Republic of the Union of Myanmar
Yangon City Development Committee

Republic of the Union of Myanmar

Collaboration Program with the Private Sector for Disseminating Japanese Technology for Traffic Flow Simulation Technology and Other ITS Technologies for Road Planning in Yangon

Final Report

23rd, March, 2015

Japan International Cooperation Agency (JICA)

Hitachi, Ltd.

Sumitomo Electric Industries, Ltd.

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JR
15-035

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1 Overview of This Project

1.1 Background

In Yangon City, with the increasing number of vehicles, traffic congestion in the central area has become serious, and reducing traffic congestion is an urgent problem. An effective solution for easing the traffic congestion can be realized by collection and utilization of quantitative traffic information such as traffic volume and travel speed.

In Yangon city, according to the final report of "the preparatory survey for urban development program in the Greater Yangon", the available traffic volume data as of September 2013 is only the result of traffic observation called "Yangon Strategic Development Plan 2020, YCDC, 2006"[1] which was performed on 17 places and at a peak time of AM and PM. Therefore, it is required to collect continuously a traffic situation information in a wide area. Fig. 1 shows the assumed current road planning process in Yangon city, and the proposed improved process. In the current process, Yangon city collects traffic volume information from sensors installed at a limited number of intersections, and it is needed to pre-assessment of road improvement plan. In this project, we demonstrate probe processing system and image processing traffic counter that enable to collect a quantitative traffic information in a wide area, and we also demonstrate a traffic flow simulation that supports a quantitative pre-assessment of a road improvement plan, and we aim to realize an effective road planning process. It is expected that with this project, Yangon government will be able to execute a road planning which can manage a future increase of traffic volume, and ease of traffic congestion in Yangon city.

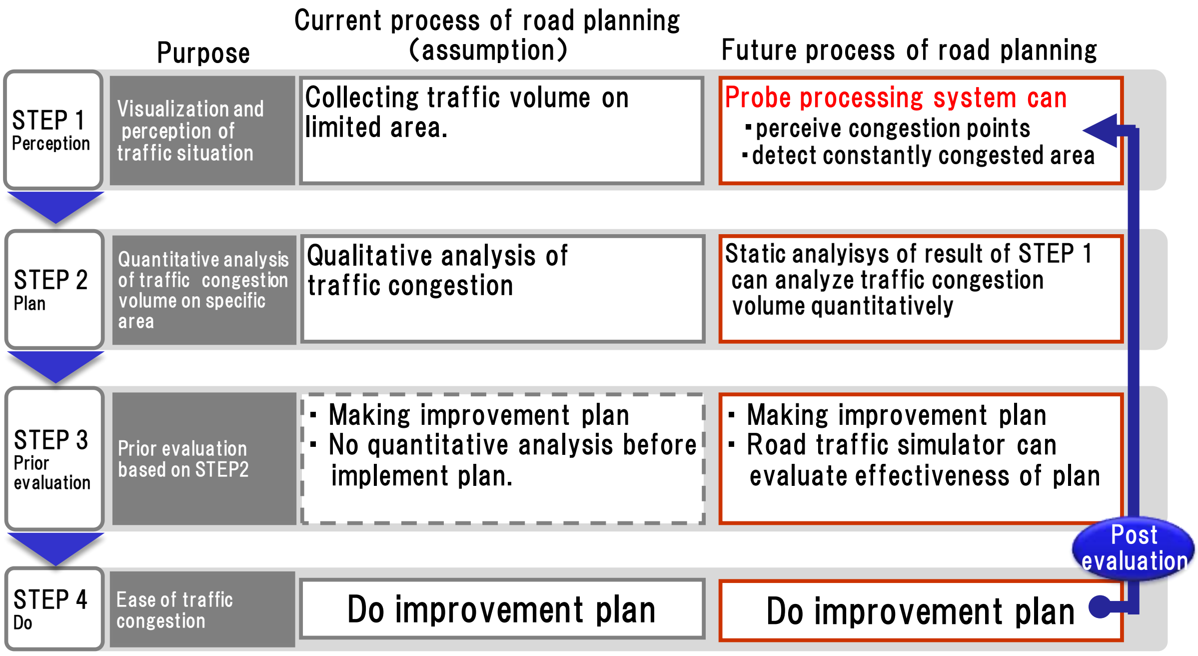

Fig. 1 A scenario for effective road planning and reducing traffic congestion

[1] Final report of the project for the Strategic Urban Development Plan of the Greater Yangon,

1.2 Purpose

In order to ease traffic congestion, it is important to perform both road planning which fundamentally improves roads, and traffic control which solves a problem happening every day. Therefore, we promote the spread of Japanese Intelligent Transportation System (ITS) technologies which contributes the both road planning and traffic control. By promoting the ITS technologies, the project aims to ease the traffic congestion in Yangon city in the future, and contribute to development of economy of Myanmar.

1.3 Overview of the Project

In order to achieve the purpose above, following 3 activities were performed in this project.

(1) Promotion of understandings of Yangon City Development Committee (YCDC) and Ministry of Transport and Communication, Yangon Region Government (MOT) about usefulness of ITS technologies such as road traffic simulator, probe processing system and image processing traffic counter.

(2) Training session about ITS technologies with ACE Data Systems who is a partner company in Yangon

(3) Visit to Japan of YCDC and MOT staffs to Japan to see a Japanese road traffic related facilities

1.4 Schedule

The schedule of the project is shown in Fig. 2.

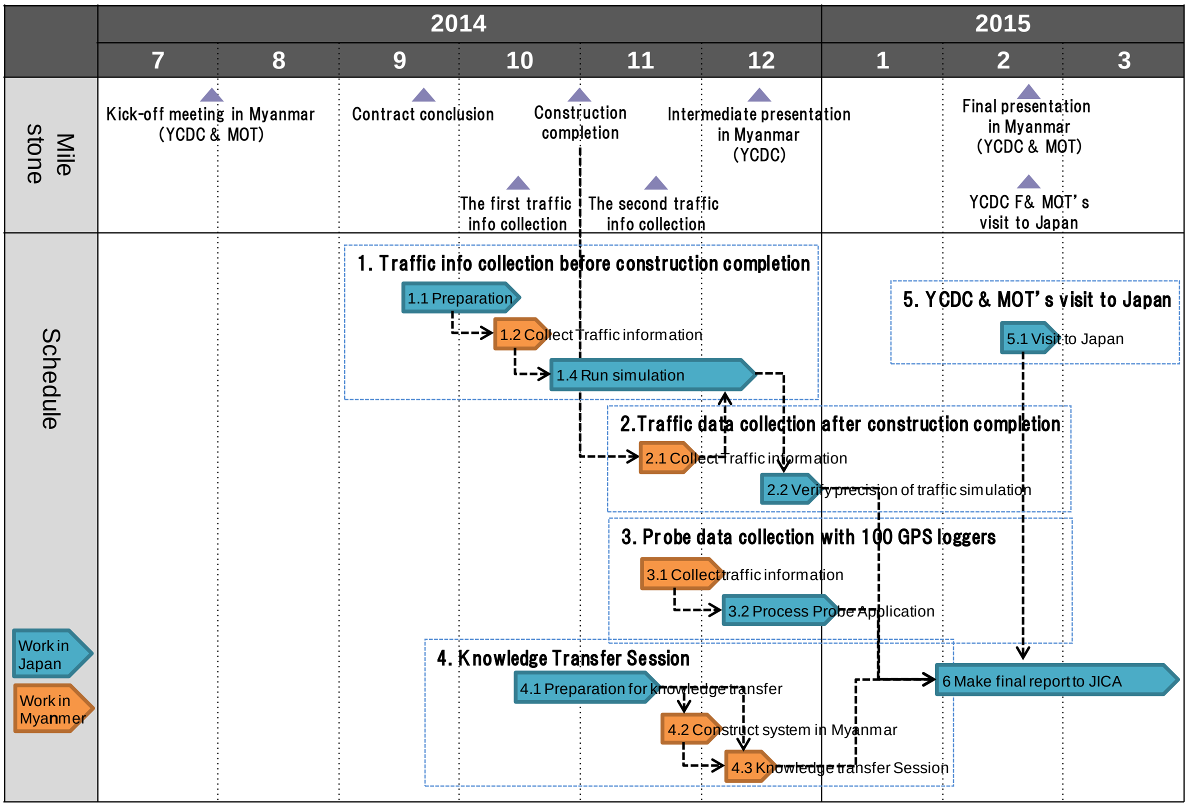

Fig. 2 Schedule

1.5 Implementing Organization

The implementing organizations are shown in Fig. 3.

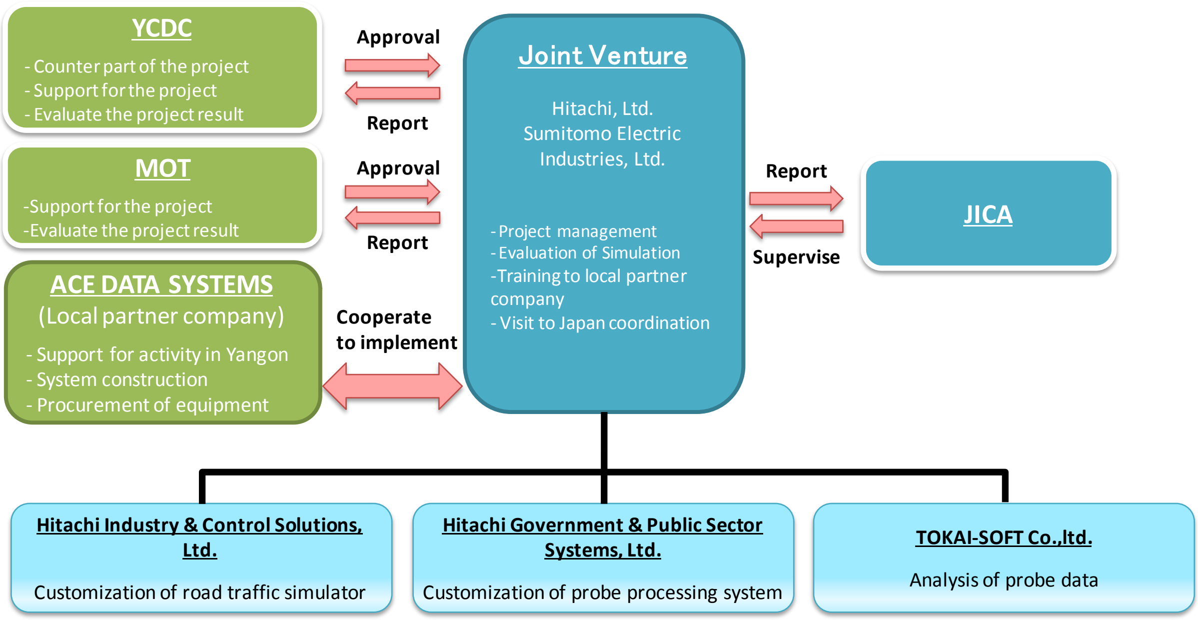

Fig. 3 Implementing Organization

2 Demonstration of efficiency of road traffic simulation technology

2.1 Evaluation of probe processing system

(1) Purpose of Demonstration Experiment

This project aims to evaluate the effectiveness of probe traffic information for grasping traffic condition.

Evaluation of the effectiveness for grasping traffic condition was conducted in the following point of view:

- Whether prove traffic information in Yangon City can be generated widely and stably enough to use for road planning usage.
- Whether probe traffic information of Yangon City has sufficient accuracy as the input for the traffic flow simulator.

(2) Analysis and Evaluation

Evaluation viewpoints about collected probe data and probe traffic information are listed in the Table 1. For this demonstration, we used 100 taxis with GPS loggers for probe data collection.

Table 1 List of Evaluation Viewpoint

#	Evaluation Viewpoint	Purpose of Evaluation	Evaluation index
1	Can probe processing system be applied for road planning?	To clarify the time condition (Probe processing system can provide probe traffic information stably with the time condition)	Number of probe data
2		To clarify the area where probe traffic information can be provided	Probe data distribution
3		To clarify the road type which has stable probe traffic information	Road section coverage ratio
4	Can probe processing system be used as input for traffic flow simulator?	To evaluate the accuracy of probe traffic information	Tendency of congestion area

(a) Number of Prove Data

It is desirable that probe data can be collected stably regardless of time transition, because number of probe data affects both supply area and accuracy of probe traffic information. Therefore we evaluated fluctuation of number of probe data.

(i) Evaluation of Daily Probe Data

Fig. 4 shows the number of daily probe data. No remarkable difference between week day and weekend is detected from this chart, so stable supply of probe traffic information can be provided regardless of weekday or weekend from taxies.

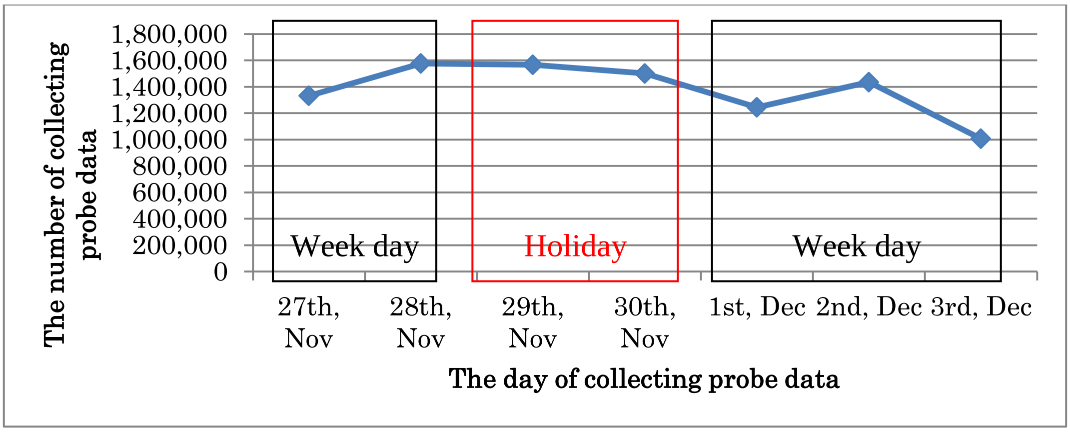

Fig. 4 Number of Probe Data (Daily)

(ii) Evaluation of 3-hours Probe Data

Fig.5 shows the number of 3-hours probe data. From this figure, we can see 3 different trends for each time periods below.

Early Morning (00:00-05:59)	The number of probe data is small
Daytime (6:00-17:59)	The number of probe data is stable
Nighttime (18:00-23:59)	The number of probe data is unstable

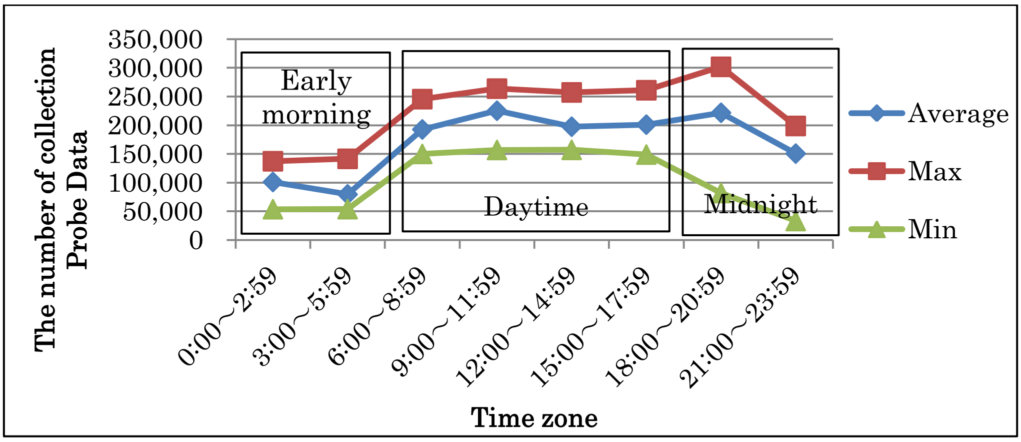

Fig. 5 Number of Probe Data (3 hours)

(b) Probe Data Distribution

It is desirable that probe data is distributed broader in shorter period of time, because the broader distributed probe data enable to create broader probe traffic information. Therefore we analyzed the distribution of probe data with criteria indicated below.

(i) Evaluation Criteria for Probe Data Distribution

In this project, we divided whole Yangon City District into certain sections and added up number of probe data collected in each section to grasp distribution of generated probe data. In reference to a Japanese statistical research compartment "area-wide mesh", we defined the size of compartment as 1km square. We evaluated probe data distribution for 3 different time period indicated in the Table 2. We chose the data in the morning rush hour time.

Table 2 Time Period for Probe Data Distribution

#	Time Period	Time of sample data
1	15 minutes	2014/11/29 07:45～07:59
2	3 hours	2014/11/29 06:00～08:59
3	24 hours	2014/11/29 00:00～23:59

(ii) Evaluation with Probe Data Distribution

Fig. 6～Fig. 8 show the probe data distribution area for each time period. If the time period is 15 minutes, that probe data is mainly distributed in the downtown area and along primary roads. Fig.5 and 6 show that if the time period become longer, the probe data distribution area become wider in the whole Yangon city. With probe data from 100 taxies, if the time period is 3 hours, the probe data distribution covers down town area. If the time period is 24 hours, the probe data distribution area covers whole Yangon city. If we can use larger number of probe cars, the probe data distribution will cover whole Yangon City in shorter time period.

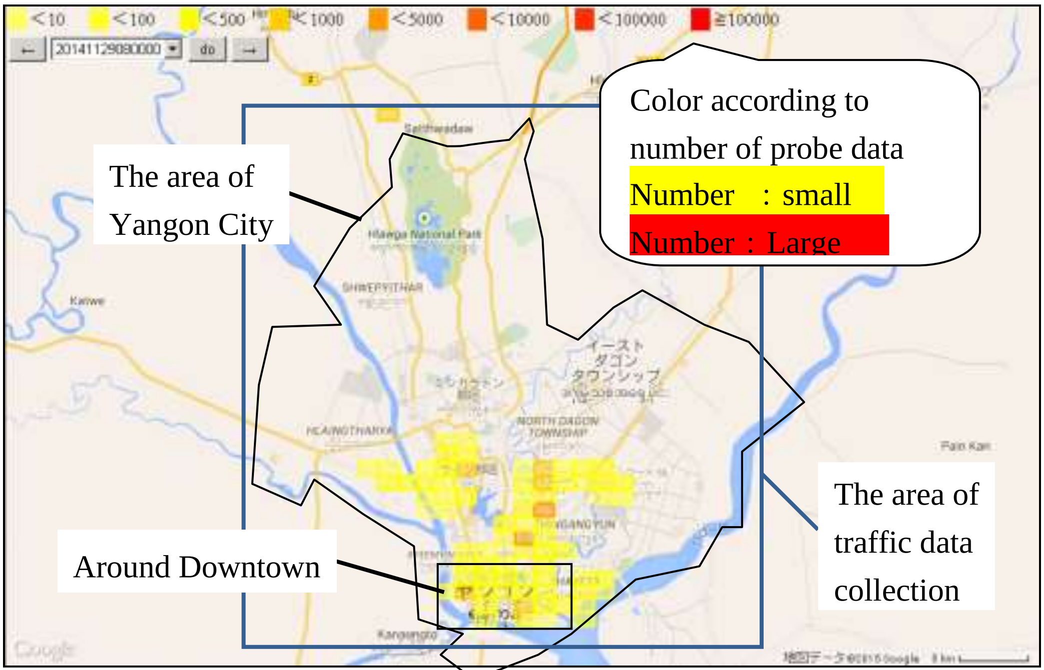

Fig. 6 Probe Data Distribution in 15 minutes

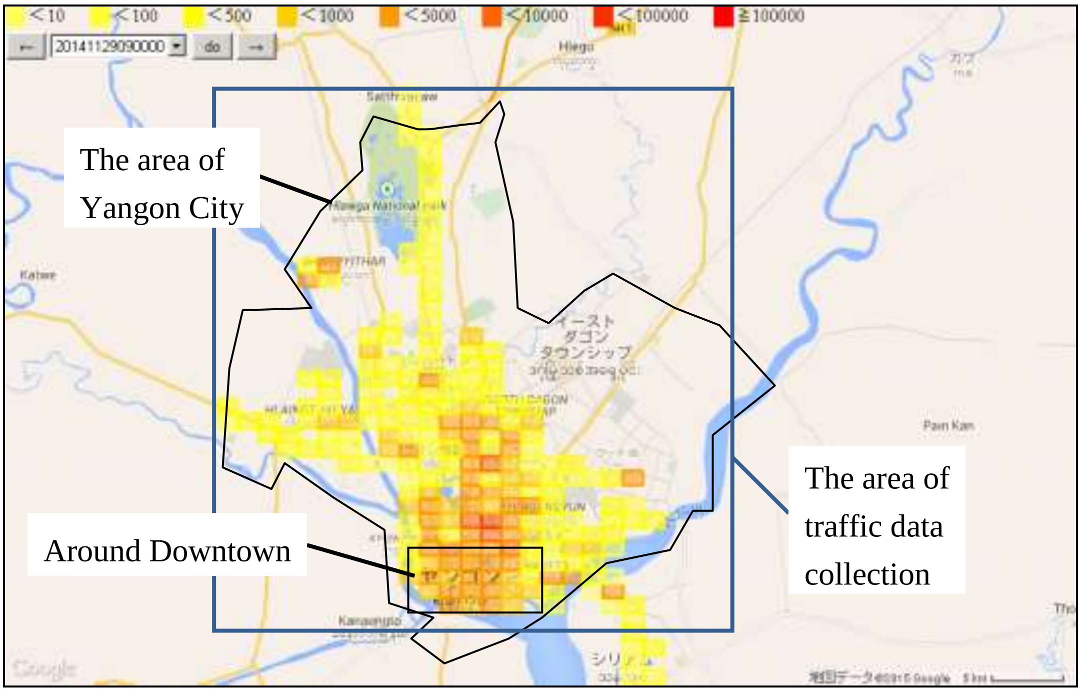

Fig. 7 3-hour Probe Data Distribution

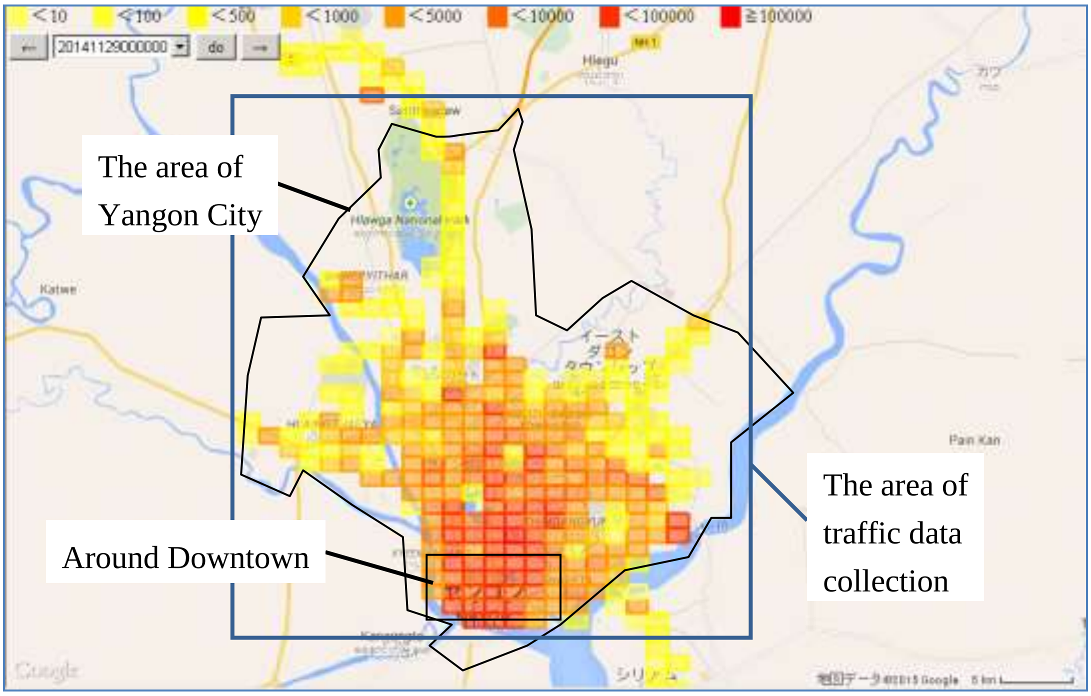

Fig. 8 24-hour Probe Data Distribution

(c) Road Section Coverage ratio

Each road is classified into several road types according to speed limit, width and so on in the traffic management operation, and each road is used for different purpose or tendency among each type. Therefore, it is possible that the amount of probe traffic information is different for each road type even in a same area. We evaluated the probe traffic information for each road type in this project.

(i) Definition for Road Section Coverage Ratio and Evaluation Criteria

Formula 2-1 shows the definition of road section coverage ratio used for evaluation index. This index enables to evaluate the amount of probe traffic information per road type. Table 3 shows the definition of road type in the digital map used in this project. We evaluated the road section coverage ratio for each road type with 3 different data collection time period shown in the Table 4.

$$\text{Road Section Coverage Ratio} = \frac{\text{Number of Road Sections where Probe Traffic Information Once or More Times during the time period}}{\text{Number of Road Sections Defined in the Digital Map}}$$

Formula 2-1Definition of Road Section Coverage Ratio

Road Sections... Certain section of a road where the road is divided by intersection in a digital map.
Time Period … Time Period to add up the probe traffic information for calculating road section coverage ratio

Table 3 Definition of Road Type in the Digital Map

Road Type	Explanation	Speed Limit (*)	Length of Road Section / Number of Road Section		Ratio
Primary Road	Main roads to travel long distance with high speed	80km/h	Length of Road Section(m)	666,708	12.82%
			Number of Road Sections	5,663	11.10%
General Road	Roads connect primary roads, and residence area	50km/h	Length of Road Section(m)	4,533,215	87.16%
			Number of Road Sections	45,342	88.86%
Roundabout	Round Intersection without Signal	10km/h	Length of Road Section(m)	1,282	0.02%
			Number of Road Sections	24	0.05%
Total of All Road Type	—	—	Length of Road Section(m)	5,201,205	—
			Number of Road Sections	51,029	—

※ "Speed Limit" is the value indicated in the digital map, and it may different from act ual ones.

Table 4 Data Collection Time Period

#	Data Collection Time Period	Purpose
1	Daily	To grasp difference in tendency between weekdays and weekend
2	Every 3 hours	To grasp difference in tendency among time zone

(ii) Evaluation of Daily Coverage Ratio

Fig. 9 indicates the daily road section coverage ratio for each road type. No remarkable difference found in each road type whether weekday or weekend from this chart.

About the difference of coverage, first, coverage of primary road is always more than 65% and probe traffic information is generated in more than half roads. On the other hand, coverage for general road is 5% and generated area is limited. And ratio in the roundabout is stable daily.

These differences may come from the operation characteristic of taxies. Taxies mainly travel along primary roads where they can travel in the faster speed, so coverage for primary road tends to be higher and coverage for general road tends to be lower. We can suppose that reason for stable coverage of roundabout is that taxis pass certain roundabouts and don't pass remaining roundabouts.

If probe traffic information is generated by using taxies as the data source, these differences of tendencies would remain even though numbers of vehicles and coverage ratio will be increased.

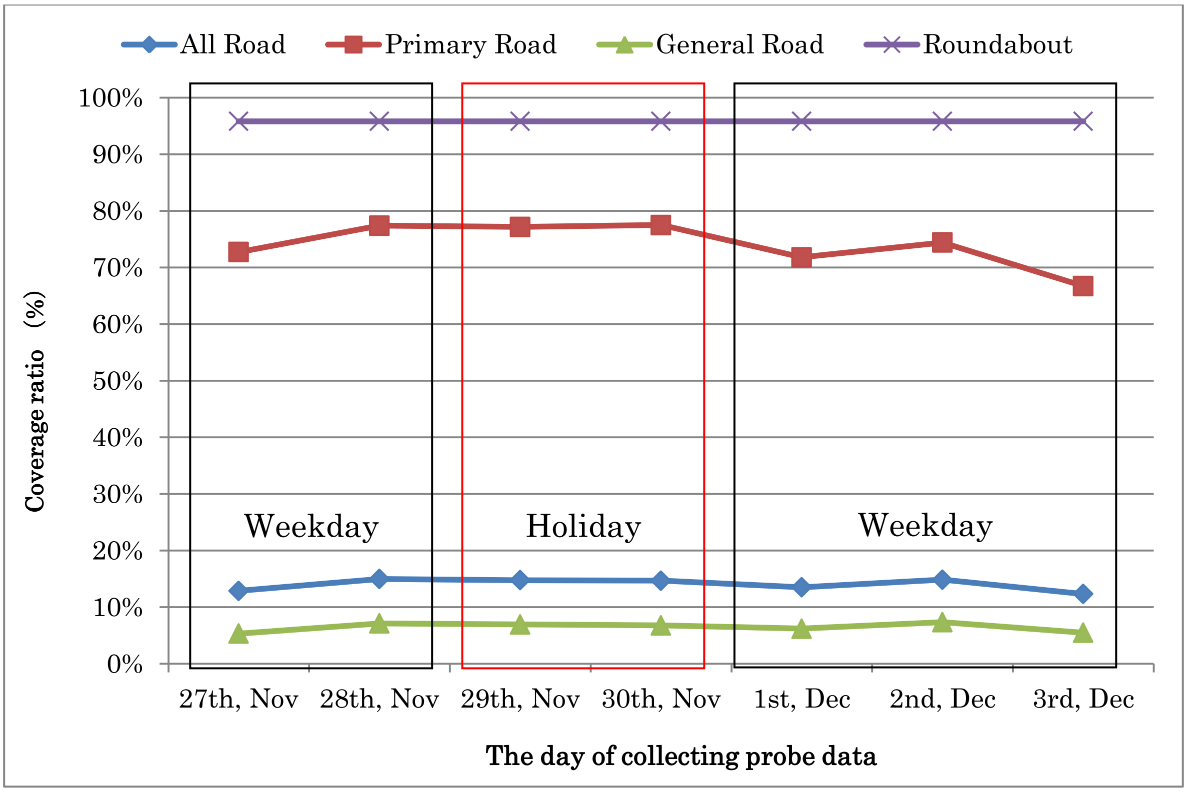

Fig. 9 Daily Coverage Ratio

(iii) Evaluation of 3-hours Coverage Ratio

Fig. 10 shows the 3-hours road section coverage ratio for all road type. Fig. 11 - Fig. 13show the 3-hours road section coverage ratio for each road type. From these figures, we can see that almost 40% of traffic information for primary roads can be provided, and traffic information provision of general roads is limited with 3-hours data collection time period.

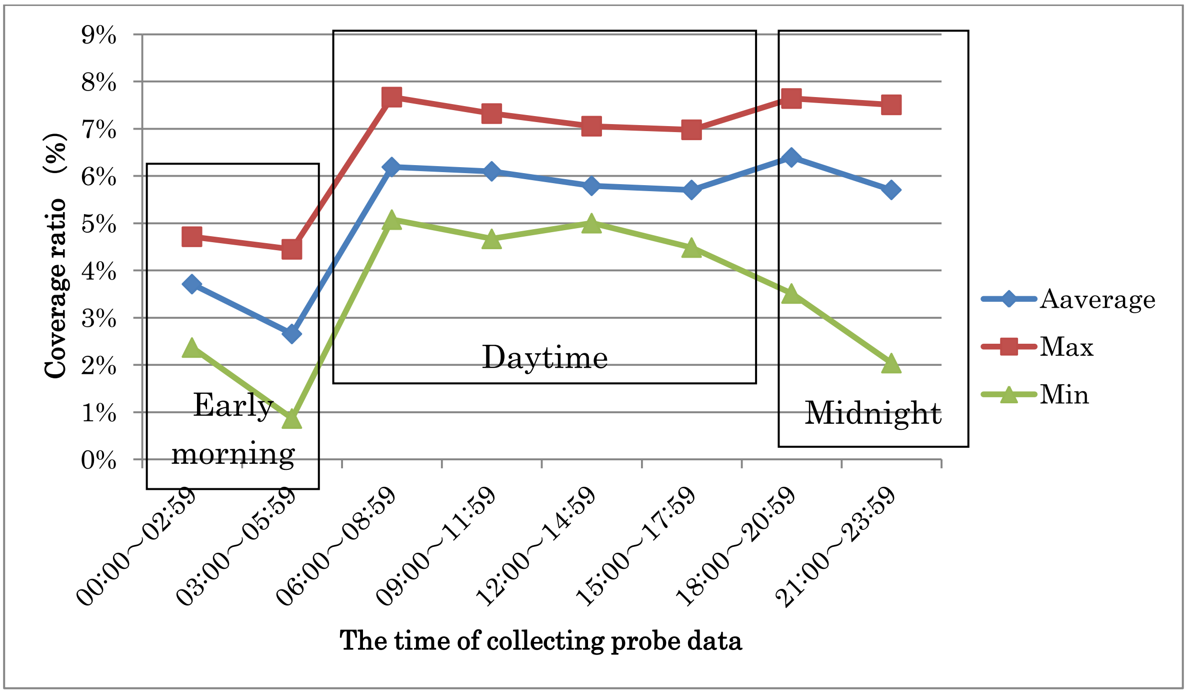

Fig. 10 3-hour Coverage Ratio(All Road Type)

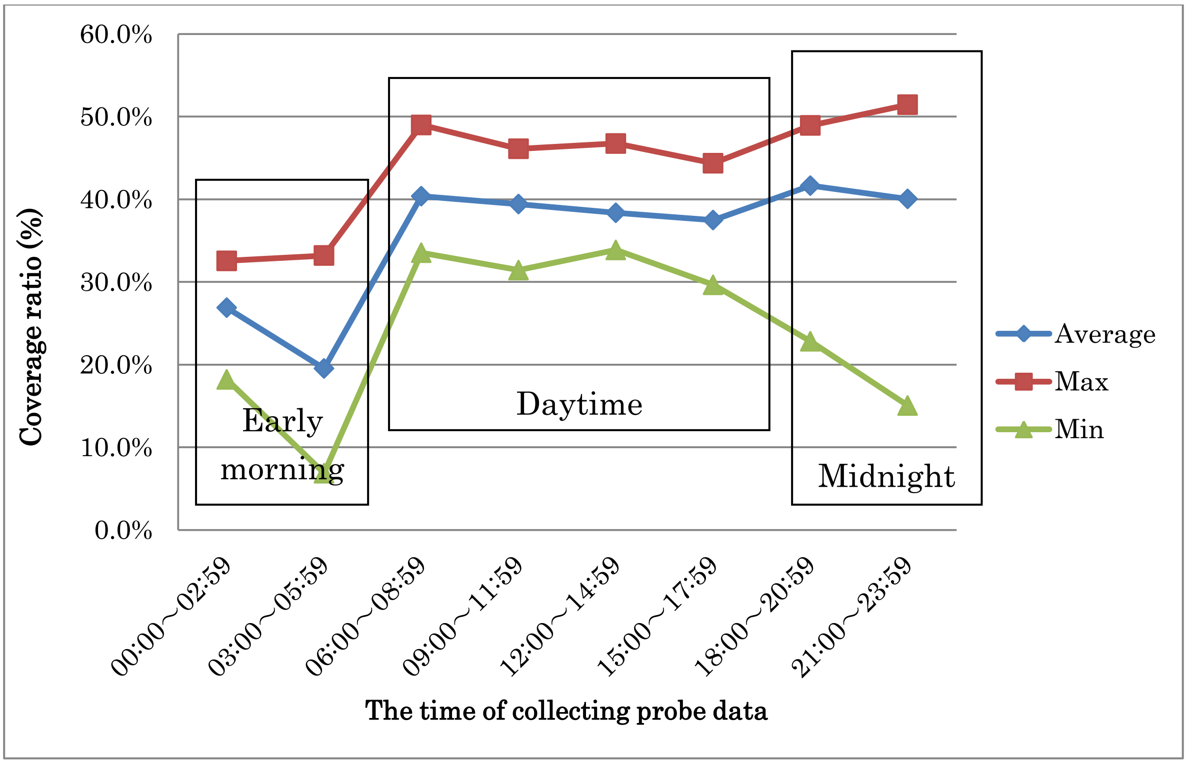

Fig. 11 3-hour Coverage Ratio (Primary Road)

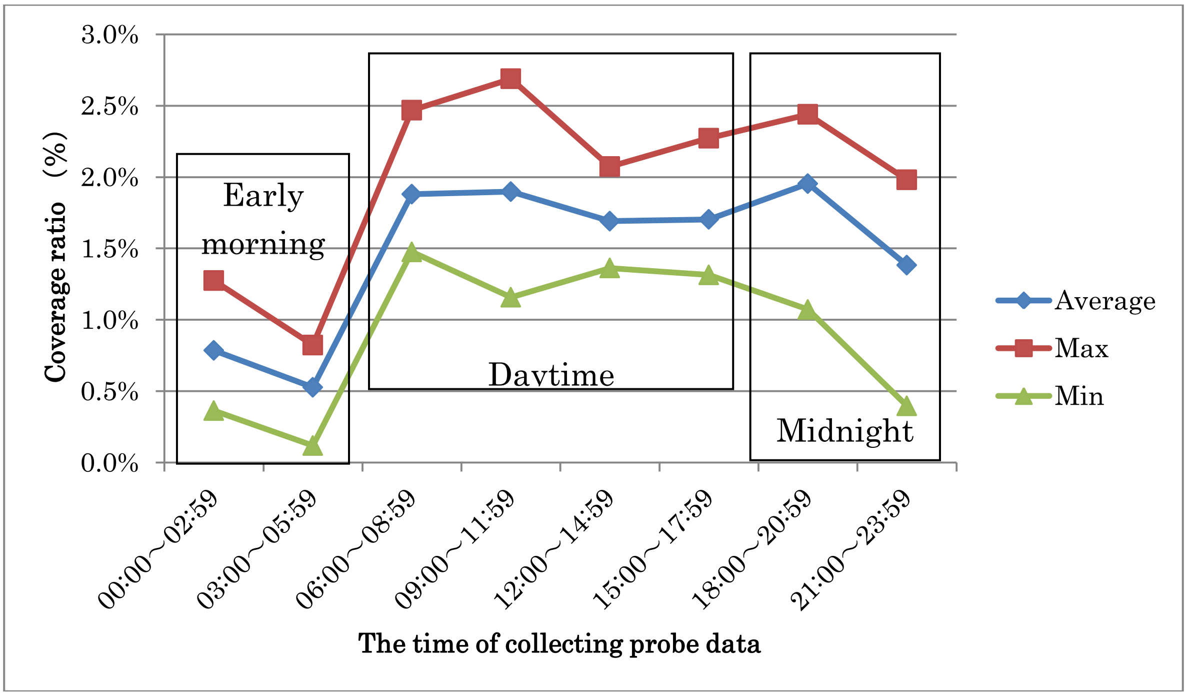

Fig. 12 3-hour Coverage Ration (General Road)

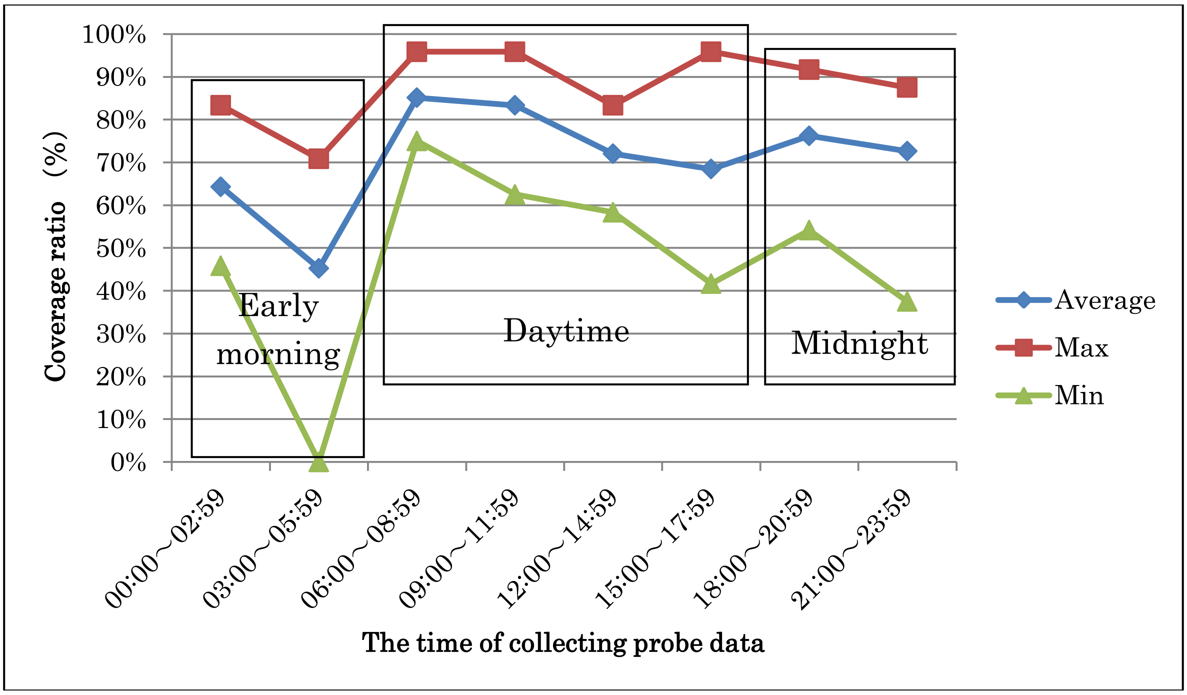

Fig. 13 3-hour Coverage Ration (Roundabout)

(d) Tendency of Congestion Area

In this project, probe traffic information have to be accurate enough to extract congestion spot appropriately because the generated probe information would be used as input data for traffic flow simulator. To evaluate this accuracy, we confirmed the identification between the actual congestion area and the area judged as congested area from the probe traffic information.

(i) Actual Congestion Area

To specify the actual congestion area for the comparison, we referred the town paper[2] written in Japanese distributed in Yangon City and seminar document[3] by JICA. Also, we chose a place where we could collect the probe data. We selected 4 congestion areas shown in the Fig. 14.

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[2] MYANMAR JAPON "Yangon Congestion & Flooding Ma", MYANMAR JAPON CO., LTD.

[3] Yangon Urban Transportation Master Plan 4th, July, 2014 JCIA seminar, JICA

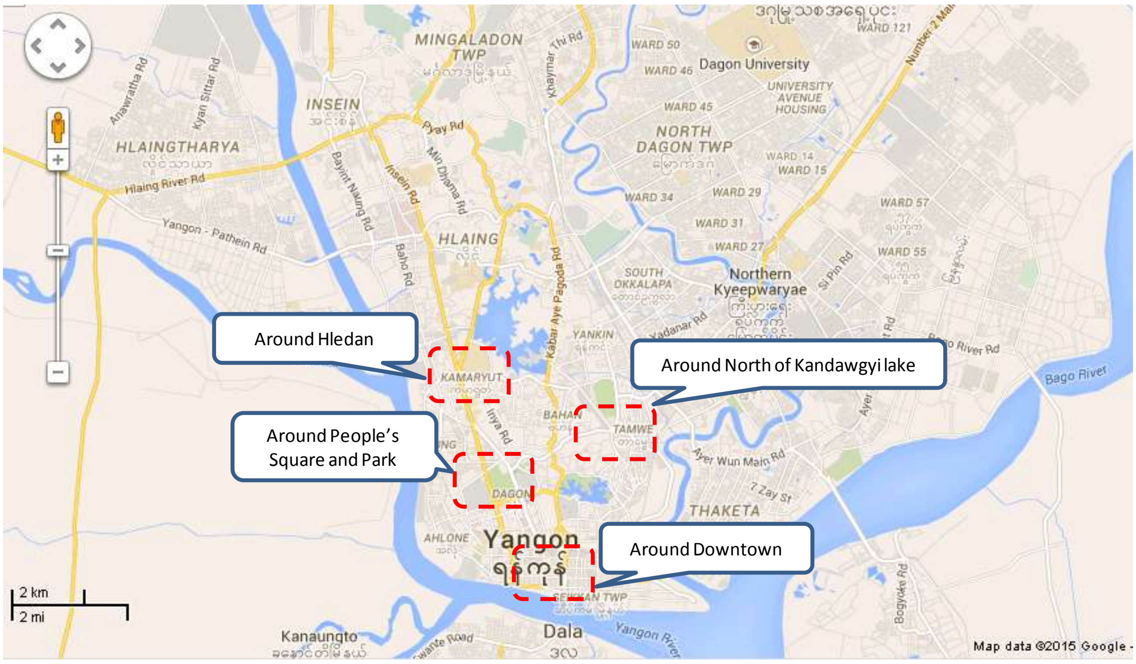

Fig. 14 Chronic Congestion Area in Actual Place

(ii) Congestion Criteria and Condition based on Probe Traffic Information

To judge the tendency of congestion, congestion level of each road section are classified into three levels as "Very Congested" "Congested" and "Smooth" based on the probe traffic information and visualized and inspected with eyes. Congestion level was classified by applying threshold value to travel speed included in the probe traffic information. Applied probe traffic information are morning (6:00～9:00), daytime(12:00～15:00) and evening(18:00～21:00).

Table 5 Threshold value of traffic information in Congestion Classification

Road Type	Threshold value (km/h)		
	Very Congested	Congested	Smooth
Highway	Less than 20	From 20 to 40	More than 40
General Road	Less than 12	From 12 to25	More than 25
Roundabout	Less than 10	From 10 to20	More than 20

(*) If the travel speed of a road section is classifiedd into "very congested", that road section will become red color in a screen."Congested": Yellow, "Smooth": Blue

(iii) Evaluation by Congestion Spot Visialization Based on Probe Traffic Information

Fig. 15～Fig. 20 show visualized congestion level. We confirmed the congestion area with 3-hours time period indicated and we found congestion around people's park (shown in Fig. 16, downtown area(shown in Fig. 17and northern part of Kandawgyi lake(shown in Fig. 18). Less congestion found in the evening but congestion remained around downtown and northern part of Kandawgyi Lake.

Compared with actual congestion areas showed in Fig. 14, congestion tendency is accorded with probe traffic information, so it is said that probe traffic information reflect actual congestion condition.

In this project, probe traffic information was generated with limited data source from only 100 taxies, more accuracy is expected with more data source.

Table 6 Overview of the Congestion Degree from Probe Traffic Information at the Actual Congestion Point

Actual Congestion Point	Probe Traffic Information Congestion Tendency		
	Morning (06:00-08:59)	Daytime (12:00-14:59)	Evening (18:00-20:59)
Around Hledan	Smooth	Congested	Smooth
Around Northern Part of Kandawgyi Lake	Very Congested	Very Congested	Congested
People's Park Area	Very Congested	Very Congested	Smooth
Downtown Area	Very Congested	Very Congested	Congested

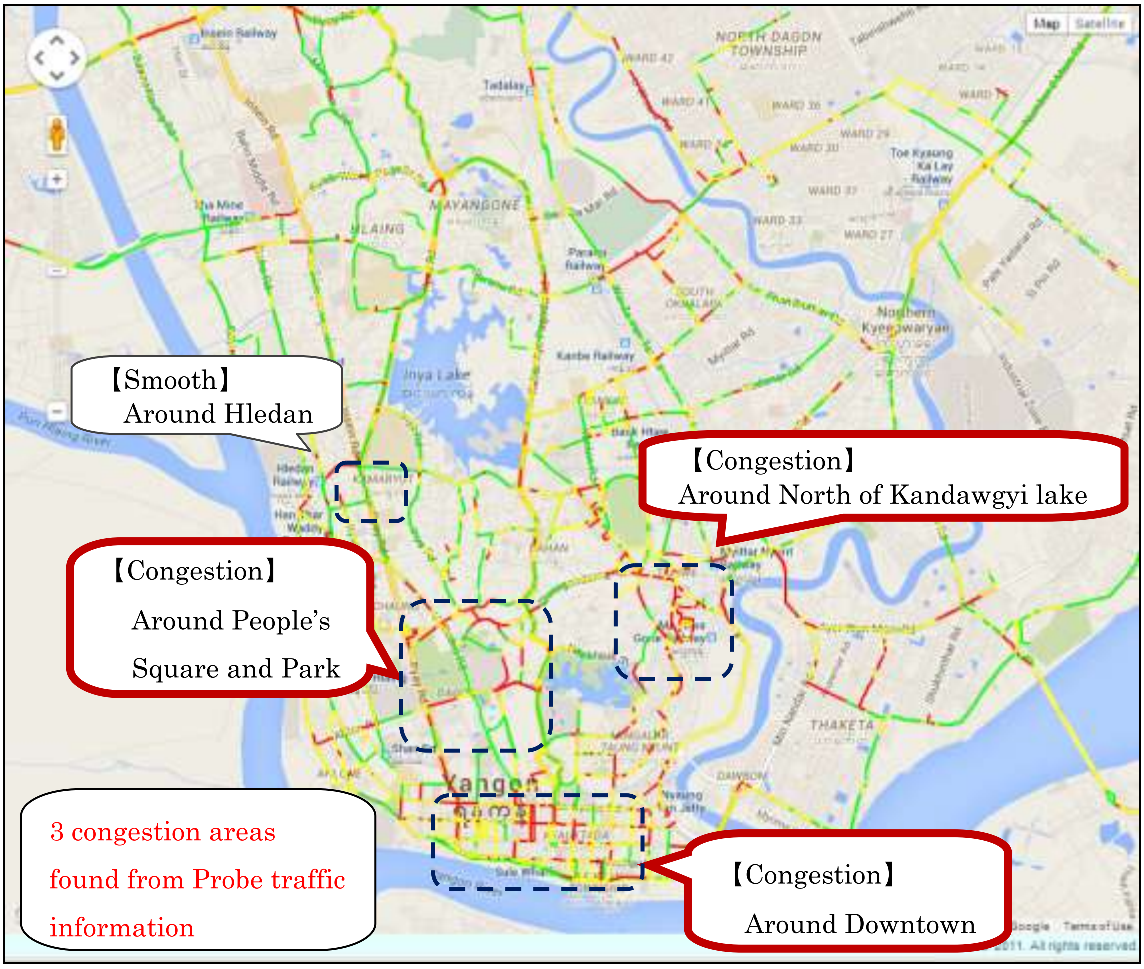

Fig. 15 Congestion Situation in the Morning Time(6:00～8:59) of 11/30/2014

Fig. 16 Traffic Information around People's Park
in the Morning Time(6:00～8:59) of 11/30/2014

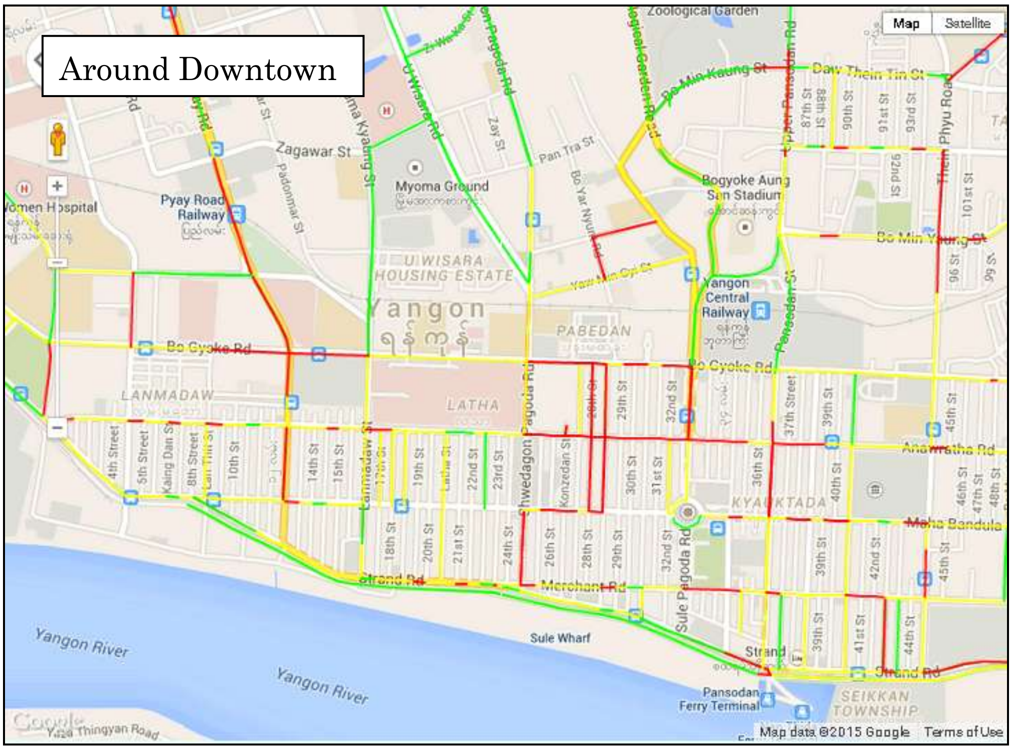

Fig. 17 Traffic Information around Downtown in the Morning Time(6:00～8:59) of 11/30/2014

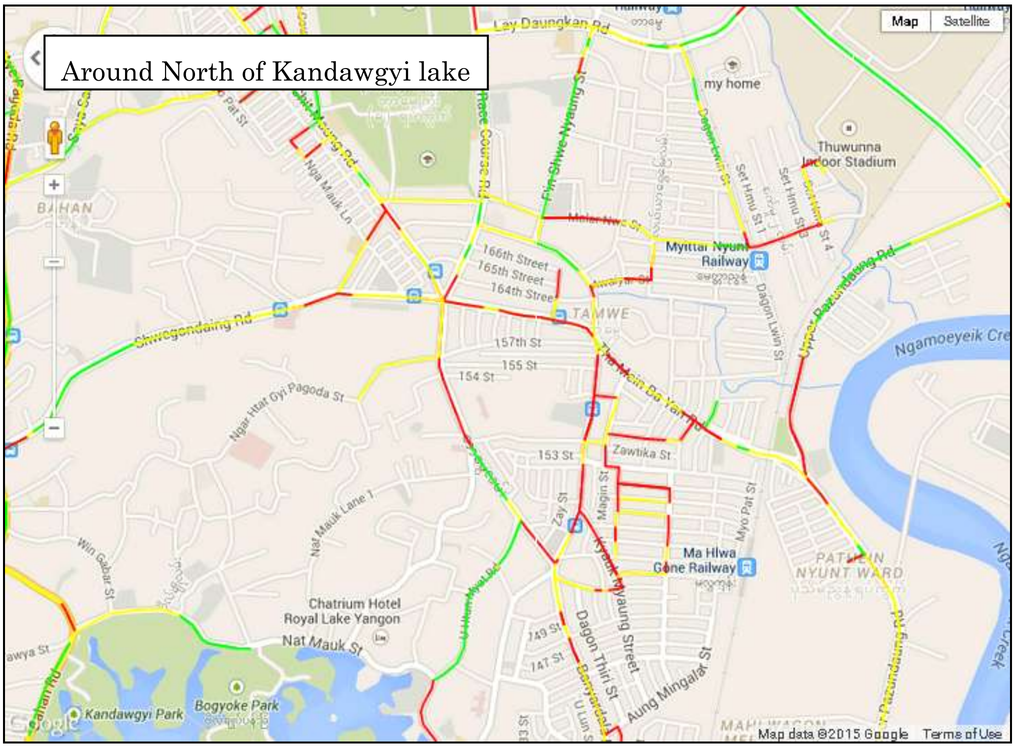

Fig. 18 Traffic Information around Northern Part of Kandawgyi Lake in the Morning Time(6:00～8:59) of 11/30/2014

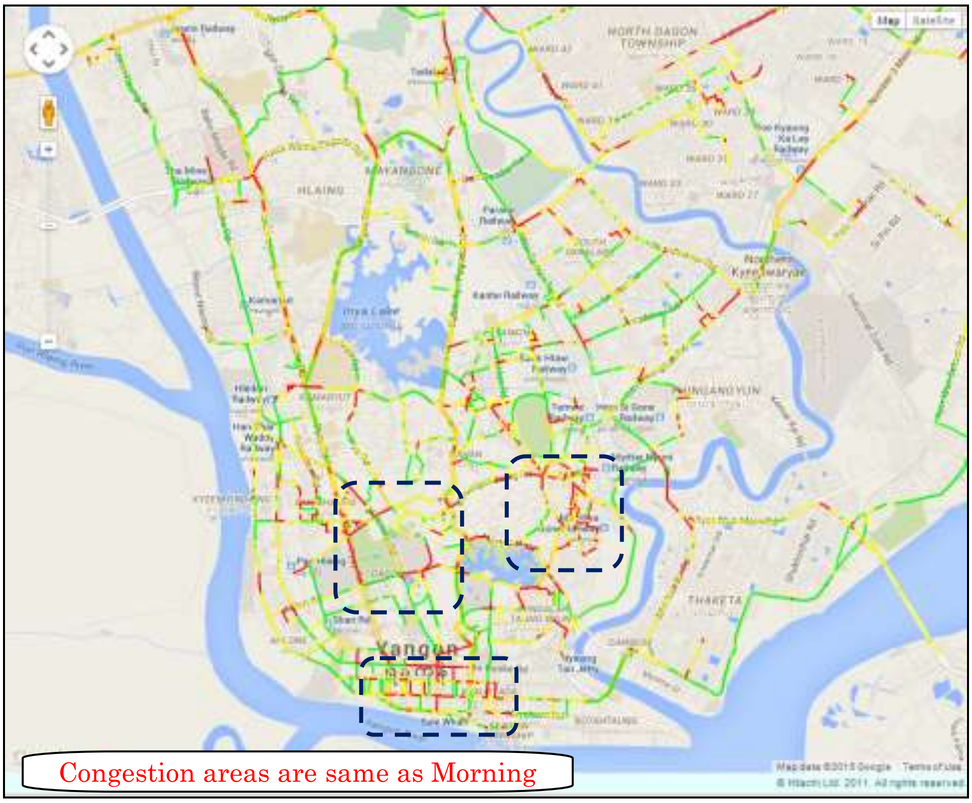

Fig. 19 Congestion Condition in the Daytime(12:00～14:59) in 11/30/2014

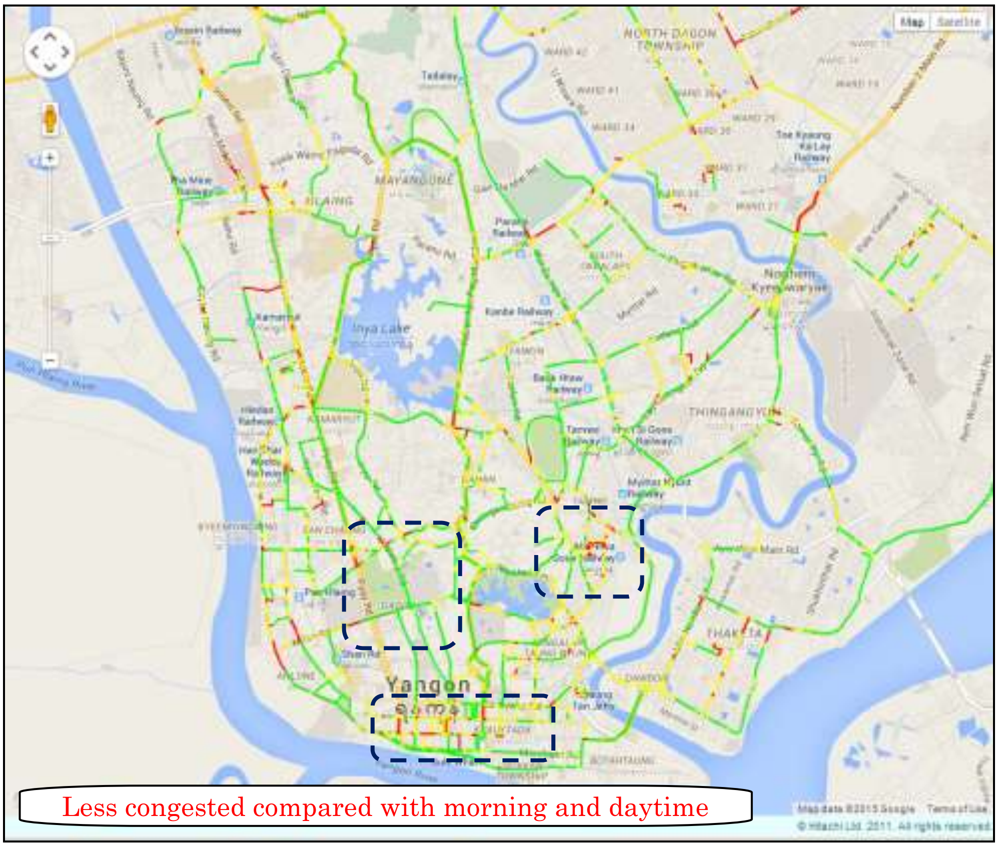

Fig. 20 Congestion Condition in the Evening(18:00～20:59) of 11/30/2014

(1) Summary

In this section, we evaluated Probe Traffic Information. Table 7 shows evaluation result list for each view points.

Table 7 Probe Traffic Information Evaluation List

#	Evaluation View Point	Purpose of Evaluation	Evaluation Result
1	Can be applied for road planning in the future?	To clarify the time condition (Probe processing system can provide probe traffic information stably with the time condition)	Stable data supply is expected with using taxies as data source in the daytime(06:00-18:00)
2		To clarify the area where probe traffic information can be provided	Probe processing system can generate traffic information in downtown area with 3-hours time period, and can generate almost whole Yangon city area with 24-hours time period.
3		To clarify the road type which has stable probe traffic information	For primary roads, information supply of about 40% is expected with 3-hours time period, and information supply of about 65% is expected with 24-hours time period. Information supply in the general road would be limited
4	Can be used as an Input to traffic simulator in this project?	To evaluate the accuracy of probe traffic information	Actual chronic congestion point and congestion tendency accorded

(a) Utilize for Road Planning

When probe processing system is used for road planning, it is said that we can understand the change of traffic situation in a day by using 3-hours traffic information. If we understand the change of traffic situation at the congestion area in a day, we can take an effective measure based on the tendency of the congestion. For example, if the congestion happened whole day, we need to take an infrastructure improvement such as widening a road. On the other hand, if the congestion happened only at a specific time, it may be possible to take a measure like changing traffic signal cycle which does not need infrastructure change.

(b) Utilize for Traffic Flow Simulator

As an input data for traffic flow simulator, we generated a traffic information at the target simulation area. On October 15^{th}, 2014, we used 10 taxis with GPS loggers, and let them run around the target area, and collected probe data.

Table. 2-1 shows the travel speeds in the direction from east to west in the target area shown in Fig. 21**.** Table. 2-2 shows the travel speeds in the direction from west to east in the target area shown in Fig. 22. We used those travel speed data as an input data for the traffic flow simulator.

Also the data that are marked with asterisk(*) in the tables mean that there were not a taxi in the road section at the time, we could not generate the travel speed. Therefore, the data are marked with asterisk are calculated as an average of data next to that time at the road section.

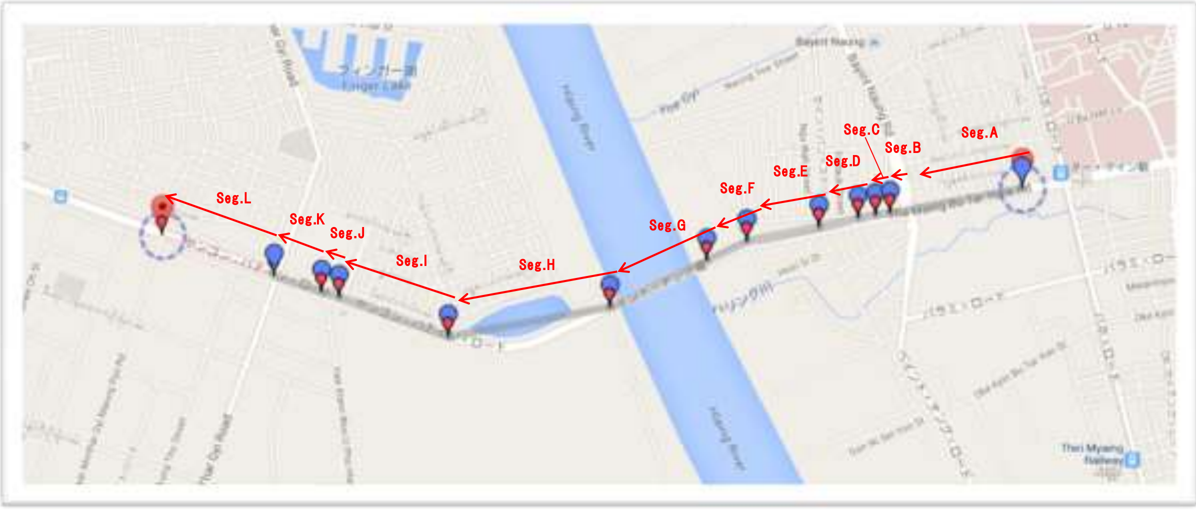

Fig. 21 Travel Speed Generated Area (East to West direction)

Table. 2-1 Travel Speed in Simulation Target Area (Before Construction, East to West)

#	Time zone			Average Travel Speed for Each Road Segment (km/h)											
				East to West Direction											
				Seg.A	Seg.B	Seg.C	Seg.D	Seg.E	Seg.F	Seg.G	Seg.H	Seg.I	Seg.J	Seg.K	Seg.L
1	17:00	-	17:15	32	32.4	2.4	3.8	4.8	11.6	15.2	20.7	23.6	29.5	6.9	51.4
2	17:15	-	17:30	23.5	7.8	7.7	4.15*	3.8	12.7	13.6	19.5	23	36.9	9	26.8
3	17:30	-	17:45	23.3	6.05*	37.3	4.15*	3.9	8	13.4	15	23.3	32.8	12.7	48.7
4	17:45	-	18:00	32.5	6.05*	3.2	4.15*	3.5	10.6	17.5	23	25.5	26.8	4.8	54.3
5	18:00	-	18:15	28.9	4.3	5.4	4.15*	3.5	9.2	15.7	15.2	21.2	26.8	11.8	25.7
6	18:15	-	18:30	10.7	3.3	3.5	4.15*	3.7	9.6	13.1	22.2	54.8	32.8	12.1	63.4
7	18:30	-	18:45	17.4	4.4	12	4.5	3.7	10.4	13.9	15.9	22.5	29.5	9.1	9.9
8	18:45	-	19:00	53.5	8.1	3.6	3	6.2	14.6	19.9	19.3*	34.5	29.5	6.8	39.6

Fig. 22 Travel Speed Generated Area (West to East direction)

Table. 2-2 Travel Speed in Simulation Target Area (Before Construction, West to East)

#	Time zone			Average Travel Speed for Each Road Segment (km/h)											
				West to East Direction											
				Seg.M	Seg.N	Seg.O	Seg.P	Seg.Q	Seg.R	Seg.S	Seg.T	Seg.U	Seg.V	Seg.W	Seg.X
1	17:00	-	17:15	21.8	26.6	36.9	23.9	4.7	12.6	23.3	23.6	25.3	37.3	32.4	21.4
2	17:15	-	17:30	15.1	23.5	26.8	7.9	5.1	11.8	14	21.9	42.2	37.3	32.4	71.4
3	17:30	-	17:45	16.5	42.1	29.5	3.4	3.5	10.1	10.6	21.1	31.7	42.7	28.4	49.1*
4	17:45	-	18:00	24.7	22.2	29.5	4	4.5	10	16.6	18.2	30.2	36.3*	25.2	49.1*
5	18:00	-	18:15	16	20	24.6	6.6	3.8	9.6	15.9	14.2	28.8	29.9	28.4	49.1*
6	18:15	-	18:30	27.2	15.4	32.8	6.6	4.3	11.4	19.4	20.7	30.2	33.2	28.4	49.1*
7	18:30	-	18:45	6.9	26.6	26.8	21.9	5.4	11.4	17.5	17.6	37.3	37.3	37.8	26.8
8	18:45	-	19:00	13.5	13.3	26.8	23.6	5.5	10.2	9.3	20.7	37.3	33.2	56.7	63

3.2 Evaluation of Image Processing Traffic Counter

(1) Purpose of Demonstration Experiment

To demonstrate the usefulness of Japanese Image Processing Traffic Counter for traffic improvement operation in Yangon City.

(2) Evaluation

(a) Image of Image Analysis

Fig. 23 shows the image of applying Image Processing Traffic Counter to the image of target area in Yangon City.

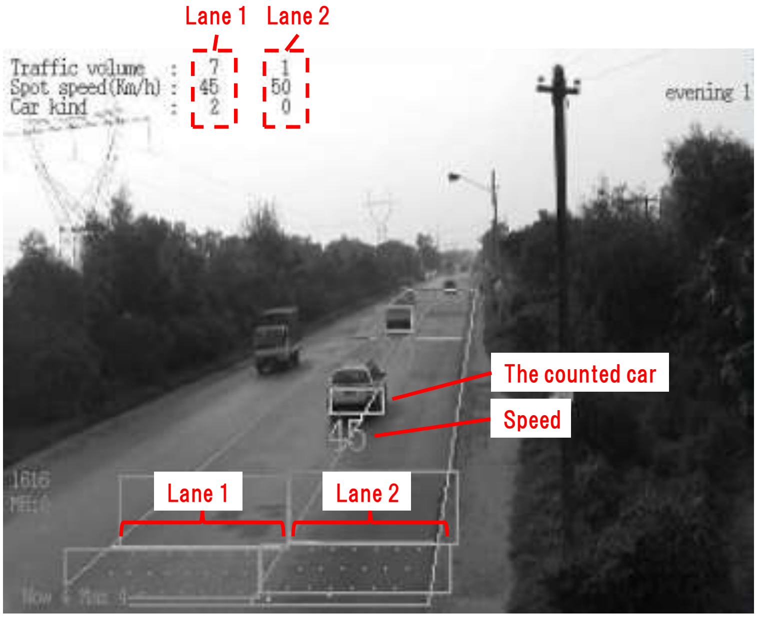

Fig. 23 Image Processing Traffic Counter Application

(b) Result of Image Processing Traffic Counter

Table 8 shows the amount of traffic and average speed as the result of analysis by Image Processing Traffic Counter from the movie data taken at the target area in Yangon City.

Table 8 Result of Image Processing Traffic Counter

Measurement time slot	Amount of Traffic (Number of Vehicles)		Average Speed (km/h)	
	Lane 1	Lane 2	Lane 1	Lane 2
17:00～17:10	119	17	31.0	27.5
17:10～17:20	103	14	30.5	26.5
17:20～17:30	101	17	30.5	26.0
17:30～17:40	121	22	31.0	23.0
17:40～17:50	120	23	29.5	19.0

※Movie for this analysis was taken on November 4th, 2014。

As shown in Table 8, Image Processing Traffic Counter can measure quantitatively the amount of traffic for each time zone.

(3) Summary

We confirmed that Image Processing Traffic Counter can automatically measure traffic flow under the road and traffic environment in Yangon City. Generally speaking, it is important to perform traffic control and road planning based on quantitative information, so automatic traffic flow measurement by Image Processing Traffic Counter can be useful to solve traffic problem in Yangon City.

3.3 Demonstration of the road traffic simulator

(1) Purpose of Demonstration Experiment

Followings are the purposes of demonstration of the road traffic simulator in this project.

(a) Evaluate the prediction ability about the tendency of traffic flow change

We evaluated the ability of Japanese Traffic Flow Simulator to predict the tendency of change of traffic flow (such as reduction in length of congestion or travel time) caused by the change of road structure.

(b) Evaluate the usefulness for the pre-assessment of the road improvement plan

We demonstrate the usefulness of the Traffic Flow Simulator which can simulate the effect of road improvement plan in advance for road administrator's road planning operation. This project carried out pre-assessment of traffic signal optimization as the model case of the pre-assessment of road improvement plan.

(1) Demonstration Substance

(a) Target Area

In order to achieve the purpose above, we needed to select the target simulation area in this project. We talked with YCDC, and decided to select the area around Bayint Naung Bridge2 as the target area for simulation. Fig. 24 shows the location where Bayint Naung Bridge2 was newly built.

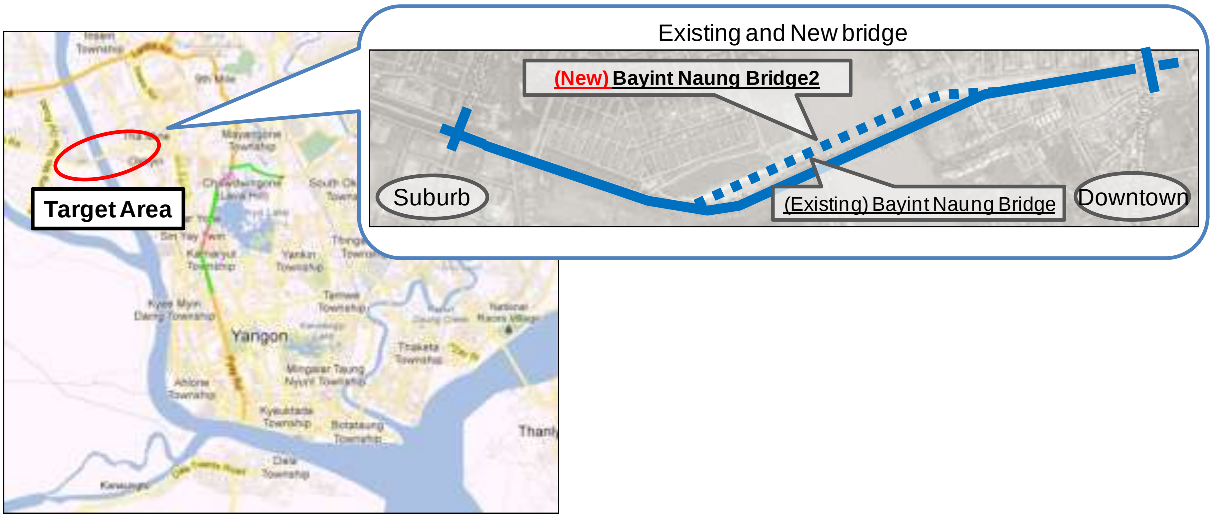

Fig. 24 Target Area for Traffic Flow Simulation

Bayint Naung Bridge already exited in this area. This bridge connects city center where many offices located with residential and industrial area. People used this bridge for commute. Other than this bridge, there was only one road that connects city center with residential and industrial area, so traffic flow was concentrated to this bridge. Furthermore, this bridge has only 1 lane for each direction, so traffic congestion occurred at the peak time in the morning and evening. In order to ease the congestion, the construction of the new bridge, Bayint Naung Bridge 2 (see Fig. 25), was planned and completed at the end of October in 2014.

Before the construction of the new bridge was completed, congestion had occurred at peak time in the evening around Point B and C in Fig. 25.

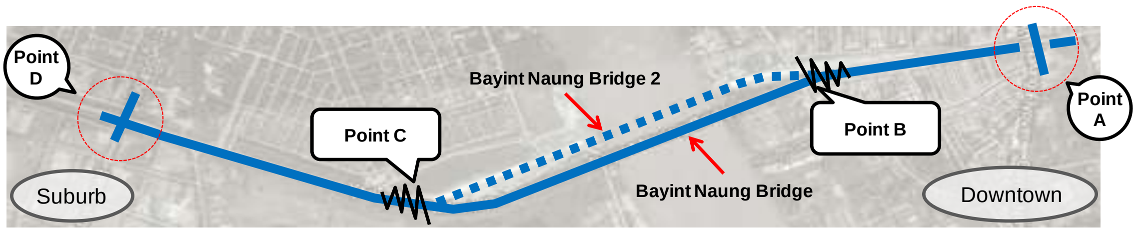

Fig. 25 Overview of around Bayint Naung Bridge

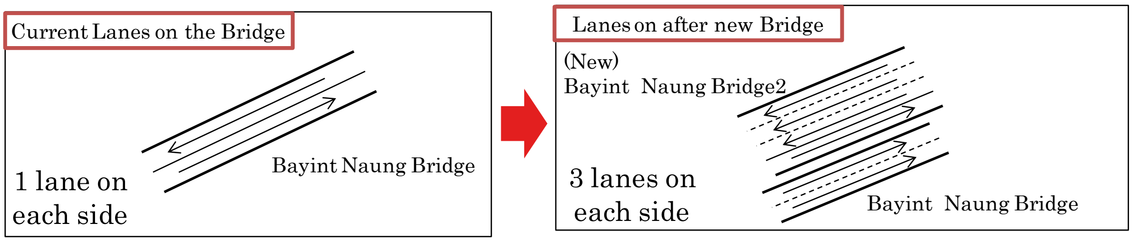

Fig. 26 Lane Change with new Bayint Naung Bridge2

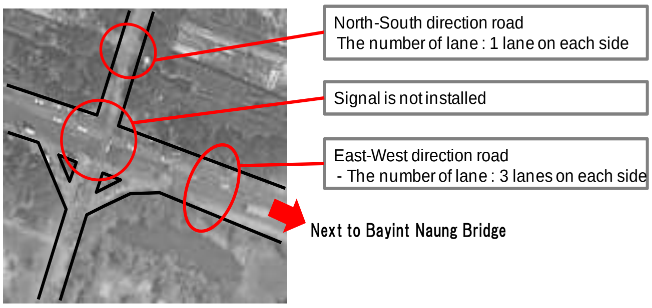

Fig. 27 Road Structure at Point D

On the other hand, after the completion of the construction of the new bridge, the number of lanes of the bridges became 3 lanes for each direction (see Fig. 26), and congestion was expected to occur at Point D (see Fig. 27) with the increase of traffic flow per unit time as the side effect of disappearance of congestion at the Point B and C.

As the change of tendency of traffic flow is expected after the completion of the construction, we set the area from Point A to D as the target area of traffic flow simulation in this project.

(b) Construction Simulation

(i) Current Condition Simulation

We conducted the simulation to simulate the current condition before the construction of new bridge. The simulation of After Construction Simulation and Optimum Traffic Signal Simulation were built based on this simulation.

(ii) After Construction Simulation

We conducted the simulation to predict the traffic flow after the construction of the new bridge in advance. This after-the-construction simulation is created based on the "Current Condition Simulation", and made a change about road and traffic information (road structure and amount of traffic) caused by the construction of the new bridge.

We found that new traffic signals are placed at the intersection of Point D during the project. Since the placement of signal affects the traffic flow, we added the traffic signal at that location in this simulation with the same signal cycles as the actual cycles.

(iii) Optimum Traffic Signal Simulation

We created the simulation to predict the traffic flow with theoretically optimum signal cycle. In this simulation, we changed the signal cycles of Point D to the theoretically optimum cycles.

(2) Evaluation

(a) Evaluation for the feasibility of the traffic flow prediction after the construction

First, we show the tendency of traffic flow change in "Current Condition Simulation" and "After Construction Simulation". Fig. 28 to Fig. 34 show the length of congestion in each simulation as the index for traffic flow

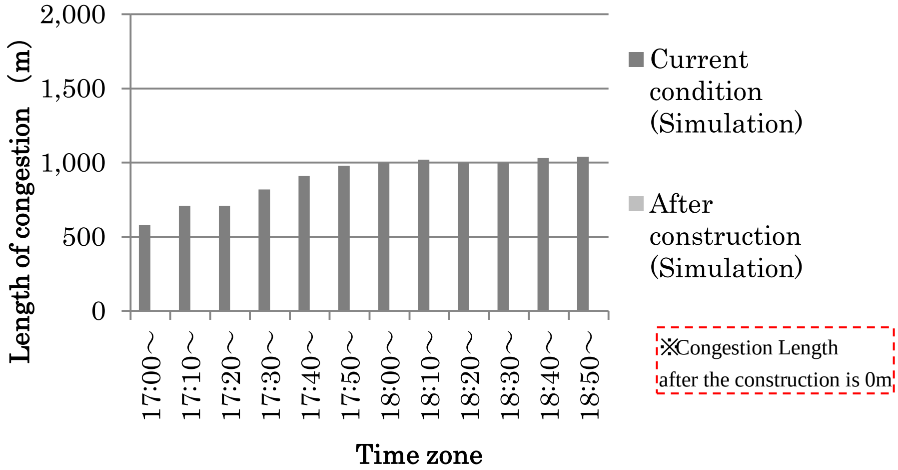

Fig. 28 Comparison of the length of Congestion at Point B (over the Fly-over) of simulation (East to West Lane)

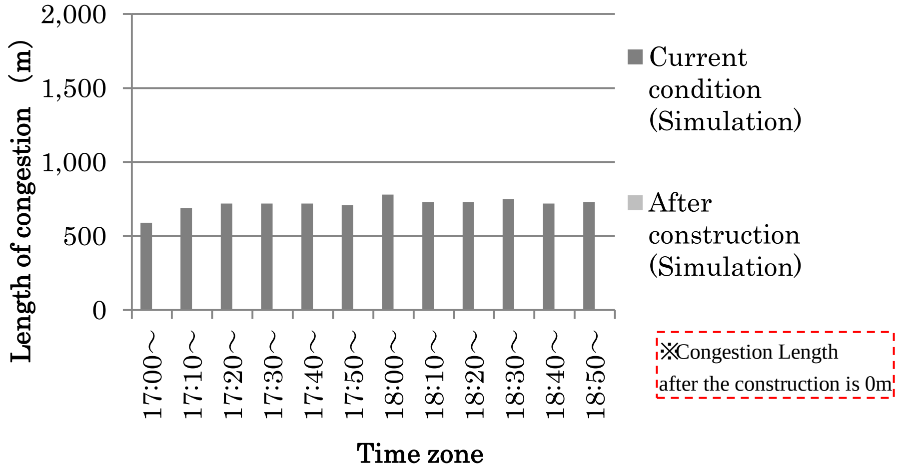

Fig. 29 Comparison of the length of Congestion at Point B (under the Fly-over) of simulation (East to West Lane)

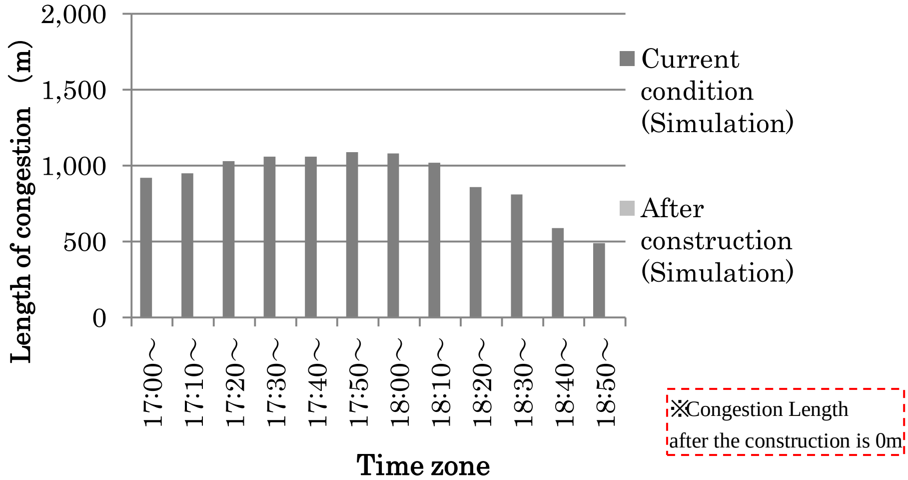

Fig. 30 Comparison of the length of Congestion at Point D of Simulation (West to East Lane)

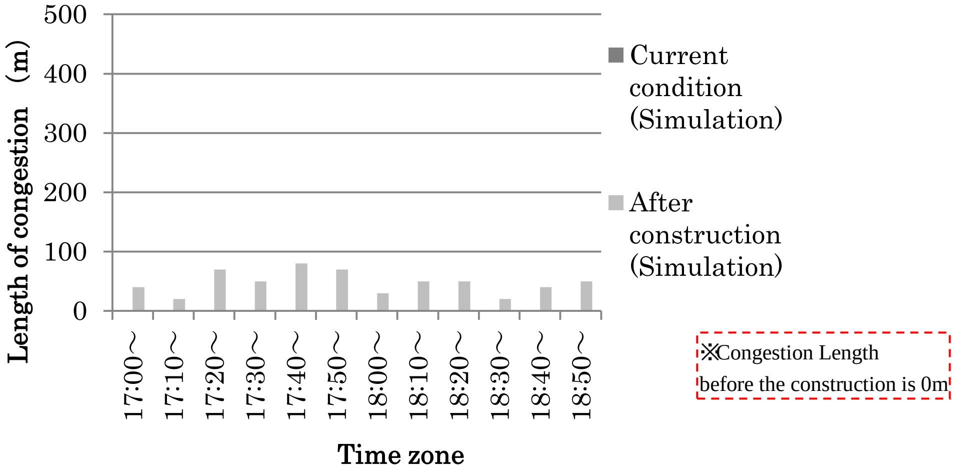

Fig. 31 Comparison of the length of Congestion at Point D of Simulation (North to South Lane)

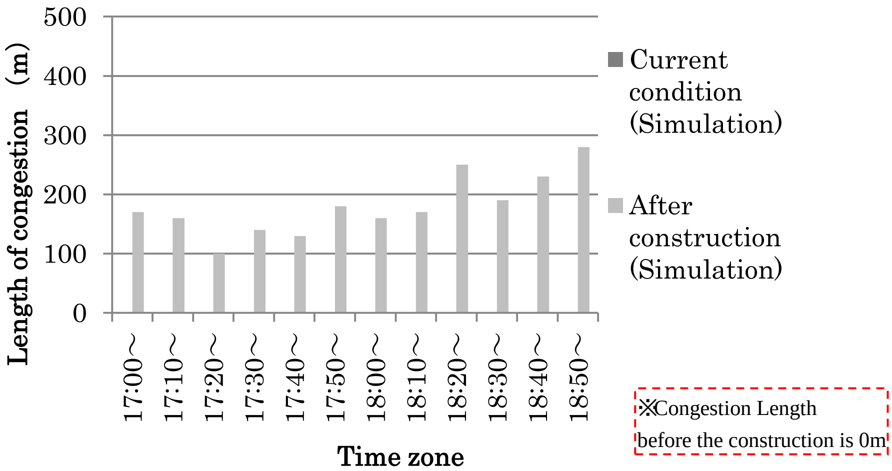

Fig. 32 Comparison of the length of Congestion at Point D of Simulation (East to West Lane)

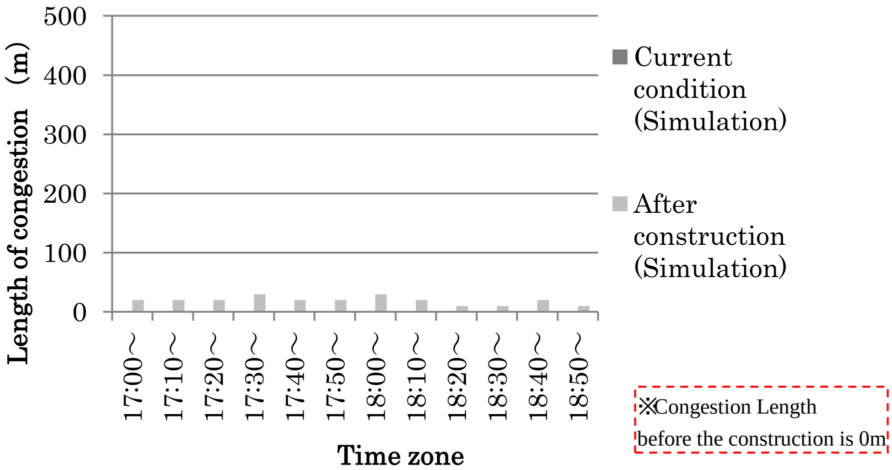

Fig. 33 Comparison of the length of Congestion at Point D of Simulation (South to North Lane)

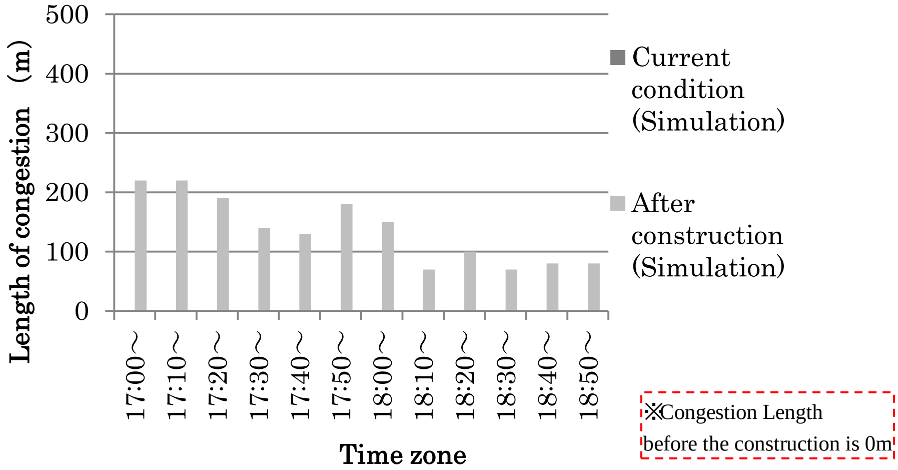

Fig. 34 Comparison of the length of Congestion at Point D of Simulation (West to East Lane)

Fig. 35 to Fig. 41 show the graph that indicate the tendency of traffic flow change before and after construction from actual observation.

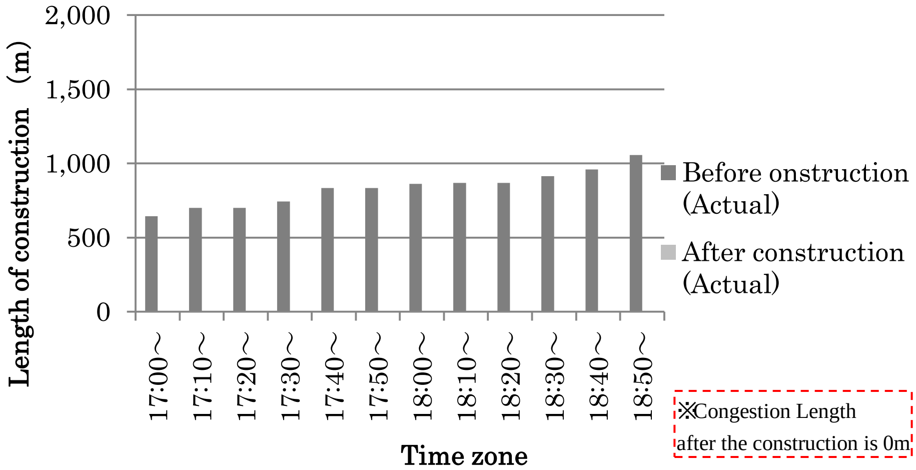

Fig. 35 Comparison of the actual length of Congestion at Point B (over the Fly-over) by (East to West Lane)

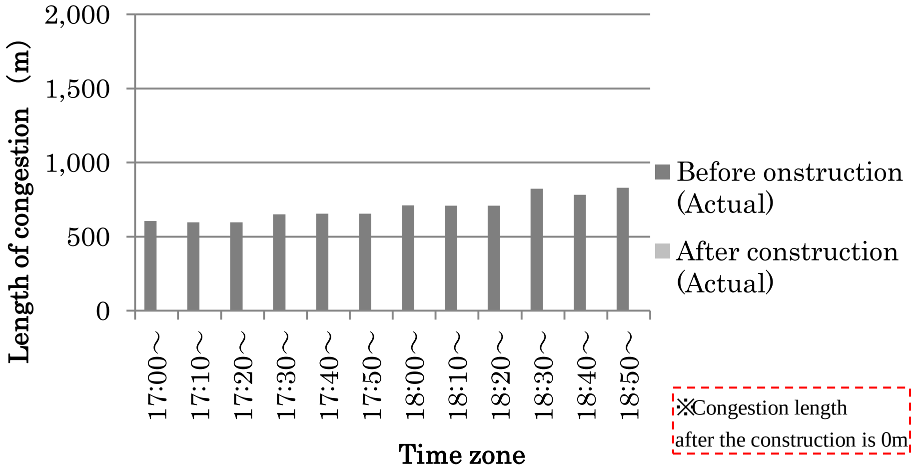

Fig. 36 Comparison of the actual length of Congestion at Point B (under the Fly-over) (East to West Lane)

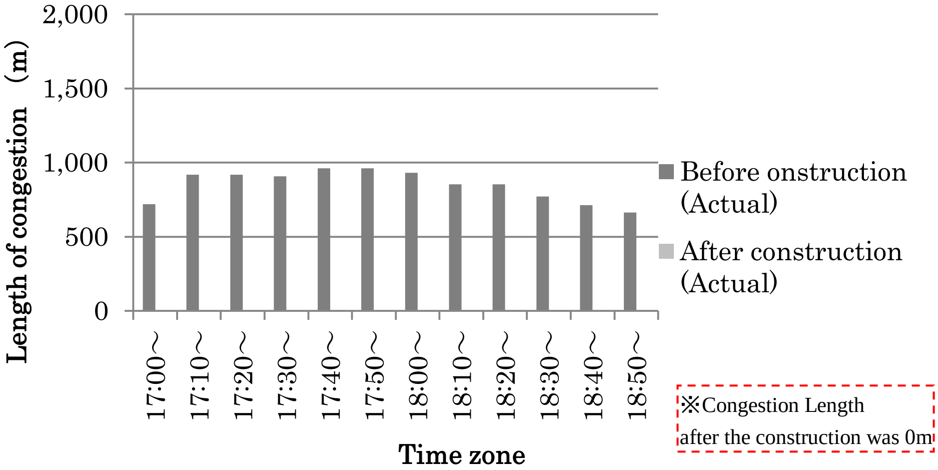

Fig. 37 Comparison of the actual length of congestion at the Point C (West to East Lane)

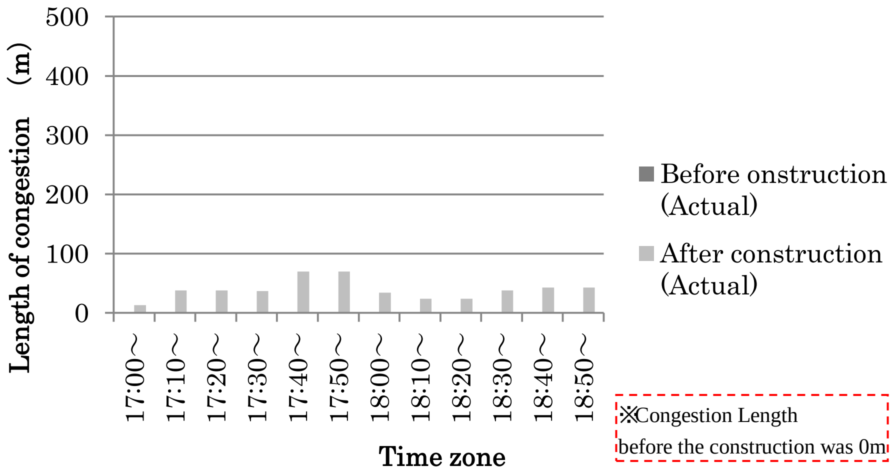

Fig. 38 Comparison of the actual length of congestion at the Point D (North to South Lane)

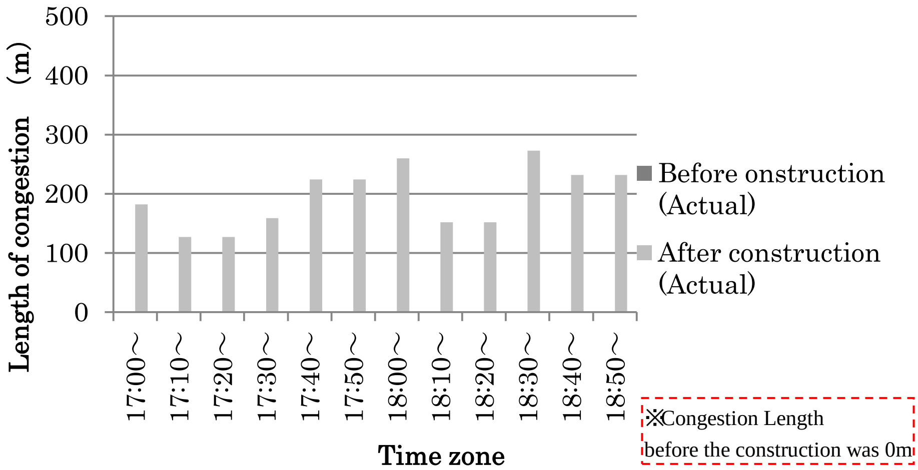

Fig. 39 Comparison of the actual length of congestion at the Point D (East to West Lane)

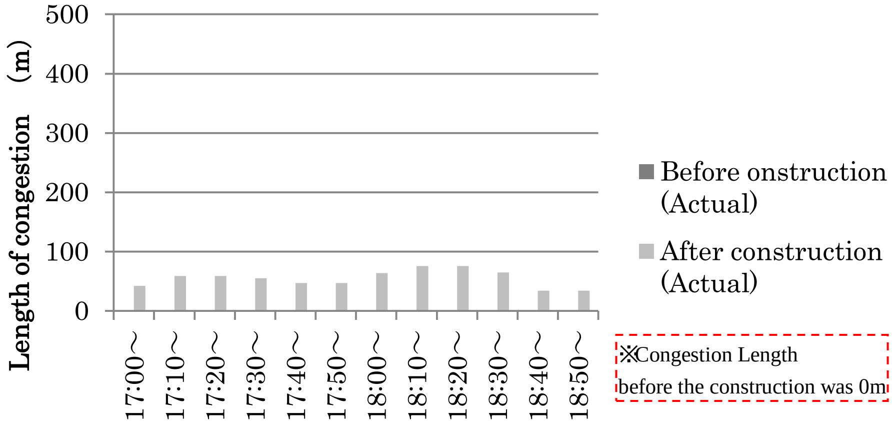

Fig. 40 Comparison of the actual length of congestion at the Point D (South to North Lane)

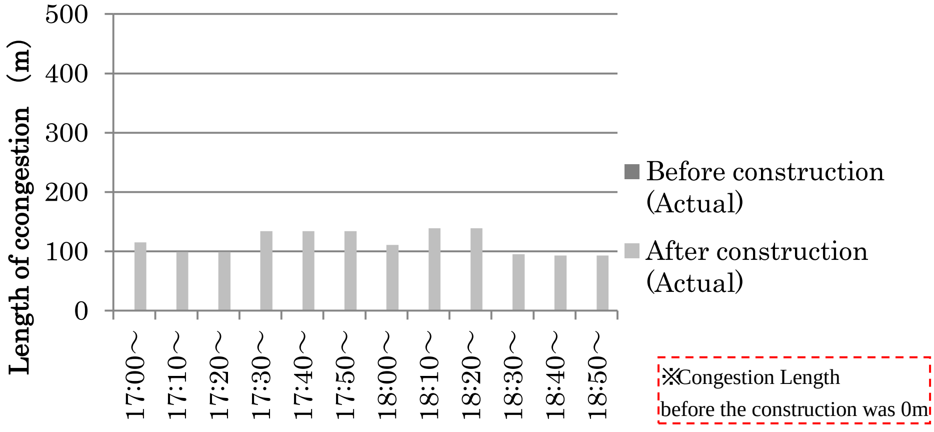

Fig. 41 Comparison of the actual length of congestion at the Point D (West to East Lane)

Graphs show that at Point B and Point C, the length of congestion which had existed before the construction disappeared in both simulation（Fig. 28～Fig. 30）and actual observation（Fig. 35 ～Fig. 37）. On the other hand , the graphs show that a remarkable increase of the length of congestion at point D in each direction in both simulation（Fig. 31～Fig. 34）and actual observation（Fig. 38～Fig. 41）.

Table 9 and 10 show the travel time between Point A and D before and after the construction in both simulation and actual observation.

Table 9 Average travel time from Point A to D

Data Source	Before Construction	After Construction
Simulation	24min.13sec.	5min.41sec.
Actual Observation	20min.27sec.	7min.12sec.

Table 10 Average travel time from Point D to A

Data Source	Before Construction	After Construction
Simulation	18min.12sec.	4min.16sec.
Actual Observation	22min.06sec.	5min.15sec.

According to the result shown in Table 9 and Table 10, travel time decreased from around 20 minutes to 5 minutes after the construction both in simulation and actual observation and these change tendencies accorded.

From these results, traffic flow simulation was evaluated that it can predict the tendency of traffic flow change.

(b) Evaluate the usefulness for the pre-assessment of the road improvement plan

Table 11 shows the current signal cycle set at the "After Construction Simulation" and optimum signal cycle set at "Optimum Traffic Signal Simulation". Fig. 42 shows the signal cycle pattern.

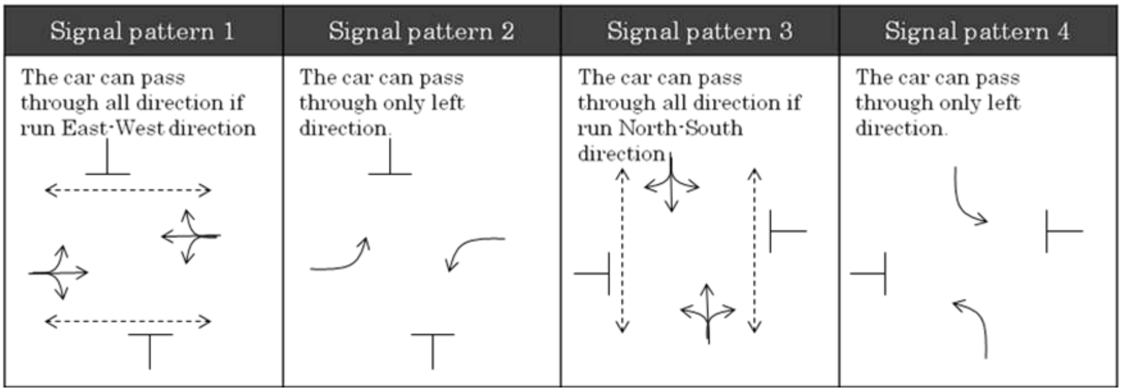

Fig. 42 Pattern of Signal Pattern

Table 11 Conventional Signal Cycle and Optimum Signal Cycle

Type	Signal Pattern 1		Signal Pattern 2			Signal Pattern 3		Signal Pattern 4			Total
	G	Y	GA	Y	AR	G	Y	GA	Y	AR	
Conventional (sec.)	41	4	17	4	0	26	6	0	0	0	98
Optimum (sec.)	48	4	7	3	2	22	4	5	3	2	100

※Example G : Green、Y : Yellow、GA : Green Arrow、AR : All Red

Fig. 43 to Fig. 46 shows the comparison of the length of congestion at Point D intersection between "After Construction Simulation" and "Optimum Signal Cycle Simulation".

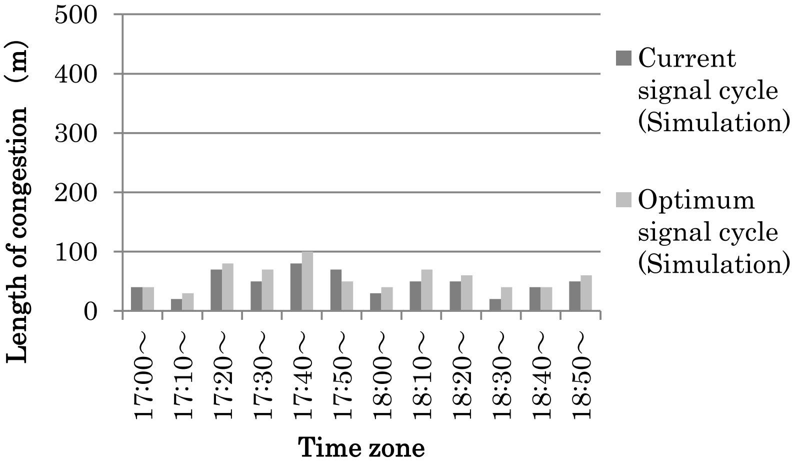

Fig. 43　Comparison of the length of congestion at Point D after the change of signal cycle (North to South Lane)

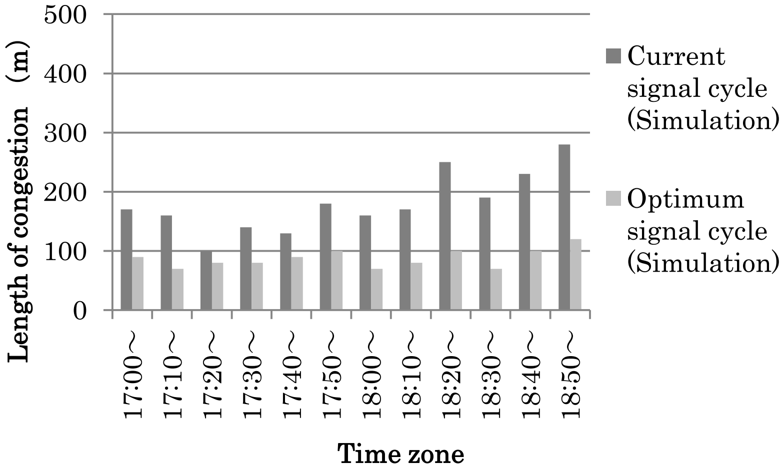

Fig. 44　Comparison of the length of congestion at Point D after the change of signal cycle (East to West Lane)

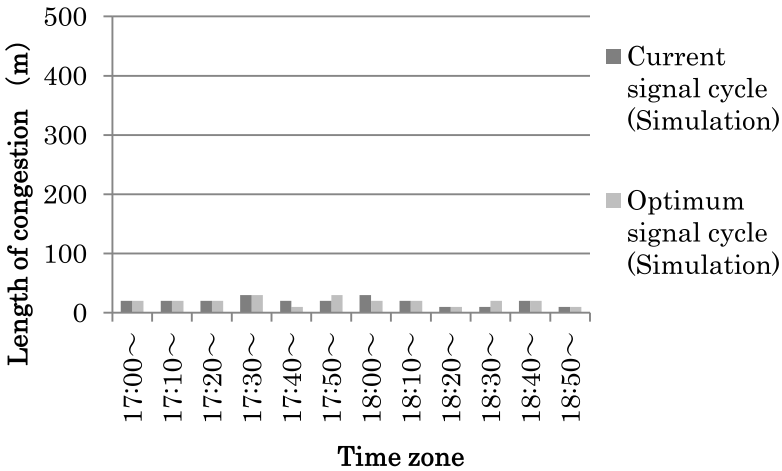

Fig. 45　Comparison of the length of congestion at Point D after the change of signal cycle (South to North lane)

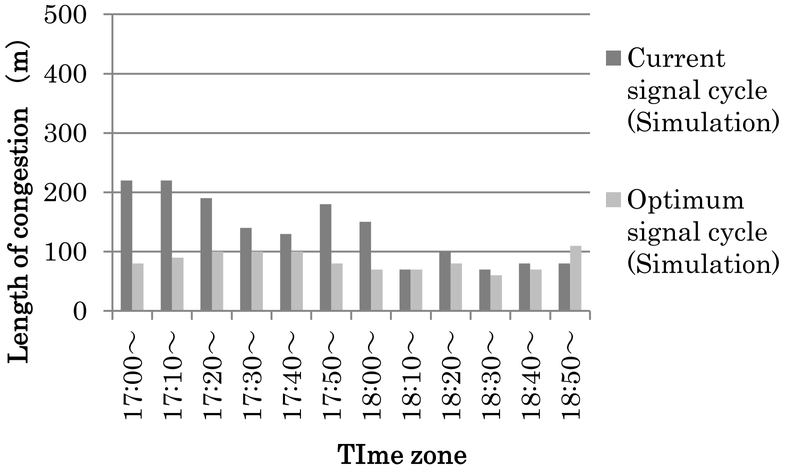

Fig. 46 Comparison of the length of congestion at Point D after the change of signal cycle (West to East lane)

Table 12 shows the total of the average (during 17:00~19:00) congestion length per lane.

Table 12 Total of average congestion length per lanes

#	Simulation	Total of average congestion length
1	Simulation of current signal cycle (After Construction Simulation)	383m
2	Simulation of optimum signal cycle (Optimum Signal Cycle Simulation)	248m

From the graph Fig. 43 to Fig. 46, length of congestion in the East to West lane which appeared in the current signal cycle simulation reduced in the optimum signal cycle simulation. The total of average length of congestion in each 4 lanes of optimum signal cycle simulation became small.

In this evaluation, we set theoretically optimum signal cycle setting as a road improvement plan and evaluated in advance with traffic flow simulation, and evaluated the usefulness by understanding improvement effect quantitatively.

(3) Summary

We compared the traffic flow of simulation and actual observation, and we evaluated that the traffic flow simulation can predict the tendency of traffic flow change, and demonstrated usefulness of pre-assessment about road improvement.

3 Training to the partner company

In this project, through the demonstration mentioned in the Chapter 2, we collected input data for Traffic Flow Simulation, Probe Information System and Image Processing Traffic Counter in cooperation with local partner company, ACE Data Systems, and instructed how to collect them.

We assume that ACE Data Systems will do construction of the ICT systems, maintenance of the system. In order to train how to construct the system and how to operate it to ACE Data Systems, we conducted “Knowledge Transfer Session”. Also, we conducted the session with YCDC staff to promote their understanding of ITS technologies.

3.1 Overview of Knowledge Transfer Session

[For ACE Data System]

Date：Dec. 17th(Wed) and 18th(Thu), 2014

Place：ACE Data Systems Office

Subject：10 ACE Data Systems Staff

[For YCDC]

Date：Dec. 19th(Fri), 2014

Place：ACE Data Systems Office

Subject：2 YCDC Staff

3.2 Contents of Knowledge Transfer Session

We explained the purposes and architecture of ITS system (Traffic Flow Simulation, Probe Processing System and Image Processing Track Counter) to the ACE Data Systems and YCDC staff in this project. Furthermore, we instructed how to build the system and how to operate the sytem with using actual machines to ACE Data Systems staff.

3.3 Result

Through this instruction, ACE Data Systems and YCDC staff acquired knowledge concerning Japanese ITS technologies such as architecture, purpose and operation. Also ACE Data Systems staffs acquired a basic know about how to build and operate Japanese ITS solutions.

4 Visit to Japan

We invited the persons related to Yangon government staffs working for road traffic field and they visited the facilities concerning road traffic in Japan.

4.1 Purpose of Invitation

We invited Yangon government staffs to visit Japanese traffic related facilities, and promote their understandings about traffic control system and ITS technologies and their operation for easing traffic congestion. Also, we aimed to promote their consideration about introduction of systems using ITS technologies in Myanmar such as traffic control system.

4.2 Overview of Invitation

(1) Schedule of Visit

Table 13 shows the schedule of visit to Japan in this activity

Table 13 Schedule to Visit Japan

#	Date	Activities
1	Feb. 23rd, 2015	✓ Travel from Yangon Airport to Narita Airport
2	Feb. 24th, 2015	✓ Arrived at Narita Airport, Japan ✓ Visited Headquarter of JICA and attended the meeting with JICA and Hitachi
3	Feb. 25th, 2015	✓ Visited Road traffic control center of the Metropolitan Police Department ✓ Visited VICS(Vehicle Information and Communication System) Center
4	Feb. 26th, 2015	✓ Explained the ITS technology of Japan at the Hitachi Collaboration Square ✓ Held the discussion with Hitachi about the traffic problems and solution in Yangon City
5	Feb. 27th, 2015	✓ Travel from Narita Airport to Yangon Airport

(2) Attendees

Table 14 shows the attendees of this activity.

Table 14 Persons who visited Japan

#	Name	Organization	Title
1	U Hla Aung	Yangon region central supervisory committee for motor vehicles	Chairman
2	U Soe Min	Yangon Transport Planning Department	Director
3	Than Myint	Traffic Police Force	Police Major
4	U Thaung Tin Htwe	Eastern District General Administrative Department	District Administrative Officer
5	U Nyan Thar	Yangon City Development Committee	Assistant Head of Department

(3) Response from Attendees

The attendees showed strong interest in Japanese ITS technologies when they visited the road traffic control center, VICS Center and Hitachi Collaboration Square in this activity.

For example, they showed interest in the multi traffic signal control technology, vehicle sensors and image traffic counter technology which automatically counts the traffic amount. It seemed that they were considering the automation of traffic information and traffic control.

In the discussion on traffic problems in Yangon at Hitachi Collaboration Square, they seemed to understand the seriousness of traffic congestion problem, but they seemed to have a problem taking effective measures. Therefore, it seems effective to propose consulting for road traffic improvement plan, or the traffic flow simulation for supporting road traffic improvement planning.

5 Conclusion

In this project, in order to spread ITS solutions such as Road Traffic Simulator in Yangon city, the effectiveness of those ITS solutions were demonstrated and training session was performed to promote Myanmar official’s understanding of technology. As a result of those activities, we have shown that Road Traffic Simulator could simulate the tendency of change of traffic after the construction of a new bridge in Yangon. This result showed that Japanese ITS solutions could work effectively in Yangon city. With the Japanese ITS solutions, it is expected that road administrators can evaluate and select an effective road improvement plan.

We have performed a training session including actual system operation, and we could promote the understanding about effectiveness of ITS solutions for local partner company and Myanmar officials. We also invited Myanmar officials to Japan and showed them Japanese road traffic related facilities, and promoted their understanding of ITS solutions and their operation.

In order to ease traffic congestion, both fundamental improvement of roads and real time traffic control are needed. In Yangon city, both road improvement plan based on quantitative analysis and traffic control based on real time traffic data collection have not been performed so far, and effective steps have not been taken to solve the severe traffic congestion problem. Therefore, we can say that installing systems to make both road planning and traffic control like Fig. 47is needed in Yangon city.

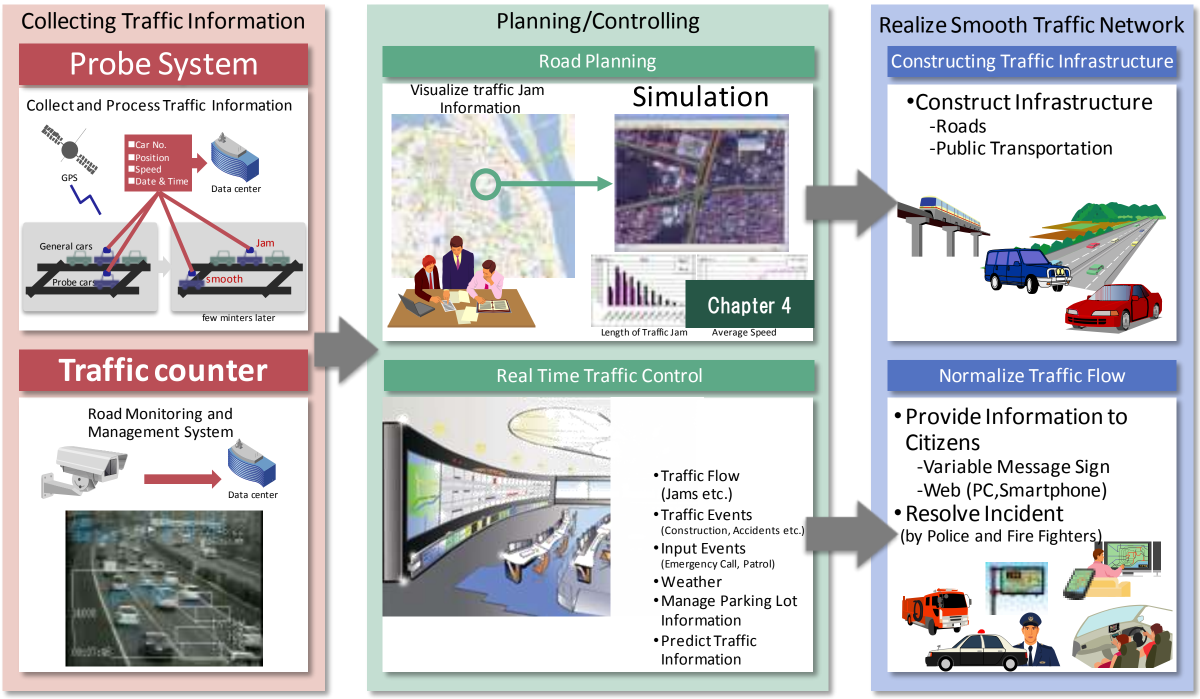

Fig. 47 System Image Needed from Yangon City

As shown in Fig. 47, the system collects quantitative traffic information utilizing Probe Processing System and Image Processing Traffic Counter. That traffic information can be used for operation of both road planning and traffic control. Using that information will enable to perform fundamental road improvement and provision of traffic information efficiently. In addition to those system mentioned above, Yangon city's needs that could be known throughout the project are shown as follows.

- During this project, we found that Yangon government is planning to install traffic signals in Yangon city. Currently, they are planning to install traffic signals with simple control function. Therefore, we assume that Yangon city will have needs for having following technologies.
  - ➢ Control of group of traffic signals in more than one intersections
  - ➢ Dynamic traffic signal control based on information of existence of cars
  - ➢ Road traffic simulator for evaluation before installing technologies above
- In the intermediate report to Yangon government and knowledge transfer session, we found that Yangon government is very interested in road traffic simulator. Also, we found that Yangon government officials do not have a lot of knowledge about traffic management. Therefore, when we install ITS solutions such as road traffic simulator, it is effective to provide a consulting service of road improvement in addition to ICT system.
- In this project, we found that the Yangon government was interested in the probe processing system which can generate real time and statistic traffic information. Because they understood the usefulness of visualization of traffic information, it can be said that a needs for an advanced solution such as analysis tools is high.

There are 2 challenges for realizing above, We need to solve them in order to spread Japanese ITS solutions. First challenge is to develop infrastructure which is related to the installation phase of ITS solutions. About the probe processing system, in order to generate traffic information in a real time manner, we need to collect a large amount of probe data. In the case of other countries, in vehicle devices with GPS loggers equipped with cars and taxies are used, and it is necessary in Myanmar case to take a measure to collect probe data. The second challenge is in a maintenance phase. In order to ease traffic congestion, it is necessary not only to install ITS solutions, but also to use them continuously. In order to achieve that, knowledge transfer and consulting to the road administrator are necessary. Engineers in Yangon for system maintenance are also necessary.

Those challenges should be considered, but it can be said that promotion of spread of Japanese ITS solutions is effective for contributing to the improvement of Yangon city's traffic issues.

6 Utilization Plan of Demonstrated Technology in Yangon City

We demonstrated the effectiveness of the Japanese ITS solutions to improve traffic problem in Yangon City throughout this project. As we mentioned in Chapter 5 “Summary”, among the ITS technology demonstrated in this project, we found that the Yangon government had a strong interest in the traffic flow simulation and the probe processing system. We consider the possibility to utilize these technologies in Yangon City as follows.

(1) Traffic Flow Simulation

In this project, we found that the Yangon government had a strong interest in traffic flow simulation. For example, Yangon government staffs spoke as follows:

- We are considering the change of direction (Left turn, straight, right turn) of lanes of a certain road. We want to confirm the effect quantitatively in advance by using the traffic flow simulation.(An officer of YCDC, at the Knowledge Transfer Session)

- In Yangon City, there is a roundabout placed between two flyovers and it is very congested. We want to ease congestion by taking several methods such as placing traffic signals and want to know the effect before the construction. (An officer of MOT, at the meeting held in Feb. 2015, in Yangon City)

From the remarks mentioned above, easing congestion is the urgent problem to solve in Yangon City and Yangon government is trying to solve it, but it seemed improvement effects are not considered quantitatively in advance. Therefore, they seems to have a high demand for evaluation of improvement effect in advance with the traffic flow simulation which enables to choose a optimum plan.

However, evaluating the improvement effect using the traffic flow simulation requires operations with knowledge and experience of the road traffic plan such as planning road improvement, collecting current road structure and traffic information, using traffic flow simulator, and analyzing simulation result. Therefore, it would be effective to send a specialist who has knowledge and experience of road traffic plan in Japan. Official Development Assistance (ODA, Technical Cooperation) can be applied to send a specialist.

(2) Probe Information Processing System

We confirmed the local government has interests in the probe processing system that generates the real time and statistical traffic information shown in Fig. 46. We assume the following utilization of probe processing system for the measures to ease congestion in Yangon City.

(a) Road Improvement Plan

Using the stored traffic information data which is generated by probe processing system, road administrator can understand the traffic congestion situation in the whole road network, bottleneck point and congestion scale. They can select and prioritize the places to take measures to ease congestion. We assume that it is necessary to provide an analytical tool for accumulated data in addition to a function to generate traffic information.

(b) Traffic Control

A traffic control system visualizes the traffic condition from real time traffic information generated from the Probe Processing System. This function enables to confirm the condition and take measures quickly by assuming the place of occurrence of sudden congestion caused by accidents etc. This function contributes to keep road network smooth.

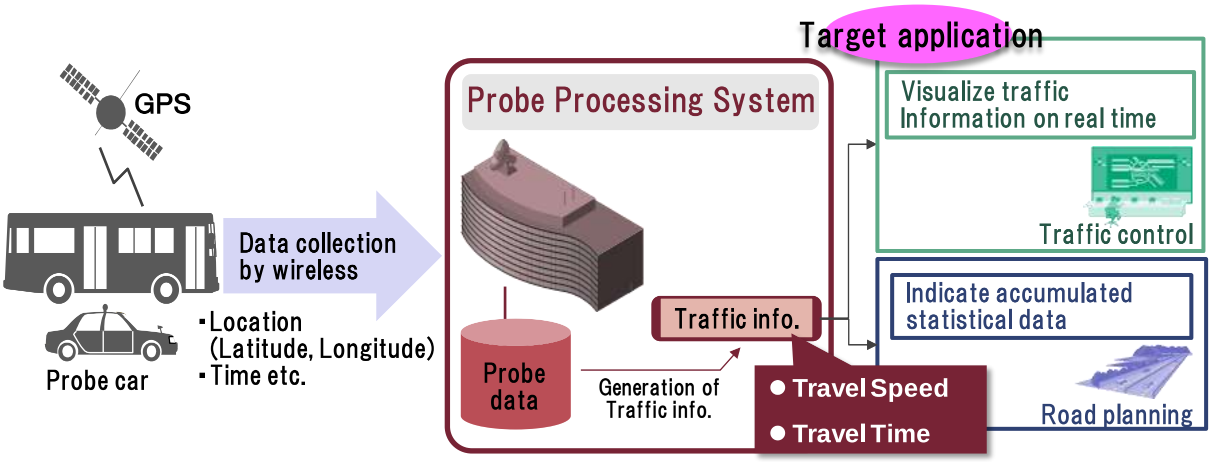

Fig. 48 Overview of Probe Information Processing System

Continuous collection of probe data is necessary to operate the probe processing system mentioned above. Probe data are collected from the in-vehicle device with GPS installed in private cars and taxies in other countries. In-vehicle devices with GPS are not spread widely in Myanmar, so collecting probe data is the issue to realize this system. Traffic control system requires a larger amount of probe data to generate real time traffic information. Therefore, aiming to introduce a system for the road improvement plan is realizable and proper as the first step to introduce this system. Official Development Assistance (ODA, Grant Aid) can be applied to introduce this system.