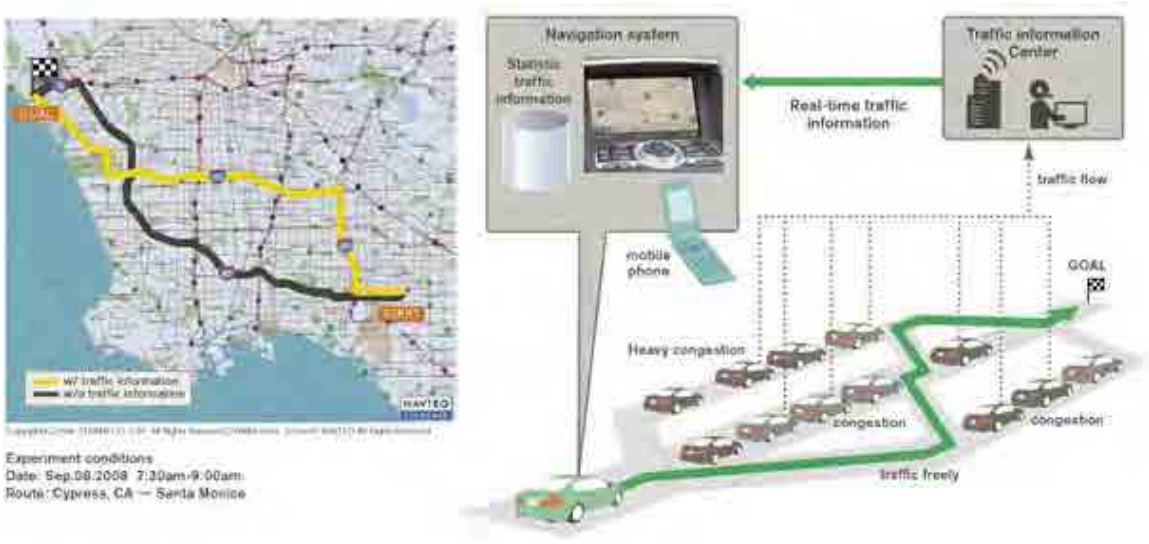
17.3 REFERENCE CASE FOR INSPIRATION

17.3.1 Traffic Information and Route Guidance Provision

The basic requirement for route guidance provision is that it conducts search and provides route information using the latest available data to the destination previously entered or designated by the user. It is either to provide information on a fixed route (e.g. information provided by VMS) or to provide an optimal route out of multiple routes (e.g. information provided by a car navigation system or a smartphone). In both cases, the objective is to provide updated route information based on the latest traffic condition from a device located along the road or from location information via a mobile device (e.g. car navigation system). Generally, an optimum route means a route where the required travel time to the destination would be minimized. However, there are other systems which provide an optimum route based on other conditions such as distance, cost, carbon dioxide emission, and a particular user request (e.g. a scenic route).

Source: FHWA HP http://www.fhwa.dot.gov/publications/publicroads/10septoct/02.cfm

FIGURE 17.3-1 TRAVEL TIME PROVISION AT ROADSIDE



*Source: NISSAN HP **http://www.nissan-global.com/EN/TECHNOLOGY/OVERVIEW/drgs.html***

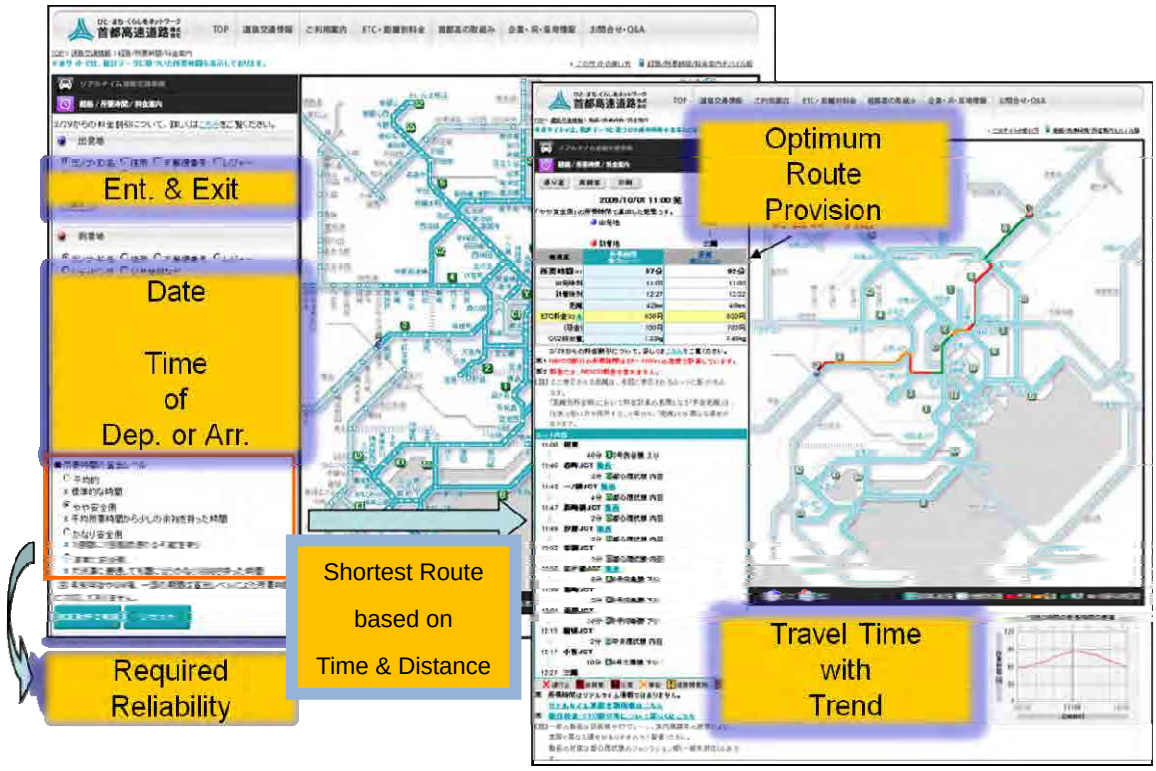
FIGURE 17.3-2 OPTIMUM ROUTE GUIDANCE

Source: HYUNDAI USA HP https://www.hyundaiusa.com

FIGURE 17.3-3 TRAVEL TIME PROVISION USING CAR NAVIGATION

Provision of optimum route information promotes dispersion of road usage, which results in easing traffic congestions. There are abundant examples regarding such technologies including information provision via VMS and via car navigation systems in vehicles that are being driven.

On the other hand, to provide Travel Time with Trend and Reliability based on big statistical data is expected for the drivers to choose optimum time and routes. That means traffic-demand is distributed by Time & Route. Recently, information provision based on such technology is on the rise.



Source: Tokyo Metropolitan Expressway HP http://www.shutoko.jp/traffic/route-time/

FIGURE 17.3-4 IMAGE OF ROUTE GUIDANCE PROVISION WITH TREND AND RELIABILITY

17.3.2 Advanced Collection of Traffic and Road Condition by Using FCD (Floating Car Data) and SNS

(1) InterNavi (Honda)

1) General Description

InterNavi is a service provided for users of Honda vehicles with a InterNavi-capable navigation system. The user must also have membership of InterNavi-Link-Premium Club.

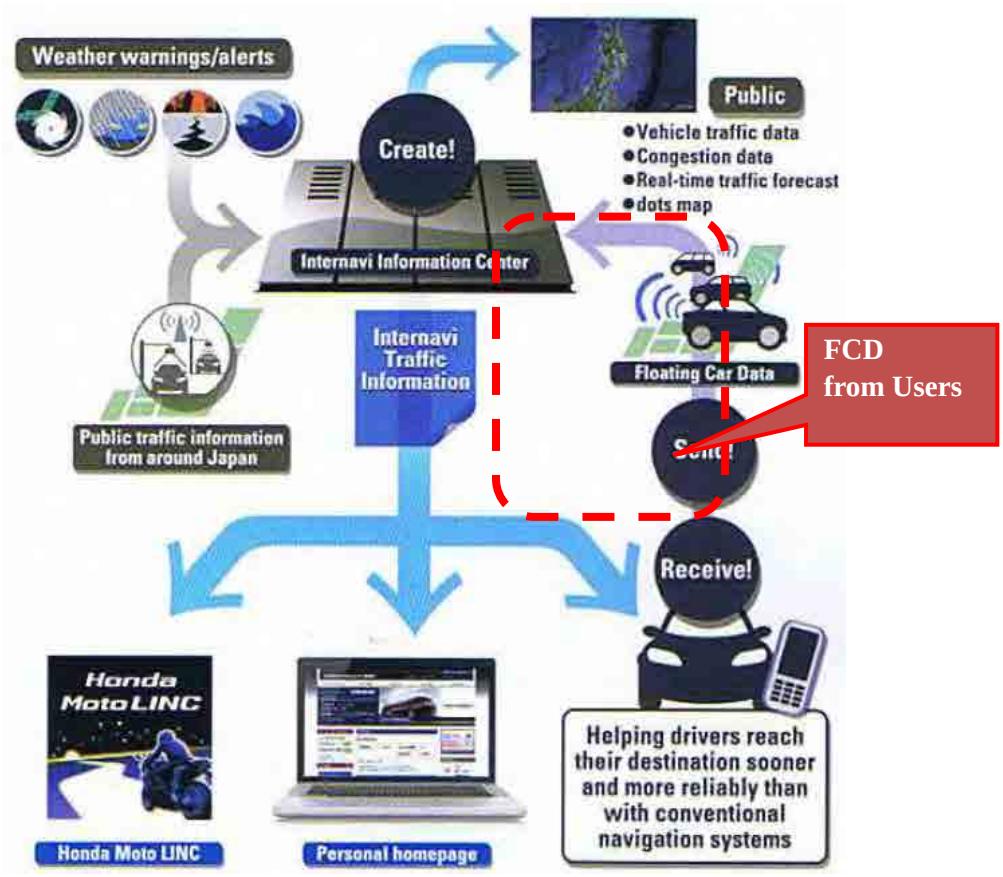
InterNavi utilizes data automatically collected from the members who agreed to send their FCD

to the information server. The service provides optimum route guidance in consideration of projected traffic jams. It also provides optimal route guidance based on various other conditions such as environment and driving safety. Examples include providing a route with least energy consumption and travelable routes at the time of a disaster/emergency. It also generates a Near-miss Map (a map which indicates locations with a potential risk of traffic accidents).

The FCD is statistically processed and sold to third parties.

Figure 17.3-5 describes collection and provision of FCD via Honda's InterNavi system.

The traffic information is generated based on FCD collected via InterNavi, which is combined and analyzed together with various public traffic information (purchased from JARTIC; Japan Road Traffic Information Center) and weather forecast data.



Source: Honda InterNavi materials

FIGURE 17.3-5 IMAGINARY OF THE COLLECTION AND PROVISION USING FLOATING CAR DATA IN INTERNAVI

2) Mission of the Data Collection

The service obtains FCD which provides real-time information on traffic congestion in order to improve accuracy of predicted arrival time in the route guidance via car navigation. It is

intended to increase the number of Honda vehicle sales by providing a unique and highly accurate route guidance service as more added value to Honda users.

Therefore, the service is only available for Honda vehicle drivers.

3) Users Incentive

The users send their FCD by activating the two-way communication function on an InterNavi-capable car navigation device. The services such as dynamic route guidance which considers real-time traffic congestion are only available for users who send their FCD.

In short, the users receive more specific traffic information and route guidance for providing their FCD.

4) Method of the Data Transmission

The users connect their mobile phone to an InterNavi-capable car navigation device and send their FCD to the InterNavi information server via a data communication service of the mobile phone network. Alternatively, they send their FCD to the InterNavi information server by using the InterNavi application for smartphones. In both cases, a wireless communication such as GSM/3G is required to use the service.

5) Users Imposition

Initially, the users need to purchase an InterNavi-capable car navigation device as well as to have a GSM/3G mobile phone service. Alternatively, in the case of Honda vehicle drivers, they need to have a GSM/3G smartphone and to install the application to use the service (available for free of charge).

The users are able to choose a “flat-rate pricing plan for car navigation (approx. PHP100/month)”, the plan is provided by Softbank (one of the mobile communication companies in Japan.

Additionally, there is a service which provides communication for free of charge if the users have a car navigation device designated by InterNavi with a built-in communication function (Link-up Free Service).

6) Disclosure of Information to a Third Party

The terms and conditions of the membership explicitly state that the collected floating car data will be statistically processed and provided to third parties. Therefore, the statistical data based on the user FCD could be provided to third parties whether or not compensation is received.

(2) INRIX

1) General Description

INRIX is a traffic information provider which integrates various FCD collected from smartphone applications and GPS tracking equipment, etc. and construction and other information collected via vehicle detectors held by public organizations. It has branch offices in over 30 countries including the US and Canada, and collects and provides traffic information in cooperation with over 130 customers and partner companies/organizations, such as automobile manufactures (e.g. Audi, BMW, Ford, Mazda, Toyota, Land-Rover, and Mercedes-Benz) and public organizations (e.g. Department of Transportation of each state). (See **Figure 17.3-6**)

Unlike other private sector companies such as Waze (to be referred in the later section), INRIX ensures quality of its traffic information by having a partnership with public organizations, and the data is also used for policy assessment such as effectiveness of public works. (See Figure 17.3-8)

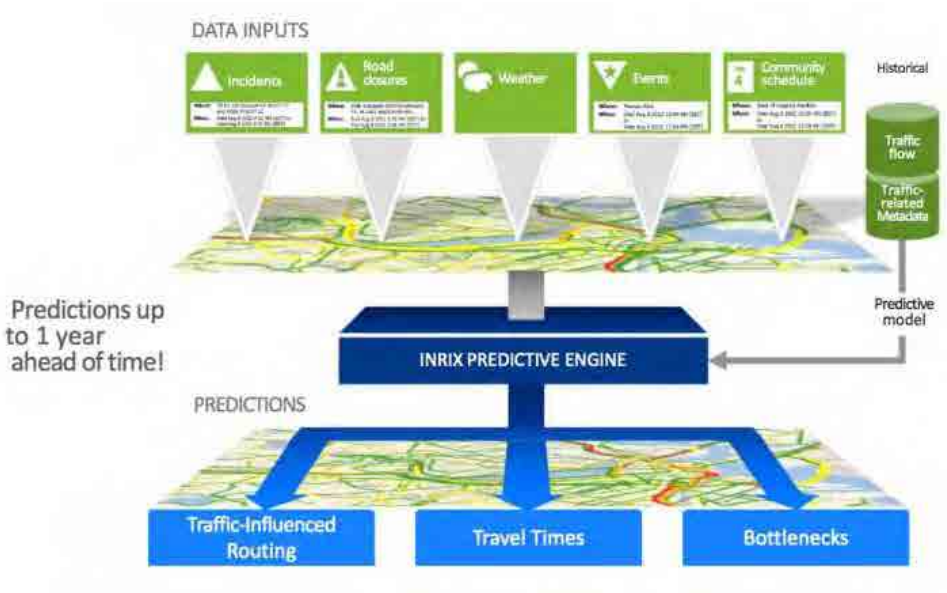
INRIX conducts predictions up to one year ahead of time based on the accumulated historical data and information on incidents, road closures and weather, and captures information regarding traffic-influenced routing, travel time and traffic bottlenecks. (See **Figure 17.3-7**)

a) Mission of the Data Collection

The collected data is used not only for providing traffic information such as traffic-optimized routes, real-time traffic report and traffic forecast but also for measures taken by public sectors regarding traffic operations, performance measures and dynamic message sign controlling. The data is also used by logistics and other service providers for their dispatch service, fastest routes planning and others.

Source: INRIX http://www.inrix.com/

FIGURE 17.3-6 IMAGINARY OF THE COLLECTION AND INTEGRATION IN INRIX



Source: INRIX http://www.inrix.com/

FIGURE 17.3-7 PREDICTION OF TRAFFIC CONDITION USING FLOATING CAR DATA IN INRIX

Congested Corridors *(U.S. Only for 2011)*

INRIX

Metro: (すべて) Select Time: Peak Hours

2011 Rank	Metro	2010 Rank	Roadway: From -> To	Length (Miles)	Worst Peak (AM/PM)	Travel Time (Mins)	Average Speed (Mph)	Delay (Mins)	INRIX Index	Index change 2010-2011
1	Los Angeles	2	I-405 NB: from I-105/IMPERIAL HWY to GETTY ..	13.1	PM					
2	New York	1	Long Island Expy EB: from MAURICE AVE/EXIT ..	16.0	PM					
3	Los Angeles	7	I-10 EB: from CA-1/LINCOLN BLVD/EXIT 1B to A..	14.9	PM					
4	New York	9	Van Wyck Expy NB: from BELT PKWY/EXIT 1 to ..	3.1	PM					
5	Los Angeles	3	I-5 SB: from EAST CEASAR CHAVEZ AVE to VA..	17.5	PM					
6	New York	8	Brooklyn Queens Expy SB: from NY-25A/NORTH..	10.2	PM					
7	Los Angeles	24	I-405 SB: from NORDHOFF ST to MULHOLLAN..	8.1	AM					
8	New York	6	Van Wyck Expy SB: from HORACE HARDING E..	6.2	PM					
9	Pittsburgh	15	I-279 NB: from LYDIA ST/EXIT 2 to US-19 TK RT..	3.4	AM					
10	San Francisco	13	CA-4 EB: from BAILEY RD to SOMERSVILLE RD	5.8	PM					
11	Riverside	5	CA-91 EB: from CA-55/COSTA MESA FWY to M..	20.7	PM					
12	Los Angeles	28	CA-110 NB: from I-10/SANTA MONICA FWY to S..	3.1	PM					
13	Miami	42	Dolphin Expy WB: from I-95 to FL-969/RED RD	5.5	PM					
14	Chicago	4	I-90/I-94 WB (Dan Ryan/Kennedy Expys): from P..	15.9	PM					
15	Boston	16	I-93 NB: from MA-28/RANDOLPH AVE/EXIT 5 to ..	10.4	AM					
16	Los Angeles	19	I-105 EB: from NASH ST to I-605	17.6	PM					
17	Chicago	34	Stevenson SB: from STATE ST/EXIT 293C to PU..	5.7	PM					
18	Los Angeles	10	I-10 EB: from CITY TERRACE DR/HERBERT AV..	12.8	PM					
19	Honolulu	35	I-1 EB: from HI-92 to S VINEYARD BLVD/WARD ..	3.9	PM					
20	New York	11	Cross Bronx Expy WB: from CONNER ST/EXIT 1..	11.3	PM					
21	Washington, DC	14	I-95 SB: from I-395 to RUSSELL RD/EXIT 148	23.9	PM					
22	Chicago	83	Eisenhower WB: from S ASHLAND AVE/EXIT 28..	8.9	PM					
23	Los Angeles	36	I-10 WB: from I-5/GOLDEN STATE FWY to NATI..	12.6	AM					

Source: INRIX http://www.inrix.com/

FIGURE 17.3-8 CONGESTED CORRIDORS OF USA AS PERFORMANCE INDEX BY USING INRIX'S DATA

b) Users Incentive

When the users run the dedicated application (distributed by INRIX for free of charge) via a smartphone in vehicle which are being driven, their FCD is automatically accumulated in the server of INRIX. The users, in return, receive various types of real time information on road and traffic conditions (e.g. traffic congestions and accidents), weather disasters, and so on. They are also able to receive other information such as predicted travel time from the current location to the destination and optimized routes. (See **Figure 17.3-9**)

Source: INRIX http://www.inrix.com/

FIGURE 17.3-9 IMAGINARY OF THE COLLECTION AND PROVISION USING FLOATING CAR DATA IN INRIX

c) Method of Data Transmission

If the smartphone application is in use, FCD is sent to the INRIX Server via a mobile communication network such as GSM/3G embedded in the smartphone. If a car navigation device or a digital tachograph device is used, data transmission is conducted according to the communication function of the particular device. However, in many cases, the transmission is likely to be conducted via a mobile communication network (i.e. GSM/3G), as well.

d) Users Imposition

When the users drive running the smartphone application or the dedicated INRIX device, their FCD and device IDs are automatically sent to and accumulated in the INRIX Server, and the users share real-time road and traffic information in return.

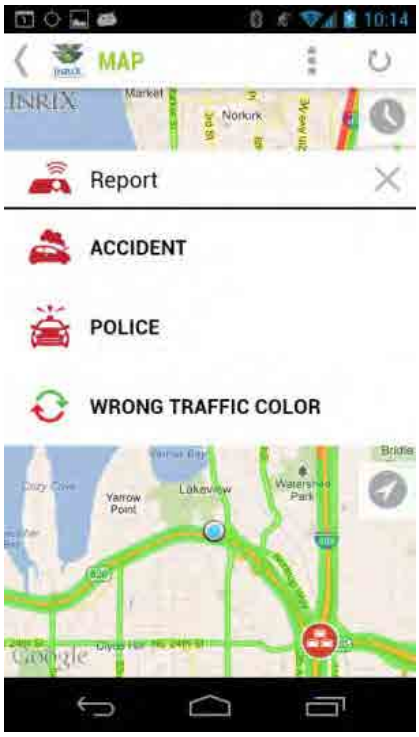
e) Disclosure of the Information to a Third Party

The users must agree to provide the device ID of their smartphone, an e-mail address and their FCD before starting to use the service. They are also requested to allow automatic and immediate start of the INRIX application right after starting the operation system such as Android and iOS. In this way, the location and other information is constantly collected via smartphones and other mobile devices.

The terms and conditions also include that the collected information are shared with the following organizations.

- within our group of companies
- with other people and businesses who help us provide our app and related services to you
- with any new business partners we may have over time
  (e.g. for a joint venture, reorganization, merger or sale affecting us)
- with our professional advisors (e.g. lawyers and technology consultants)
- where we are legally obliged to do so (e.g. to comply with a lawful government request)

Alternative Route Guidance



Submission of Report

Source: INRIX http://www.inrix.com/

FIGURE 17.3-10 USER INTERFACE OF INRIX APPLICATION

(3) Waze

1) General Description

Waze is a social mobile application which combines a mobile navigation system and a SNS. On top of sharing FCD based on GPS information, the users are also able to share traffic information such as congestions and accidents among others. The service also has a function to edit road information such as city/suburb name, street number, street name, and a digital road map. For example, selecting “Pave” function in Waze and making multiple travels on a road which is not on the existing digital road map, a new road is generated based on the FCD and reflected in the digital road map.

The number of Waze users around the world is approximately 36 million (Source: Waze, as of the end of 2012), although the number of users within the Philippines is not known. See **Figure 17.3-11** for Waze user interface screens.

Navigation User Interface

Menu of Report

Purchase Point

Waze (2012)

Source: Waze HP ***http://www.waze.com/***

FIGURE 17.3-11 WAZE

a) Mission of the Data Collection

Waze is provided to general individual users for free of charge. In Israel where the headquarters of Waze is located, the collected FCD and other information are provided for profit to corporations and other users according to their particular requests (such as DRM and traffic information). However, as of March 2013, a fee-based service does not exist other than Israel. In the US, the data is provided for free of charge to TV traffic information channels such as ABC. According to Waze in the US, the service is provided for free of charge because the current top priority is to increase the number of Waze users.

Waze provides a LBS (Location Base Service) not only in Israel but also in the US, and utilizes it for so called the “O2O (Offline to Offline)” service which distributes advertisement of the customers to the users.

Along with the rapid increase in the number of users, the company has developed a partnership

with car navigation manufacturers such as Clarion and Pioneer. As a result, the Waze application is one of the recommended vehicle device applications of these manufacturers to be connected with the users' smartphones.

*LBS
It is a collective term for services which mainly utilize location information. Examples of the services utilizing LBS include displaying of the current location on the map and introduction of sales/event information of the nearby stores.

Source: Clarion USA HP http://www.clarion.com/us/en/top.html

FIGURE 17.3-12 "WAZE" ON CLARION ON-BOARD-UNIT

Source: PIONEER USA HP http://www.pioneerelectronics.com/PUSA/

FIGURE 17.3-13 "WAZE" ON PIONEER ON-BOARD-UNIT

b) User Incentive

When the users run Waze in the vehicle that is being driven, their FCD and the device ID are automatically accumulated in the server of Waze. This makes other users to share real time road and traffic information.

The users are also able to exchange and share various kinds of information (e.g. traffic conditions and accidents, weather disasters) among themselves.

Furthermore, the users earn points according to their usage of the service, and obtain a special

avatar (an icon to show the current location on the map while using Waze) based on the number of points and the current rank. The users collect points when sending FCD and traffic congestion/incident information, and/or when passing the location where a particular icon is placed on the road map.

c) Method of Data Transmission

The service is provided through a smartphone application, and the data is collected via mobile communication networks (GSM/3G).

d) Users Imposition

The users must have a smartphone which has GSM/3G wireless communication functions. However, both the application and use of various kinds of information shared among the users are free of charge.

However, corporate users must pay a fee for using map and/or traffic information collected and updated by the users.

e) Disclosure of the Information to a Third Party

The users must agree to provide the device ID of their smartphone, an e-mail address and their FCD before start using Waze. In the terms and conditions, it is stated that their private information including their FCD is not provided to other companies, except for the associated and partner companies of Waze.

The Waze application has a function to link with SNS services such as Foursquare and Facebook.

The service also has a function to share event information (e.g. traffic congestion/incident and police enforcement) among the users. However, there is no function to cancel the sent data after completion of investigation on traffic incidents/ease of traffic congestion.

The collected information is accumulated in the servers located in Israel and the US, and only Waze can review and summarize the information. According to an interview to a partner agent of Waze, Waze may allow modification of the current application or use of the collected information by partner companies upon their request if it leads to provision of useful information which could increase the number of users. However, at present, even Waze agents are not in the position to review the information without any restriction.

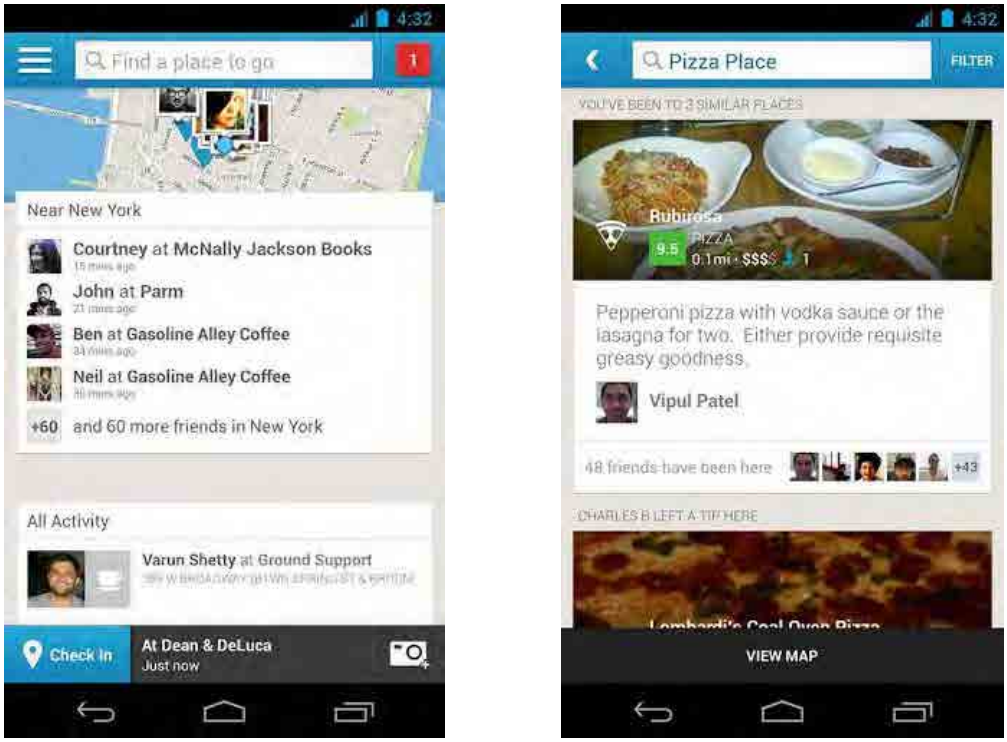
(4) Foursquare

1) General Description

Foursquare is one of the social network services which use location information.

The service is provided via various devices such as a web browser, mobile phones and smartphones. The users “Check In” when they make a visit to a particular place, and can share the information with friends who are also Foursquare users. At the time of “Check In”, the users can also send pictures taken at the place as well as comments, and earn points according to the number of “Check In” and the category of the visit.

Foursquare’s users interface of Smartphone Application as shown in **Figure 17.3-14**.



Sharing and Check In User Interface　　Shop Information and User Comment

Source : Google Play ***https://play.google.com/store***

FIGURE 17.3-14 USER INTERFACE OF FOURSQUARE

a) Mission of the Data Collection

The purpose of obtaining information from the users is to use it for the function of LBS. Foursquare has a partnership with commercial vendors such as Starbucks, Pepsi and McDonald, and displays nearby shops and other information advertisements according to the users’ location information. Furthermore, in London, the number of “Check In” of the users at major train/bus stations, airports etc. is summarized for a survey purpose.

b) Users' Incentive

The users can share information among friends who are also Foursquare users. They can also obtain word-of-mouth store information from other users. They earn points and receive a title called "Badge" according to their service usage. There is also a mechanism that a user who checked in the same place and sent comments and pictures most will become "Mayor" of the place.

In some cases, such loyal customers with the status of Mayor are rewarded with specials such as receiving a lunch voucher. In this way, the application has been actively utilized in the real business and services.

c) Method of the Data Transmission

When the service is provided through a mobile phone or a smartphone, the data is collected via mobile communication networks (GSM/3G).

d) Users' Imposition

The users must have a smartphone which has GSM/3G mobile communication functions. However, both the application and various pieces of information shared among the users are free of charge.

e) Disclosure of the Information to a Third Party

The users must agree to provide an e-mail address, location and other information before start using Foursquare. In the terms and conditions, it is stated that the private information including the location information is not provided to other companies, except for the associated and partner companies of Foursquare.

It should be noted that accuracy of the location and other information of the service is not secured because the users can access to Foursquare homepage and "Check In" from a personal computer at work or at home, without actually being present at the particular location.

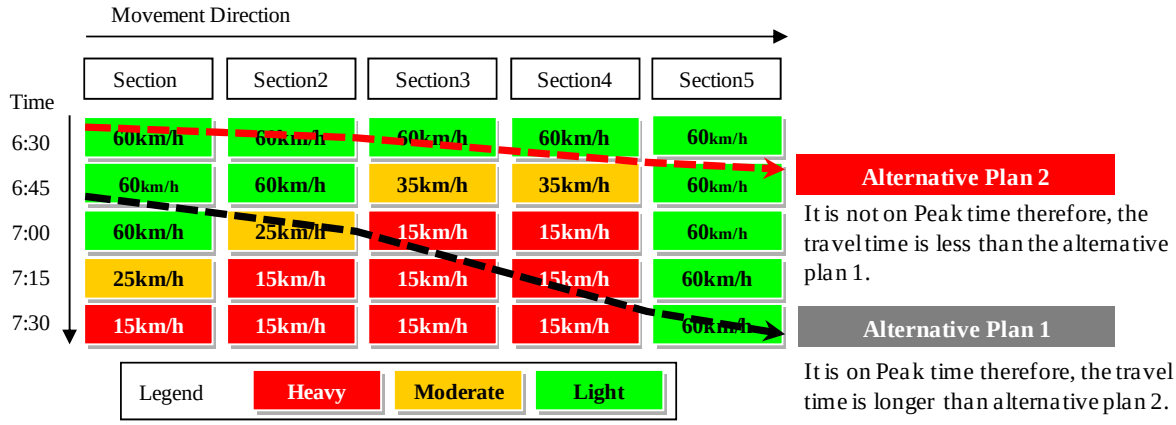
17.3.3 Gamification

Gamification is the use of game thinking and game mechanics in a non-game context in order to engage users and solve problems. Gamification is used in applications and processes to improve user engagement Return on Investment, Data Quality, Timeliness, and Learning.

Through integration of game elements, the users are encouraged to use existing systems and services without feeling a large psychological burden to do so.

Figure 17.3-15 shows an example of gamification for choosing a departure time. As shown in

the figure, in the comparison of leaving at 7:00 (Alternative Plan 1) and leaving at 6:30 (Alternative Plan 2), the overall travel time will be shorter if Plan 2 (leaving at 6:30) is selected because it will avoid traffic congestions and peak times from Section 2 to Section 4. However, in reality, the users many not actually change their behavior pattern accordingly because it is not so easy to change an established behavior pattern. Still, gamification remains as one of the incentives to change the users' behavior patterns. The reference case of Gamification are shown as follow pages,

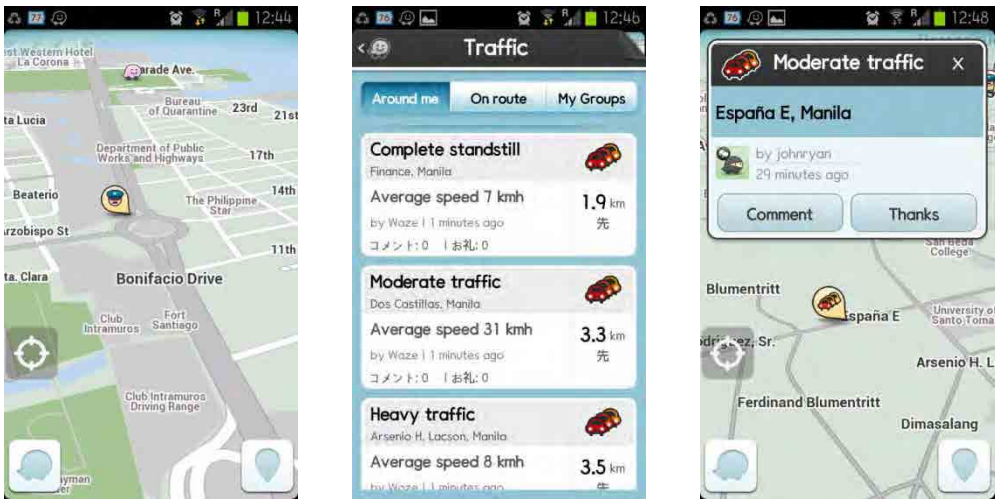


Source: JICA Study Team

FIGURE 17.3-15 EXAMPLE, COMPARISON OF TRAVEL TIME DEPEND ON DEPARTURE TIME

(1) Point and Digital Contents Incentive in case of Waze

In the case of Waze, a user can submit a report (such as regarding the congestion level, accident and road closure). When the report is shared with other users and "Thanks" button is clicked, the user will be rewarded (e.g. receiving a point). (See **Figure 17.3-16**)



Source: Waze HP ***http://www.waze.com/***

FIGURE 17.3-16 EXAMPLE, VOTING OF "THANKS" FOR REPORT BY USER

The users accumulate points according to their report submissions, and receive particular items based on their points. They will also receive extra points when passing a designated spot. The type of avatar (an icon to show the current location) changes according to the accumulated number of points. (See **Figure 17.3-17**)

Since Waze is not aimed for producing social benefits such as ease of traffic congestion, distribution of items does not take the aspect into consideration (e.g. placing of items along routes diverted from congested routes).

Source: Waze HP ***http://www.waze.com/***

FIGURE 17.3-17 EXAMPLE OF GIVING POINT AND ITEMS ON WAZE

(2) Point and Badges Incentive in Case of Foursquare

In the case of Foursquare, the users are given points according to their service usage, and awarded with a particular “Badge” based on the number of points and the ranking status they have earned, as shown in **Table 17.3-1** .

There are various kinds of Badge, and the users are motivated to submit their location information and reports with pictures and comments in order to obtain them.

Furthermore, in the case of the service application to sightseeing spots and restaurants, unique kinds of Badges are given according to the number of visits and “Check In” at designated places in order to increase the number of visitors.

TABLE 17.3-1 EXAMPLE OF BADGES ON FOURSQUARE

	Name	Obtain Condition of Badges
	Newbie	The first “Check In” via Foursquare
	Adventurer	“Check In” at 10 different places
	Superstar	“Check In” at 50 different places
	Crunked	“Check In” at 4 different places between 8:00pm to 12:00am
	Local	“Check In” 3times at the same place in a week
	Super User	“Check In” 30 times in a month
	Bunaken (Indonesia)	First, follow the Manado City – Bunaken via Foursquare Second, “Check In” at 5 places according to Bunaken recommendation
	KL-lite (Malaysia)	First, follow the Kuala Lumpur City – KL-Lite via Foursquare Second, “Check In” at 5 places according to KL-Lite recommendation

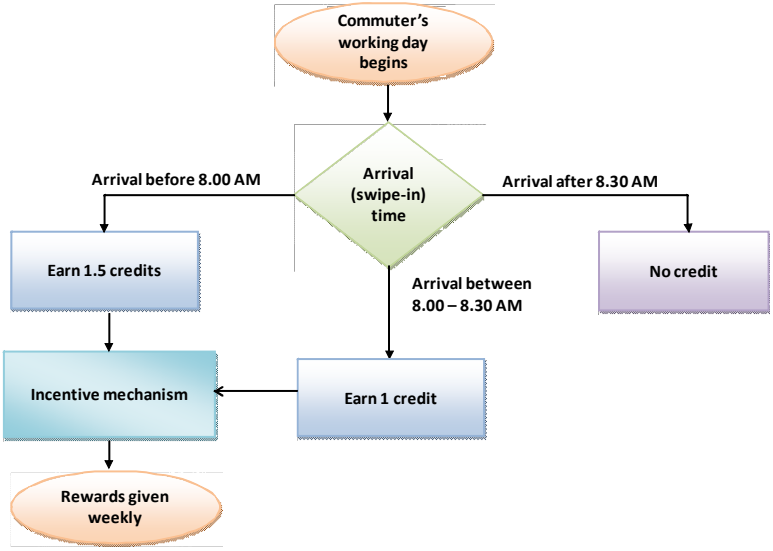
Source: Foursquare http://foursquare.com/

(3) Giving a Monetary Incentive in Case of INSTANT Project

INSTANT is a joint pilot project between Infosys, which is a Bangalore (India)-based major IT consulting and software development company in the world, and Stanford University in the US. The project was conducted between the period of 27 weeks starting in October 2008, and targeted four bus lines used by Infosys employees. The purpose of the project was to ease concentration of commuting times by giving monetary incentives to bus users arrived at office in early hours, as shown in **Figure 17.3-18**.

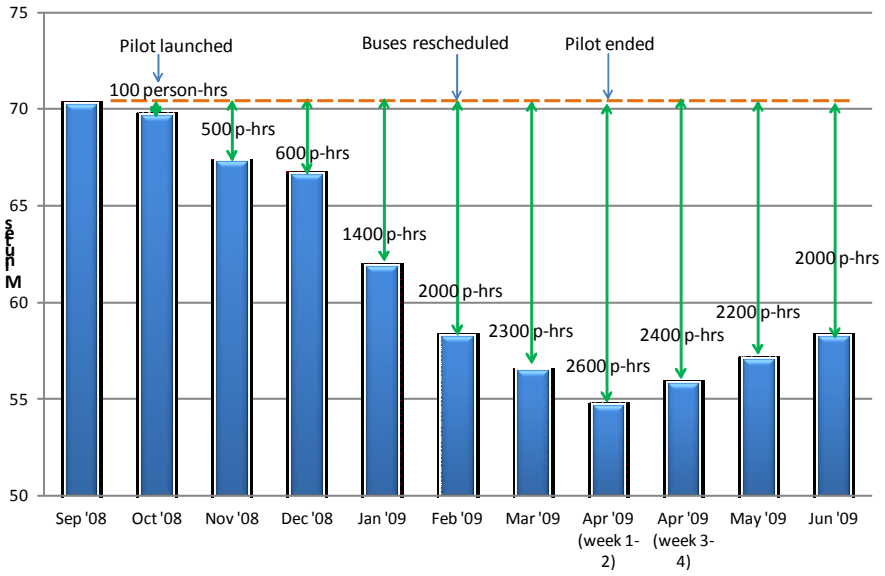
As a result of the project, the average bus commuting time during morning hours was shortened by approximately 15 minutes at maximum due to ease of ease of passenger concentration, as shown in **Figure 17.3-19**.

After completion of the project in April 2009, the passengers’ communing pattern is returning to the original state. However, it is expected that the effect of the pilot project will be sustainable. It is because those who were successful in changing their behavior are likely to keep the new pattern of arriving at office in early hours having experienced the effectiveness of reduction in travel time.



Source: Stanford University http://simula.stanford.edu/Incentive_mechanisms/Instant.html

FIGURE 17.3-18 RULE OF GIVING AN INCENTIVE



Source: Stanford University http://simula.stanford.edu/Incentive_mechanisms/Instant.html

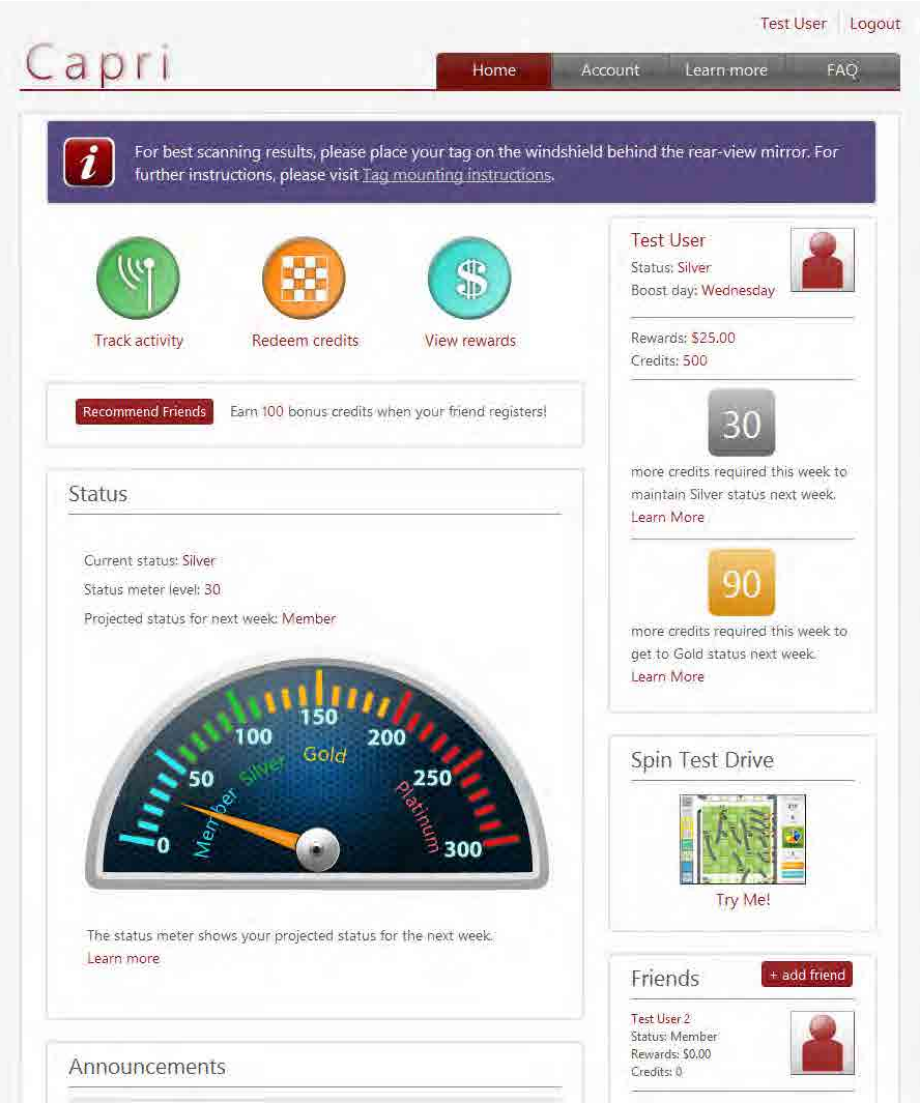
FIGURE 17.3-19 AVERAGE MORNING BUS COMMUTE TIME (AND TOTAL PERSON-HRS SAVED)

(4) In cas.e of CAPRI

Working with Stanford's Parking & Transportation Services, the Stanford Center for Societal Networks has launched Capri in 2012 to study the effects of incentives and social interaction on commute and parking patterns. This project is funded by a generous grant from the US Department of Transportation.

Capri is currently focusing on shifting Stanford commute schedules away from congested peak times - a win-win for commuters and for the environment. Capri roll out a program to help

reduce congestion in Stanford parking lots.



Source: Stanford University ***https://stanfordcapri.org/***

FIGURE 17.3-20 STATUS POINT OF USER

(5) In case of INSINC

INSINC encourages participants to shift their commute schedules on the Singapore rail system away from overcrowded peak times. The more commuters participate in INSINC, the more opportunities they will have to receive random rewards. INSINC aims to reduce crowded trains by distributing the load, resulting in a more efficient use of Singapore's transportation resources, a win-win for commuters and for the environment. Working with Singapore's LTA (Land Transport Authority), researchers from Stanford University and the National University of Singapore had launched INSINC in Jan 2012 to study the effects of incentives and social interaction on public transit commuting. With the end of the pilot trial in Jul 2012, LTA has appointed Transit Link Pte Ltd as their operating agent to continue the INSINC study for another 18 months.

INSINC is a project to promote commuting during off-peak hours. The participants who contributed to ease of the congestion are rewarded with incentive points which are accumulated in a CEPAS card registered in advance.

For example, the participants win one point per kilometer when commuting via train. And the number of points increases to three points if commuting via train during an off-peak hours (hours except for the peak time between 7:30 and 8:30). The participants are also able to choose a bonus point day during the week, and obtain five points per kilometer on that day.

The participants obtain a status of Bronze, Silver, Gold or Platinum, and the higher the status is, the more they obtain points per kilometer. (See **Table 17.3-2**)

Source: Stanford University https://insinc.sg/

FIGURE 17.3-21 STATUS POINT OF USER

TABLE 17.3-2 RULE OF GIVING AN INCENTIVE

Monday - Friday	Bronze	Silver	Gold	Platinum
Before 6:30am off-peak	1x	1x	1x	1x
6:30 - 7:30am decongesting	3x	4x	5x	6x
7:30 - 8:30am peak	1x	1x	1x	1x
8:30 - 9:30am decongesting	3x	4x	5x	6x
After 9:30am off-peak	1x	1x	1x	1x

Source: Stanford University https://insinc.sg/

17.4 ADVANCED TRAFFIC NAVIGATOR

17.4.1 Function

MMDA has planned to improve their Traffic Navigator. In fact, MMDA's presentator at the 2nd ITS Seminar introduced MMDA's Future includes:

1) the upgrading of the Traffic Navigator (TNAV) with automation of data collection via video analytics
2) Upgrading of MMDA mobile applications including CCTV screen shots, video live streaming, and integration of new lines
3) GPS-based Bus Management System to monitor bus operations, congestions, and violations
4) Launch of Automated Traffic Navigator

   On top of the above functions, we suggest to develop the following functions in the pilot project to be available for the Advanced Traffic Navigator.

5) Digital Road Map

   Provide the information on traffic congestions in an easy-to-understand manner, and develop a DRM with appropriate segmentation at each of the major intersections and junctions for realization of an optimum route search function

6) Information Management by using Multi-Layer, GIS Database

   Develop a function to facilitate input, update and addition of information by different category of information and by different organization via utilization of a multi-layer GIS database, and to control information according to the development stage of information collection system. Also include a function to link different events such as “traffic congestion due to traffic accident” by analyzing the relationship between different events (i.e. traffic accident and congestion)

7) General Road and Traffic Information Database

   Develop a database function to realize an integrated control of event information (e.g. traffic condition, traffic accident, road construction, etc.) and static information (e.g. the number of lanes by line and by segment, road width, etc.)

8) Smartphone Application for Data Collection

   Develop and provide a smartphone application with the concept of gamification in order to promote collection of the user FCD and reports on traffic information

9) Optimum Route and Departure Time Guidance
   Develop a function to conduct optimum route search based on changing traffic condition with consideration to departure and arrival times

To develop functions required for the Advanced Traffic Navigator, not only human resources but also utilization of equipment and information communication technologies (e.g. software) are indispensable. It should be noted that information communication technologies alone will not achieve the target since final decisions and judgment should be made by responsible persons.

To this end, an optimum man-machine interface is required for development of the Advanced Traffic Navigator.

17.4.2 Minimum Requirement of Advanced Traffic Navigator

(1) Development of Digital Road Map

The current Traffic Navigator utilizes Google Map as its map data.

More specifically, it uses Google API on Google Map which makes a type of digital road map limited to lines where traffic information is provided.

As shown in **Section 17.2.2(1)**, development of a DRM including minor streets takes a long time. Therefore, as long as provision of information on traffic condition is concerned, an expansion of coverage on the current digital road map would be sufficient for the time being.

However, in order to realize the functions requested in the Advanced Traffic Navigator, it is indispensable to create a DRM with the following characteristics.

1. The data structure is suitable for depicting networks, and allows computerized searches for the route with the shortest distance, time, etc.
2. Data on arterial roads of the prefectural level and higher is updated in advance of road openings and other changes.
3. DRM also includes a great deal of other data such as width, and road structures such as bridges and tunnels.
4. DRM also assigns unique node and link IDs.

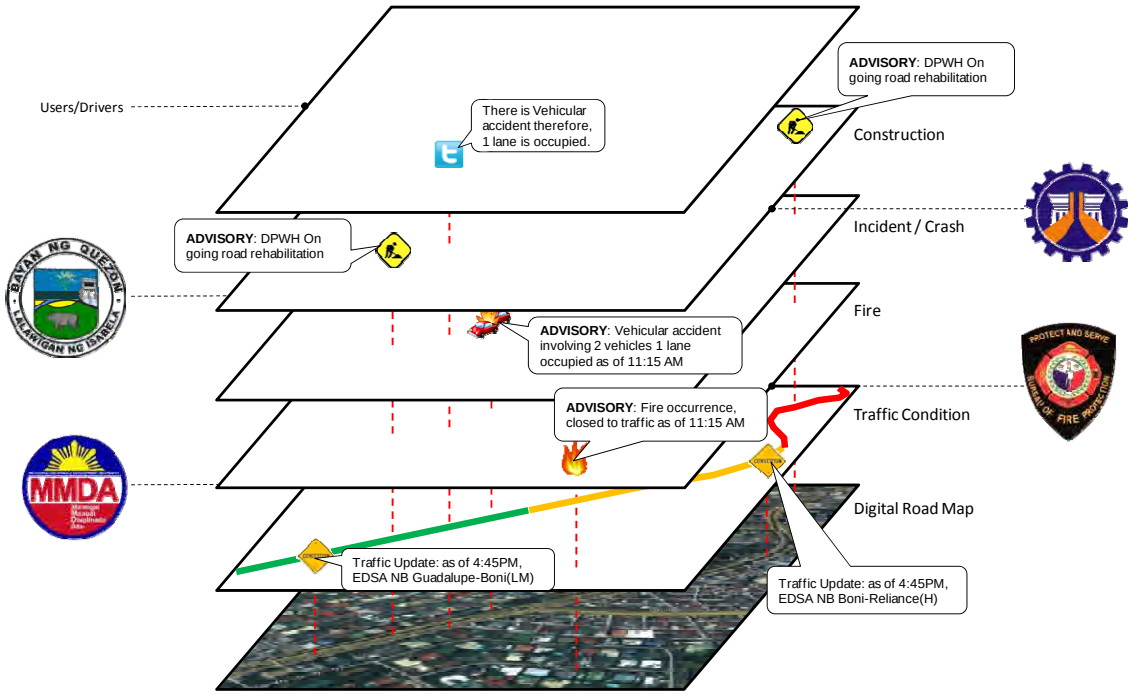
Source: Japan Digital Road Map Association http://www.drm.jp/english/drm/e_index.htm

FIGURE 17.4-1 DIGITAL ROAD MAP IN JAPAN

(2) Information Management by Layer Structure of GIS Database

As to information on traffic conditions, various organizations including DPWH, MMDA and LGU are involved for collection and maintenance. In order to understand real-time information on traffic conditions, it is also indispensable to collect information from users including vehicle drivers.

Under the circumstance, in order to collect information from various organizations at one place and to observe it from a multiple and comprehensive viewpoint, information control based on a layer structure using GIS is necessary. The system should be run on a web-based GIS server with an access control with input/update of information by each layer so that each of all relevant organization can input/update information as necessary. (**Figure 17.4-2**) Such information control in a layer structure enables observation and provision (display) of the necessary information only by making each layer either visible or invisible. As a natural result of displaying multiple information on the same screen, it is possible to conduct analysis of relationship and correlation of individual events (e.g. causal relationship between road construction work and traffic congestion), and to take appropriate actions accordingly (e.g. temporal stop of the road work or providing alternative routes). As to collection of information from users (e.g. via Twitter), it is also possible to verify credibility of such information by reviewing it with other information. However, in this case, the tweet from users must be geo-tagged (attached with latitude and longitude information). Consistent management and control of traffic and road data is not only necessary for provision of traffic information to users, but also could be utilized for other purposes such as asset management and policy assessment. It would lead to provision of more advanced services to road users and more sophisticated road control and maintenance.



Source: JICA Study Team

FIGURE 17.4-2 IMAGINARY FOR DATA MANAGEMENT ON LAYER STRUCTURE BY USING WEB BASED GIS

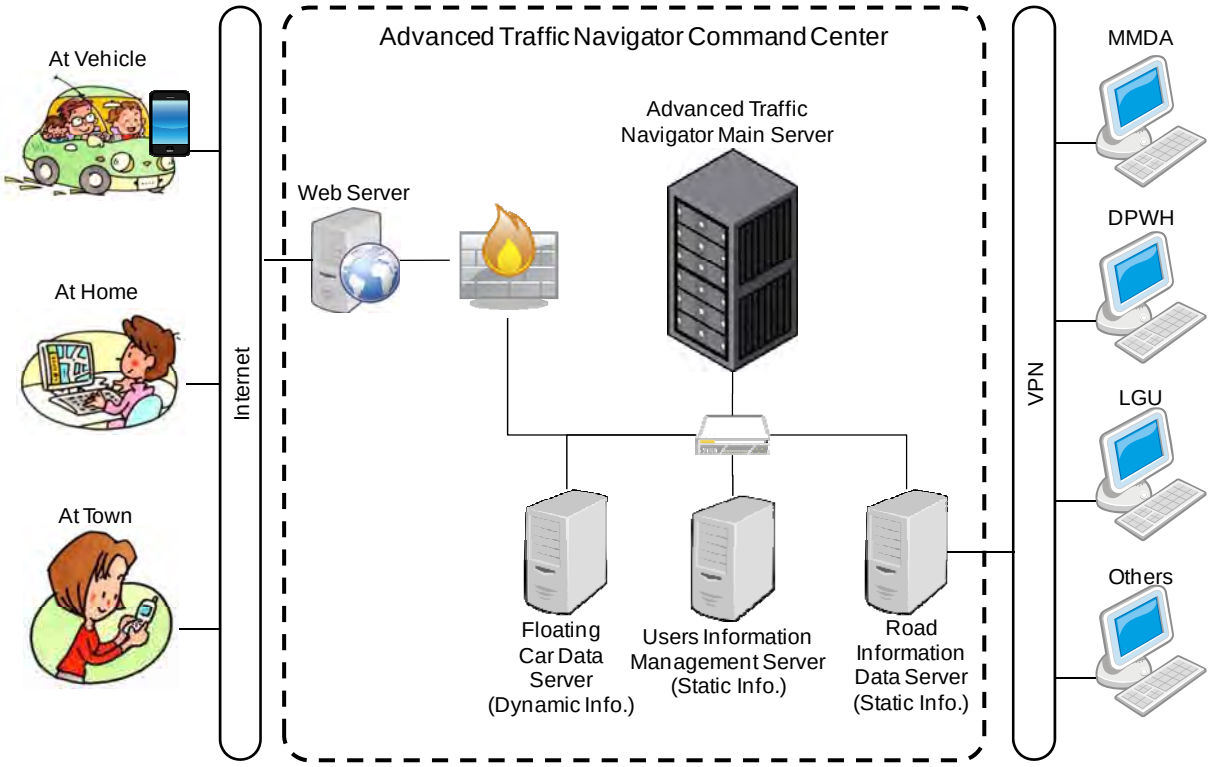
(3) System Architecture

Information to be controlled in the Advanced Traffic Navigator includes static information such as the number of traffic lanes, width of roads, speed limits and road works as well as dynamic information such as travel speeds and event information (e.g. traffic accidents and vehicle breakdowns).

Such information is collected and held by various organizations, which requires an information control based on a layer structure.

Furthermore, as to dynamic information, the user and enforcer reports which are constantly submitted/updated need to be controlled and displayed, and they need an external access via Internet, etc.

Therefore, as shown in **Figure 17.4-3**, information which is constantly updated and that less frequently updated should be controlled separetely. The system should also consider an external access and ensure the security as well.



Source: JICA Study Team

FIGURE 17.4-3 IMAGINARY: SYSTEM ARCHITECTURE OF ADVANCED TRAFFIC NAVIGATOR

17.4.3 Improvement of Information Collection from Users by Utilization of Gamification

As shown in **Section 17.3.3**, active user involvement could be promoted via utilization of "Gamification". Utilization of user information such as FCD and tweets for collecting traffic information is becoming a worldwide trend, which should be expanded at development of the Advanced Traffic Navigator.

Although the current Traffic Navigator already collects and provides information based on user information through Twitter, Facebook and so on, the Advance Traffic Navigator should further expand utilization of FCD by promoting active involvement of the users. It is also desirable to develop a system to collect geo-tagged information on road situations on top of reports with comments and pictures.

For example, in the case of collecting FCD, vehicles which can provide FCD may concentrate on a few major roads. In such a case, it could be possible to improve data collection on the routes with less FCD by locating point items along these routes to increase vehicle travels, as shown in **Figure 17.4-4**.

It is also possible to promote traffic diversions from heavily congested to less congested roads

using the same method.

Source: JICA Study Team

FIGURE 17.4-4 IMAGINARY OF GIVING A POINT FOR THE COLLECTION OF FLOATING CAR DATA

For the purpose of identifying bottlenecks of traffic congestion and understanding their traffic condition, it is possible to create a function for the users to earn special reward items if they submit a report with geo-tagged information and pictures of these bottleneck points.

We suggest building such functions based on the concept of gamification in the Advanced Traffic Navigator in order to expand data collection and to promote user behavioral change.

(1) Collection of Traffic Data

The existing Traffic Navigator captures information on traffic conditions from user reports via Twitter and observations by enforcers and CCTV.

The Advanced Traffic Navigator is planned to capture and provide traffic information based on FCD.

As shown in **Figure 17.4-3** and **Figure 17.4-4**, expansion of FCD is indispensable, and necessary functions should be developed in the Advanced Traffic Navigator accordingly.

However, it should be noted that FCD itself is not sufficient to capture the entire traffic conditions for the following reasons.

a. FCD is GPS-based location data. Therefore, FCD is not available from segments where GPS wave is blocked (e.g. lower layer of viaduct or road which run parallel to a viaduct, road segment where a number of high-rises are located in proximity).
b. The amount of FCD is projected to be low for a while at the beginning.
c. The original function of FCD is to capture travel speed, and it is not primarily intended to capture traffic volume information.

To solve the first issue (the above a.), data from vehicle detectors at nearby intersections may be used. Alternatively, it is necessary to build information collection method, such as installation of fixed-type vehicle detectors.

It is also necessary to take a similar action to solve the second and third issues (the above b. and c.). That is, either to use data from vehicle detectors at nearby intersections, or to evenly install fixed-type vehicle detectors.

In particular, as to the third issue (the above c.), a study has been in progress to estimate a traffic volume from FCD by collecting traffic volume/speed data via vehicle detectors along with traffic speed data from FCD. For this to be successful, basic data collection is required.

It should be noted that installation and refurbishment of vehicle detectors is not intended in the future, and the installations should be minimized accordingly.

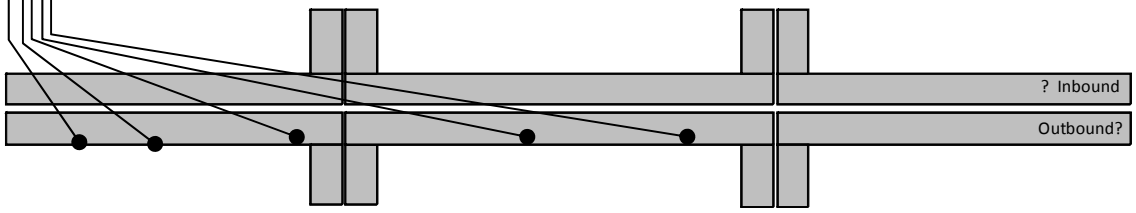
(2) Analysis of Floating Car Data

FCD is a series of time-space information of individual vehicles. Based on FCD, it is possible to capture a traffic condition. **Table 17.4-1** is one example of FCD collected via devices such as smartphones. The data includes the information of date/time and latitude/longitude, and calculation of travel speed is available.

By plotting FCD on a DRM, it is also possible to identify the road where the user is driving and the direction of the travel. (See **Figure 17.4-5**)

TABLE 17.4-1 SAMPLE OF FLOATING CAR DATA

ID No.	Latitude	Longitude	Speed	DATE, TIME
01	35.566461	139.5659	76.562119	2013-03-26T03:26:52.000Z
02	35.566453	139.56577	76.014709	2013-03-26T03:27:02.000Z
03	35.566446	139.56564	75.317772	2013-03-26T03:27:12.000Z
04	35.566448	139.5655	74.602638	2013-03-26T03:27:22.000Z
05	35.566455	139.56537	73.839684	2013-03-26T03:27:32.000Z



Source: JICA Study Team

FIGURE 17.4-5 IMAGINARY FOR MAP MATCHING AND LINKAGE FROM FLOATING CAR DATA

The accuracy of FCD depends on the number of GPS satellites available at the time of data collection. Sometimes there are data which are largely deviated from the routes. Therefore, data cleansing is required as a precondition for collection and analysis of FCD.

There are multiple methods for data cleansing, and one example is to compare preceding and succeeding location point data. If the speed between the location points is significantly lower or higher than the speeds between other locations points, the location point should be excluded from data calculation. Another example is to compare travel speed of FCD among vehicles. If the travel speed of a vehicle is significantly lower or higher than that of other vehicles, FCD from the vehicles should be excluded from data calculation.

Figure 17.4-6 shows generation of traffic condition information from FCD.

For example, as shown in the upper half of 10:00 am column of **Figure 17.4-6**, individual vehicle travel speeds are calculated based on their FCD at 10:00 on March 26, 2013.

In the column, a, b, c-links represent an outbound direction and d, e, f-links represent an inbound direction. In order to conduct route search, it is necessary to prepare a DRM with segmentation at each of the major intersections and junctions. (See the bottom half of 10:00 am column of **Figure 17.4-6**)

Based on the location information from FCD, a road link where each vehicle is travelling is identified, and the link is matched with the vehicle's travel speed. The harmonic average of the data of travel speed matched to the road link is calculated to compute the travel speed for each

road link. The bottom half of 10:00 column of **Figure 17.4-6** shows the travel speed of each road link (the color is based on the definition shown in **Table 17.4-2**).

TABLE 17.4-2 DEFINITION OF TRAFFIC CONDITION

Traffic Condition	Definition	Color
Light	More than 30km/h	Green
Moderate	More than 20km/h and Less or equal to 30km/h	Yellow
Moderate to Heavy	More than 10km/h and Less or equal to 20km/h	Orange
Heavy	Less than 10km/h	Red

Source: JICA Study Team

However, FCD is collected only from vehicles whose drivers have agreed to data collection and sending. Therefore, not all links necessarily have information on traffic conditions.

Let's take an example on March 26, 2013. As shown in the upper half of 10:05 column of **Figure 17.4-6**, there is no FCD on the c-link (in outbound direction) and on the d-link (in inbound direction). In the case of d-link, vehicle detectors are installed on the road side and thus travel speed collected by them are used for data calculation. If both FCD and vehicle detectors do not exist, travel speed data from FCD recorded in the most recent past could be used for calculation of travel speed data.

Therefore, in the case of c-link at the bottom half of 10:05 column of **Figure 17.4-6**, the travel speed is displayed as 50.00km/h, which is the data recorded at 10:00 on the day and the most recent past data available for the link.

As described in the above, data cleansing and introduction of traffic control technologies regarding data imputation are crucial for utilization of FCD.

(3) Accumulation of Historical Traffic Condition

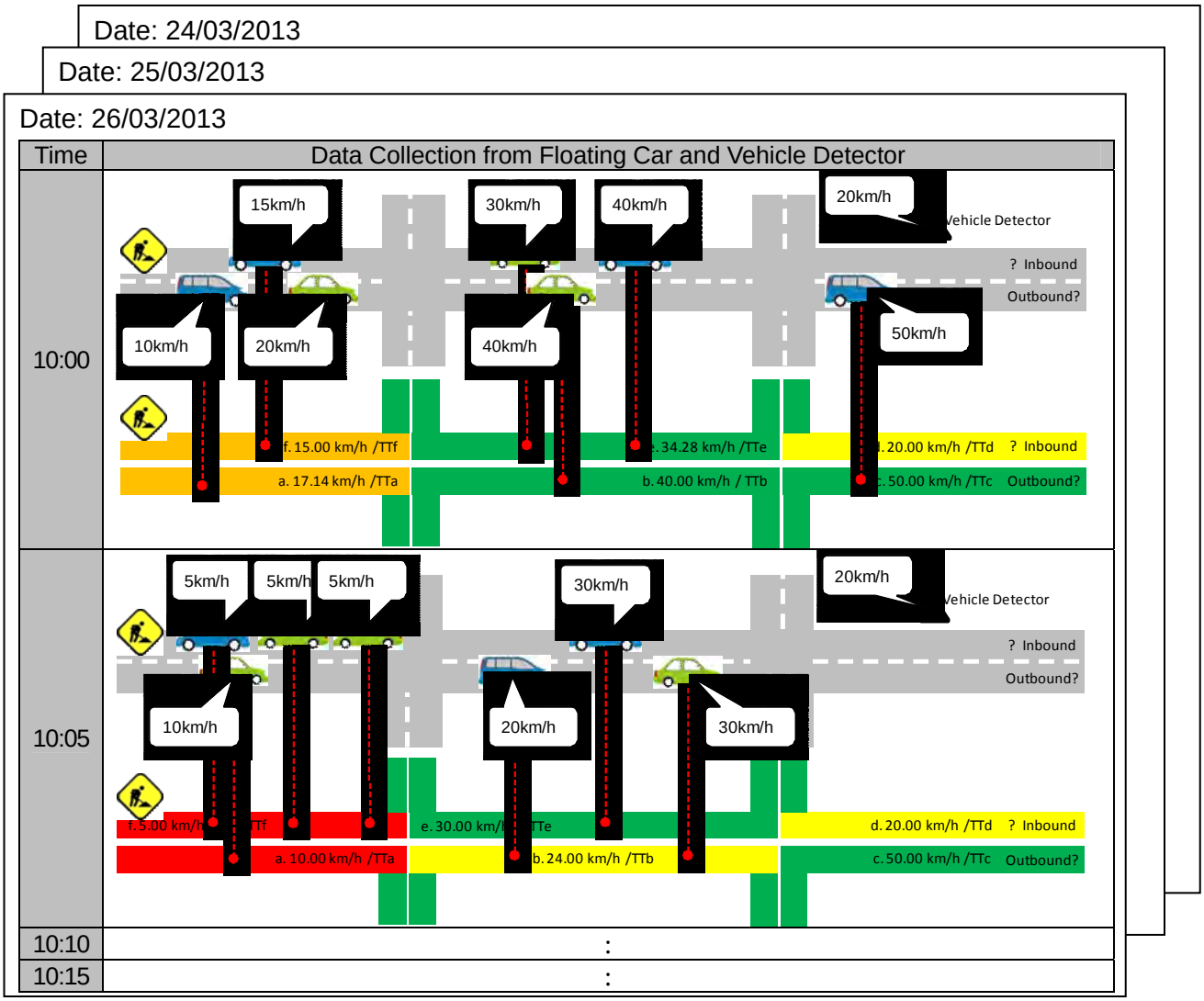
If past data is kept as a database, it could supplement understanding of the current traffic condition. Also, by recording and summarizing past data according to different categories such as time of day and day of month, it is possible to refer to past traffic data on specific occasions, such as bargain sales season at a shopping mall and during the holy week and Christmas holiday in order to identify routes and time of day heavy congestion is anticipated.

Figure 17.4-7, for example, if the traffic condition on December 24, 2012 can be viewed by time of day, it reveals that traffic conditions are different between 13:00 and 16:00 even though they are on the same Origin-Destination route, and thus it is possible to encourage drivers to depart without waiting until 16:00.

On the other hand, the data could be part of so called "big data", and be utilized not only for

traffic information provision but also for various purposes such as planning of a new road/major road rehabilitation and policy assessment regarding road development.

Additionally, user interface for the operator to view both live and historic data as shown in **Figure 17.4-8**.



Source: Study Team

FIGURE 17.4-6 IMAGINARY FOR GENERATION OF TRAFFIC CONDITION

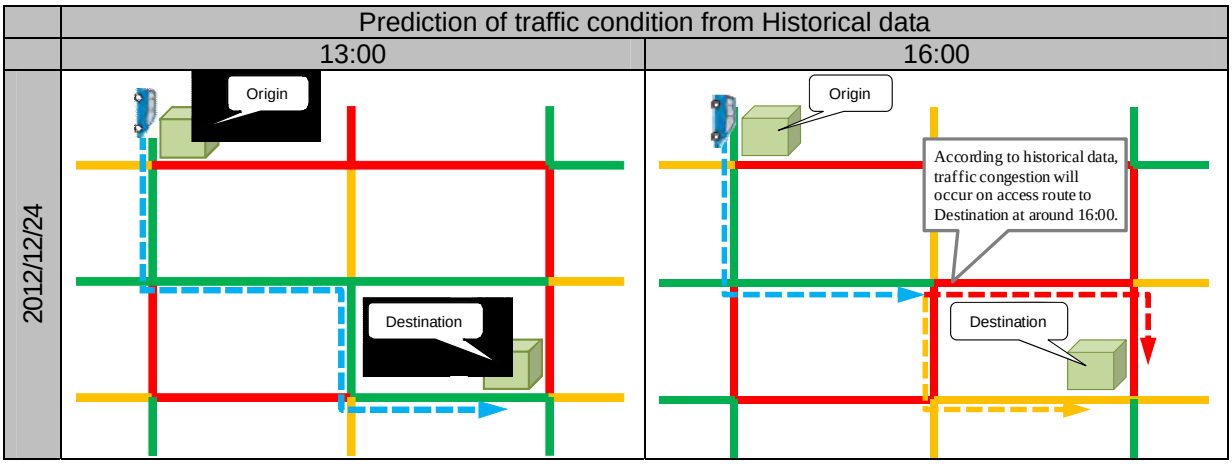
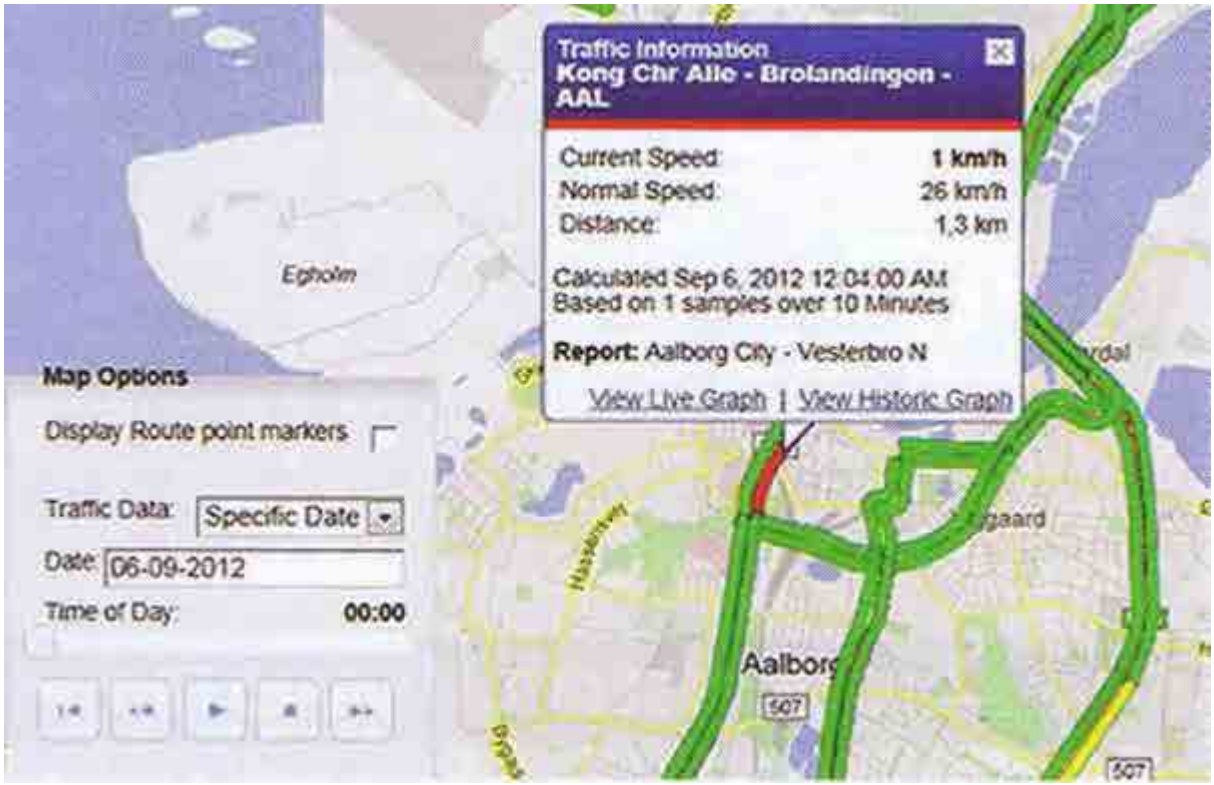


FIGURE 17.4-7 IMAGINARY FOR PREDICTION OF TRAFFIC CONDITION FROM HISTORICAL DATA



Source: Thinking Highway ***http://thinkinghighways.com/***

FIGURE 17.4-8 SAMPLE OF USER INTERFACE FOR THE OPERATOR TO VIEW BOTH LIVE AND HISTORIC DATA

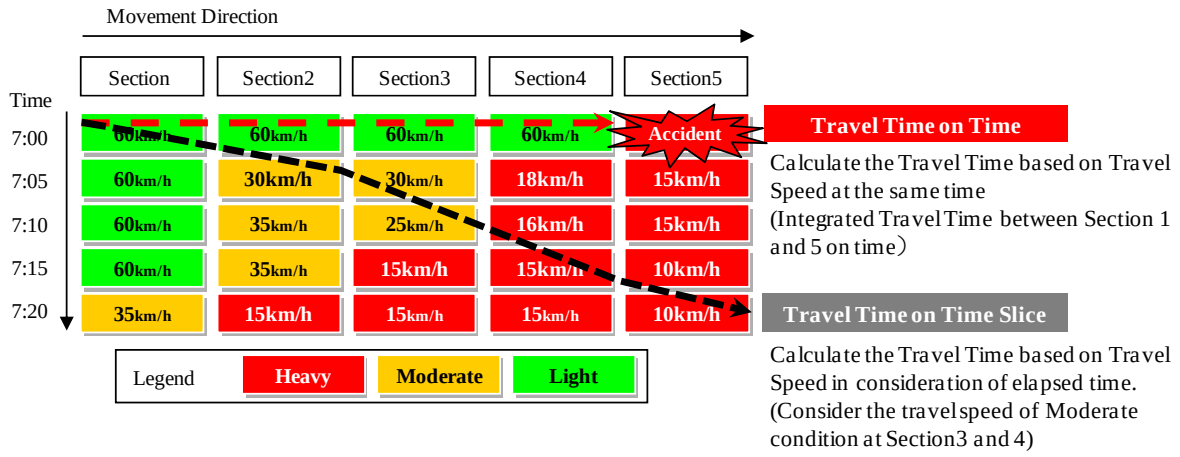
(4) Prediction of Traffic Condition

The real time information simply means to arrange the most recent information on a space. A driver moves on a space as time goes by. Obviously, there is a time gap between the time of collecting information and that of actual driving. Such a gap becomes wider particularly under severe traffic congestion due to a traffic accident.

Under a normal condition, provision of statistical prediction based on the accumulated data is possible. However, it is not the case at the time of occurrence of a traffic incidence.

Advancement of the information collection technologies such as FCD and vehicle detectors and their application to traffic incidents will enable a highly accurate future traffic simulation based on the traffic engineering. Since there are many prediction methods ranging from a simple one for a limited usage to an advanced one for utilization in various situations, an appropriate method selection would be required depending on the purpose (usage).

For easing traffic congestion based on temporal dispersion of demands, trend information on travel time is necessary, and for that, prediction of traffic condition is indispensable. Technologies for prediction of traffic condition not only contribute to ease of congestion but also have potential for prediction of impacts on roads at the time of rehabilitation including those on their peripheral roads.



Source: JICA Study Team

FIGURE 17.4-9 TRAVEL TIME PREDICTION

17.5 IMPLEMENTING AGENCY: MMDA

The project shall be conducted by MMDA in made consideration to the development experience of Traffic Navigator. Even, following bodies shall be participation under conducted by MMDA.

- Academic bodies (e.g. University of Philippines) :
  Development of Smartphone Application, Development of Internet website, Development of application for Aggregate analysis of FCD
- Mass media/Broadcasting (e.g. TV5) :
  Extend the traffic information and service to a wider of people
- Wireless Telecom Company (e.g. SMART) :
  Technological support about Smartphone device and Wireless communication

Also, DPWH and LGU shall be participation in the project for making Road and Traffic information satisfactory. It is necessary information for the elaboration of optimum route guidance, travel time calculation and so on.

The elaboration and extension of DRM (Digital Road Map) is absolutely imperative for the project infrastructure. However, the development and implementation of DRM has a need for the big development budget. Therefore, there is a need to use a loan with a suitable donor such as JICA.

Definitely, enhancement of contents and service are the key of the project. Therefore, consultation and study are absolutely imperative with Transportation Control System Specialist who is knowledgeable about traffic engineering and ITS Specialist who is knowledgeable about Gamification and nomadic device (e.g. Smartphone).

CHAPTER 18
RFID-BASED EDSA BUS TRAVEL TIME INFORMATION PROVISION SYSTEM

18.1 INTRODUCTION

18.1.1 Background

MMDA launched the Metro Manila Traffic Navigator (TNAV) in 2011. MMDA is upgrading TNAV to Automatic Traffic navigator (ATNAV). This system “RFID-based EDSA Bus Travel Time Information System” will constitute an important part of ATNAV.

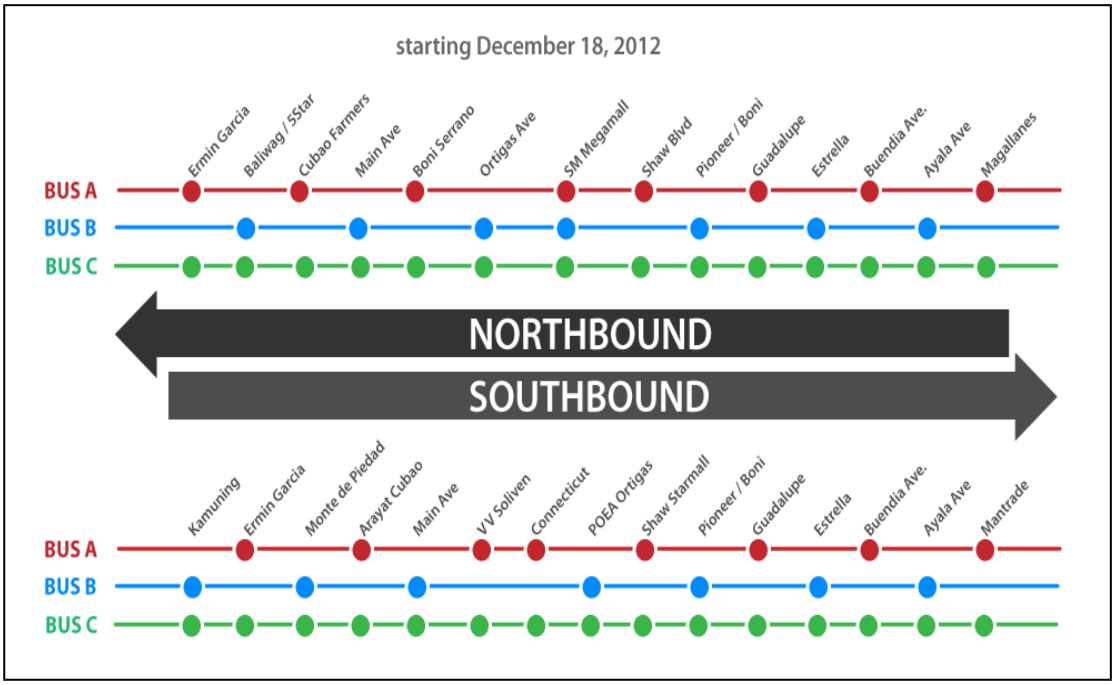
TNAV aims to provide traffic information basically for car users and not for bus passengers. This system intends to provide travel time information to public transport users, mainly bus passengers. Rail transit passengers can also utilize this information.

EDSA (or C-4) is the most important thoroughfare in Metro Manila and has a 50m ROW. MRT-3 runs at the center of the road and there are 5 traffic lanes on each side of MRT-3 (or a total of 10 lanes for motor vehicles), of which 2 lanes each side are used as “Exclusive Bus Lanes”.

There are about 3,500 buses which have a franchise to operate on EDSA. Traffic volume of EDSA at the Guadalupe Bridge is 220,000 vehicles/day in 2011, of which 6% or 13,200 vehicles are buses.

It is estimated that buses are carrying over 330,000 passengers per day, whereas MRT-3 carries about 400,000 ~ 500,000 passengers per day. Thus, buses and MRT-3 are quite important public transport modes in Metro Manila.

MMDA introduced New EDSA Bus Segregation Scheme to improve the bus passenger transport efficiency and also to reduce traffic congestion at bus stops. This scheme introduced 3 types of bus operation as shown in **Figure 18.1-1.**



Source: MMDA

FIGURE 18.1-1 MMDA'S NEW EDSA BUS SEGREGATION SCHEME

Bus Type-A : Buses assigned to this type stop at every other bus stops.
Bus Type-B : Buses stop at every other bus stops where a bus type-A does not stop.
Bus Type-C : Buses stop at all bus stops.

Most of the bus companies operating in Metro Manila are small- to medium-size companies, therefore, it is not practical to ask each company to provide travel time information to public transport passengers. The public sector should be the one to provide traffic information.

18.1.2 What are the Problems on the Part of the Bus Passengers?

At present, bus passengers are not provided information on travel time, thus they are encountering the following problems;

- If I take a bus now, how many minutes would it take from A point to B point?
- Which should I use, a bus or MRT-3?
- Should I take a bus now or should I leave later?
- Should I take Type A (Type B) bus or Type C bus to arrive at my destination on time?

18.1.3 Objectives

This system is proposed to be implemented as a "Pilot Project". The objectives of this system are as follows:

- To provide bus travel time along EDSA to public transport passengers, mainly to bus passengers.
- To improve convenience of public transport passengers. They are provided information on the following:
  - Which type of bus (Type-A, B or C) or MRT-3 to be selected to arrive at their destinations on time?
  - What time would they arrive at their destinations?
  - When to ride a bus (earlier than usual or as usual or later than usual)?
  - When on board in a bus, they can accurately estimate arrival time.
- To improve bus operations and to reduce congestion at bus stops, since bus passengers are distributed over certain times and overconcentration of passengers are reduced.
- To reduce car users at EDSA which contributes to traffic congestion mitigation when convenience of bus utilization is experienced by people. Car users will shift to public transport mode.

18.2 OUTLINE OF THE PILOT PROJECT

This system is proposed to be implemented along EDSA as the Pilot Project, then expanded to other bus transport corridors.

Outline of the pilot project is as follows;

(1) Data Collection System

- Six RFID checkpoints along EDSA from Magallanes to Timog are established as shown in **Figure 18.2-1.** All checkpoints are selected at the biggest inter-modal points.
- RFID readers (or antenna) are installed for both north and south bounds at established RFID checkpoints.
- RFID tag is stickered at all franchised buses at EDSA (about 3,500 buses).
- Readers (antennas) send each passing bus ID and timestamp to the central server at MMDA Command Center via SMS.
- Data transmission via SMS is planned for reliability and cheaper network charges.

Source: MMDA

FIGURE 18.2-1 RFID CHECKPOINT LOCATION

(2) Data Processing

- The central server processes data into actual travel time.
- When enough historical data are compiled, accurate travel time is estimated by day of a week or a month.

(3) Bus Travel Time Information Provision

Travel time information is provided by various means of communication as follows;

- Trough text message of mobile phones
- Through smart phones
- Through internet
- Through existing LED VMS
- Through VMS at bus stops
- Through monitor inside a bus

Overall image of the system is shown in **Figure 18.2-2.**

Source: MMDA

FIGURE 18.2-2 OVERALL IMAGE OF THE SYSTEM

(4) Equipment to be Used

Under this pilot project, the following equipment is used;

TABLE 18.2-1 EQUIPMENT LIST

Equipment	Unit Price (Php)	Quantity
a) RFID Tag	90	4,000
b) RFID Antenna	87,000	12
c) Sham Traffic Lane Control Unit	350,000	12
d) Analysis Processor (server and software)	6,500.000	1

Source: JICA Study Team

VMS at bus stops and monitors inside a bus will be installed after this Pilot Project.

18.3 IMPLEMENTING AGENCY AND SCHEDULE

The implementing agency is MMDA. The implementing schedule is estimated at one (1) year including post system impact evaluation period.

TABLE 18.3-1 IMPLEMENTATION SCHEDULE

Activity	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Basic Study												
Tender Documents Preparation												
Bidding												
Installation of System												
Post Evaluation												

Source: JICA Study Team

18.4 ESTIMATED COST

The system installation cost is estimated at 12.9 Million Pesos.

TABLE 18.4-1 SYSTEM INSTALLATION COST

Item	Unit	Quantity	Unit Price (Php)	Cost (Php)
RFID Tag	pcs	4,000	90.00	360,000.00
RFID Antenna	set	12	87,000.00	1,044,000.00
Sham Traffic Lane Control Unit	set	12	350,000.00	4,200,000.00
Installation	set	12	65,000.00	780,000.00
Travle Time Prediction Analysis Processor	L.S	1	6,500,000.00	6,500,000.00
Total				**12,884,000.00**

Source: JICA Study Team

18.5 POSSIBILITY OF FUTURE EXPANSION OF THE SYSTEM

The proposed system has a great possibility for future expansion in various ways as follows;

- Can be expanded to all other bus routes in Metro Manila.
- Can be used for surveillance and control of illegal bus operation.
- Can be applied to other urban centers in the Philippines as well as mega-cities in other countries under the same situation.
- When the system is expanded to cars, the system can be utilized for “Road Pricing”.

18.6 EFFECTS AND IMPACTS OF THE SYSTEM

Huge favorable effects and impacts can be expected as follows;

- Over 330,000 bus passengers along EDSA can be benefitted by being provided with bus travel time. They will no longer worry about uncertain travel time and can estimate accurate arrival time.
- Bus passengers can select time of when to take a bus, thus over-concentration at bus stops will be mitigated and bus operation will be improved resulting in mitigation of EDSA traffic congestion.
- Public transport passengers are provided with modal choice information, for decision to take a bus or to take MRT-3. Two public transport systems along EDSA will be evenly utilized by public transport passengers.
- Since convenience of the public system will be greatly improved, shifting of car users to public transport system can be expected which will contribute to mitigation of traffic congestion along EDSA.
- As mentioned in section 18.5, this system has great potential for expansion in the future, Metro Manila traffic problems can be mitigated when the system is expanded.

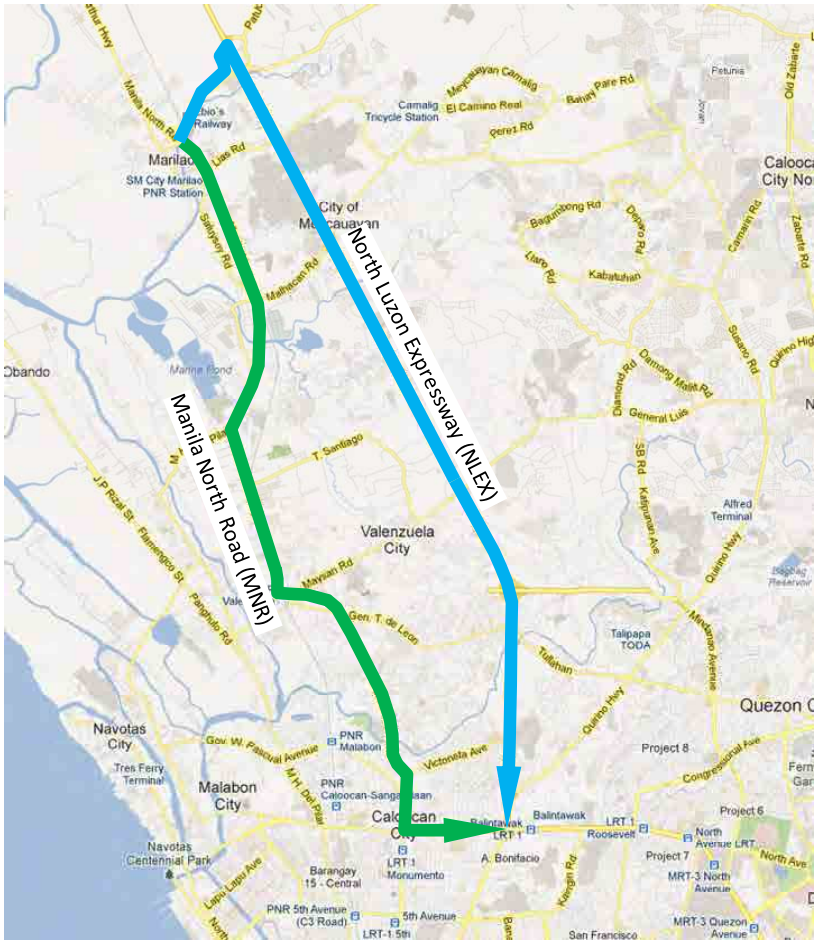
CHAPTER 19
TRAFFIC INFORMATION SYSTEM ALONG MANILA NORTH ROAD / NORTH LUZON EXPRESSWAY

19.1 INTRODUCTION

19.1.1 Background

MNR (MANILA NORTH ROAD or MCARTHUR HIGHWAY) is an arterial road and NLEX (NORTH LUZON EXPRESSWAY) is an expressway. They run parallel to one another in the north of Metro Manila, and connect the central and the northern parts of Manila.

In the area where they run parallel, MNR generally has two lanes each way, while NLEX generally has three lanes in both directions although the number of lanes may vary in some segments. The transport demand is expected to increase in the future as the development of SCTEX (Subic-Clark-Tarlac Expressway) makes further progress. The traffic volume (section) based on AADT survey is approximately 15,000Veh/Day for MNR and approximately 54,000Veh/Day for NLEX.



Source: Study Team

FIGURE 19.1-1 TARGET AREA (ROADS) OF PROJECT

MNR and NLEX run in parallel and they are major thoroughfares from the north to the central part of Metro Manila. They are connected to each other via access roads located at each interchange of the expressway. In a field survey, we have identified guidance sign boards along MNR, which provide information on the access road to the nearest interchange of NLEX. We consider this could provide groundwork for meeting one of the basic preconditions for providing real time traffic information.

(The sign is hidden by Tree)

(The sign is hidden by fixed-wires)

(The sign is broken)

(Proper sign)

Source: Study Team

FIGURE 19.1-2 GUIDANCE SIGN BOARD FOR NLEX ON MNR

With regard to road conditions, MNR has areas where reduction of the vehicle speed is inevitable. This is because MNR is a residential road, and one of the lanes at the side of footway is often occupied as workplaces, parking and retail premises. There are also concerns about road surface in some areas along MNR (i.e. driving performance is reduced at road maintenance areas). On the other hand, NLEX secures high driving performance as an expressway by introducing various rules such as limiting entry/exit points and restricting vehicles allowed on the expressway. The road surface along NLEX is better condition than MNR.

(Loading / Unloading by Jeepney)

(Work Space)

(Retail Premises)

(Construction Work)

Source: Study Team

FIGURE 19.1-3 ROAD CONDITION OF MNR

Source: Study Team

FIGURE 19.1-4 ROAD CONDITION NLEX

With regard to traffic condition (road usage condition), MNR has a constant problem of traffic congestion, while NLEX secures a relatively free traffic flow.

Traffic conditions found along MNR are as follows:

- Significant slowdown of the vehicle speed occurs in the downtown locations due to existence of school zones.
- Regarding inter-city segments, there are some areas where traffic flows freely although

slight reduction in speed occurs due to existence of large-sized vehicles.

- Existence of overloaded large vehicles seems to have negative impacts on roads, traffic and surrounding environment.
- Reduction in vehicle speed is occasionally seen due to passenger loading/unloading of overcrowded Jeepney and random pedestrian/vehicle crossings and retail premises on the street.

In particular, although MNR is a residential road, we found many large-sized vehicles along MNR. The existence of such large vehicles seems to threaten the safety of the area residents and the surrounding environment as well as to have a negative impact on the road control and maintenance.

Source: Study Team

FIGURE 19.1-5 TRAFFIC CONDITION OF MNR

Source: Study Team

FIGURE 19.1-6 TRAFFIC CONDITION OF NLEX

As to collection of traffic data and provision of traffic information, NLEX collects traffic data via loop coil vehicle detectors and provides information through VMS (Valuable Message Signboard), SNS (Social Networking Service) and web site. However, such traffic information is only available for the expressway, and there is no collection/provision of traffic data/information for MNR.

Source: Study Team

FIGURE 19.1-7 TRAFFIC INFORMATION PROVISION OF NLEX BY USING VMS

Source: Traffic Navigator http://mmdatraffic.interaksyon.com/nlex/system-view.php

FIGURE 19.1-8 TRAFFIC INFORMATION PROVISION OF NLEX ON THE WEB AND SNS

19.1.2 Objectives

The function of both roads which run in parallel and are connected to each other should be fully exercised through appropriate task assignment (spatial dispersion) depending on the traffic as well as usage situations and surrounding environments.

As it is the case this time, if an arterial road and an expressway run parallel to one another, their particular roles should also be considered for assignment of the task. It goes without saying that an arterial road is a basic infrastructure for those who live in the vicinity, thus passing vehicles and large-sized vehicles which could pose serious concerns to the living environment should be eliminated as much as possible. On the other hand, the role of an expressway is to secure a high driving performance in order to provide an efficient transportation method for passing vehicles. It also increases profitability of an expressway if it is used by as many drivers as possible.

Under the circumstance, a conversion of traffic demand from an arterial road to an expressway would bring a win-win situation for both roads. However, in reality, the expected result has not been produced due to the lack of traffic information which would promote spatial dispersion of the traffic.

Therefore, in this project, we aim to improve the traffic situation and the peripheral environment through promoting appropriate spatial dispersion of traffic demands. At the same time, we suggest pilot measures to encourage the usage of expressways as well as to improve profitability of Expressway Company.

19.2 CONCEPT FOR PROJECT

In this project, we provide information of travel time comparison via VMS in order to promote conversion of usage from a significantly congested arterial road (MNR) to a more freely flowing expressway (NLEX).

Upon conducting an OD (Origin-Destination) survey and choosing an information-providing device, we pay attention so that the time lag between the two roads will not be too large as to the range/distance of the expected conversion. We also note the fact that a travel time for the road varies significantly by time of day. In order to proactively encourage the usage conversion, we also consider the appropriateness of current usage situation of the arterial road.

The information to be provided is not a length of traffic congestion but a travel time for the arterial road and for the expressway based on the travel time comparison of a fixed OD. We provide information on travel time because the traffic congestion length cannot properly reflect the level of vehicle speed reduction. It is also important to remember that it is difficult to show

multiple pieces of information via VMS at one location and limited space, and that the purpose of providing information is to let drivers choose a optimum route in order to promote dispersion of traffic demands. To keep these in mind, we provide information of travel time comparison, which is a clear and simple choice between the two for easy decision making, even for drivers who are not familiar with receiving information during their drive. The information of travel time comparison is also an indicator which includes the level of speed reduction.

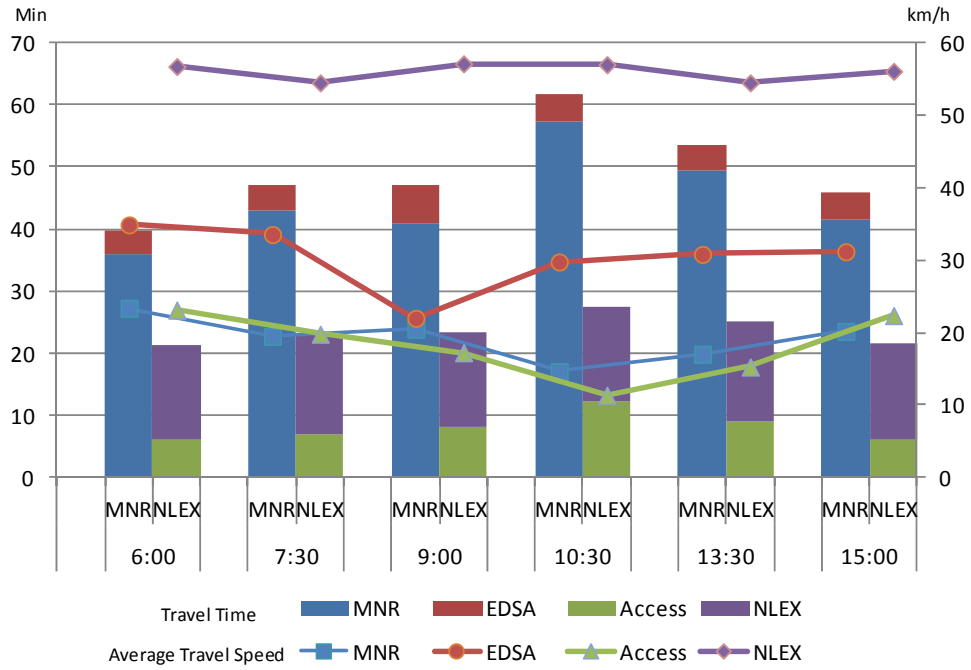
Source: (http://www.traffictechnologytoday.com/)

FIGURE 19.2-1 EXAMPLE FOR INFORMATION PROVISION OF TRAVEL TIME COMPARISON

19.3 PROJECT OUTLINE

19.3.1 Road Traffic Condition

We measured travel times for both cases using MNR and NLEX when driving a route starting from Marilao on MNR and ending at Balintawak on EDSA (Epifanio de los Santos Avenue). Two vehicles left the starting point at the same time, and their travel times upon reaching the destination were measured for each time zone of the day. The following chart shows the result of the survey.



Source: Study Team

FIGURE 19.3-1 COMPARISON OF TRAVEL TIME AND AVERAGE SPEED

The travel times in the case of using NLEX were shorter by 18-34 minutes compared to those via MNR. Depending on a time zone of the day, the travel times to the destination were different in both cases, and the gaps between using MNR and using NLEX were also different. From this point, providing information according to the traffic situation is expected to promote spatial dispersion of the traffic demand.

The result also shows that the travel times were highly stable in the case of using NLEX, while they were significantly different between time zones in the case of using MNR.

Focusing on the case of using NLEX, we noted that the percentage of travel time on the access road was high in the total time required to reach the destination. Therefore, we assume it would be beneficial to improve the traffic flow of the access road at the same time if possible. Such improvement would generate a wider time gap between using MNR and using NLEX, which would further promote the usage conversion from the arterial road to the expressway.

19.3.2 Proposed Project

Considerations with regard to providing information of travel time comparison for MNR are summarized as below:

- Except for some inter-city segments, the overall vehicle speed is low and significant speed reduction occurs intermittently. Therefore, if a comparison is made for a distance of several tens of kilometers, the travel time for the expressway will be much shorter

(the time gap between MNR and NLEX will be too large), therefore we assume that users are likely to use the expressway regardless if information of travel time comparison is provided or not.

- We assume that active encouragement to use access roads which are poorly developed and currently suffering traffic congestions should be avoided.
- We assume that the expressway toll of approximately PHP100 is not a large burden for those who could afford to buy a vehicle, considering the benefits they obtain using the expressway (in terms of time to destination, travel performance, accident risk, etc).

CLASS 1

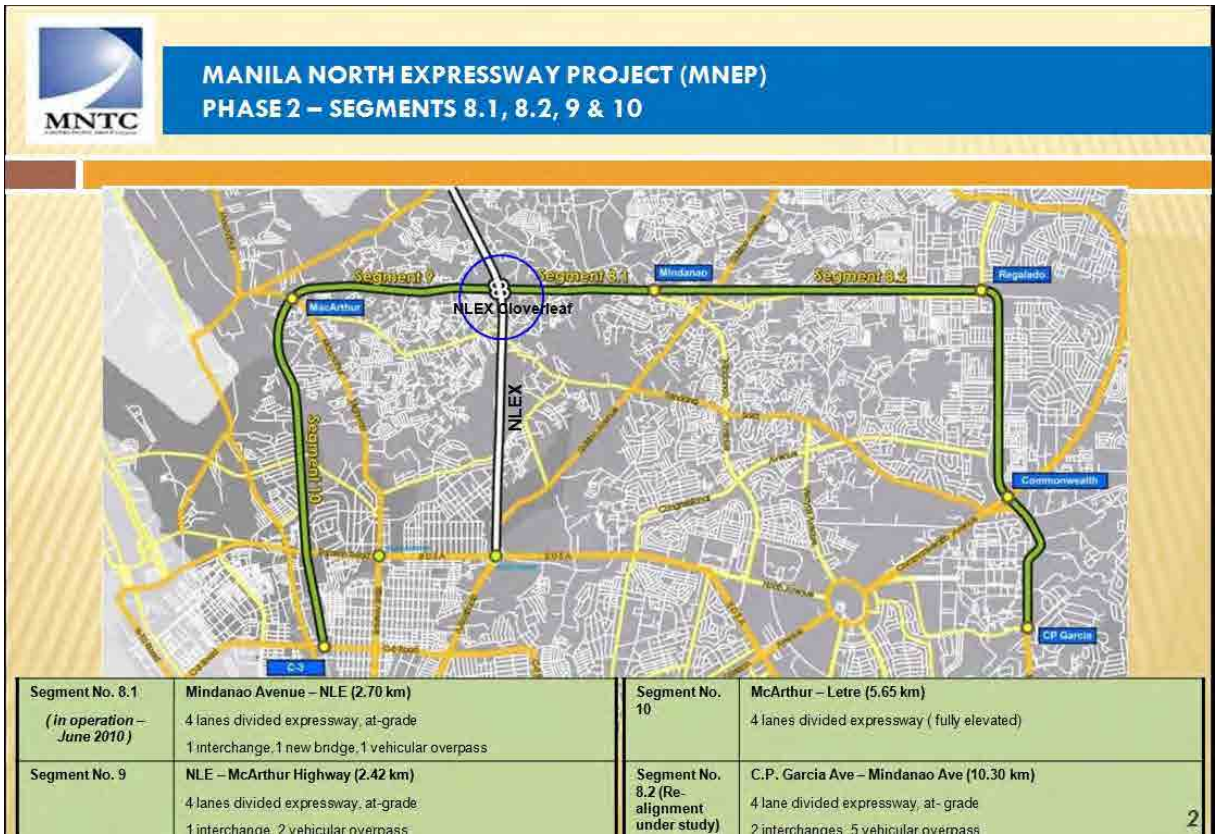
Toll Plaza	BWK	MIN	VAL	MEY	MAR	BOC	STR	PUL	SNM	SNF	MXC	ANG	DAU
Mindanao Ave.	45.0												
Valenzuela	45.0	45.0											
Meycauayan	45.0	45.0	45.0										
Marilao	45.0	45.0	45.0	45.0									
Bocaue	56.0	56.0	56.0	56.0	56.0								
Balagtas	70.0	70.0	70.0	70.0	70.0	14.0							
Tabang	80.0	80.0	80.0	80.0	80.0	24.0							
Sta. Rita	85.0	85.0	85.0	85.0	85.0	29.0							
Pulilan	103.0	103.0	103.0	103.0	103.0	47.0	17.0						
San Simon	133.0	133.0	133.0	133.0	133.0	78.0	49.0	31.0					
San Fernando	157.0	157.0	157.0	157.0	157.0	101.0	72.0	54.0	23.0				
Mexico	175.0	175.0	175.0	175.0	175.0	119.0	91.0	73.0	42.0	19.0			
Angeles	198.0	198.0	198.0	198.0	198.0	142.0	114.0	96.0	64.0	41.0	22.0		
Dau	218.0	218.0	218.0	218.0	218.0	162.0	133.0	115.0	84.0	60.0	41.0	19.0	
Sta. Ines	218.0	218.0	218.0	218.0	218.0	162.0	133.0	115.0	84.0	60.0	41.0	19.0	14.0

Source: MNTC (http://www.mntc.com/nlex/tolltable-class1.htm)

FIGURE 19.3-2 TOLL TABLE (CLASS 1) OF NORTH LUZON EXPRESSWAY

According to our understanding of the road and traffic situations based on the field survey, we select Marilao in this project as a place where information provision of travel time comparison is likely to produce positive results. The specific reasons of the selection are as follows:

- The distance from EDSA (central Manila) is approximately 15km; as a result, the absolute gap between the travel times is small under the free flow condition.
- Almost all streets in this area are urbanized:
  - Traffic is congested due to a large number of people and loading/unloading vehicles on the street.
  - Transport demand is expected to be high.
- It is close to the expressway; a long-distance travel is not necessary to reach the expressway.
- The range of road data collection is small; collection of highly accurate information is possible.
  - It is also meaningful as a range of data intake for Traffic Navigator of MMDA.
  - The road data could be utilized for comparison at the time of network expansion in the future as road/traffic performance index.



Source: MNTC (http://www.mntc.com/images/MNEPPhase2_large.jpg)

FIGURE 19.3-3 MANILA NORTH EXPRESSWAY PROJECT

On the other hand, consideration of the following points would be required:

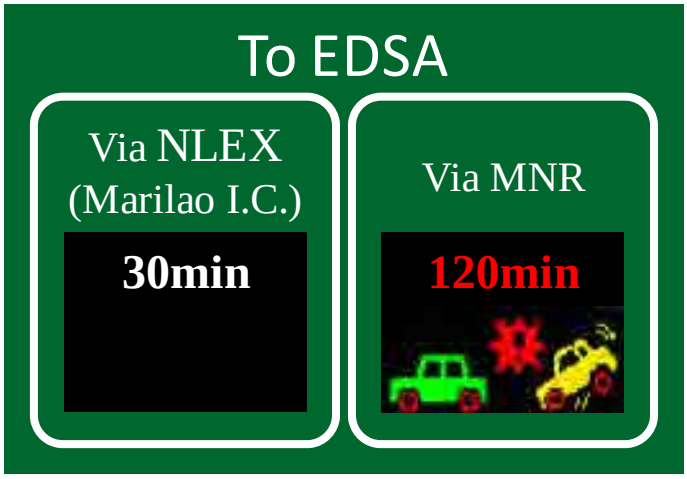
- Method of result verification
  - For understanding the real conversion of the demand, it is necessary to obtain data of the traffic amounts before and after the project, for both MNR and NLEX, respectively.
- Understanding of the traffic congestion of NLEX at the connection points to EDSA
  - There may be time zones where the time to destination via the expressway is longer than that via MNR. (Even in this case, a social benefit is achieved due to appropriate spatial dispersion of the traffic demands)

As a result of the above considerations and the field survey, we install a device for information provision at an intersection between MNR and an access road connected to Marilao interchange. However, before the intersection, there is no existing structure to which the information device could be mounted. Therefore, a pole should be installed as well to install the information equipment. It is a arterial road with two lanes each way.

Considering the above-mentioned traffic situation, we suggest installation of an overhung-type information board. The information equipment should be a combination type of traffic signs and

a LED display device, and provides information about traffic situations along NLEX and MNR, respectively. The basic information to be provided is the travel time from the point where the information equipment is installed to EDSA (or Balintawak), with display of incident symbols depending on the situation.

The image of travel time information signboard for this project is as follow.



Source: Study Team

FIGURE 19.3-4 TRAVEL TIME IIFORMATION PROVISION IMAGE

We select a zone before the congested area along MNR, and install an ultra-sonic sensor and a CCTV (Closed-Circuit Television) camera as devices for collecting information. The equipment should be mounted to existing structures such as pedestrian bridges as much as possible so that the number of new pole installation would be minimized. The traffic data that you should collect in this equipment is traffic volume and vehicle speed of each point.

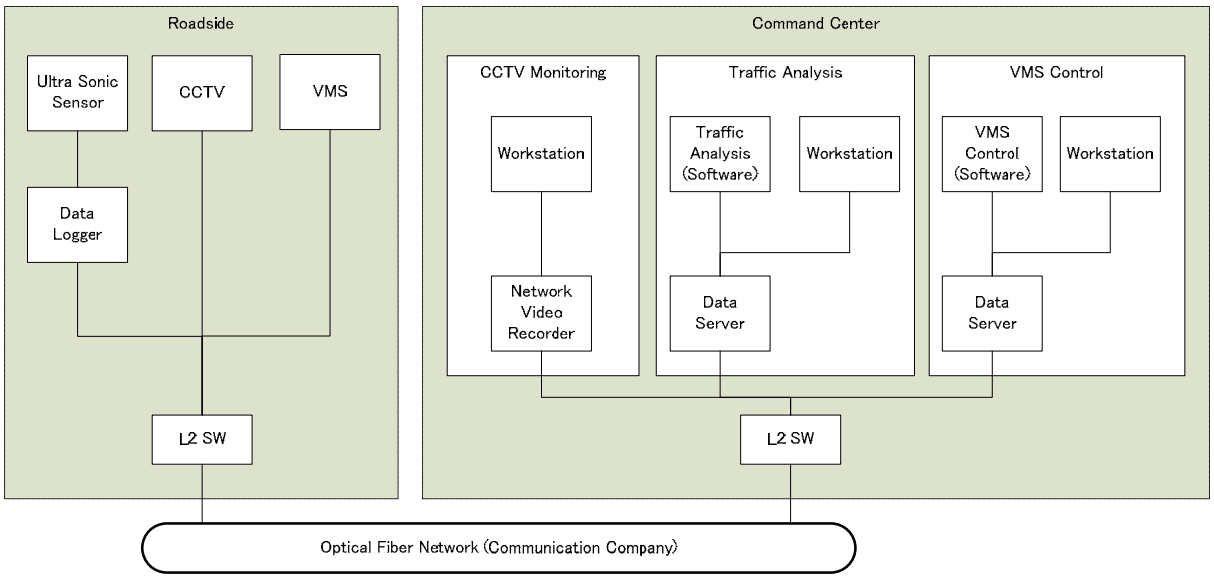
It is predicted based on collected data in the travel time of each route. At the same time, collection and provision of information are controllable at the Traffic Command Center within DPWH, and the data are shared with the Traffic Operation Center of NLEX.

A list of equipment to be used, unit price of each equipment and quantities are shown in table below. And the system configuration and equipment arrangement plan are shown in figure below.

TABLE 19.3-1 EQUIPMENT TO BE USED

Equipment Name	Unit Price (PHP)	Qty.
CCTV Camera (FIX Type)	320,200	10
Vehicle Detector (Ultra Sonic Sensor)	169,960	10
Variable Message Signboard	3,830,000	1
Main Unit (Server at Center)	127,774	3
Network Video Recorder (Center)	383,824	1
Monitor Screen (Center)	31,024	3
Printer (Center)	20,400	1
Backup Media Drive (Center)	67,300	2
VMS Center Controller (Software)	2,390,000	1
Traffic Analysis Processor (Software)	1,924.000	1
Layer 2 Switch (Network Equipment)	212,000	1
Switching Hub (Network Equipment)	23,800	14

Source: Study Team



Source: Study Team

FIGURE 19.3-5 SYSTEM CONFIGURATION IMAGE

Source: Study Team

FIGURE 19.3-6 EQUIPMENT ARRANGEMENT PLAN

19.4 IMPLEMENTING AGENCY AND IMPLEMENTATION SCHEDULE

19.4.1 Implementation Agency

The project will be conducted by DPWH, however shall be corroborated with NLEX and MMDA for the implementation fruitfully.

19.4.2 Implementation Schedule

The all equipment which is proposed in this project needs the installations. Assumed installations are shown below;

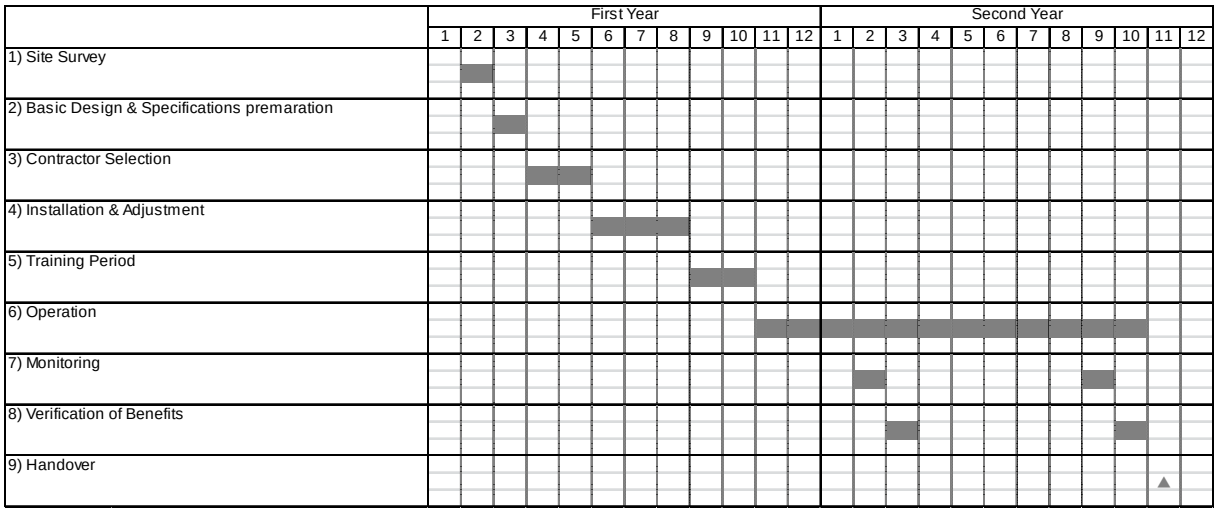
1) Installation of gantry for Variable Message Signboard of Manila North Road
2) Installation of Variable Message Signboard to the gantry
3) Installation of gantry for Ultra Sonic Sensor and CCTV Camera of Manila North Road
4) Installation of Ultra Sonic Sensor to the gantry
5) Installation of CCTV Camera to the gantry
6) Installation of communication cable
7) Installation of equipment for Command Center

The experimental project will propose the traffic control system for information provision which consists of several components as implementation conditions. Not only each component conforms to the specification but also the whole system is to be composed so as to function as one system.

The equipment arrangement plan of the outline showed it with **Figure 19.3-6**, but the implementation phase of the project needs a field survey and a detailed design.

The project implementation schedule is shown in **Table 19.4-1**.

TABLE 19.4-1 PROPOSED IMPLEMENTATION TABLE



Source: Study Team

19.5 ESTIMATED COST

(1) Traffic Information System Installation Cost

Traffic information system installation cost was estimated at Php 15.02 Million as shown in **Table 19.5-1.**

(2) Annual Operation and Maintenance Cost

Annual operation and maintenance cost was estimated at Php 5.40 Million as shown in **Table 19.5-2.**

TABLE 19.5-1 TRAFFIC INFORMATION SYSTEM INSTALLATION COST

Item	Unit	Quantity	Unit Price (PHP)	Cost (PHP)	Cost by		
					Foreign	Local	Tax
1. Traffic Information/Control							
Vehicle Detection							
CCTV Camera (Fix Type) for Monitoring	set	10	320,200	3,202,000	0	2,849,780	352,220
Ultra Sonic Sensor/Data Logger	set	10	169,960	1,699,600	0	1,512,644	186,956
CCTV Monitoring System							
Monitor Screen	set	1	31,024	31,024	0	27,611	3,413
Mani Unit	set	1	128,468	128,468	102,774	7,708	17,986
Network Video Recorder	set	1	383,824	383,824	191,912	142,015	49,897
Traffic Analysis Processor							
Main Unit / Server for Traffic Analysis Processor	set	1	204,770	204,770	102,385	75,765	26,620
Traffic Volume Calculation (Software)	set	1	1,924,000	1,924,000	962,000	711,880	250,120
Traffic Data Server							
Monitor Screen	each	1	44,800	44,800	0	39,872	4,928
Data Server							
Main Unit (including Keyboard and Mouse)	each	1	127,774	127,774	102,219	7,666	17,888
Backup Media Drive	each	1	67,300	67,300	0	59,897	7,403
VMS Type A	set	1	3,830,000	3,830,000	3,064,000	229,800	536,200
Switching HUB for Terminal Layer	set	1	25,800	25,800	2,580	20,640	2,580
VMS Center Controller							
Data Server							
Main Unit	set	1	128,468	128,468	102,774	7,708	17,986
VMS Controller (Software)	set	1	2,390,000	2,390,000	1,912,000	143,400	334,600
Monitor Screen	each	1	31,024	31,024	0	27,611	3,413
Printer	each	1	20,400	20,400	0	18,156	2,244
Backup Media Drive	each	1	67,300	67,300	0	59,897	7,403
2. Communication System							
Layer 2 SW	set	1	212,000	212,000	178,080	4,240	29,680
Switching Hub	set	14	25,800	361,200	36,120	288,960	36,120
3. Electric Back-up Power Supply							
Backup Power Supply Facilities							
UPS	set	1	150,000	150,000	0	133,500	16,500
Grand Total				15,029,752	6,756,845	6,368,751	1,904,156

Source: Study Team

TABLE 19.5-2 ANNUAL O&M COST OF MNR/NLEX CORRIDOR INFORMATION PROVISION PROJECT

Item	Unit	Unit Price (Php)	Quantity	Cost (Million Php)	Cost Component (Million Php)		
					Foreign	Local	Tax
Replacement of Equipment Parts (2% of Total Cost)	L.S.	300,000.00	1.00	0.300	0.225	0.033	0.042
Electricity	Php/ Year	400,000.00	1.00	0.400	–	0.357	0.043
Staff Cost	Month	300,000.00	12.00	3.600	–	3.214	0.386
Running Cost of Office	Month	40,000.00	12.00	0.480	–	0.429	0.051
Rental Fee of Communication Line	Month	30,000.00	12.00	0.360	–	0.321	0.039
Management Cost (5% of above Cost)	–	–	–	0.257	–	0.229	0.028
Total O & M Cost per Year				**5.397**	**0.225**	**4.583**	**0.589**

Source: Study Team

19.6 EFFECT AND IMPACT OF PROJECT

(1) The Purpose of the Evaluation

Impact of introduction of information provision was conducted with respect to NLEX and North Manila Road (NMR). The major content of the information is traffic situation for both NLEX and NMR so that drivers can select preferable road to be used. The impact evaluation was conducted in terms of alleviation of traffic congestion in NMR due to shifting some portion of the traffic volume from NMR to NLEX. The evaluation index is travel time cost saving which is expressed in monetary term.

(2) Evaluation Flowchart

The evaluation flowchart is shown as follows:

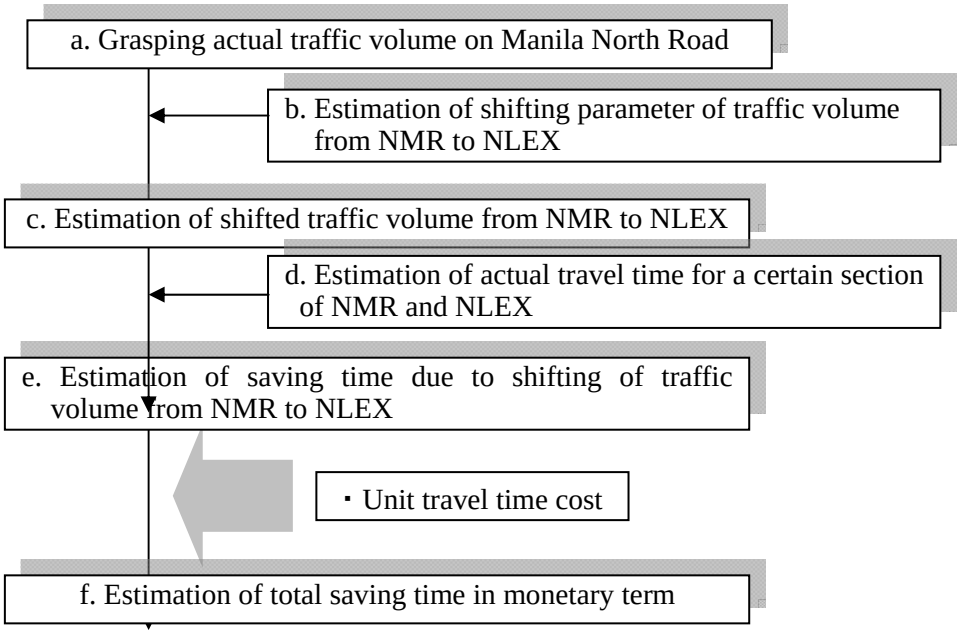


FIGURE 19.6-1 IMPACT EVALUATION FLOWCHART

(3) Results

1) Grasping actual traffic volume on Manila North Road

Traffic field survey for NMR and NLEX was conducted. Through the survey, traffic volume of NMR, actual travel time between targeted section of NMR and NLEX was grasped. Results of field survey are as follows:

TABLE 19.6-1 VOLUME OF TRAFFIC ON MNR

Traffic Volume [PCU/16 hours]	Traffic Volume [PCU/24 hours]
7,635	9,445

2) Estimation of shifting parameter of traffic volume from NMR to NLEX

A certain portion of traffic is expected to move from NMR to NLEX in order to avoid traffic congestion on NMR. Such change of traffic behavior can be expected if the traffic information for both NMR and NLEX provided for road users. The ratio of traffic volume on NMR which goes toward EDSA was estimated as 12%. The expected ratio of shifting traffic volume may be estimated as approximately 50% of traffic which goes to EDSA. On the basis of such idea, the shifting parameter was estimated as 12% multiplied by 50% then 6.0%.

3) Estimation of shifted traffic volume from NMR to NLEX

Taking account of existing traffic volume on NMR: 9,445 [24hours PCU], and estimated shifting parameter: 6.0%, estimated shifted traffic volume from NMR to NLEX can be obtained as follows:

TABLE 19.6-2 ESTIMATED SHIFTED TRAFFIC VOLUME FROM MNR TO NLEX

Traffic Volume on NMR [PCU/24 hours]	Shifting Parameter [%]	Shifting Traffic Volume per Day [PCU/day]	Shifting Traffic Volume per Year [PCU/year]
9,445	6.0	567	141,750

4) Estimation of actual travel time for a certain section of NMR and NLEX

The field survey for grasping actual travel time at targeted section on NMR and NLEX. The average travel speed and travel time was obtained as follows:

TABLE 19.6-3 ACTUAL TRAVEL SPED AND TRAVEL TIME ON MNR TO NLEX

	Average Travel Speed [km/hour]	Length of targeted Section [km]	Travel Time [minutes]
NMR	19.8	16.2	49.1
NLEX & Access Road	42.3	16.8	23.6

***Note**: Six Times Travel Survey (6:00, 7:30, 9:00, 10:30, 13:00, 15:00)*

5) Estimation of total saving time in monetary term

On the basis of the above-mentioned study results, the total saving time and saving travel time cost were obtained shown as follows:

TABLE 19.6-4 TRAVEL TIME (TT) SAVING EFFECT OF TRAFFIC SHIFTING FROM MNR TO NLEX

Average TT Saving (minutes/trip/PCU)	TT Saving per Day (minutes/day)	TT Saving per Year (minutes/day)
25.6	14,515	3,628,800

TABLE 19.6-5 TRAVEL TIME COST (TTC) SAVING BENEFIT OF TRAFFIC SHIFTING FROM MNR TO NLEX

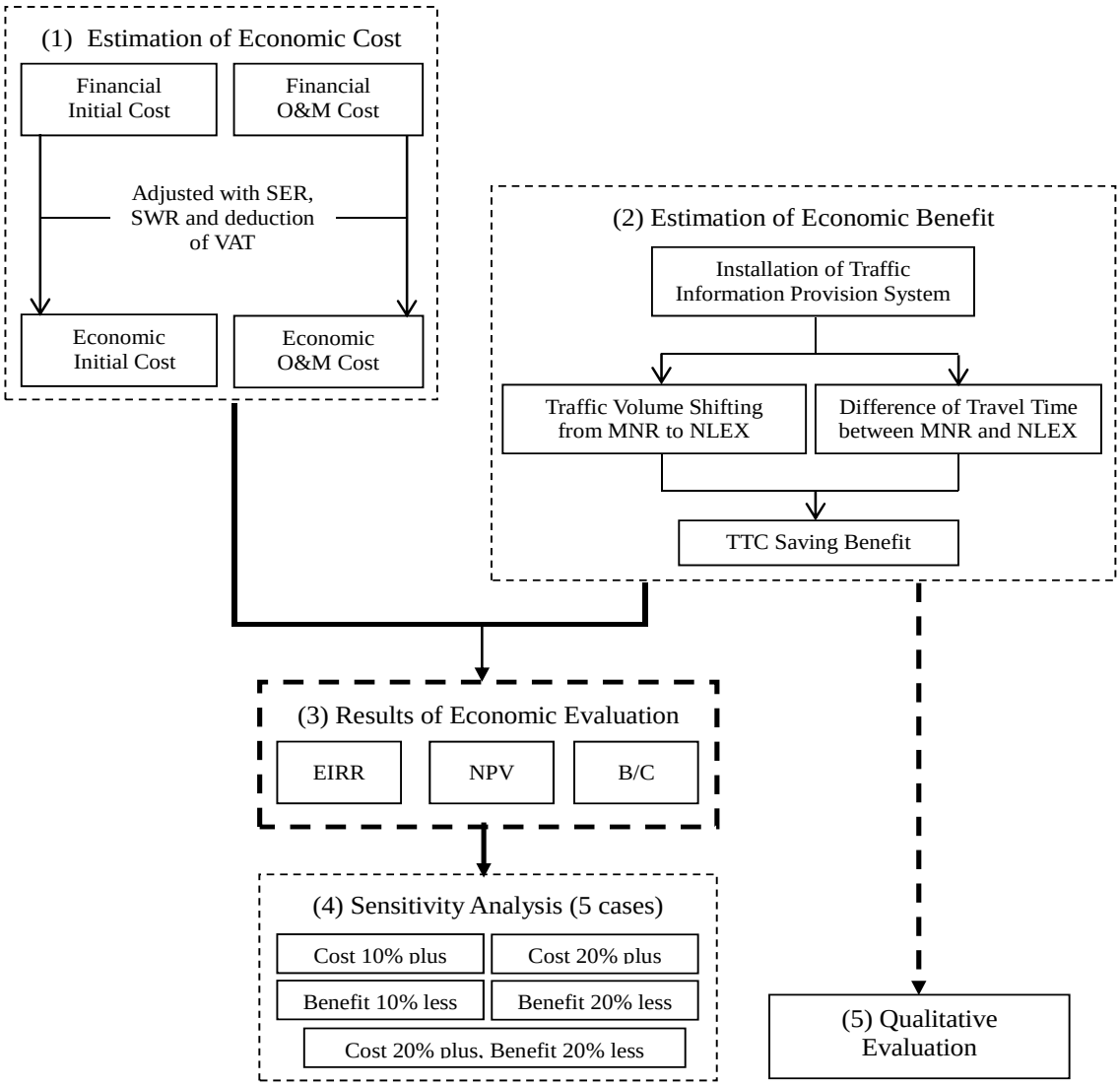
Unit TTC (Php/minute/ PCU)	TTC Saving per Day (Php. million/day)	TTC Saving per Year (Php. million/year)
7.8	0.11	28.30

19.7 ECONOMIC EVALUATION

19.7.1 Methodology

(1) Framework and Workflow of Economic Evaluation

The framework and workflow of economic evaluation on the project of Traffic Information System Installation along Manila North Road/North Luzon Expressway (MNR/NLEX) are reflected in the following flow chart.



Source: Study Team

FIGURE 19.7-1 FRAMEWORK AND WORKFLOW OF ECONOMIC EVALUATION OF TRAFFIC INFORMATION SYSTEM INSTALLATION ALONG MNR/NLEX

(2) Basic Concepts and Assumptions

1) Reference to the Metro Manila Master Plan

The basic concepts and assumptions adopted in the economic evaluation of this project include approach of quantitative and qualitative analysis, application of shadow prices, indicators of economic evaluation, and other basic assumptions. As all the basic concepts and most of the assumptions here are the same as those adopted previously in the section regarding the Metro Manila Master Plan, description of this part is omitted except for the following 2 points.

2) Economic Evaluation Focused on the Impact of Traffic Information Provision

Unlike the Metro Manila Master Plan and Mega Manila Master Plan in which all the seven areas of ITS development are targeted, the scope of this pilot project is confined to the area of traffic information provision. Therefore, the work of economic evaluation on this project is focused on analyzing the impact of introducing the traffic information provision system, or to be more specific, the benefit of TTC saving brought forth by the traffic shifting from the congested MNR to the relatively faster moving NLEX as a result of the installation of this system, which is regarded as benefit quantifiable. In addition, there are also benefits unquantifiable, to which the approach of qualitative analysis is applied.

3) Project Period Subject to the Evaluation

The period of this pilot project subject to the economic evaluation is assumed to be 10 years.

19.7.2 Economic Cost of the Project

(1) Initial Cost

1) Financial Cost

The initial cost of this project consists of costs of the following 4 categories, including the physical contingency cost assumed to be 5% of the 3 basic cost categories.

- Traffic Information Control System
- Communication System
- Back-up Power Supply System
- Physical Contingency

The project is scheduled to be started in October, 2013, but the initial investment cost is expected to be disbursed in the beginning of 2014. The financial cost of the initial investment by category is stated in the table with the breakdown of foreign currency portion, local currency portion as well as tax item.

TABLE 19.7-1 FINANCIAL COST OF INITIAL INVESTMENT (UNIT: PHP. MILLION)

No.	Item	Total	Foreign	Local	Tax
1	Traffic Information/Control	14.307	6.543	5.941	1.822
1.1	Vehicle Detection	4.902	0.000	4.362	0.539
1.2	CCTV Monitoring System	0.543	0.295	0.177	0.071
1.3	Traffic Analysis Processor	2.129	1.064	0.788	0.277
1.4	Traffic Data Server	0.240	0.102	0.107	0.030
1.5	VMS Type A	3.856	3.067	0.250	0.539
1.6	VMS Center Controller	2.637	2.015	0.257	0.366
2	Communication System	0.573	0.214	0.293	0.066
3	Electric Back-up Power Supply	0.150	0.000	0.134	0.017
4	**Total (Item1+2+3)**	**15.030**	**6.757**	**6.368**	**1.905**
5	Phisical Contigency (5% of Item 3)	0.752	0.338	0.318	0.095
Grand Total		**15.782**	**7.095**	**6.686**	**2.000**

Source: Study Team

2) Conversion to Economic Cost

The values of financial cost are converted into that of the economic cost in the same way as what has been explained in the previous chapters. As a result of the conversion, the values of economic cost are reflected in the following table.

TABLE 19.7-2 ECONOMIC COST OF INITIAL INVESTMENT (UNIT: PHP. MILLION)

No.	Item	Total	Foreign	Local
1	Traffic Information/Control	11.416	7.852	3.565
1.1	Vehicle Detection	2.617	0.000	2.617
1.2	CCTV Monitoring System	0.460	0.354	0.106
1.3	Traffic Analysis Processor	1.750	1.277	0.473
1.4	Traffic Data Server	0.187	0.122	0.064
1.5	VMS Type A	3.830	3.680	0.150
1.6	VMS Center Controller	2.572	2.418	0.154
2	Communication System	0.433	0.257	0.176
3	Electric Back-up Power Supply	0.080	0.000	0.080
4	**Total (Item1+2+3)**	**11.929**	**8.108**	**3.821**
5	Phisical Contigency (5% of Item 3)	0.596	0.405	0.191
Grand Total		**12.526**	**8.514**	**4.012**

Source: Study Team

(2) Operation and Maintenance (O&M) Cost

With regard to the O&M cost of the project, the 7 cost items with values of annual amount are indicated in terms of both financial cost and economic cost as seen from the following table. The way in which the financial cost of respective items is converted into economic cost is the same as what has been adopted in the previous chapters.

TABLE 19.7-3 FINANCIAL COST AND ECONOMIC COST OF O&M
(UNIT: PHP. MILLION)

No	Item	Financial Cost				Economic Cost		
		Total	Foreign	Local	Tax	Total	Foreign	Local
1	Replacement of Equipment Parts	0.300	0.225	0.033	0.042	0.303	0.270	0.033
2	Electricity	0.400	0.00	0.357	0.043	0.357	0.00	0.357
3	Staff Cost	3.600	0.00	3.214	0.386	1.928	0.00	1.928
4	Running Cost of Office	0.480	0.00	0.429	0.051	0.429	0.00	0.429
5	Rental Fee of Optical Fiber Cable	0.360	0.00	0.321	0.039	0.321	0.00	0.321
6	Management Cost (5% of above Cost)	0.257	0.00	0.229	0.028	0.229	0.00	0.229
7	Physical Contingency	0.270	0.011	0.229	0.029	0.178	0.014	0.165
Total O & M Cost per Year		**5.667**	**0.236**	**4.812**	**0.618**	**3.746**	**0.284**	**3.462**

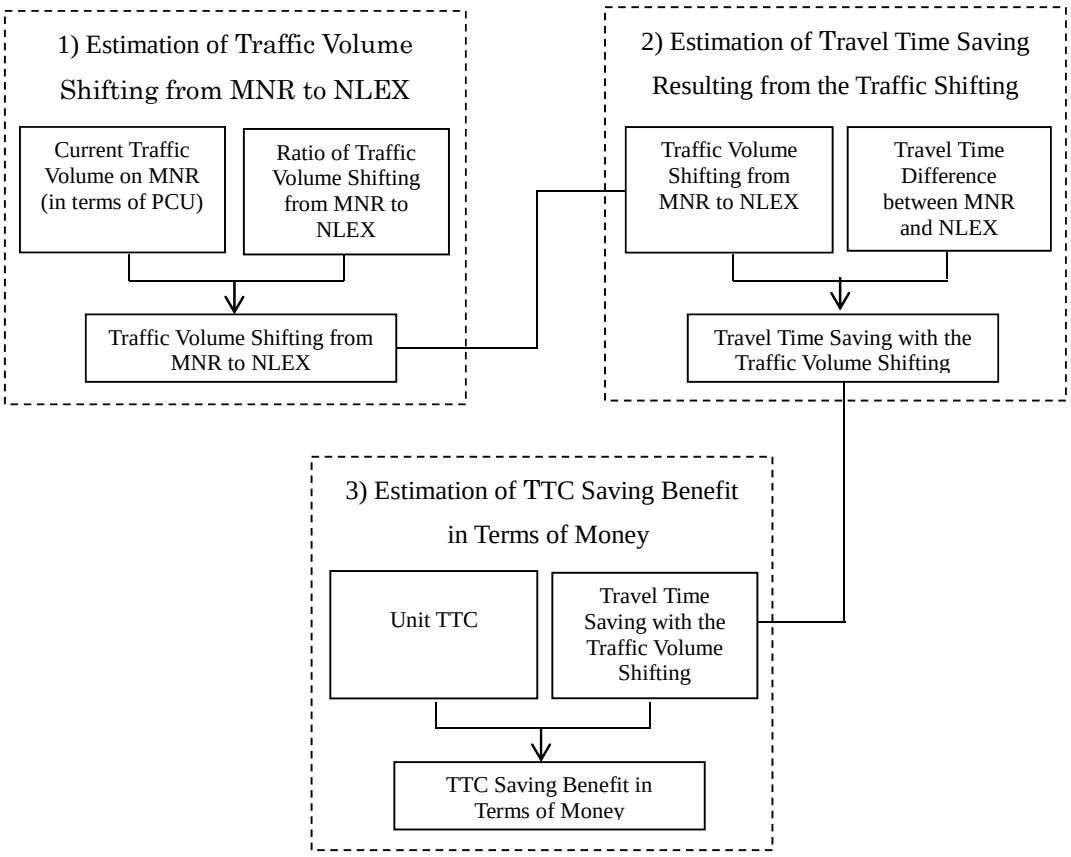
Source: Study Team

19.7.3 Quantifiable Economic Benefit of the Project

As stated in the previous section of methodology, the economic evaluation of this chapter is focused on analyzing the impact of introducing the traffic information provision system, and only the benefit of TTC saving resulting from the traffic shifting from the congested MNR to the relatively faster moving NLEX is regarded as quantifiable in this analysis. Therefore, the passage below is devoted to evaluating the above-mentioned benefit deriving from the installation of traffic information provision system.

(1) TTC Saving Benefit Deriving from Traffic Information Provision

With regard to the impact of this pilot project, the TTC saving benefit can be estimated by measuring the current traffic volume on the MNR and the difference of travel time between driving through MNR and NLEX, and assuming the ratio of traffic volume likely to shift from MNR to NLEX when introducing the traffic information provision system, followed by the calculation of traffic shifting volume, saving of travel time per day and per year, and their values in terms of money. The whole process can be illustrated by the following flow chart.



Source: Study Team

FIGURE 19.7-2 PROCESS OF TTC SAVING BENEFIT ESTIMATION REGARDING THE IMPACT OF TRAFFIC INFORMATION PROVISION SYSTEM INSTALLATION

1) Estimation of Traffic Volume Shifting from MNR to NLEX with This Project

Based on the result of a traffic survey conducted by another JICA Study Team[1], the inbound traffic volume on MNR estimated to be 9,445 PCU per day. Meanwhile, the traffic volume likely to shift from MNR to NLEX is expected to account for 6% of total traffic volume on MNR. Accordingly, under the condition that the traffic information system is installed, the traffic volume shifting from MNR to NLEX is expected to be 567PCU/day and 141,750PCU/year (on the basis of 250 weekday's year) as seen from the following table.

TABLE 19.7-4 TRAFFIC VOLUME EXPECTED TO SHIFT FROM MNR TO NLEX

Traffic Volume (PCU/24 hours)	Ratio of Shifting Taffic Volume (%)	Shifting Taffic Valume per Day (PCU/day)	Shifting Taffic Valume per Year (PCU/year)
9,445	6.0	567	141,750

Source: Study Team

2) Estimation of Travel Time Saving Resulting from the Traffic Shifting

According to a field survey conducted by the Study Team, the average difference of travel time

[1] JICA Study, "MMUTIS Update and Capacity Enhancement Project" conducted in September 2012.

between MNR and NLEX is estimated to be 25.6 minutes with the trip via MNR taking longer time than that of NLEX. Based on this estimation as well as the afore-mentioned values of traffic shifting volume per day and per year, the saving of travel time can thus be figured out as indicated in the following table.

TABLE 19.7-5 TRAVEL TIME SAVING RESULTING FROM THE TRAFFIC SHIFTING

Average TT Saving (minutes/trip/PCU)	TT Saving per Day (minutes/day)	TT Saving per Year (minutes/day)
25.6	14,515	3,628,800

Source: Study Team

3) Estimation of TTC Saving Benefit

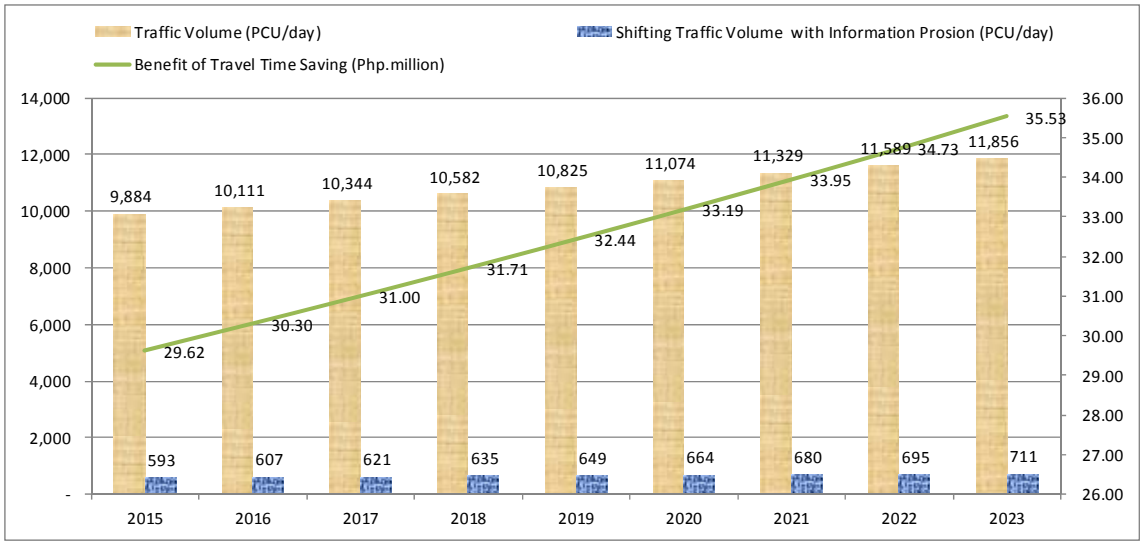
On the basis of the above results as well as the unit TTC value (7.8 peso/minute/PCU), the TTC saving benefit is estimated to be Php.28.3 million/year as seen from the table below.

TABLE 19.7-6 TTC SAVING BENEFIT PER DAY AND PER YEAR

Unit TTC (Php/minute/ PCU)	TTC Saving per Day (Php.million/day)	TTC Saving per Year (Php.million/year)
7.8	0.11	28.30

Source: Study Team

As the evaluation of this project is intended to cover a period of 10 years starting from 2014 to 2023, in light of the previously mentioned annual growth rate of 2.3% up to the year 2030 with regard to the traffic volume in the Metro Manila Region, the benefit generated each year within the project period can be estimated as illustrated in the following diagram.



Source: Study Team

FIGURE 19.7-3 TTC SAVING BENEFIT ACCRUING FROM THE INTRODUCTION OF TRAFFIC INFORMATION PROVISION SYSTEM

19.7.4 Result of Economic Evaluation

With the values of all the cost items and quantifiable benefit item, major results of economic evaluation of the pilot project are figured out as indicated in the table below.

TABLE 19.7-7 MAJOR RESULTS OF ECONOMIC EVALUATION OF TRAFFIC INFORMATION PROVISION SYSTEM

EIRR (%)	NPV (Php. million)	B/C
161.5	102	4.4

Source: Study Team

As seen from the above table, EIRR is far above the value of SDR (15%), and the values of NPV and B/C also exceed their respective threshold levels, showing that the economic effect of this project will be exceptionally good. Moreover, as the project contains also unquantifiable benefits, the economic viability could be regarded better than the above quantitative result when taking into consideration all the unquantifiable benefits.

The calculation table with values of cost-benefit stream is presented below.

TABLE 19.7-8 COST-BENEFIT STREAM (MNR/NLEX) (UNIT: PHP. MILLION)

Year	Cost						Benefit		Net Economic Benefit
	Initial Cost				O&M Cost	Total Cost	Traffic Information Provision (TTC Saving)	Total Benefit	
	Traffic Information Control System	Communication System	Back-up Power Supply	Physical Cotingency					
2014	11.42	0.43	0.08	0.60	3.75	16.28	0.00	0.00	(16.28)
15	0.00	0.00	0.00	0.00	3.75	3.75	29.62	29.62	25.87
16	0.00	0.00	0.00	0.00	3.75	3.75	30.30	30.30	26.55
17	0.00	0.00	0.00	0.00	3.75	3.75	30.99	30.99	27.24
18	0.00	0.00	0.00	0.00	3.75	3.75	31.71	31.71	27.96
19	0.00	0.00	0.00	0.00	3.75	3.75	32.44	32.44	28.69
20	0.00	0.00	0.00	0.00	3.75	3.75	33.18	33.18	29.43
21	0.00	0.00	0.00	0.00	3.75	3.75	33.95	33.95	30.20
22	0.00	0.00	0.00	0.00	3.75	3.75	34.73	34.73	30.98
23	0.00	0.00	0.00	0.00	3.75	3.75	35.53	35.53	31.78
								EIRR=	161.493%
								NPV(Php million)=	102
								Present value of cost=	30
								Present value of benefit=	132
								B/C=	4.4

Source: Study Team

19.7.5 Sensitivity Analysis

The sensitivity of the project to potential risks is verified by assuming the following 5 cases:

- Case 1: 10% plus of cost
- Case 2: 20% plus of cost
- Case 3: 10% less of benefit
- Case 4: 20% less of benefit
- Case 5 20% plus of cost and 20% less of benefit

The results of sensitivity analysis on the 5 cases are summed up in the following table, which show that, even under the strictest conditions assumed in Case 5, the EIRR value of this project is still well above the SDR value.

TABLE 19.7-9 PROJECT SENSITIVITY IN 5 CASES (MNR/NLEX)

	Base	Case 1	Case 2	Case 3	Case 4	Case 5
EIRR (%)	161.5	144.9	131.2	143.3	125.1	100.8
NPV (Php. million)	102	99	96	89	76	70
B/C	4.4	4.0	3.7	4.0	3.6	3.0

Source: Study Team

19.7.6 Qualitative Evaluation

In addition to the quantifiable benefits evaluated above, there are also several kinds of unquantifiable benefit worthy of mentioning. These benefits include faster moving traffic flow, saving of vehicle operation cost (VOC), reduction of CO_2 emission, traffic accident reduction and user's psychological comfort. Justifications for these benefits are as follows.

- Faster Moving Traffic Flow

  Implementation of this project will provide the road users with information regarding the current situation of congestion in real time along both the MNR and the NLEX so that the general road users can shift from the congested road to the less congested one. As a result, by easing congestion on either of the two roads, this service will ensure faster moving traffic flow in the overall road network so as to reduce average driving time.

- Saving of VOC

  By improving the traffic efficiency in the overall road network, VOC including cost of fuel consumption, engine oil consumption, tire and tube consumption and vehicle repair and maintenance will be significantly reduced.

- Reduction of CO2 Emission

  The above-mentioned saving of VOC, particularly the saving of fuel consumption will result directly in the reduction of CO2 emission as this is ascribable to fossil fuel consumption.

- Traffic Accident Reduction

  As the improvement of traffic efficiency will ease traffic congestion and chaos, this will in turn contribute to the reduction of occurrence probability of traffic accident and hence reduce the social loss resulted from the accidents.

- User's Psychological Comfort

  By providing the real time information of traffic conditions, the introduction of this system will assure road users of a highly efficient, smooth and comfortable travel along the roads.

CHAPTER 20
STANDARDIZATION OF ETC

20.1 INTRODUCTION

Toll expressways has been constructed and operated by various private companies. Each private company adopted its own ETC system. Even though both company A and company B adopt the same system such as DSRC-passive ETC, but they do not adopt the same operation system, thus they are not compatible with each other.

This trend will continue even in the future, and more kinds of ETC systems will be introduced in the Philippines. Various problems explained in the succeeding sections of this chapter will be encountered. Thus, standardization of ETC is needed as soon as possible.

20.2 WHY STANDARDIZATION IS NEEDED?

Various present and future problems are discussed below.

(1) Low Penetration Rate of ETC Users

- Toll road operators adopted their own ETC System.

  NLEX - Easytrip (DSRC-Passive) } Not compatible at present
  Skyway & SLEX - E-pass (DSRC-Passive)
  Cavitex - E-tap (Smart Card)
- They are not compatible with each other, thus road users have to buy each operator's OBU.
- Current penetration rate of ETC users is low at about 35% only.
- If common ETC system is established, 61% of expressway users answered that they will install ETC OBU.
- Different ETC system by operators is impeding promotion of ETC-lane utilization.

(2) High Cost of On-Board-Unit (OBU)

- Current OBU cost ranges from 1,400 ~ 2,000 pesos.
- About 60% of toll road users answered to the Study Team's survey that they are willing to use ETC if OBU cost is less than 1,000 pesos.
- Currently there are three (3) types of ETC system. If toll road users wish to use an ETC lane, they have to buy three (3) types of OBU which cost about 3,500 pesos.
- High cost of OBUs and need to install different types of OBU is impeding promotion of ETC-lane utilization.

(3) Expected Problems in the Near Future

- Various expressways will be built in the near future as shown in **Figure 20.2-1,** and expressway network will be formed.

- Many expressways will be short in distance.
- If expressway users have to stop at each expressway entrance, travel time is lost and faster/seamless travel on expressways will be affected.
- Some expressways to be constructed in the central area of Metro Manila will encounter ROW acquisition difficulty, therefore, number of toll booths needs to be reduced as much as possible. To achieve this, cash lanes at toll plazas need to be reduced; instead ETC lanes with common ETC system need to be installed.
- Above will reduce traffic congestion at toll plazas, and realize smooth, faster, and seamless travel on expressways.

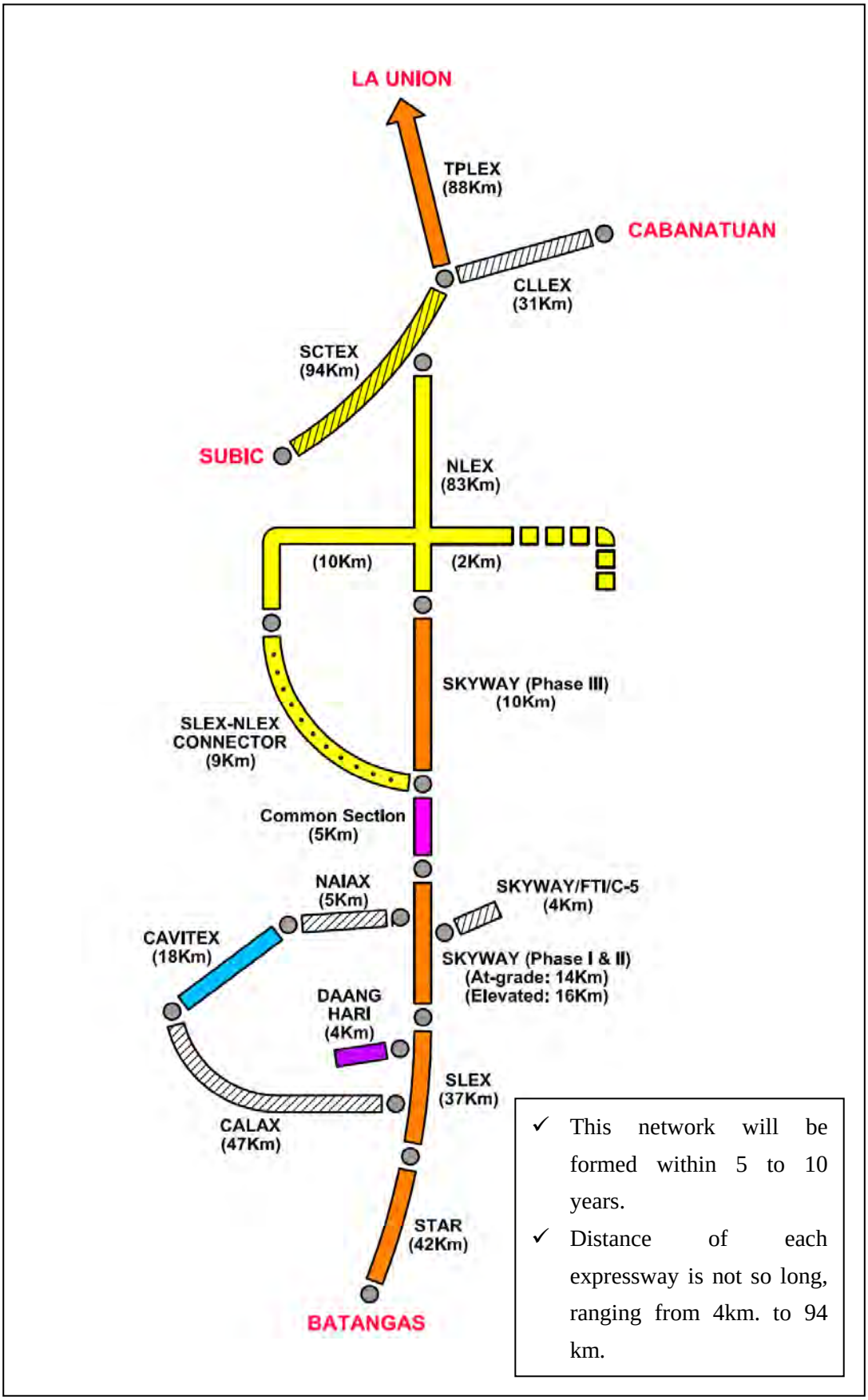


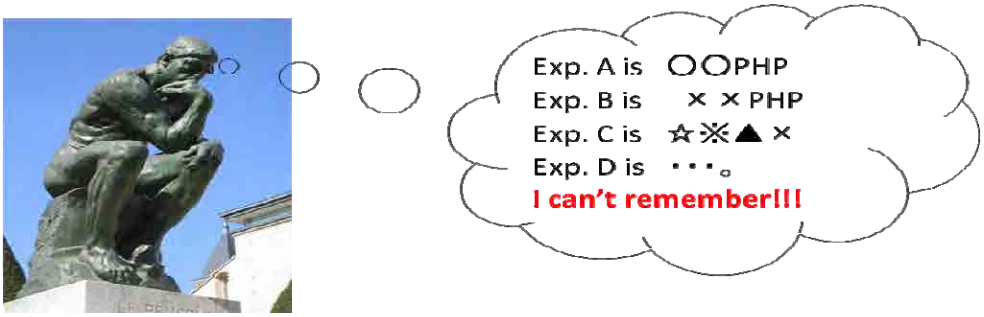
FIGURE 20.2-1 TOLL ROAD NETWORK IN NEAR FUTURE

(4) ETC Users Problems in the Near Future

If Standardization of ETC System is not achieved, what will happen to expressway users?

- ETC users have to buy many OBUs which will discourage promotion of ETC utilization

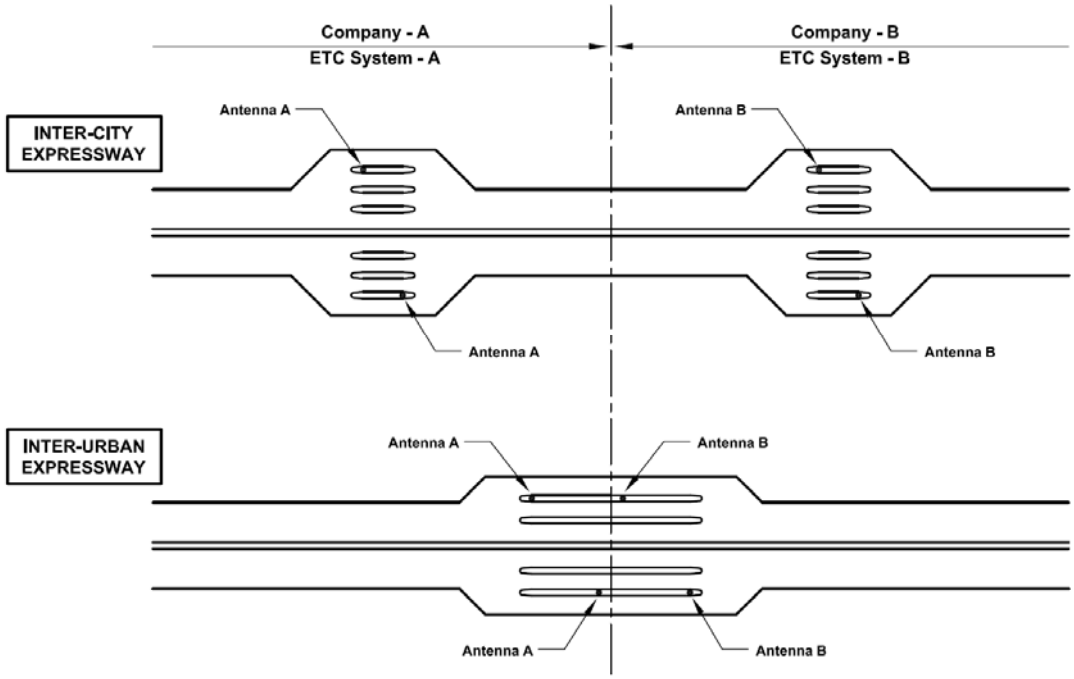
- ETC users will have a hard time to remember how much remains in each expressway OBU, since mostly prepaid system.



- Many troubles of insufficient remaining balance in OBU at a toll booth will occur and efficiency of ETC will be lost.

(5) Problems on the Part of the Concessionaire

- On the part of the Concessionaires, they need additional investment for the toll barrier, if ETC system is NOT Standardized.



- Penetration rate of ETC users will remain low, thus the operators have to rely on cash-lanes operation. They will encounter high operation cost.

20.3 WHAT ARE THE PROBLEMS, IF STANDARDIZATION IS IMPLEMENTED?

(1) On the part of Concessionaires

- Existing system needs to be removed and standardized system needs to be newly installed. ⟶ Additional investment (However, this cost may be off-set by savings in the operation cost.)
- Clearing House needs to be established to distribute toll incomes to respective Concessionaire.

(2) On the part of Expressway Users

- OBU currently being used to be cancelled and standardized OBU has to be purchased.

20.4 ETC IN THE WORLD

Currently, ETC has been operating in the world and various types of ETC exist due to the difference of wireless communication method between Roadside Antenna (hereinafter referred to as "RSA") installed at the toll plaza and OBU. Typical ETC are shown in **Figure 20.4-1** below and their features are explained in the following sections.

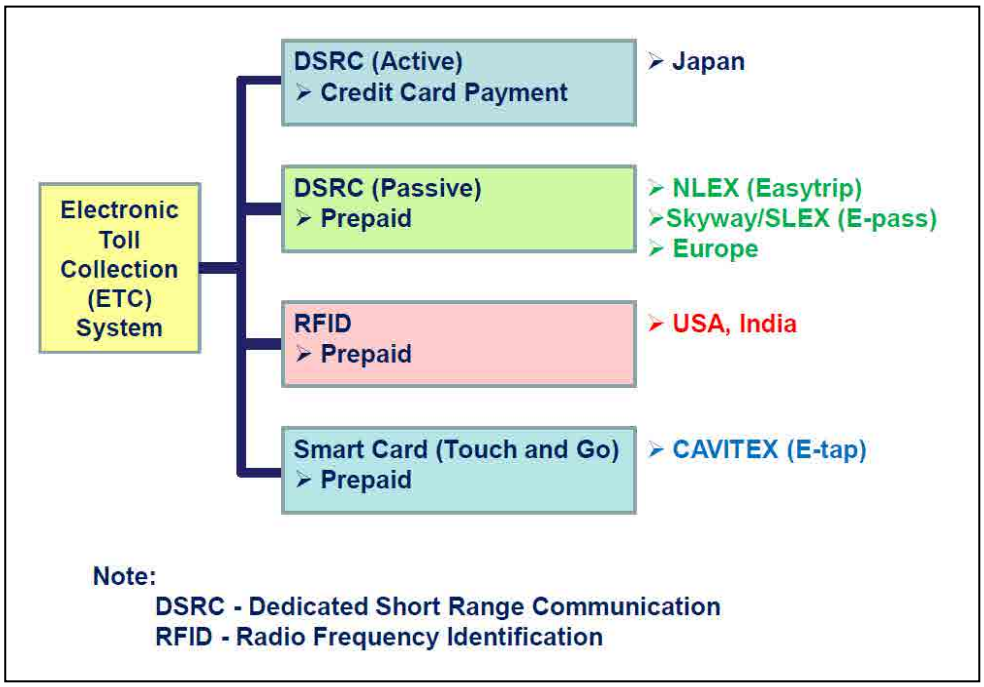


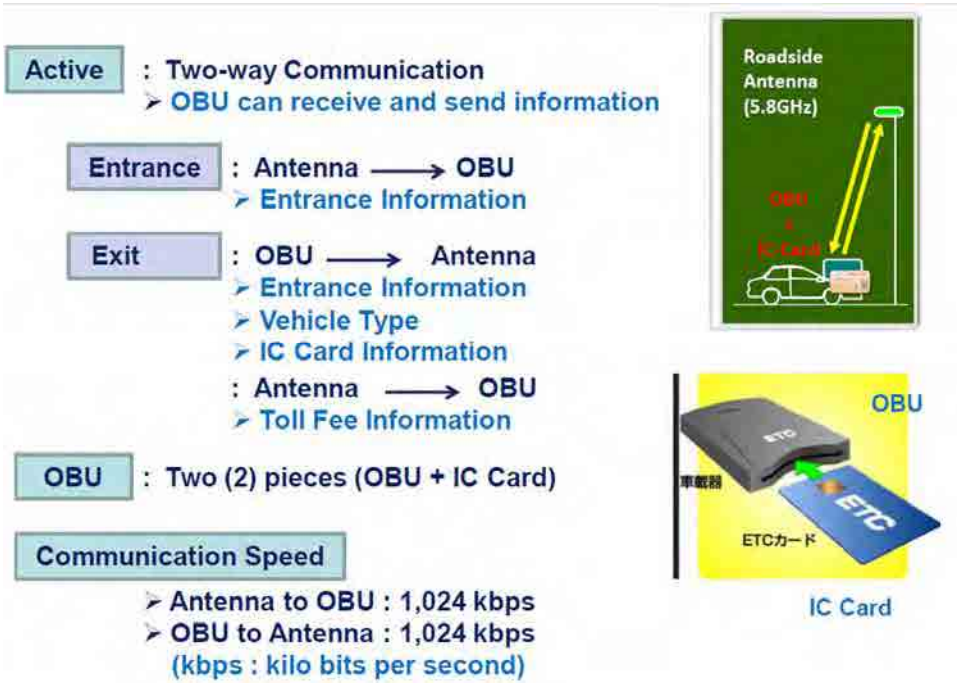
FIGURE 20.4-1 ETC IN THE WORLD

ETCs in various countries are presented in **Annex 20.1.** International standards of ETC and future trend of ETC is shown in **Annex 20.2.**

20.5 CHARACTERISTICS OF EACH ETC SYSTEM

20.5.1 DSRC Active

In this method, both a road-side antenna (RSA) and an on-board-unit (OBU) have function to emit radio wave to communicate with each other. Radio waves at the frequency band of 5.8GHz or 915MHz are often used. Ability to emit radio waves from each unit has achieved reduced output of radio waves. In addition, it allows high-speed and high-capacity communication. Some ETC systems have ability to emit and receive radio waves with the speed of 1,024Kbps (Kilobits per second).

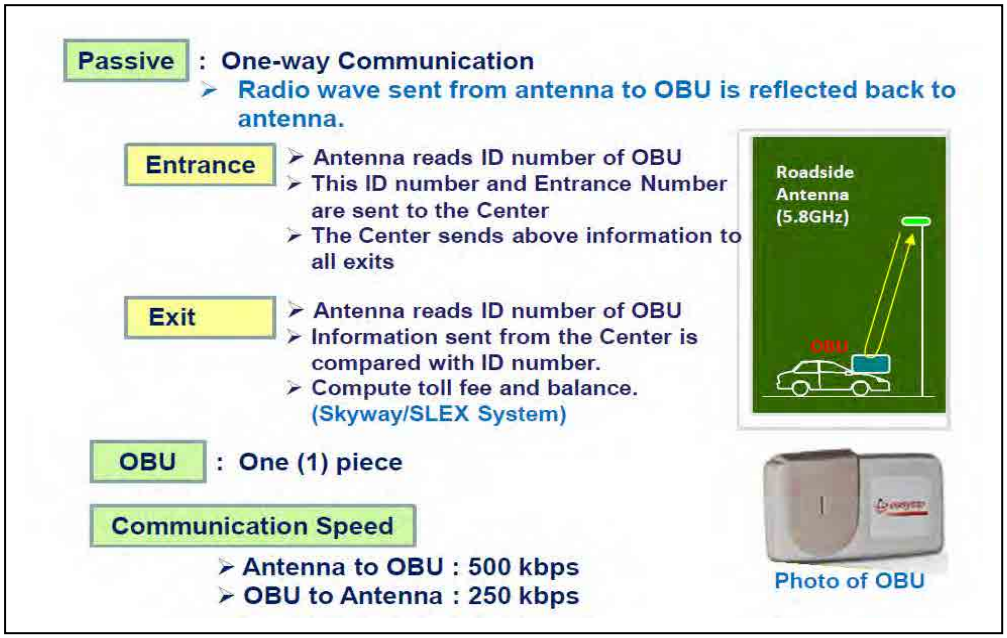


20.5.2 DSRC Passive

RSA has function to emit radio wave while OBU does not have the function. The reflection of radio wave emitted by RSA is used to communicate with each other. This method mainly uses radio waves at the frequency band of 5.8GHz or 915MHz,

This is the most widely used method in the world with a central focus on Europe. In general, OBU is composed of only 1 piece (main body only) which communicates with RSA.

NLEx, SLEx and SKYWAY in Mega Manila adopt DSRC Passive at the frequency band of 5.8GHz and one-piece type OBU. The communication speed is 250Kbps (in Uplink (OBU to RSA)), 500Kbps (in Downlink (RSA to OBU)).



20.5.3 RFID

RSA has function to emit radio wave while OBU does not have the function. The reflection of radio waves emitted by RSA is used to communicate with each other. This method mainly uses radio waves at the frequency band of 915MHz.

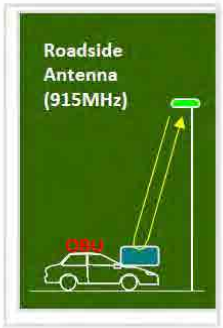
There is a card type OBU and it is put (pasted) on the front glass of a vehicle.

It is mainly operated in U.S.A., and Indian government has adopted RFID as unified ETC standard in the country and established the specifications. In general, OBU is composed of only one-piece (main body only) which communicates with RSA like DSRC passive.

The communication speed is up to specification, and maximum speed is 512Kbps at present.

Function : Function is almost the same as DSRC Passive.

OBU : One (1) piece of card.
(Similar size of credit card).
It is usually put (pasted) on the front glass of the vehicle.



Communication Speed

- Maximum of 512 kbps.

Photo of OBU

20.5.4 Smart Card (Touch and Go)

This method requires users to bring a Smart Card into contact with the Card Reader / Writer at the toll booth for communication. Smart Card is a non-contact IC card. However, it is necessary to put the Smart Card very close to the Card Reader / Writer for sending and receiving data. Thus, vehicles must stop at the toll gate. In this regard, it is different from the previously described (non-stop at the toll gate) methods. This method is adopted at CAVITEX, Manila and some of the toll roads in Bangkok, Thailand.

Flat Rate

- Vehicle class is determined manually.
- Read ID Number and deduct toll fee.
- Balance is recorded in the card.

Card Reader/Writer

Distance Related Toll Rate

Entrance ➢ Entrance Information is recorded in the card.

Exit

- Vehicle class is determined manually.
- Read ID Number and Entrance Information.
- Calculate Toll Fee.
- Deduct toll fee and record balance in the card.

Smart Card

20.6 COMPARISON OF CHARACTERISTICS OF ETC SYSTEM

Characteristics of each ETC system is summarized in **Table 20.6-1.**

TABLE 20.6-1 SUMMARY OF CHARACTERISTICS OF ETC SYSTEM

		DSRC Active	DSRC Passive	RFID	Smart Card
Applicability to Toll system		• Flat rate • Distance based	• Flat rate • Distance based	• Flat rate (Note-1)	• Flat rate • Distance based
Technical Specification	International standard	ITU-R M.1453 ISO15628	ITU-R M.1453 ISO15628	ISO18000-6C	ISO14443 type-A (Note-2)
	Frequency of band	5.8GHz	5.8GHz	915MHz (USA)	13.56MHz
	Data communication speed	Down link 1,024Kbps Up link 1,024Kbps	Down link 500Kbps Up link 250Kbps	Max. 512Kbps	Vehicle stops until transaction is completed
	OBU Type	2 Pieces (OBU+IC card)	1 Piece (OBU)	1 Piece (OBU)	IC-Card
	OBU Durability	Long	OBU needs to be replaced after 4~5 years	Long	Long
Accuracy of System	Communication reliability (in specification)	99.9999% (Japan)	99.5% (NLEX)	99.5% (India)	N/A
	Average communication error ratio (actuality)	0.007%	0.3%	N/A	N/A
	Communication errors for 100,000 transactions	7	300	500	N/A
Operation	User Payment Method	Post payment (Credit Card) & Prepaid	Prepaid	Prepaid	Prepaid
	Balance information Recorded at	IC card & Center	Center	Center	IC card & Center
	Updating Speed of Balance after Exit or Reloading	Instantly	After some minutes (Usually 25 min. or more, depend on system design)	After some minutes (Usually 25 min. or more, depend on system design)	Instantly
	Other payment method in the case of OBU or RSA problem	IC card & Cash	Cash	Cash	IC card & Cash
Cost	Facility cost (Operator's cost)	Medium	Medium	Medium	Low
	OBU price (PHP) (User's cost)	About 2,000	1,400～1,700	50～75	100
Vehicle Speed at ETC lane		30～40km/h	0～10km/h	0～5km/h	Vehicle has to stop
Other Usages such as at railways, restaurants, etc.		Possible (IC card can be used for other purpose)	No (No IC card)	No (No IC card)	Possible (IC card can be used for other purpose)

Note-1: Can be applicable for a distance based toll system, though there is not an achievement.
Note-2: Type-B and Felica can also be applicable.
Source: JICA Study Team

20.7 SELECTION OF STANDARD ETC SYSTEM

Two-stage approach is recommended.

First Stage

- Most important thing is to drastically increase ETC users penetration rate from present 35% to 80 – 90%.
- Present bottleneck for the low penetration rate is the price of OBU. OBU cost of RFID and Smart Card (Touch and Go) is 100 pesos or less. Therefore, if one of them is selected as a Standard ETC System, ETC users penetration rate will be drastically improved.
- Another factor to be considered is IC card utilization. IC card will be drastically used for multi-purpose payments such as rail fare payment, payment at gas stations, restaurants, parking lots, convenient stores, etc. Toll fee payment should be one of them, therefore, ETC system which uses IC card should be selected.
- Considering OBU price and IC card usage, Smart Card (or Touch & Go) is the strong candidate for the first step ETC system.
- Although in case of Smart Card (or Touch & Go) system, all vehicles have to stop at a toll booth, transaction at a toll booth is much faster than cash payment. Also, DSRC-passive-system users are frequently stopping at a toll booth at present, thus, efficiency of Smart Card System is not so bad compared to DSRC-passive-system.
- One problem of Smart Card (or Touch & Go System) is very limited money loading stations. Money loading at a toll booth should be eliminated.

Second Stage

- Time will come to improve ETC lane efficiency with the increase of traffic, or **non-stop operation** at ETC lanes.
- When such time comes, it is recommended to adopt “non-stop operation” ETC system which is DSRC-active ETC system with IC card.
- It is expected that OBU price will be much reduced than at present and income level of ETC users will be improved and capable of spending for OBU.

20.8 INTEROPERABILITY AGREEMENT AND ESTABLISHMENT OF CLEARING CENTER HOUSE

20.8.1 Needs of Interoperability Agreement and Clearing Center House

Standardization of ETC system requires a) interoperability agreement among all expressway operators and b) establishment of a clearing center house.

At present, the Skyway Operator and the SLEX Operator reached the interoperability agreement and seamless travel between two expressways is being assured. However, a Clearing Center

House is not established, but all information on pre-paid amount, tollage information, etc. is shared between two operators and revenues are shared between two operators in accordance with usage of expressway section. This can be possible, since only two companies are involved.

Once ETC system is standardized for all expressways, at least six (6) operators will be involved and more than six (6) operators may be involved in the future. Thus, a Clearing Center House to handle all prepaid amount, tollage information, determining tollage share of each operator in accordance with usage of each toll expressway, etc. should be established.

20.8.2 Outline of Clearing Center House

Functions of a Clearing Center House (CCH) are as follows (see **Figure 20.8-1**);

- Manage information on deposit/reloading of all ETC users.
- Manage accounts (balances) of all ETC users.
- Manage all information on expressway usage (in and out, which expressways, for each ETC user.
- Distribute toll revenue to each operator in accordance with respective usage of each expressway.

Two examples in Japan (SUICA card case and ETC) are presented in **Annex 20.3.**

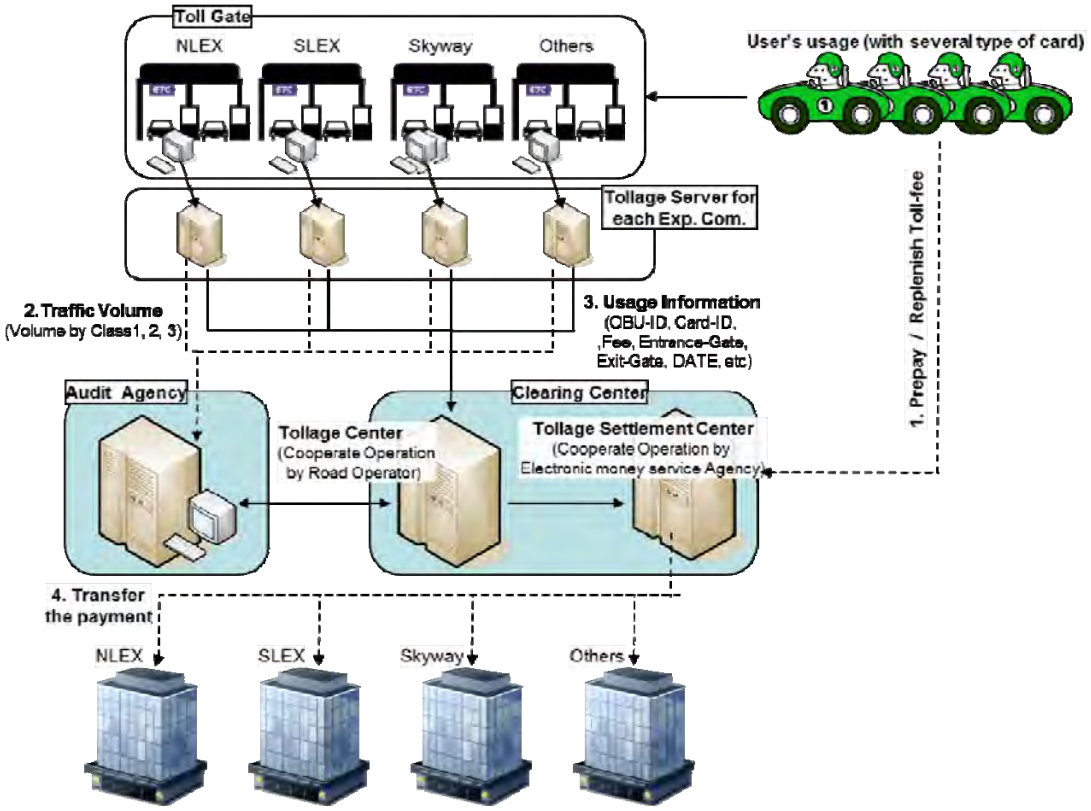


FIGURE 20.8-1 CONCEPT FOR CLEARING CENTER HOUSE

20.8.3 Operational Form of CCH

The operational form of the CCH depends on whether or not an OBU has balance information. The difference is explained below.

(1) If an OBU does not have balance information

Balance information of users is managed by CCH. CCH updates a list of balance information of all accounts at any time, and sends it to each roadside unit via a center of each O&M company. Main units and communication equipment used in CCH are required for high performance and high availability because all ETC usage and information on balance increase must be reflected on the list.

(2) If an OBU has balance information

Balance information of users are recorded and stored on OBUs (IC cards). Therefore, the transaction described in the item (1) will not occur. However, for the purpose to audit the amount of balance on IC card, CCH must update a list of balance information of all accounts at any time and store it.

20.9 HOW TO REALIZE STANDARDIZATION OF ETC

TRB and DPWH must firmly decide the standardization of ETC system for efficient and seamless travel on expressways. TRB and DPWH in collaboration with DOF and PPP Center should create a “Standardization Committee” which should do the following:

- Prepare standardization criteria.
- Select the standard ETC system.
- Prepare specifications of standard ETC system.
- Constant discussion and exchange of views with toll road operators until consensus and agreement between TRB/DPWH and operators is reached.
- Guide and support for establishment of Clearing Center House.
- Amend the Toll Concession Agreement (TCA) or Supplemental Toll Operation Agreement (STOA) to specify adoption of standard ETC system.
- If necessary, toll rate should be adjusted, although it may not be necessary, since ETC standardization will drastically increase ETC user penetration rate which will result in savings of operation cost.

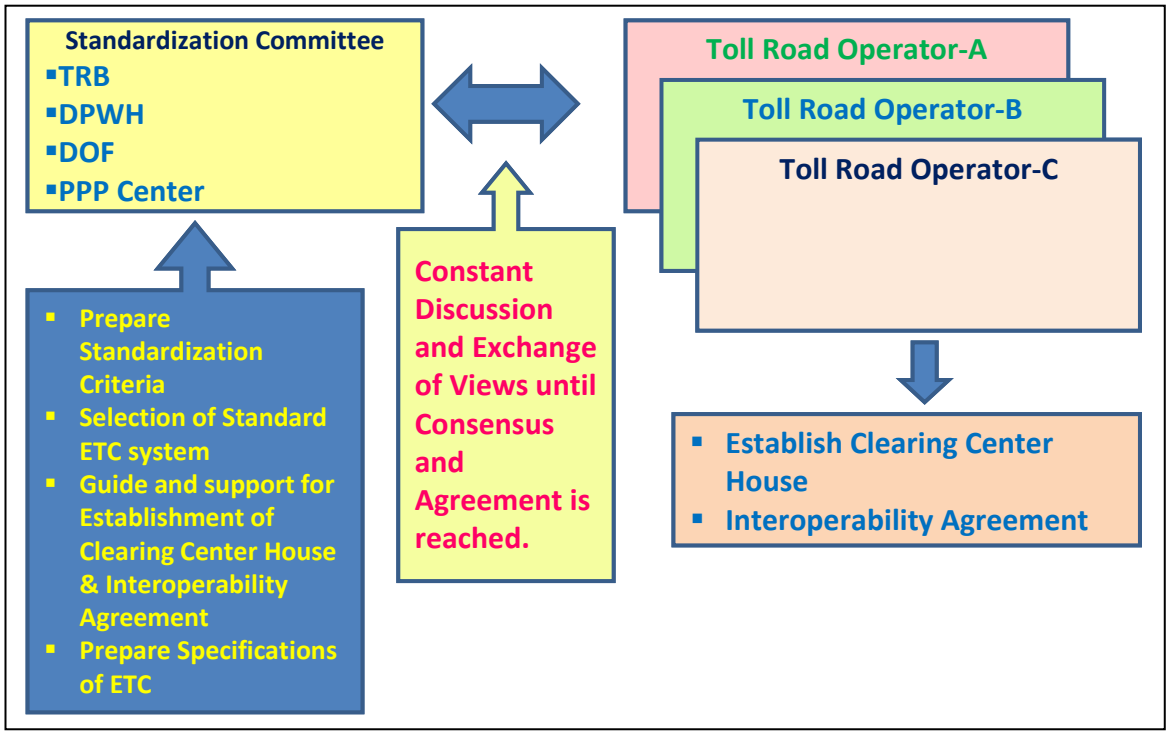


FIGURE 20.9-1 CREATION OF STANDARDIZATION COMMITTEE

CHAPTER 21
RECOMMENDATIONS

1. FIRM COMMITMENT OF THE GOVERNMENT TO IMPLEMENT THE MASTER PLAN

This Master Plan was jointly prepared by DPWH/MMDA and JICA, with the participation of DOTC, NEDA, TRB and UP-NCTS. The Government, especially DPWH and MMDA should firmly COMMIT to implement the ITS projects recommended by the Master Plan.

2. COLLABORATED DEVELOPMENT OF TRANSPORT INFRASTRUCTURE AND ITS PROJECTS FOR MITIGATION OF MEGA MANILA TRANSPORT PROBLEMS

Mega Manila area, particularly Metro Manila and its periphery, suffers serious traffic congestion problems. The Government is continuously required to develop transport infrastructure. More urban rail projects, toll expressway projects, grade separation (or flyover) projects at major intersections, improvement projects of bus transport such as BRT projects and integrated bus terminal project must be continuously pursued, all of which will drastically improve traffic congestions.

At the same time, the Government should also pursue the software solutions represented by ITS projects in collaboration with transport infrastructure project. ITS projects do not require huge capital investments unlike transport infrastructure projects, still ITS projects can bring about high effects on transport efficiency improvement. The Government should pursue transport infrastructure projects simultaneously with ITS projects.

3. ACTIVE IMPLEMENTATION OF ITS PROJECTS

ITS projects bring huge impacts, thus they should be actively implemented. Although effects of ITS projects are not so visible, accumulated effects are huge. For example, in case of advanced signalization project of intersections, savings of travel time at one intersection per vehicle will be only 2 to 3 seconds, however, aggregated savings of 85 intersections will be 14,868 hours per day which will bring about 4.8 Million Php savings per day.

Upgrading of Traffic Information Collection and Provision System will achieve the following:

- All existing roads will be evenly utilized in accordance with their traffic capacity since travellers are provided information of less congested roads, thus over-concentration of traffic at certain roads will be reduced.
- If travellers are provided with traffic congestion information, they will adjust their starting time (they may start their travel earlier or later than scheduled), thus concentration of travel at certain period (or during peak hours) will be mitigated.
- Above effects will reduce overall travel time of Metro Manila vehicle trips by 4% (referencing the survey in Japan) which is about 44,000 vehicle hours/day, thus aggregated effect of this system is quite huge.

As explained above, travel time savings bring also about less consumption of fuel and less emission of CO_2 which will greatly contribute for economic savings as well as environmental condition improvement including contribution for global warming.

Above shows that ITS projects should be actively implemented as early as possible.

4. FOR SUSTAINABLE ITS DEVELOPMENT

1) Creation of Strong Body for ITS Promotion

Top level coordination committee composed of DPWH, DOTC, MMDA, PNP, and DOST, should be created under the **Office of the President** which should achieve the following:

- ITS policy formulation for ITS Development
- Inter-agency coordination/cooperation on jurisdiction/mandate issues.
- Coordination to avoid overlapped investment.

2) Institutional Arrangement

- **For integration of traffic information and provision**, a third party organization needs to be created. MMDA is in-charge of the traffic information collection within Metro Manila and DPWH is responsible outside of Metro Manila. Urbanization is rapidly progressing towards Metro Manila periphery where similar traffic problems as Metro Manila are being experienced. In order to integrate traffic information of areas with different jurisdiction, a

third party organization should be created which integrates all traffic information and provides it to all concerned agencies.

- **For effective public transport monitoring**, LTO, LTFRB, MMDA and Traffic Police need to efficiently coordinate. Database of vehicle registration and franchises given to public utility vehicles should be shared by agencies concerned and utilized for effective monitoring of public utility vehicles.
- **For toll road interoperability and standardization of ETC system**, TRB, DPWH and toll road operators should work together to achieve seamless and efficient travel on all toll expressways.
- **For promotion of private sector initiative**, particularly effective transportation of commodities by truck companies and efficient and comfortable travel of people by bus companies, the Government should advocate the private sector to adopt ITS technologies as much as possible.

5. STRENGTHENING OF DRIVER/PEDESTRIAN EDUCATION AND ENFORCEMENT OF TRAFFIC RULES AND REGULATIONS

Infrastructure development and ITS technology application alone will not perfectly solve traffic problems. To achieve smoother traffic and safer travel, education of drivers/pedestrians and enforcement of traffic rules and regulations must be simultaneously implemented. The Philippine Road Safety Action Plan (PRSAP) should be reinforced and continuously pursued with the involvement of all agencies concerned.

6. CAPACITY DEVELOPMENT OF DPWH AND MMDA

Past and current DPWH's direction is highly "construction-oriented", thus application of ITS technology for the road sector has not been so much focused yet. It is high time for DPWH to seriously consider ITS technology for traffic management, road management, information provision for road construction/maintenance works, road closure due to natural calamity, etc. Capacity development of DPWH staff should be made through implementation of projects recommended by this Master Plan.

Although MMDA is one of the most advanced agencies in ITS application, MMDA should still consider capacity development for ITS technology; more staff should gain capacity on ITS technology. Capacity development of more staff should be done through implementation of on-going and future projects.

7. RECOMMENDATIONS ON PILOT PROJECTS

1) Phase III of Metro Manila Traffic Signal Control Project

To complete the on-going upgrading of the existing traffic signal controlled intersection (150 intersections) and to traffic signal controlization of currently non-signal controlled intersection (212 intersections), this project should be implemented in succession with Phase II. The project is highly economically feasible, and contributes for reduction of CO_2 emission (global warming problem) and improvement of traffic safety.

Implementing agency is MMDA.

2) Traffic Signal Control Project of Bicutan and Sucat Intersections

Sucat and Bicutan intersections are quite complicated intersections with many conflicts of traffic movement. These are currently controlled manually. These intersections should be controlled utilizing latest technologies to achieve smoother traffic flow, and to reduce the potential of traffic accidents.

The Government decided quite recently to establish a temporary integrated bus terminal near Bicutan intersection which will totally change traffic movement, thus traffic signalization at Bicutan should be implemented after assessing traffic movements of a temporary integrated bus terminal. It is recommended that signalization of Sucat Intersection should be implemented first. The experience of Sucat Intersection should be reflected to Bicutan Intersection.

The project is proposed as one of the candidate of “Experimental Project”. Implementing agency is MMDA in collaboration with Paranaque City and Skyway operator.

3) Metro Manila Route Guidance

MMDA launched the Metro Manila Traffic Navigator (TNAV) in 2011. MMDA is developing the second generation of TNAV which is called Automated Traffic

Navigator (ATNAV). MMDA is planning to use floating-car-data (FCD) to minimize roadside equipment. This approach is exactly in line with the global trend.

Route Guidance System constitutes an important part of ATNAV. Various recommendations made by this Master Plan should be reflected in the development of ATNAV which should be launched as soon as possible.

Implementing agency is MMDA.

4) RFID-based EDSA Bus Travel Time Information Provision System

EDSA is the most important thoroughfare in Metro Manila. More than 330,000 bus passengers and 400,000 ~ 500,000 MRT-3 passengers are relying on this thoroughfare for their daily trips. To provide bus travel time information to public transport passengers will greatly improve the convenience of public transport passengers and contribute to traffic congestion mitigation. In a long run, car passengers will shift to bus transport which also contributes the reduction of overall traffic problems in Metro Manila. This pilot project should be implemented as soon as possible as a top priority project.

Implementing agency is MMDA and this project is the current top priority project of MMDA.

5) Traffic Information System Along Manila North Road (MNR) and North Luzon Expressway (NLEX)

MNR and NLEX run almost parallel with each other and located in the one traffic corridor. This project was proposed as one of the candidates of “Experimental Project”. This project will examine the effects of a traffic information system and if successful, the similar system should also be adopted for the other traffic corridors.

Implementing agency is DPWH in collaboration with NLEx Operator and TRB.

6) Standardization of ETC

The Government is pursuing development of toll expressway network which will be realized in the near future. `Standardization of ETC system is required to achieve seamless travel on all toll expressways. TRB and DPWH should take initiative for this issue, although it is not easy to realize the standardization because of different opinions of toll operators. Continuous dialogue among TRB, DPWH and toll operators will be definitely needed until consensus will be created.

8. TO COPE WITH RAPID DEVELOPMENT OF INFORMATION/ COMMUNICATION TECHNOLOGY (ICT)

Innovation of Information/Communication Technology is rapidly progressing day by day. Application of latest technology should be always seeked, thus ITS technology adopted initially should be reviewed and updated. Likewise, this Master Plan should be reviewed at every 5-6 years and updated regularly.

9. CREATION OF ITS-PHILIPPINES

ITS-Philippines should be created as soon as possible and ITS technology, standardization and ITS applications should be jointly promoted by the public sector, the private sector and the academic sector.

10. PREPARATION OF ITS MASTER PLAN FOR OTHER AREAS OF THE PHILIPPINES

ITS Master Plan should be also prepared for other areas of the Philippines such as regional urban centers, strategically important provinces, etc., reflecting characteristics of each area to improve transport efficiency.