13.4. MOTOTAXI STUDY

13.4.1. TRIP CHARACTERISTICS IN THE DISTRICTS OF HUAYCAN AND SANTA CLARA

(1) General

In the F/S study, the construction of the trunk bus system, which is easily used by the lower income population, is one of the study purposes. In particular, the bus network system is an important issue in network configuration and fare rate. Those issues closely relate the bus operation to mototaxis. The mototaxi passengers will increase under a coarse bus network, while the passengers will decrease in the fine network.

In this study, since the bus line will be introduced in Huaycan and Santa Clara, where low income residents dwell and mototaxis and buses operate together, the low income population survey regarding travel conditions was carried out in June 2006. The survey was carried out in the morning peak hour. Approximately 380 samples were collected in Huaycan and 230 samples in Santa Clara, where the surveyed area is divided into 300m mesh and 1-3 samples were collected from each mesh.

The survey data is used in the analysis of the modal split between mototaxis and buses in consideration of the income level, in other words Estrato ranks, when the bus network is planned in those areas.

(2) Characteristics of Inhabitants

Figure 13.4-1 shows the distribution of residents, by Estrato, who dwell in Huaycan and Santa Clara, respectively, in which the brown color indicates Estrato C-D, and the green color is Estrato E in 100m mesh. As can be seen, the residents of Estrato E live in the slopes of hilly terrains and mountains far away from major roads. Since buses do not directly operate in these low-income areas, the residents in the area must use moto-taxis to arrive house after alighting from a bus.

Huaycan Santa Clara

Figure 13.4-1 Distribution of Residents by Estratos C-D and E

Figure 13.4-2 shows the distribution of walking time from the house to the Center of Huaycan according to Estrato C-D, E and extremely poor people who live in public land without permission (invasion). As can be seen, the lower the income, the longer the travel time. This is obvious from the distribution of residents by Estrato C-D and E.

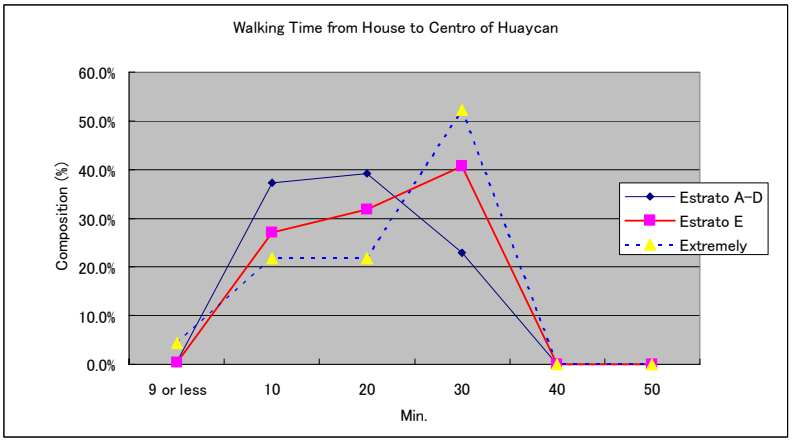


Figure 13.4-2 Walking Time from House to the Center of Huaycan

(3) Trip Characteristics

1) Trip Purpose

In the morning peak hour the trips of residents in those areas are predominant for specialized purpose: “to work”. The survey says that the ratio of “to work” purpose accounts for approximately 60 – 70 % of the total in each area.

2) Total Travel Time

Figure 13.4-3 shows the distribution of the total travel time from the house to the destination. As can be seen, the travel time in Estrato E of Huaycan does not show the clear peak, while Estrato E in Santa Clara shows the peak in a range of 30 minutes. On the other hand, Estrato C-D in both areas shows a peak of 10 minutes.

Approximately 30-45% of the total has a travel time of more than 60 minutes in both areas. The ratio of travel time which exceeds 90 minutes is approximately 20% of the total in Huaycan, and 10% in Santa Clara. As can be seen, a third to a half of the residents are forced to travel for an hour or more.

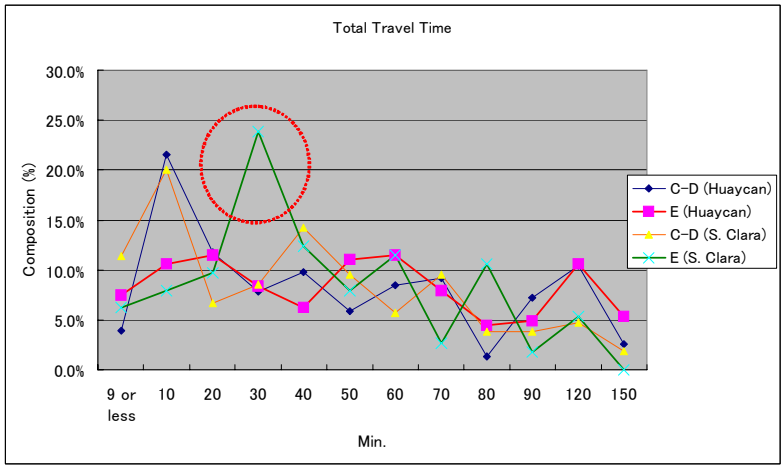


Figure 13.4-3 Total Travel Time by Estrato C-D and E

(4) Travel Conditions from House to Bus Stop

1) Travel Time to Bus Stop

Figure 13.4-4 shows the accumulative percentage of travel time from house to bus stop. As can be seen, approximately 95% of the total in Estrato C-D of both areas and Estrato E in Santa Clara have a travel time of less than 10 minutes, in contrast to 85% in Estrato E of Huaycan. The ratio of travel time exceeding 15 minutes is approximately 5% of the total, except for Estrato E of Huaycan (15%). As can be seen, almost all bus passengers can arrive at a bus stop within 10 minutes.

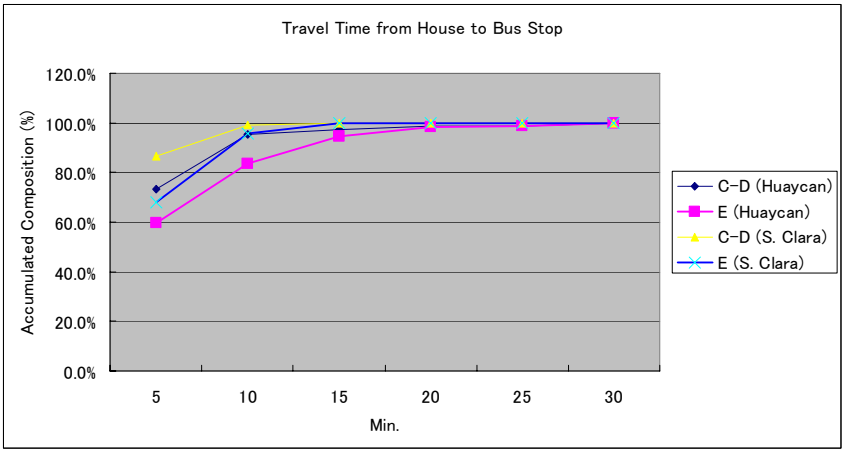


Figure 13.4-4 Accumulated Percentage of Travel Time from House to Bus Stop

2) Sub-Mode

Figure 13.4-5 shows the selected travel modes from house to bus stop. As can be seen, the walking mode takes a higher ratio at 85% of the total in use in both areas and Estratos. The mototaxi ratio is approximately 15%.

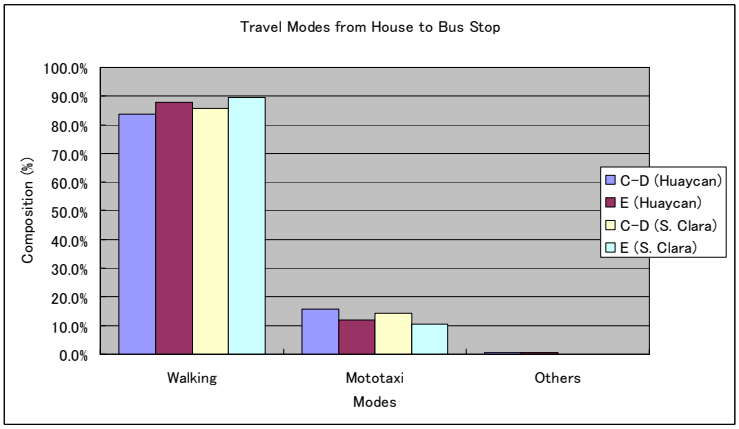


Figure 13.4-5 Travel Modes from House to Bus Stop

(5) Travel Conditions to Destination

1) Modes

Figure 13.4-6 shows the selected travel modes from bus stop to destination. As can be seen, the bus mode takes a higher ratio at 70-80% of the total in use in both areas and Estratos. The mototaxi ratio is approximately 10-20%. In Estrato E of Huaycan and Santa Clara, the bus mode is somewhat higher than that of Estrato C-D, while the mototaxi is lower.

As for the extremely poor people, the mototaxi ratio is higher in Huaycan and the walking ratio is higher in Santa Clara. In Huaycan, since the residents live on the slopes of hilly terrains and mountains away from major roads, they have to use mototaxis.

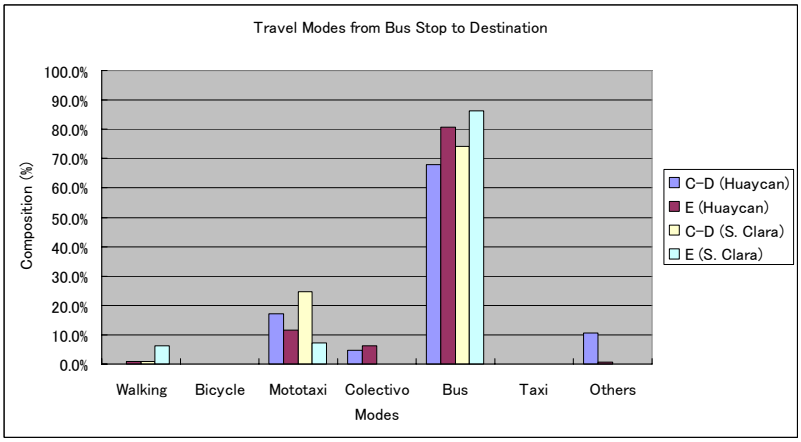


Figure 13.4-6 Travel Modes to Destination

Table 13.4-1 shows the selected travel modes from bus stop to destination, which are inside Huaycan or Santa Clara. These are travel modes for internal-internal trips. As can be seen, the ratio of mototaxi users to the total rises considerably in both areas. Its figures are approximately 60% and 80% for Estrato C-D in both areas. As for Estrato E, the ratio is close to 50% in both areas.

Table 13.4-1 Travel Modes in Internal – Internal Trips

Modes	Huaycan		Santa Clara	
	Estrato C-D	Estrato E	Estrato C-D	Estrato E
Mototaxi	61.9%	47.5%	81.0%	44.4%
Bus	38.1%	52.5%	19.0%	55.6%

Table 13.4-2 shows the ratio of bus use after using mototaxis from the house. This means that the residents use the mototaxi from the house to the bus stop and then, they use a bus until they arrive at their destination after getting off the mototaxi. As can be seen, the ratio of bus use is higher in both areas. Its figures in Huaycan and Santa Clara range between 60 to 66% and 86 to 90% of the total mototaxi users, respectively. They pay both the fare rates of mototaxi and bus.

Table 13.4-2 Ratio of Bus Use after the Use of Mototaxis from the House

	Huaycan		Santa Clara	
	Estrato A-D	Estrato E	Estrato A-D	Estrato E
Mototaxi-Bus	66.7%	59.3%	86.7%	91.7%

2) Reasons not to Use Bus

The major reasons not to use the bus are “No Bus Routes” and “No Bus Route to Destination”. The ratios of those are approximately 40-50% in sum of them. The answer of “Prefer to Mototaxi” is different between Huaycan and Santa Clara. Santa Clara has higher ratio of it at 35-40%, in contrast to 10-20% in Huaycan.

13.4.2. MOTOTAXI CHARACTERISTICS IN HUAYCAN AND SANTA CLARA

(1) General

This section focuses on the mototaxi travel characteristics in Huaycan and Santa Clara, while in the previous section 13.4.1, general travel characteristics in those areas in terms of trip purpose, travel time, and modal choice are analyzed based on the surveyed data. The mototaxi travel conditions are analyzed based on the same survey data carried out in Huaycan and Santa Clara.

(2) Use of Mototaxi from House to Bus Stop

1) Travel Time of Mototaxi

Figure 13.4-7 shows the distribution of the total travel time of mototaxis from the house to the bus stop. Approximately 70% of the total have a travel time of less than 5 minutes, in exclusive of Estrato E of Santa Clara at 40%. The ratio of travel time exceeding 15 minutes is approximately 0-5% of the total. Almost all bus passengers can arrive at a bus stop by mototaxi within 10 minutes. The travel time of the mototaxi is half of that of walking when people don't use the mototaxi.

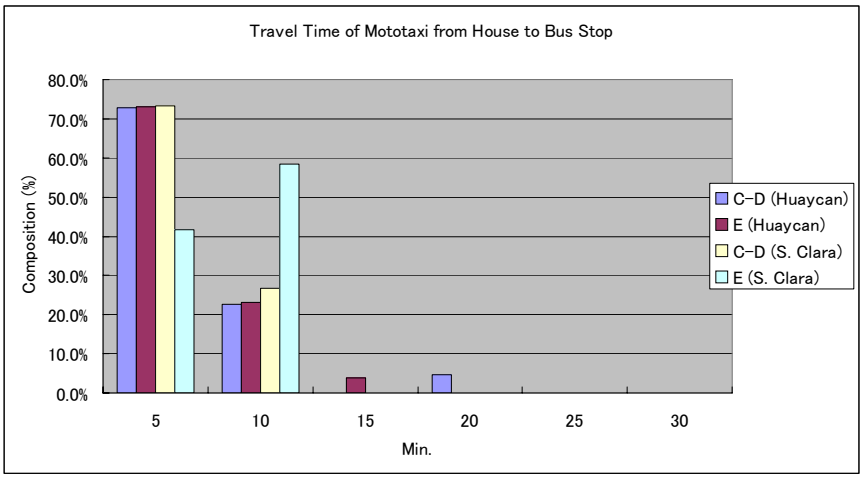


Figure 13.4-7 Travel Time of Mototaxi from House to Bus Stop

2) Fare Rate of Mototaxi

Figure 13.4-8 shows the distribution of the paid moto-taxi fee in the morning peak hour. As can be seen, approximately 80-90% of the total is a paid fare of S/. 0.50 or less except for that of Estrato C-D in Huaycan. This means that passenger already pays S./0.5 before getting on a bus.

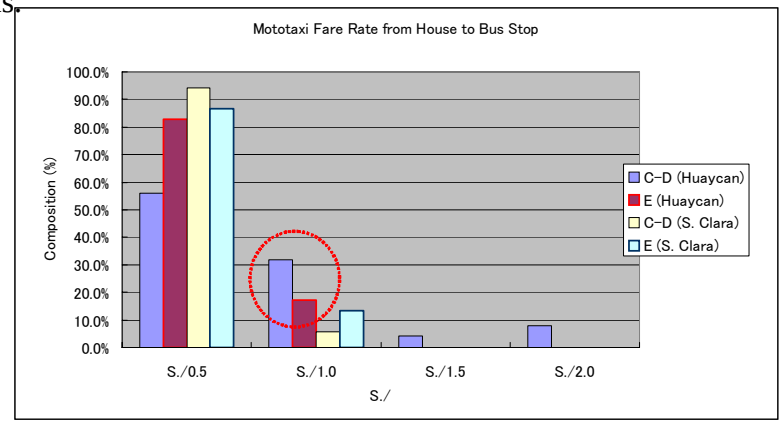


Figure 13.4-8 Mototaxi Fare Rate from House to Bus Stop

(3) Mototaxi Travel Characteristics within Huaycan and Santa Clara

1) Mototaxi Travel Time

Figure 13.4-9 shows the distribution of mototaxi travel time from house to destination. This travel is inside Huaycan and Santa Clara. This is because the moto-taxi operation outside those areas is restricted and the mototaxi does not go out those areas. Approximately 60% of the total has a travel time of less than 5 minutes in both areas, in contrast to 70% in travel time from house to bus stop. Approximately 80% of the residents use mototaxi within 10 minutes. The difference between travel time from house to bus stop in Figure 13.4-7 and inside the area in Figure 13.4-9 is on a travel time of 15 minutes. The passengers who travel 15 minutes are in existence at 10-15% of the total.

Figure 13.4-9 Mototaxi Travel Time to Destination

2) Mototaxi Fare Rate

Figure 13.4-10 shows the distribution of the mototaxi fare rate from house to destination. This is a fare rate when the mototaxi is used within Huaycan and Santa Clara under the travel times as shown in Figure 13.4-9. As can be seen, approximately 60% of the total is a paid fare of S/. 0.50 or less. However, in Estrato C-D of Huaycan, approximately 20% of the total is a paid fare of S/. 1.50, or more. This is considerably higher for the travel within the area than that of bus.

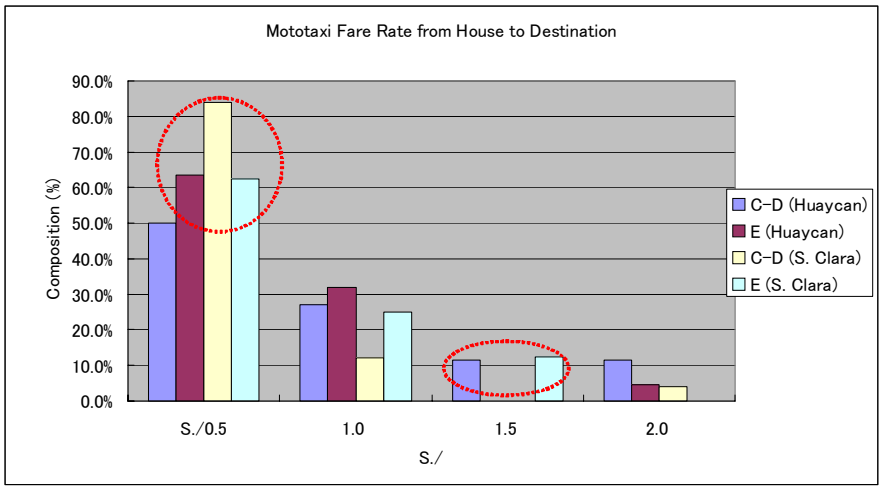


Figure 13.4-10 Mototaxi Fare Rate from House to Destination

(4) Conditions of Mototaxi Use

1) Frequency of Mototaxi Use

The survey says that the ratio of passengers who use the mototaxi everyday is as low as 10% of the total. Approximately 60-70% of the total does not use a mototaxi in Santa Clara, in contrast to 30% in Huaycan. By the reason of higher rate for the residents, it seems that mototaxi use is a low level. According to the interview survey, approximately 30-40% of the passengers have the opinion that the present rate is high. The passengers in Huaycan have a higher "Expensive" ratio than that in Santa Clara.

2) Reasons of Mototaxi Use

The difference for reasons of mototaxi use between Huaycan and Santa Clara are the ratios of "Convenience for Shopping" and "Low Frequency of Bus Service". The former is higher in Santa Clara. The latter is higher in Huaycan.

(5) Summary and Issues

The travel characteristics and mototaxi conditions in Huaycan and Santa Clara are summarized in the following manner:

- The travel modes from house to bus stop are selected from walking (85% of the total) and mototaxi (15%).
- Among the above mototaxi users for Estrato E in Huaycan, approximately 60% of the total mototaxi passengers are passengers who use a bus until the destination after getting off a mototaxi. This is because there are no bus lines near their houses, they have to go to the bus stop in a mototaxi.
- In the selected travel modes from bus stop to destination, the bus mode takes a higher ratio at 70-80% of the total. However, the mototaxi is selected at a higher ratio for travel inside Huaycan or Santa Clara. In the case of short travel, the mototaxi is very convenient.
- In these surveyed areas, buses and mototaxis are operated together. Since the people in Estrato E and the extremely poor people fairly use a mototaxi as a sub-mode until the bus stop, they must bear its fee.
- The extension of a bus line is not easy for roads that don't have enough width for the operation of a bus in the slopes of hilly terrains and mountains.
- The share of travel demand of mototaxis and buses is closely related to the bus network. For instance, in the case of a coarse bus network, the share of mototaxis will rise according to the survey data. In the study, the bus network system is examined and the optimum network system is proposed in the next section.

13.4.3. TECHNICAL ANALYSIS FOR MODAL SHARE OF MOTOTAXI AND BUS

(1) General

The bus competes with mototaxis in its operation area. The bus operation affects the mototaxi operation in terms of number of passengers and operated vehicles. The bus network system closely relates the bus operation to mototaxis. The mototaxi passengers will increase under a coarse bus network, while the passengers will decrease in the fine network. This section analyzes the conditions of modal choice between bus and mototaxi under a bus line network, and identifies a mototaxi function as public transport when the bus system is introduced. Finally, the preferred bus network system as well as mototaxi planning direction is proposed.

In this section, Huaycan is selected as a study area, where low income residents dwell and mototaxis and buses operate together. The travel demand for buses and mototaxis is forecast by a demand model based on the interview survey in Huaycan. Based on the estimated travel conditions in Huaycan, general planning direction of the bus network system is proposed. Figure 13.4-11 shows a study flow chart which is mentioned above.

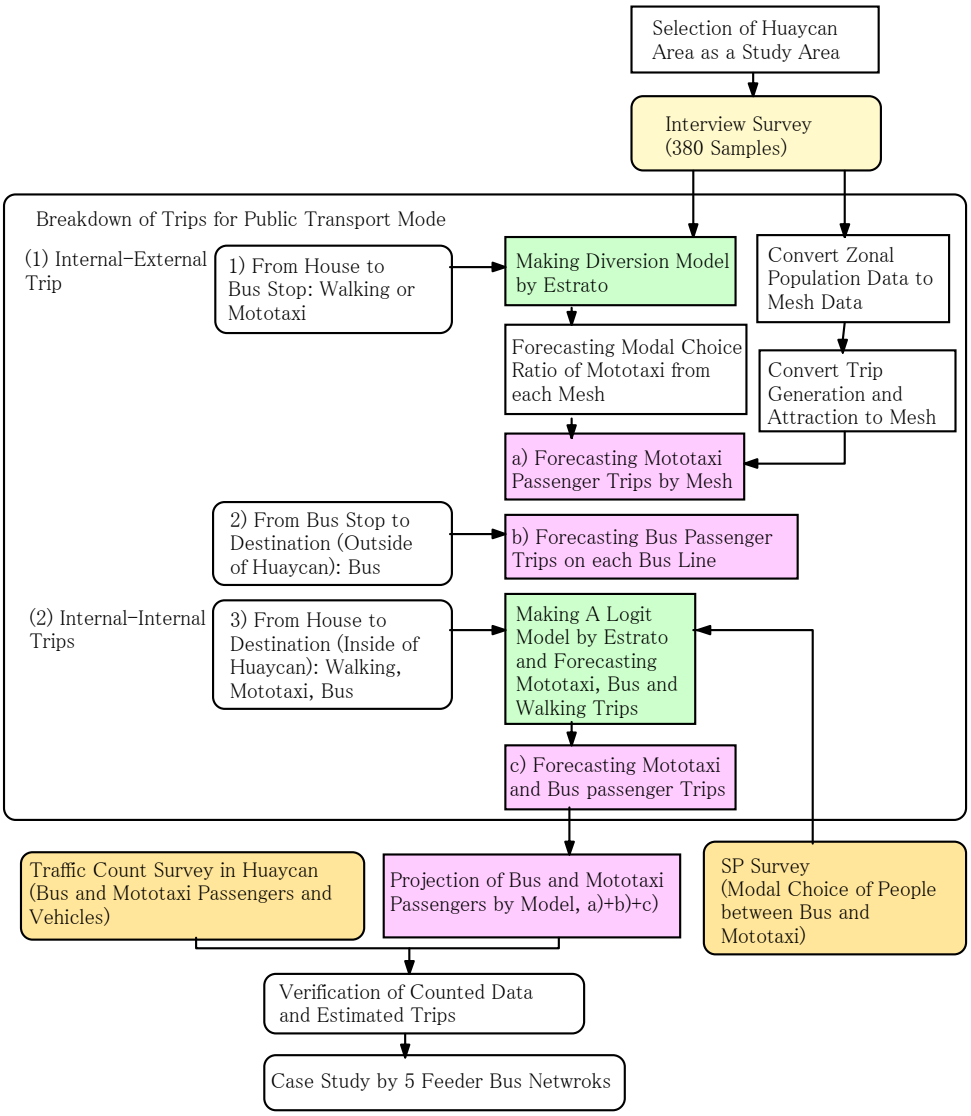


Figure 13.4-11 Study Flow Chart

(2) Travel Conditions in Huaycan

1) Internal-External Trips

As for the travel mode from house to bus stop, the walking mode takes a higher ratio at 85% of the total. The mototaxi ratio is approximately 15%. The ratio of bus use after using mototaxis from the house in Huaycan ranges between 60 to 66% of the total mototaxi users. They pay both the fare rates of mototaxi and bus. This means that the residents use the mototaxi from the house to the bus stop and then, they use a bus until they arrive at their destination after getting off the mototaxi.

In the selected travel modes from bus stop to destination, the bus mode takes a higher ratio at 70-80% of the total. The mototaxi ratio is approximately 10-20%.

2) Internal-Internal Trips

The ratio of mototaxi users to the total rises considerably in the internal-internal trips from bus stop to destination inside Huaycan. Its figures are approximately 60% and 50% in Estrato C-D and Estrato E, respectively.

(3) Forecasting Model

1) Internal-External Trips

a) Diversion Model

Based on the analysis in the travel mode between house and bus stop in the internal-external trips, a diversion model for a modal split is developed by Estratos C-D and E. Figure 13.4-12 shows the diversion ratio of mototaxi use against the walking time from house to bus stop. In this Figure, the dots show the survey data and the lines show the values estimated by the forecasting model. The diversion curve in Estrato E shows that the longer the walking time is, the lower the diversion ratio of mototaxi is. This shows since the residents of Estrato E live in the slopes of hilly terrains and mountains far away from major roads, mototaxi can not directly operate. On the other hand, the diversion ratio of mototaxi in Estrato C-D rises in proportion to the walking time. This is because they live on flat land.

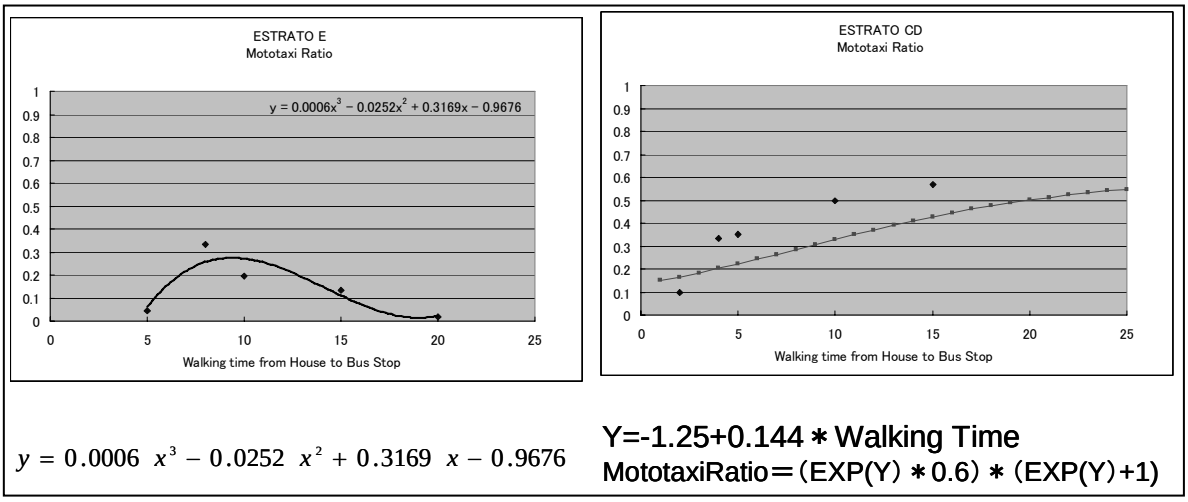


Figure 13.4-12 Diversion Models of Internal-External Trips

b) Mototaxi Passenger Ratio

The diversion model is applied to the mesh data analysis in which the study area is divided into 100m mesh data. The population and trip data such as generation and attraction are also divided into 100m mesh data. Figure 13.4-13 shows a part of the study area with yellow color which is divided into the mesh. And also, the walking distance between a house (zone centroid) and a bus stop (red line) with blue color line is shown in the mesh data. In the beginning, the walking distance from every zone centroid in the mesh is calculated and then, a mototaxi passenger ratio to the total trips is forecast by the diversion model.

Figure 13.4-14 shows the mototaxi passenger ratio to the total in the bus network of the base case, which sums the ratios by Estratos C-D and E. As it can be seen, the areas away from bus routes are higher in the ratio than those in areas close to bus routes.

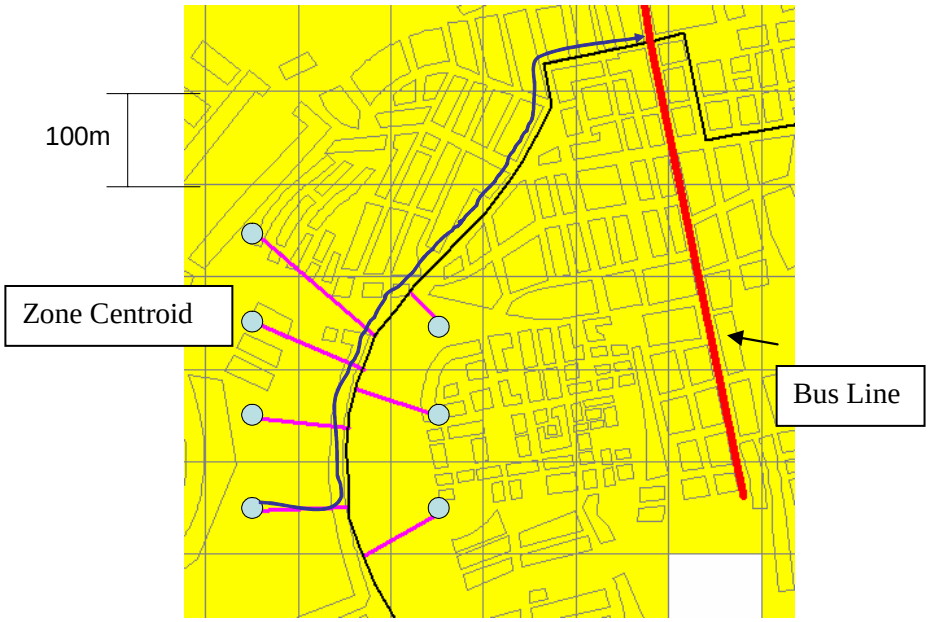


Figure 13.4-13 Walking Distance from House (Zone Centroid) to Bus Stop

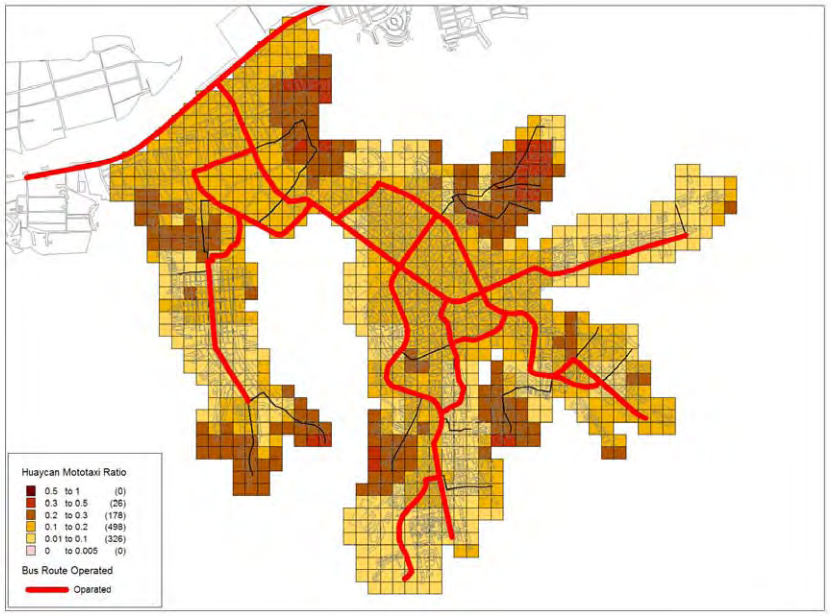


Figure 13.4-14 Mototaxi Passenger Ratio from House to Bus Stop in the Base Case

c) Mototaxi Passenger Volume (Corresponding to a) in Figure 13.4-11)

Mototaxi passenger volume is estimated by the method which multiplies the passenger ratio calculated above by the trip generation and attraction in the mesh. Figure 13.4-15 shows the mototaxi passenger volume from house to bus stop in the mesh. As can be seen, the mototaxi passenger volumes are heavy in central and peripheral areas. This is because the former is heavy in the trip generation and attraction, and the latter is higher in the ratio.

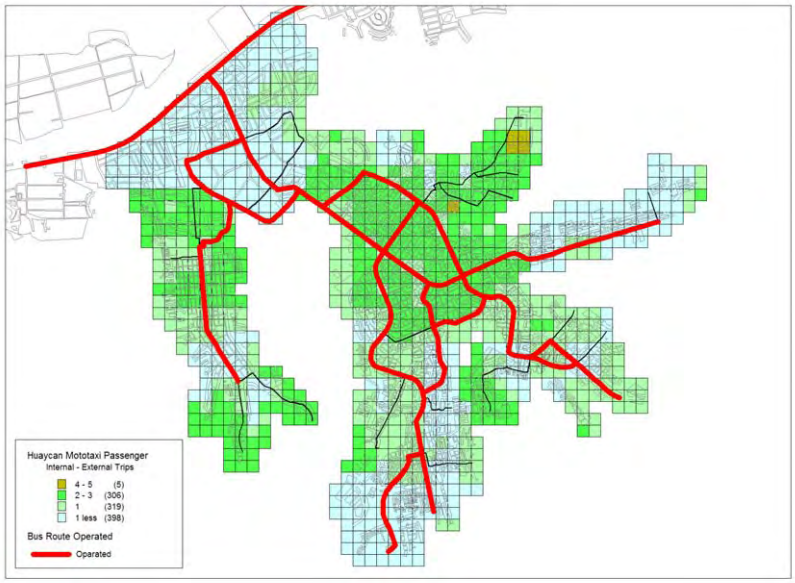


Figure 13.4-15 Mototaxi Passenger Volumes from House to Bus Stop in the Base Case

d) Bus Passenger Volume (Corresponding to b) in Figure 13.4-11)

After arriving at a bus stop, the person uses a bus until the destination outside Huaycan. This internal-external trip from a bus stop to the destination is forecast on the OD trip data, not the mesh data. The bus passenger volumes on the bus lines are forecast by the transit assignment method which assigns a bus OD table on the bus lines. Figure 13.4-16 shows a zoning system and bus line network. The traffic zone in Huaycan is divided into sub-zone.

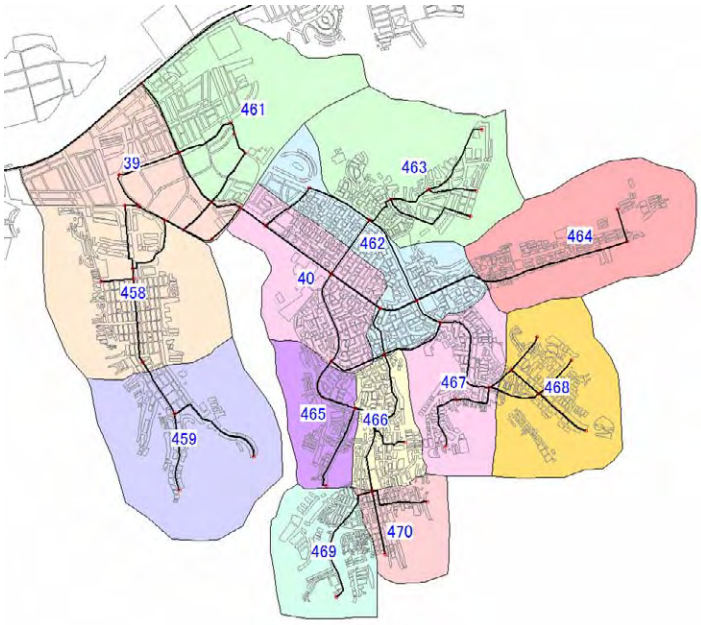


Figure 13.4-16 Zoning System and Bus Line Network in Huaycan

2) Internal-Internal Trips

a) Logit Model

In order to see a modal choice condition in the internal-internal trip inside Huaycan, the stated preference (SP) survey was carried out in June 2006 before making the modal split model. There were approximately 400 interviewed samples. The SP survey collects the modal choice data of people between walking, mototaxi and bus under the combination of travel time and cost (fare rate) in Huaycan area. The logit model was developed based on the data of the SP survey. The modal split model was made by Estrato C-D and E. A utility function in the logit model is following. Table 13.4-3 shows model coefficient of utility function by mode, which is composed of walking, mototaxi and bus modes.

$U_{walking} = \beta_1 \times \text{Travel Time}$

$U_{mototaxi} = \alpha_1 + \beta_1 \times \text{Travel Time} + \beta_2 \times \text{Travel Cost}$

$U_{bus} = \alpha_2 + \beta_1 \times \text{Travel Time} + \beta_2 \times \text{Travel Cost}$

Where:

Ui: Utility of mode i: mode option (walking, mototaxi, and bus)

β_1, β_2: coefficient of mode

$$Pi = \frac{\exp(Ui)}{\Sigma \exp(Uj)}$$

Where:

Pi: probability to choose the mode i

Table 13.4-3 Coefficient of Utility Function

	ESTRATO	
	E	CD
Walk Constan	-2.4526	-2.6590
MT Constant	0.3180	0.7151
Time	-0.1231	-0.1277
Cost	-6.3225	-5.8386

b) Projection of Mototaxi and Bus Volumes (Corresponding to c) in Figure 13.4-11)

The modal share of the internal-internal trips is forecast by the logit model which applied on the public transportation OD table estimated in the Master Plan Study, but the zoning system shown in Figure 13.4-16. In the beginning, the modal share in Huaycan is forecast on the sub-zone base and then, the trip volume by mode by zone is forecast. Finally, the trip volume is divided into the mesh in proportion to the population density.

Figure 13.4-17 shows the mototaxi passenger volume in the internal-internal trip inside Huaycan in the Base Case. As can be seen, the mototaxi passenger volumes are relatively heavy in central and some peripheral areas. This means that the mototaxi passenger flows are relatively heavy between the central and the peripheral areas.

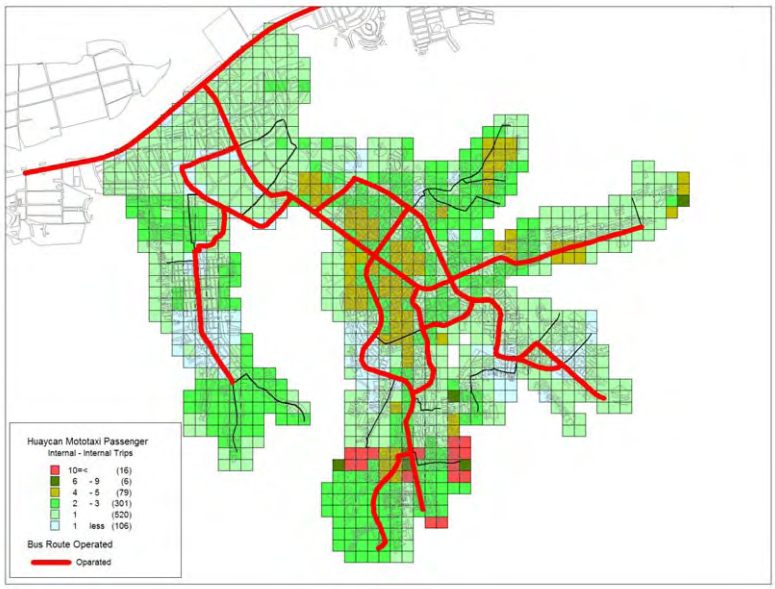


Figure 13.4-17 Mototaxi Passenger Volumes from House to Destination (Huaycan) in the Base Case

3) Total Mototaxi Passengers

Figure 13.4-18 shows the total mototaxi passenger volumes in the base case which sum up the internal-external and the internal-internal trips. This forecast volume is verified by the counting data which the passenger volume count survey was carried out at seven (7) survey locations in September 2006. Figure 13.4-19 shows the counting location and its passenger volume.

Figure 13.4-20 shows the result of calibration which compares the counting data and estimation. As can be seen, the result is acceptably accurate.

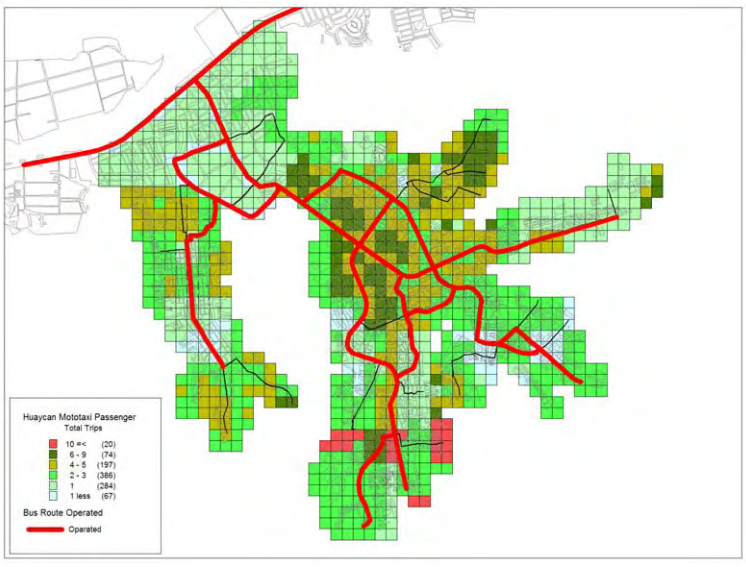


Figure 13.4-18 Total Mototaxi Passenger Volumes in Base Case

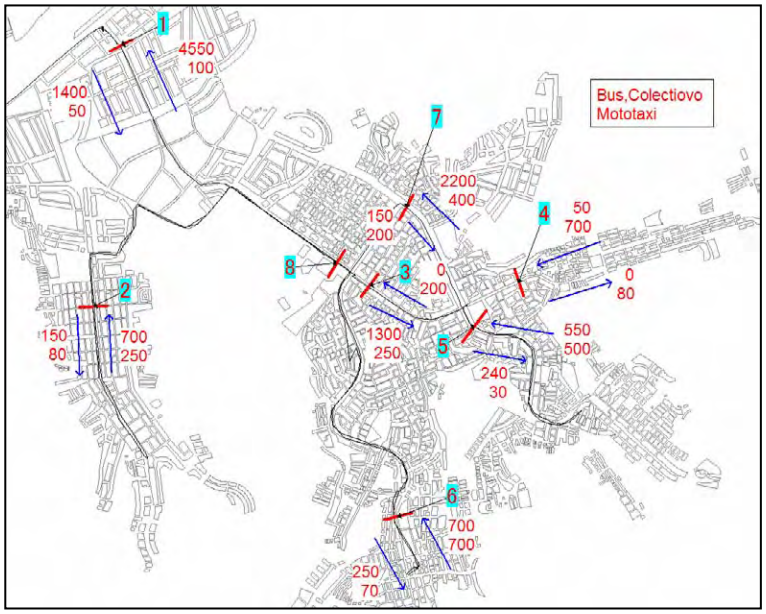


Figure 13.4-19 Passenger Volume Count Data in Huaycan

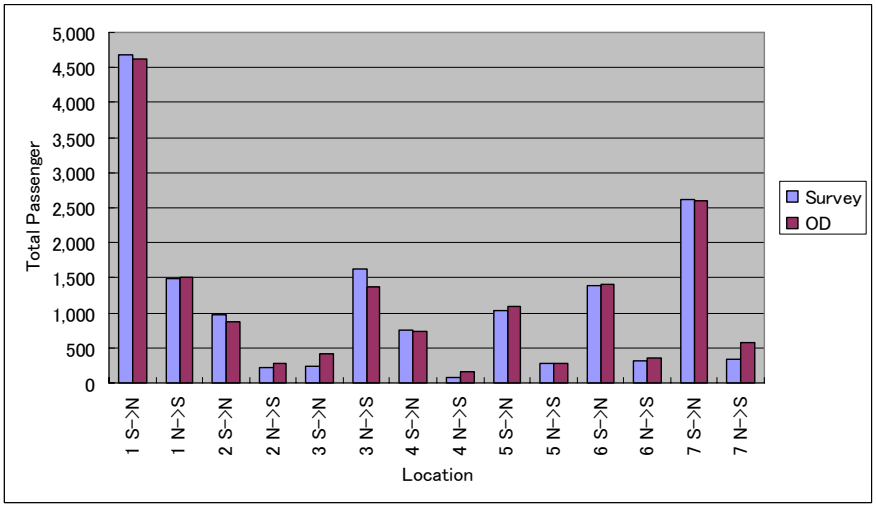
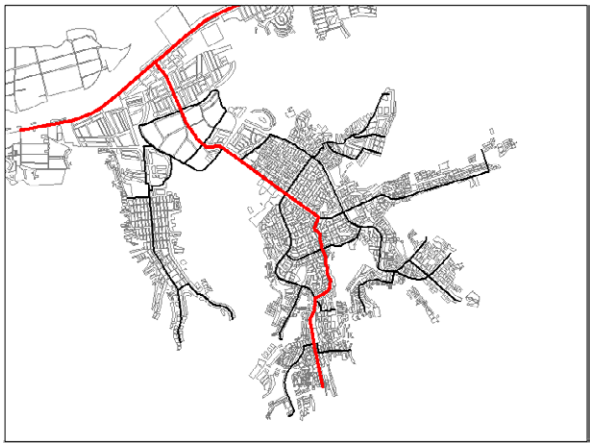


Figure 13.4-20 Comparison between Counting Data and Estimation

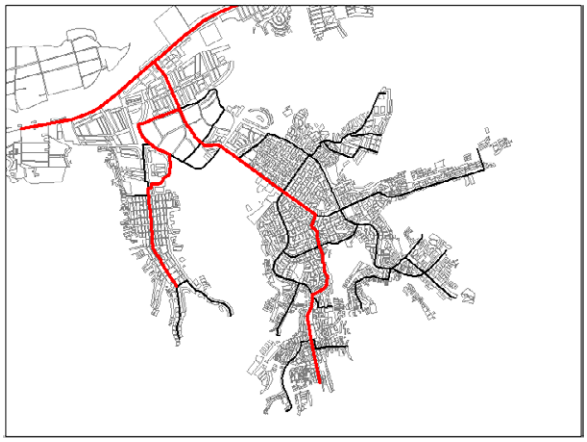
(4) Alternative Cases

The bus network system closely relates the bus operation to mototaxis. The mototaxi passengers will increase under a coarse bus network, while the passengers will decrease in the fine network. In order to analyze the conditions of modal choice between bus and mototaxi under a given bus line network, the sensitivity analysis of modal choice is done under case study networks. According to the analysis, a mototaxi function as public transport identifies when the bus system is introduced in the study area.

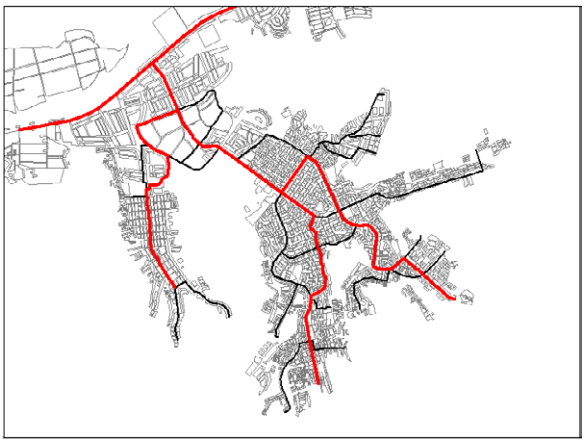
Figure 13.4-21 shows the alternative network cases which are composed of bus networks from a coarse network (case-1) to a fine one (case-5). The network of alternative case-5 is similar to the present bus network in Huaycan.



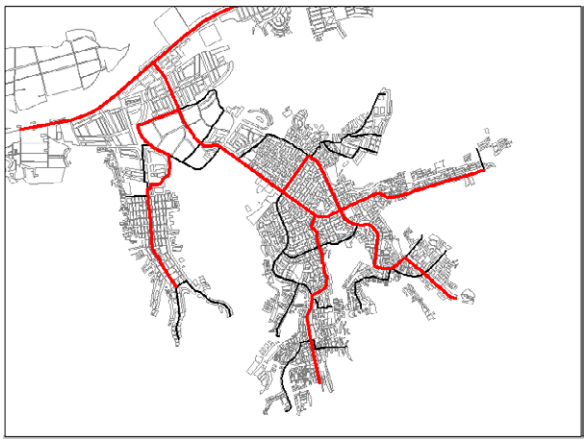
Case-1



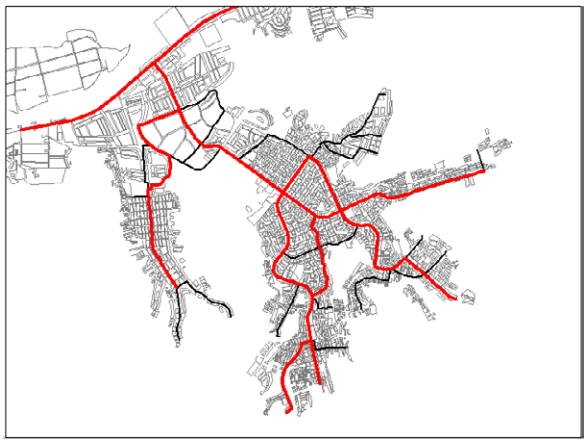
Case-2



Case-3



Case-4



Case-5

Figure 13.4-21 Alternative Cases of Feeder Bus Network

(5) Analysis of Feeder Bus Line Network

1) Covered Population by Bus Lines

When a bus line network is fine, the service area covered by a bus line is greater. That is, the finer the line network, the larger the covered area. Figure 13.4-22 shows the area within

500m from bus line in the case-1. A walking distance of 500m is equivalent to 8-9 minutes. As for the travel time to a bus stop from house in the survey, approximately 95% of the total takes a travel time of less than 10 minutes.

Figure 13.4-23 shows the ratio of population covered within 500m to the total and the average walking distance between house and bus stop by the alternative cases. In case-5 of the present network, the covered population ratio is approximately 90% and the walking distance is 300m, in contrast to 47% and 1100m in case-1. Case-3 is 80% in the covered and 500m in the distance.

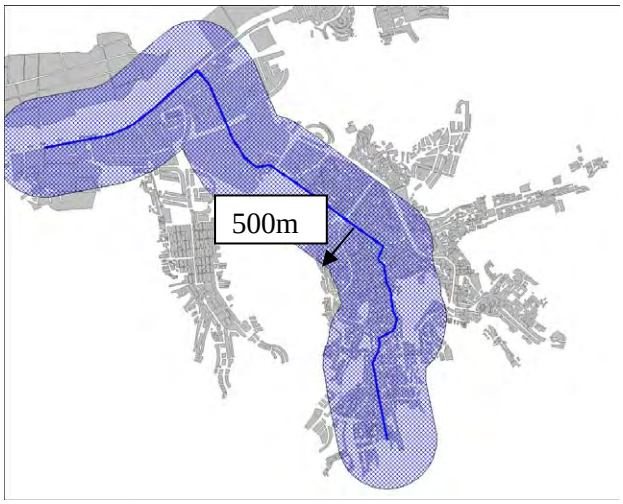


Figure 13.4-22 Service Area within 500m from Bus Lines in Case-1

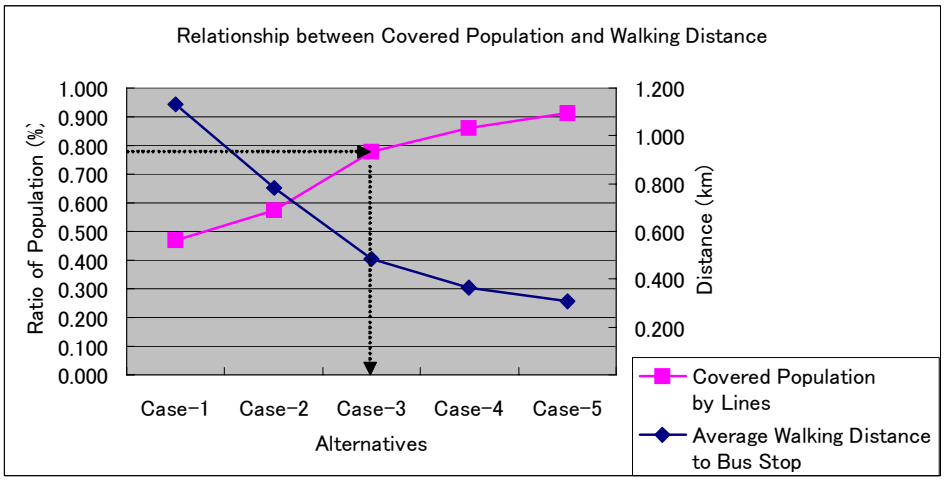
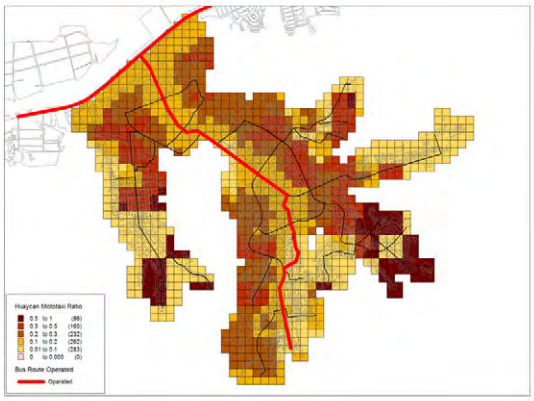


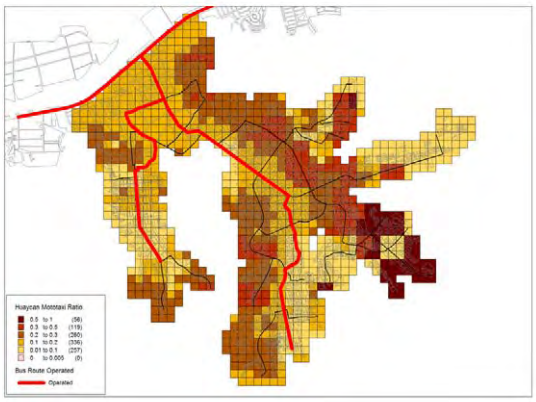
Figure 13.4-23 Covered Population and Walking Distance by Alternative Cases

2) Mototaxi Passenger Volumes by Alternatives

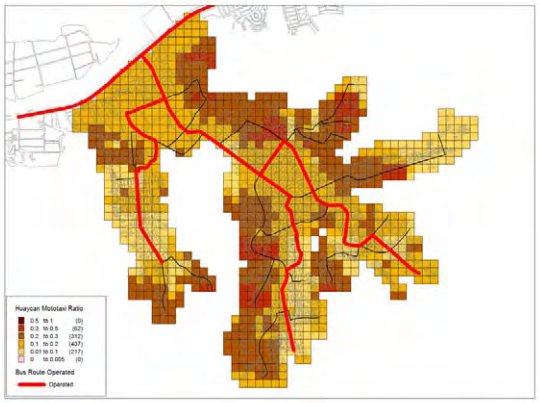
Figure 13.4-24 shows the mototaxi passenger ratio to the total by the alternative cases. As can be seen, the mototaxi passenger ratio decreases with the progress of the line network in distance.



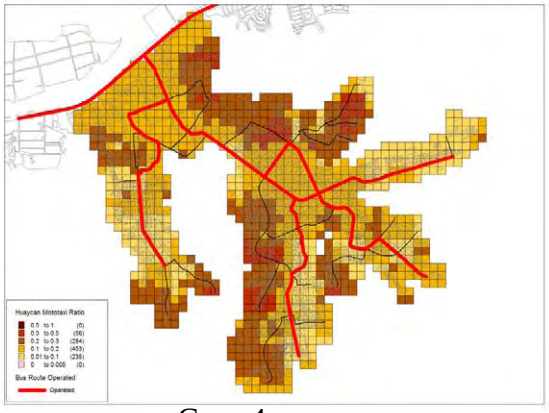
Case-1



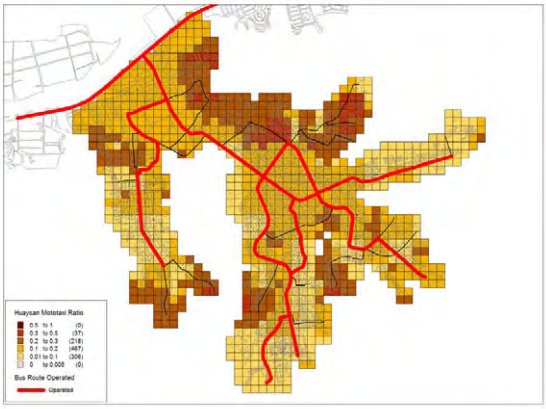
Case-2



Case-3



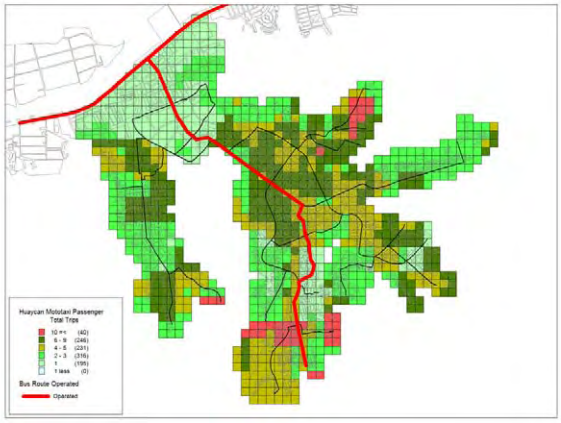
Case-4



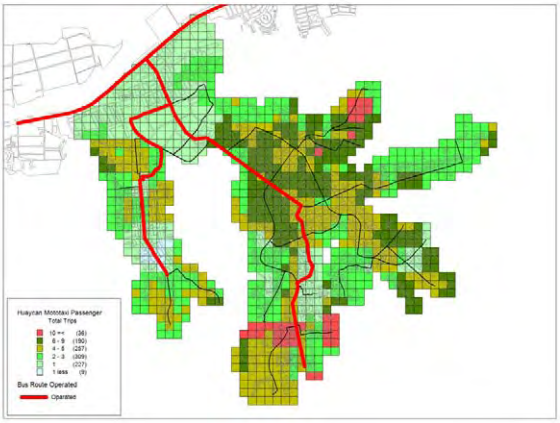
Case-5

Figure 13.4-24 Mototaxi Passenger Ratio from House to Bus Stop by Alternative Cases

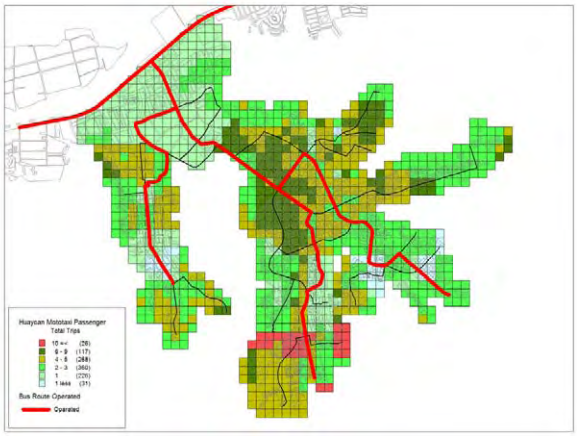
Figure 13.4-25 shows the total mototaxi passenger volumes by the alternative cases. As can be seen, the mototaxi passenger volume decreases with the progress of the line network in distance.



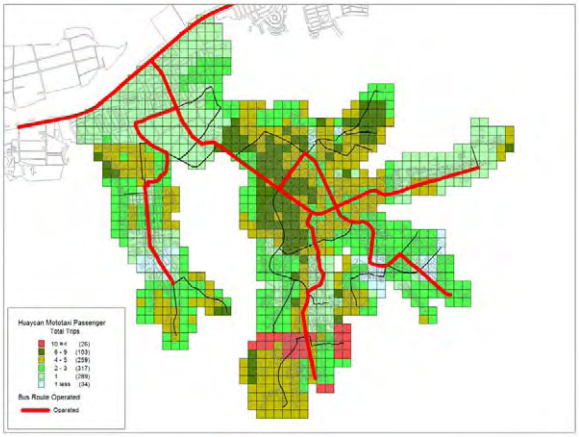
Case-1



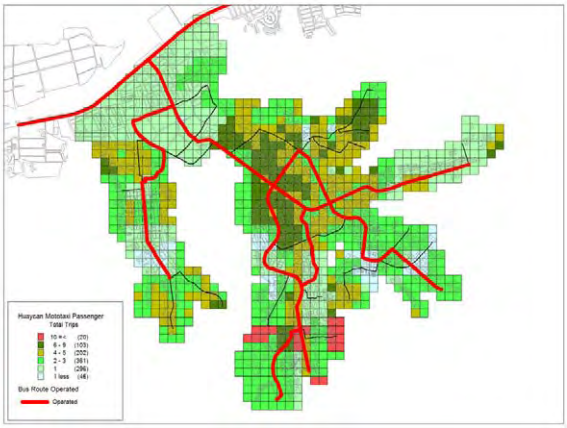
Case-2



Case-3



Case-4



Case-5

Figure 13.4-25 Total Mototaxi Passenger Volumes by Alternative Cases

3) Modal Shares of Bus and Mototaxi

At the same time as the estimation of the mototaxi passenger volume by the alternative cases, bus passenger volume is also forecast by the forecasting model. Figure 13.4-26 shows the modal share of passengers by the cases, which consists of three modes, bus, bus and mototaxi, and mototaxi modes. As can be seen, the bus share is predominant in every

case. The modal shares of passengers in the case-5 are approximately 72% for bus, 17% for mototaxi and 12% for mototaxi and bus, respectively. In case-1, the bus share has decreased to 59% and the mototaxi and its combination modes have increased to a 23% and 18% share, respectively.

In the case of a covered population ratio of 80% in which the average walking distance is 500m, the shares are 67% for bus, 19% for mototaxi, and 14% for mototaxi and bus in case-3.

Figure 13.4-27 shows the increase and decrease ratios of total vehicle volumes to ratios of case-5. The mototaxi volumes in case-3 increase 1.16 times, while the bus volumes decrease 0.95 times. The increase ratio is low in the bus volume and is higher in the mototaxi.

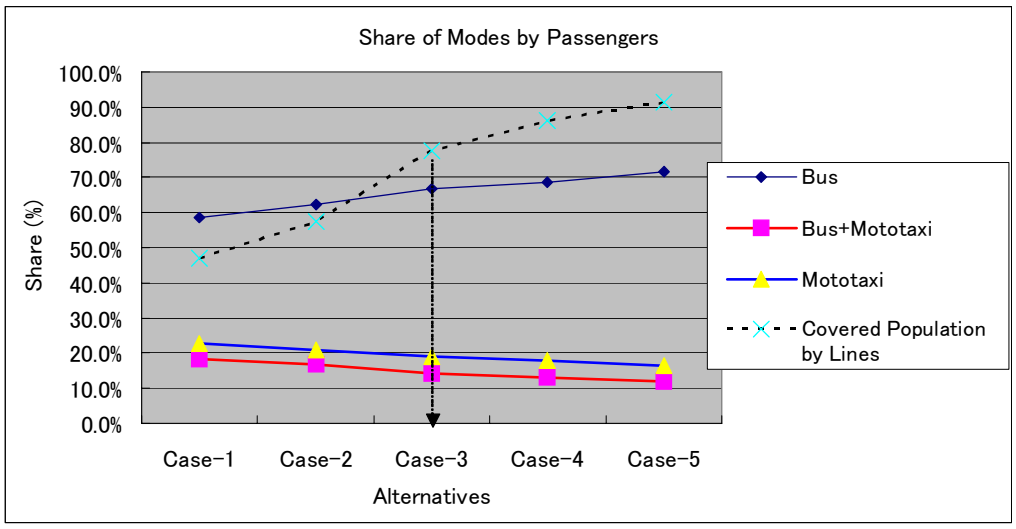


Figure 13.4-26 Modal Share of Passengers by Alternative Cases

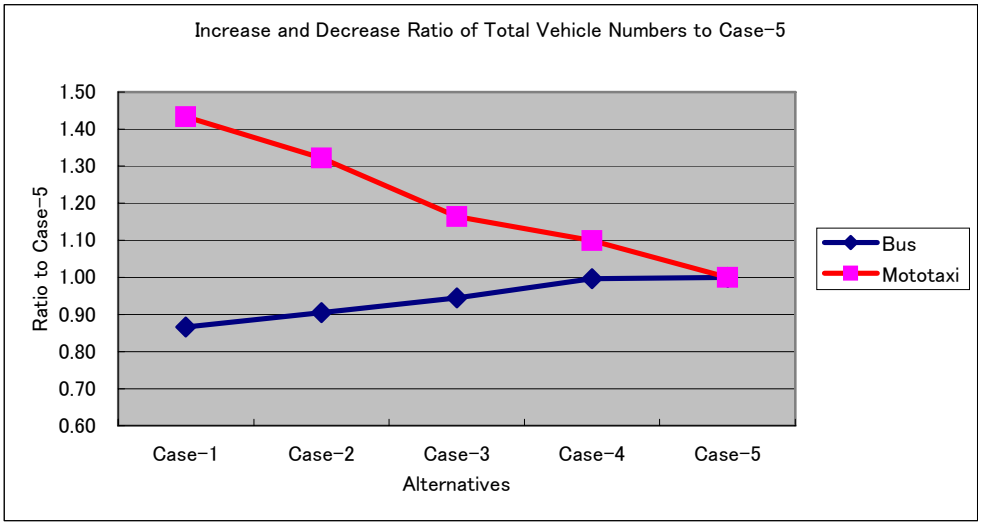


Figure 13.4-27 Increase and Decrease Ratios of Total Vehicle Numbers to Case-5

4) Travel Time of Walking and Mototaxi Passengers

The travel times of the walking and mototaxi passengers who travel from his/her house to a bus stop vary considerably in accordance with the coarse or fine bus networks. Figure

13.4-28 and Figure 13.4-29 show the distribution of walking time by walking passengers and mototaxi passengers by the alternative networks. The travel time of the mototaxi passenger in Figure 13.4-29 converts into a walking time.

As can be seen, the walking times within 10 minutes in both the walking and mototaxi modes are predominant in percentage in case-4 and case-5, while in case-1 and case-2 the composition ratios in the range of 20 minutes or over are higher than that in other cases. The travel behavior of mototaxi passengers is noticeable in the range of 20 minutes or over of the walking time in comparison with that of walking passengers.

The walking time is remarkably different between the alternatives. Table 13.4-4 shows the average walking time by the alternative cases. The ratios of the average time of cases-1 and 2 to case-5 are approximately 3.8 and 2.6 times.

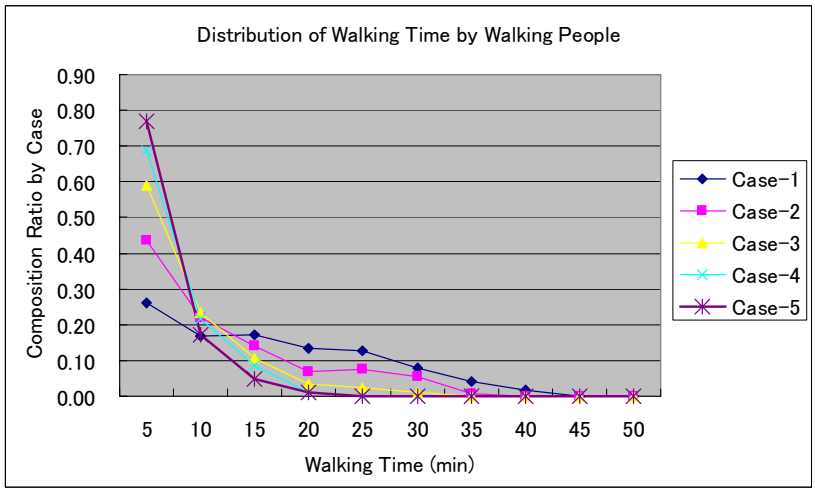


Figure 13.4-28 Distribution of Walking Time by Walking People

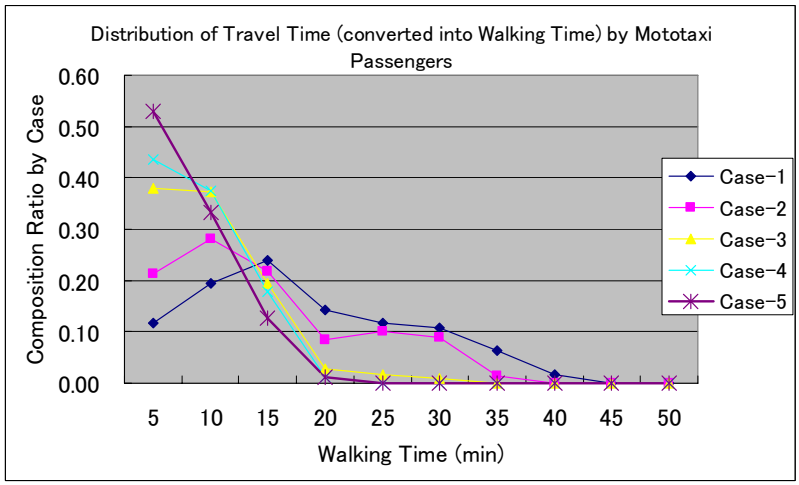


Figure 13.4-29 Distribution of Travel Time (converted into Walking Time) by Mototaxi Passengers

Table 13.4-4 Average Walking Distance by the Alternative Cases

	Case-1	Case-2	Case-3	Case-4	Case-5
Average Walking Distance	1.146	0.790	0.486	0.365	0.305
Ratio to Case-5	3.76	2.59	1.59	1.20	1.00

Figure 13.4-30 shows ratio of the walking time of 20 minutes or over and at the same time the covered population ratio by the alternatives. The ratios of over 20 minutes are remarkable in cases-1 and 2. The ratio of case-3 is as low as 3% for the mototaxi and 4% for the walking people. Cases- 4 and 5 are 0% in ratio. In the interview survey data, a ratio of 95% of the people who travel from a house to a bus stop is within 15 minutes or less of walking time. In comparison with the survey data, the walking time of over 20 minutes will be the limit. Therefore, a bus network where the ratio of over 20 minutes is in the range of 2-3% of the total passengers is defined as a limited network density. In this ratio, the ratio of population covered by the network is approximately 70% or more.

From the above discussion, a minimum bus network service needs to prepare the covered population ratio of 70% or more.

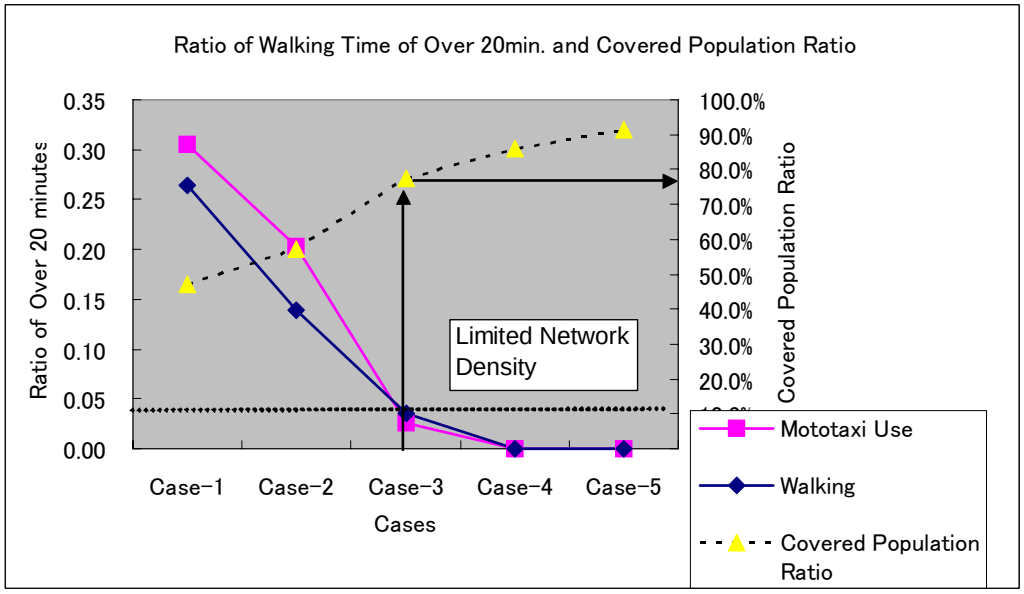


Figure 13.4-30 Ratio of Walking Time of 20 minutes or more to Total and Covered Population Ratio

(6) Summary

In low-income residential areas a bus route network has several problems. The (extremely) low-income people live on the slope of hilly terrain and mountains far away from a major road. Since the current bus is not directly operated into this low-income area, the residents in the area must use a moto-taxi to reach home after alighting from a bus. Therefore, in the study, the bus route network system is examined for the share of bus and mototaxi.

The characteristics of the modal shares by the bus line network are summarized in the following manner:

- The mototaxi passenger ratio relates to the coarse or fine bus line network. The mototaxi share of passengers varies from 17% to 23% for mototaxi and from 12% to 18% for mototaxi and bus in accordance with a fine and coarse networks.
- Areas away from bus routes are higher in the ratio of mototaxi than those in areas close to bus routes.
- The operation volumes in a coarse bus network (case-1) rise at 1.5 times for a mototaxi and decrease at 0.9 times for a bus in comparison with a fine network (case-5).
- As for the walking time from a house to a bus stop, the bus network density is remarkable in travel time. From the viewpoint of residents, a bus network where

the ratio of over 20 minutes is in the range of 2-3% of the total passengers is defined as a limited network density. In the application of this ratio, a minimum bus network service needs to prepare the covered population ratio of 70% or more.

- In the case of a covered population ratio of 70%, the shares are 67% for bus, 19% for mototaxi, and 14% for mototaxi and bus.
- Since it is impossible to prepare the bus line at the population ratio of 100% due to geographical features, it is necessary to coexist with a bus and a mototaxi under the bus network service with a covered population ratio of 70% or more.

13.4.4. DEVELOPMENT STRATEGY OF MOTOTAXI

(1) Strategy

- Since the extension of a bus line is not easy for roads that don't have enough width for the operation of a bus in the slopes of hilly terrains and mountains, it is necessary to operate a mototaxi in areas like Huaycan and Santa Clara.
- Mototaxi remains in existence as a paratransit system to support a bus system, at the same time as a main mode for the internal trips inside an area in a suburb of the study area. Especially, the mototaxi is convenient for shopping.
- The operation area has to be limited to a certain area and the operation on main roads has to be restricted because of mototaxi performance such as speed, engine power and 3-wheel body.

(2) Suggestion

- Mototaxi stand and terminal facilities should be prepared near a transfer point of bus and market.
- Improvement of security and traffic safety should be required in the same manner as the taxi operation.

CHAPTER 14
Cargo Transportation Study

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Cargo Transportation Study

14. CARGO TRANSPORTATION STUDY

14.1. CURRENT CONDITIONS

14.1.1. CURRENT REGULATIONS

Current freight traffic regulations adopted in the study area are as follows.

(1) Authorization

Lima Metropolitan Municipality (MML: Municipalidad Metropolitana de Lima) and Callao Provincial Municipality (MPC: Municipalidad Provincial del Callao) implement the freight traffic authorization, regulation and control.

(2) Adopted Regulations

Regulation of the Freight Traffic Control is implemented based on the following national constitution, national laws, supreme decrees, Edicts, Municipal Resolutions and Mayor's Decrees.

1) Article 194 of the Political Constitution of Peru: the subject of Municipal Authorization

2) Law No 27181: Land Transport and Traffic general law

3) Law No 27972: Municipal organization law

4) Supreme Decree No. 009-2004-MTC: National Administration of transport

5) Supreme Decree No. 058-2003-MTC: National Administration of Vehicles

6) Supreme Decree No. 023-2004-MTC: National Regulation of Transport Administration

7) Edict No. 021: fulfillment of regulation and control of vehicle transport

For Lima

8) Ordinance No. 132: control and restriction of transport in Lima Province

9) Municipal Directory Resolution No. 1899-96-MML/DMTU: authorization of permits for the roads on which freight transport is not allowed to travel

10) Municipal Directory Resolution No. 020-04-MML/DMTU: Authorization of freight transport inside Lima's Central Historic Area

11) Municipal Directory Resolution No. 147-2001: Authorization of dealing with Solid Waste (general cargo transport is also included in this law)

For Callao

12) Decree of the Mayorship of Callao: regulation of freight road control in Callao

Based on the municipal resolution of Lima and mayor's decree of Callao, freight transport flow is controlled as follows;

1) Most national roads and some freeways shown in Table 14.1-1 allow large freight transport to freely pass through without any permission.
2) The other roads (excluding the roads inside the Central Historic Area) need permission from MTC for entry by each freight vehicle. The permission does not generally apply in the morning and evening peak hours.

3) Regulation is strictly adopted inside the Central Historic Area as shown in Table 14.1-1.

Av. Panamericana Norte, Av. Tupac Amaru, Av. Nestor Gambetta, Autopista Ramilo Priale, Av. Argentina, Via de Evitamiento, Carr. Central, Av. Circunvalación, and Av. Panamericana Sur.

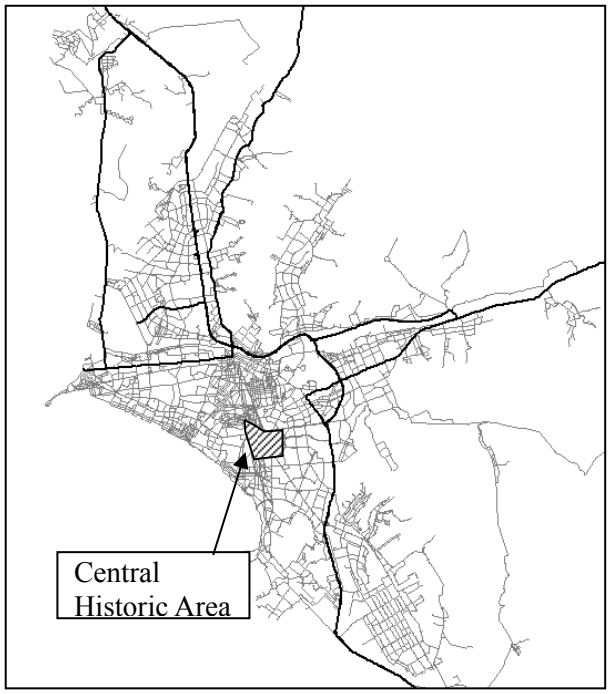


Figure 14.1-1 Trunk Roads where Large Truck Vehicles are permitted to Pass through

Table 14.1-1 Freight Traffic Control Items in Lima and Callao Metropolitan Area

Area	Type of Vehicle	Area/Time Zone Restriction
Central Historical Area	Age>10years or Total weight >6.5 ton	Possible to pass between 21:00-6:00
	Other freight vehicles	Possible to pass between 6:00 – 21:00 outside morning and evening peak hours
Other Area	Trucks*	Available on the road permitted by specific law No time zone restriction For the other road, specific permission for each vehicle is necessary. Even permitted on the peak time, it is prohibited to then Cathy- this beats me
	Other freight vehicles	Able to pass all day

Note: * defined as the freight vehicle with a weight of more than 3.5ton by MTC

14.1.2. FREIGHT VOLUMES AND ITEMS FOR EACH DIRECTION

Figure 14.1-2 shows the total freight volume from/to the main direction in the Lima and Callao Metropolitan area. Main direction is the North, East and South. The inbound freight volume in each direction is approximately 12,800 t/day to 16,900 t/day. On the other hand, the outbound volume is approximately 8,700 t/day to 12,800 t/day. In the east direction, the freight volumes are not balance in the inbound and outbound directions.

In the cargo transportation survey, the cargo items are interviewed and categorized into 8 items (1.Farming/Fishery Products, 2.Food Industrial Products, 3.Light Industrial Products, 4.Wood Products/Mineral, 5.Heavy Industrial Products and 6. Other items) by each vehicle.

Figure 14.1-2 shows the composition ratio of cargo transportation by each item passing through the boundary of the municipality. The characteristics of cargo items in each direction are summarized as follows.

- Farming/Fishery Products (of all directions) are distinguished in ratio in the inbound direction.
- On the other hand, industrial products, especially food products (of Eastern outbound) and heavy industrial products (of all directions) are distinguished in ratio in the outbound direction.

The agricultural products are transported into the Lima metropolitan area, while the industrial products are sent to the outside of Lima.

The composition ratio of Cargo items is shown in Figure 14.1-3 whose cargo items are transported from/to the major cargo transportation facilities inside the Lima and Callao Metropolitan Area, that is, the port of Callao, Jorge Chavez international airport, the wholesale market in La Victoria, the Pampilla Oil refinery and 5 Transport Companies.

- The main cargo items carried into the facilities are “others”, which are approximately 47.0% of total.
- The main cargo items carried from the facilities are “food products” and “heavy industrial products”. Its figures are approximately 30% of the total, respectively.

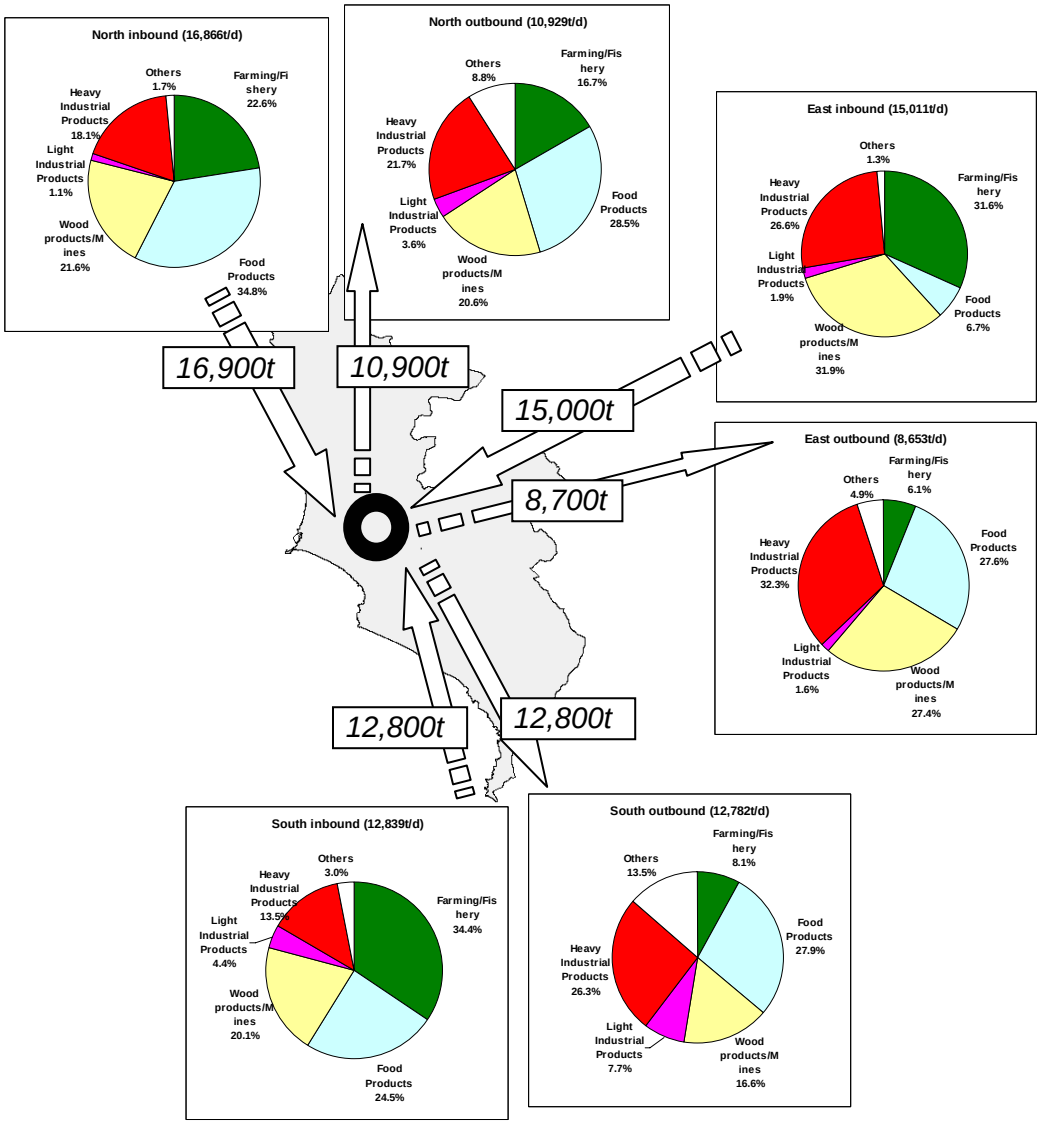


Figure 14.1-2 Composition Ratio of Cargo Transportation (From North, East, South)

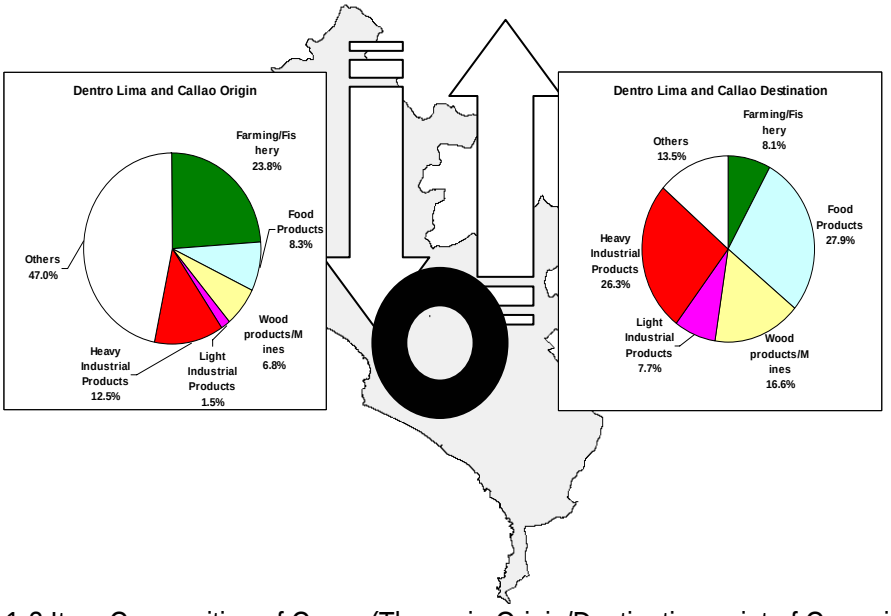


Figure 14.1-3 Item Composition of Cargo (The main Origin/Destination point of Cargo in Lima and Callao)

14.1.3. LOAD WEIGHT OF CARGO VEHICLE

In the cargo vehicle interview survey on the Cordon line, the capacity and the actual load volume of trucks were also interviewed. The ratio of actual load weight to the loading capacity by each direction is shown in Figure 14.1-4 which is the loading ratio of trucks passing through the boundary of the municipality. As it can be seen, the load capacity ratio ranges between 40% and 60%. The average carrying cargo weight per truck ranges between 12ton and 16ton except for the eastern outbound direction (8.7ton) as shown in Table 14.1-2.

Figure 14.1-5 and Table 14.1-3 show the loading ratios in the major cargo transport facilities in Lima and Callao. The loading ratios are considerably different by the facilities. The loading ratios carried into or out of international airport and whole sale market are remarkably different. The cargo loading ratios carried into the facilities range between 60 to 85%, in contrast to 10% for carrying out. The port of Callao and the transport companies are balanced in carrying into and out.

The average cargo weights per truck are also different in the facilities as shown in Table 14.1-3. The heavy weight trucks arrive to the market, and unloaded trucks return to the production areas. On the other hand, the airport facility is inversed in loading. The Callao port is in balance in loading.

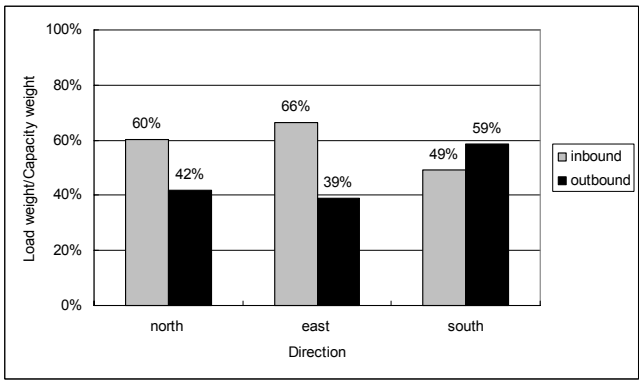


Figure 14.1-4 Directional Ratio of Actual Load Weight to the Loading Capacity from the Cordon Line Survey

Table 14.1-2 Average Load Weight per Truck of Inbound/Outbound on the Cordon Line Survey

(Unit: ton/veh)

Direction	Inbound	Outbound
North	15.9	12.1
East	15.1	8.7
South	12.1	14.4

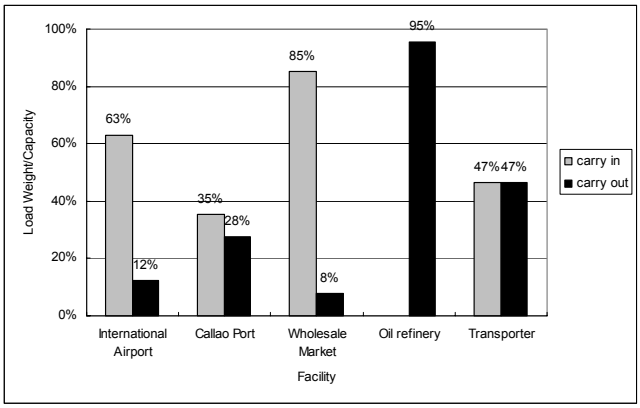


Figure 14.1-5 Ratio of Actual Load Weight to the Capacity at Main Facilities

Table 14.1-3 Average Load Weight per Truck Carried into/out of the Main Facilities (ton/veh)

	Carry-in	Carry-out
Airport	14.8	2.8
Callao Port	8.2	10.5
Market	17.5	1.6
Refinery	0.0	3.3
Transporters	13.0	13.0

14.1.4. HOURLY FLUCTUATION OF LARGE TRUCK VOLUME

The large cargo truck travel is restricted in exclusive of several major roads. In order to see the influence of the truck for the restriction, the hourly fluctuation of truck volume on the boundary of the municipality is analyzed. Figure 14.1-6 shows the hourly fluctuation of cargo truck volumes on the Cordon line which is on the boundary of the municipality. The traffic volume data counted in the Master Plan study is used.

As it can be seen, there is no remarkable fluctuation in each direction by the restriction of large trucks. It seems that the large trucks are not influenced by the time zone restriction.

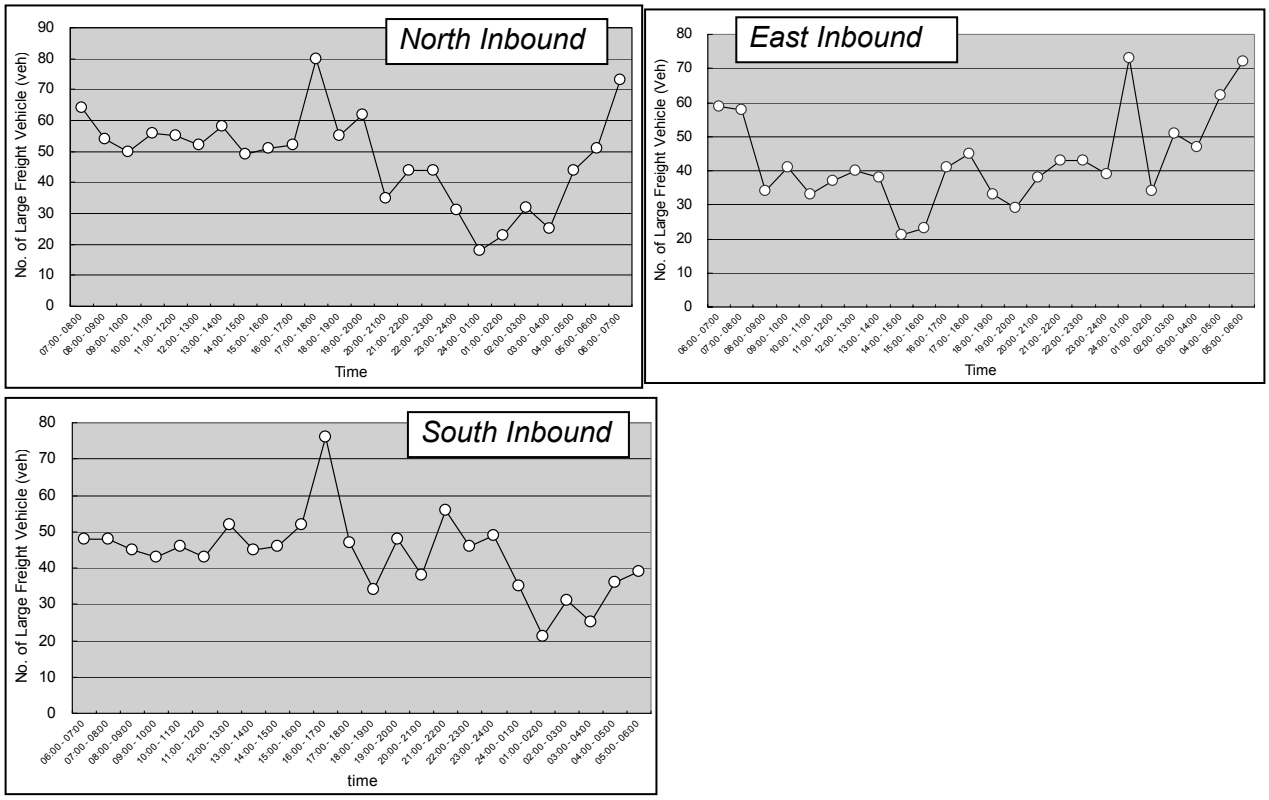


Figure 14.1-6 Hourly Fluctuation of Cargo Truck Volumes on the Cordon Line (6:00-24hours)

The influence of the restriction in the main cargo facilities is also analyzed. Since those facilities are located within the municipality, the direct influence of the restriction is associated. Figure 14.1-7 shows the hourly fluctuation of the large cargo truck volumes in the main cargo facilities.

In the fluctuation in the port of Callao and the Market, the truck volume does not fall at night time. It may indicate that the large trucks avoid traffic congestion on the roads without restriction in the day time. As for the market facility, it may also indicate that it is necessary to carry agricultural production into the markets before they open, at the same time avoiding the traffic congestion.

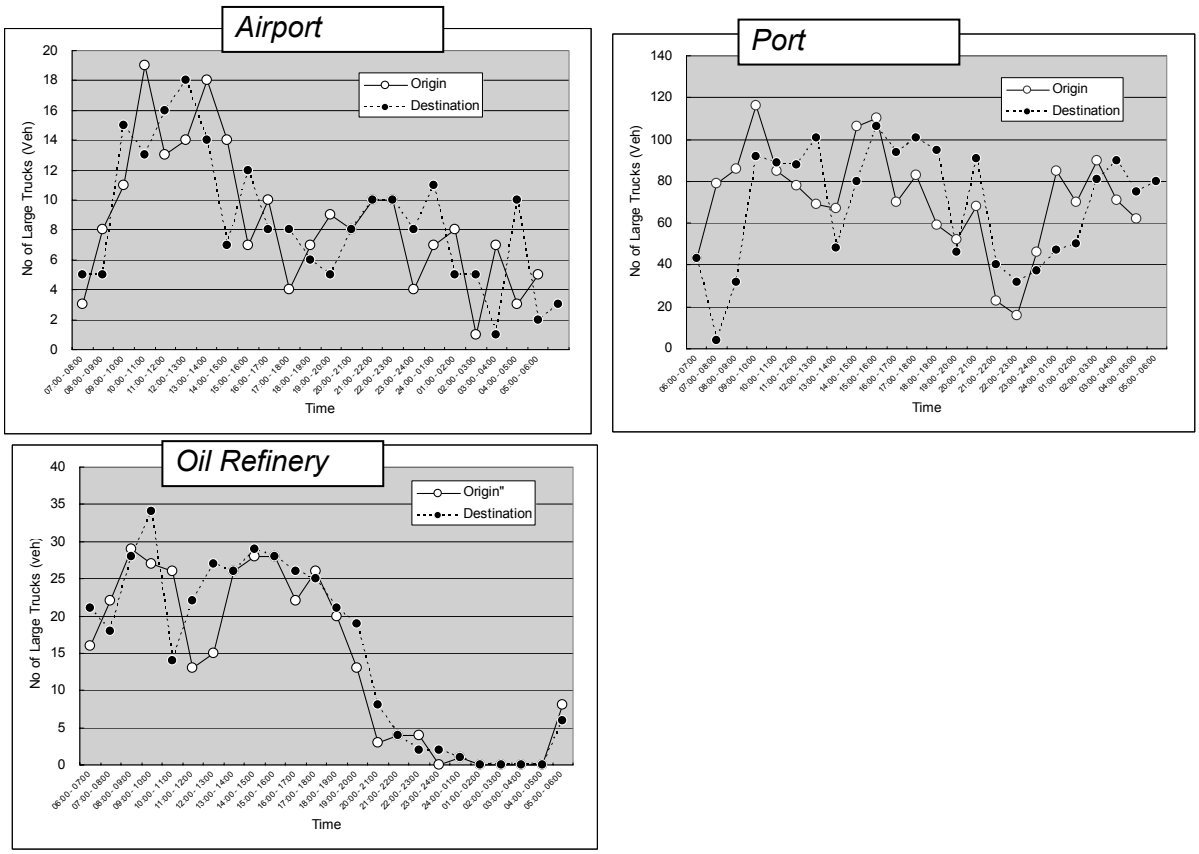


Figure 14.1-7 Hourly Fluctuation of Truck Volume in the Airport, the Port of Callao and the Oil Refinery (6:00-24 hours)

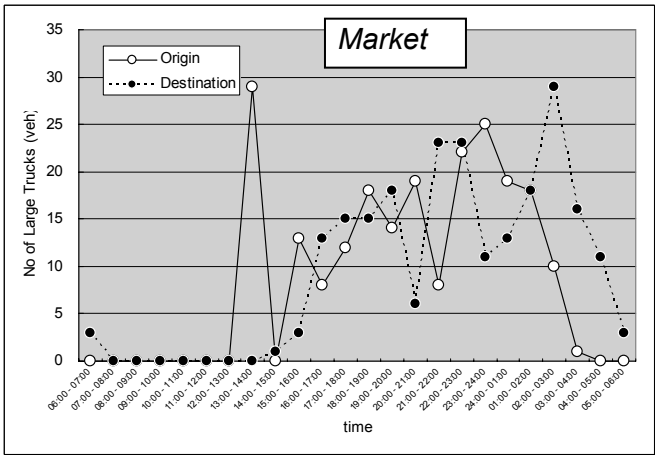


Figure 14.1-8 Hourly Fluctuation of Truck Volume in the Market (6:00-24 hours)

14.1.5. HEAVIER LARGE TRUCK VOLUMES ON THE ROAD NETWORK

Figure 14.1-10 shows the relationship between the all traffic volumes and large truck volume which is classified into two, one is a road with the restriction of the large truck travel and the other is a road without the restriction. The traffic data was counted in 2004 in the Master Plan Study.

Table 14.1-4 shows roads with heavier large truck volumes according to Figure 14.1-10. Figure 14.1-9 shows the roads classified into 3 categories: one is the large truck volumes with less than 1,000 veh/h, the second is in a range of 1,000 to 3,000 veh/h, the third is more than 3,000 veh/h. As it can be seen, the heaviest large truck volumes which are more than 3,000 veh/h, which are indicated by the red circle in Figure 14.1-9, are counted on the roads without the restriction, which shows a black width band in Figure 14.1-9. These

roads are Panamericana Norte (Near the intersection with Av. Alfonso Ugarte) and Panamericana Sur (South of the intersection of Av. Circunvalación). Panamericana Norte, Via de Evitamiento, Panamericana Sur, Nestor Gambetta, Av. Argentina and Carretera Central also carry the large trucks with approximately 1,500 vehicles per day.

Table 14.1-4 Roads with Heavier Large Truck Volumes

	Point (on road)	Volume
1	Pan Americana Sur (Derby Bridge)	4,027
2	Pan Americana Sur (Primavera Bridge)	3,975
3	Pan Americana Norte (Peatonal Positos Bridge)	3,432
4	Carretela Central (Rotary Sta. Anita)	2,803
5	Pan Americana Sur (Alipio Ponce Bridge)	2,576
6	Av. Nestor Gambetta (Ov. Faucett- Ferroles)	2,488
7	Carretela Central (Prolongación J. Prado)	2,106
8	Av. Nestro Gambetta (Marquez)	2,087

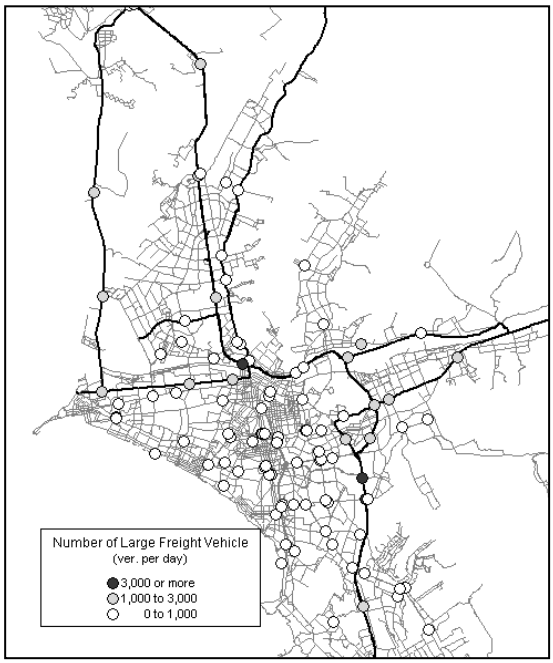


Figure 14.1-9 Number of Heavier Large Truck Volumes

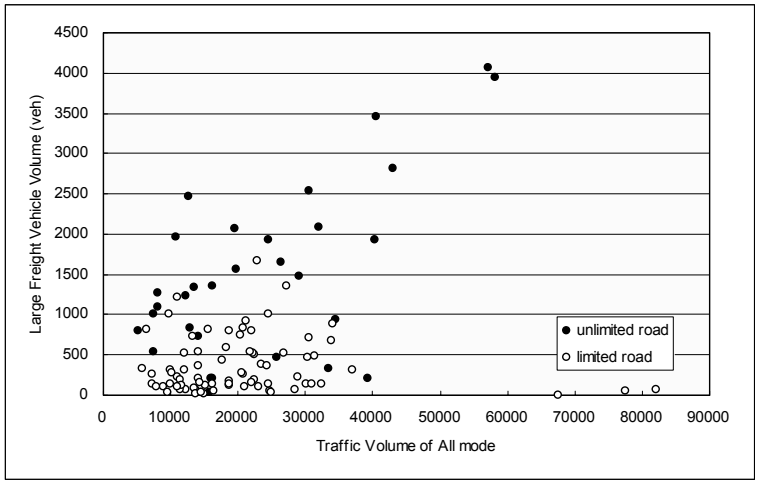


Figure 14.1-10 Relationship between All Traffic Volumes and Large Truck Volumes in 2004

14.1.6. RATIO OF LARGE TRUCK VOLUME TO TOTAL TRAFFIC VOLUME

Figure 14.1-11 shows the roads with a higher ratio of large trucks in which the red color shows a ratio of 10% or more, the yellow color is in range of 5% to 10%, and the white is 5% or less. The higher ratios concentrate on the roads without the restriction. The highest ratio is recorded on Av. Nestor Gambetta at a ratio of 19.6 %.

The roads which have the heavier large truck volume and higher ratio of large truck, concentrate on the ones without the restriction. The restricted roads are banned for the travel of large trucks throughout the day. However, according to Figure 14.1-12, there are a few roads in which the traffic volume is more than 3,000 veh/h and the ratio of large trucks is 10% or more. Almost all of the roads are below the above criteria.

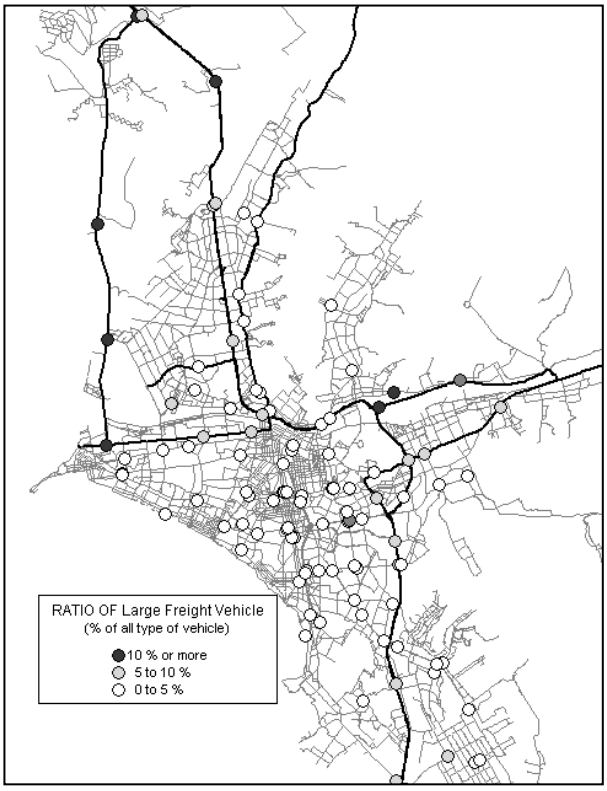


Figure 14.1-11 Road Locations of Heavier Large Truck Ratio

Table 14.1-5 Roads with Heavier Large Truck Ratio

	Point (on road)	Ratio(%)
1	Av. Nestor Gambetta (Ov. Faucett- Ferroles)	19.9
2	Av. Argentina (Ov. Centenario)	18.2
3	Pan Americana Sur (Av. El Sol)	15.5
4	Ramilo Priale (Peaje)	15.0
5	Carettera Ventanilla (Pte. Hermosa)	13.3
6	Carretela Central (Pte. Los Angeles)	13.3
7	Av. Nestor Ganbetta (Marquez)	10.7
8	Av. Checa Eguiguren	10.3
9	Pan Americana Norte	10.3

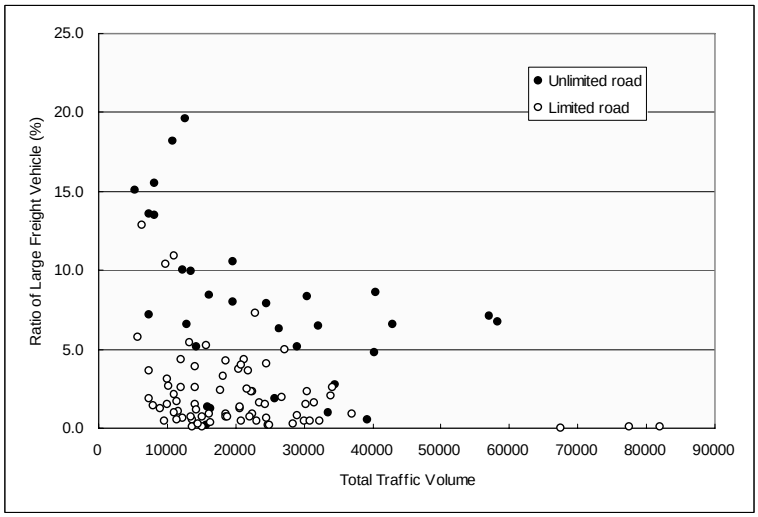


Figure 14.1-12 Relationship between Traffic Volume and Ratio of Large Truck to the Total

14.1.7. EFFECT OF TRAFFIC CONGESTION BY LARGE TRUCK

In order to see the effect of large trucks on traffic congestion, the volume and capacity ratio referred to in the HCM Manual 2000 was calculated for the roads which have a higher ratio of large trucks to the total and heavier truck volume. The selected roads have a traffic volume of 1,000 veh/h or more and a ratio of 5% or more in the morning peak hour according to the above analyses. Table 14.1-6 shows the volume and capacity ratios on the selected roads. Figure 14.1-13 shows them in which the red color is a ratio of 1.0 or more, the yellow is in range of 0.75 to 1.0, the green is in range of 0. 5 to 0.75, and the blue is 0.5 or less. The criteria recognized as the traffic congestion will be at a ratio of 0.75 or above.

As can be seen, the number of roads with a ratio of 0.75 or above is as few as 7 road segments. Those roads are CO-71 and CO-72 (Panamericana Sur), CO-06 and CO-07 (Panamericana Norte), CO-13 (Av. Nestor Gambetta), CO-36 (Carretera Central), and CO-40 (Miguel Checa Eguiguren), which are located on the entrance of the Central Lima in the arterial roads.

In the road segments which have the heavier traffic volume and the higher ratio of large truck, the traffic congested roads are a few which concentrates on Panamericana Norte, Sur and Carretera Central.

Table 14.1-6 Volume and Capacity Ratio on the Selected Roads in the Morning Peak Hour

		Peak Traffic Volume(7-8)					
section NO	Road	Total Traffic Volume	Large Vehicle	Traffic Flow in peak 15min (converted to (=V)	Number of Lanes	Adjusted Saturation Traffic Flow (=C)	V/C Ratio
CO-06	Pan Americana Norte	2592	113	3644	6	3952	0.92
CO-07	Pan Americana Norte	2821	46	3020	6	4037	0.75
CO-08	Pan Americana Norte	1496	78	1556	4	2447	0.64
CO-10	Pan Americana Norte	809	62	916	4	2301	0.40
CO-11	Pan Americana Norte	602	34	684	4	2191	0.31
CO-12	Nestor Gambetta	1452	154	1580	4	2516	0.63
CO-13	Nestor Gambetta	914	129	1052	2	1334	0.79
CO-28	Mariano Pastor Sevilla	1568	49	1796	4	3242	0.55
CO-35	Ramiro Priare	622	43	808	4	2659	0.30
CO-36	Carretera Central	2553	140	2732	6	3642	0.75
CO-37	Carretera Central	1143	84	1232	6	3961	0.31
CO-38	Carretera Central	565	69	632	4	2399	0.26
CO-39	Carretera Central	1936	112	2084	6	3522	0.59
CO-40	Miguel Checa Eguiguren	843	76	948	2	1204	0.79
CO-44	Nicoras Arriola	1442	37	1760	4	3006	0.59
CO-47	Alipio Ponce Vasquez	2191	128	2368	6	4093	0.58
CO-71	Pan Americana Sur	4144	188	4572	6	4399	1.04
CO-72	Pan Americana Sur	4104	300	4952	6	4404	1.12
CO-74	Pan Americana Sur	1540	98	1824	6	4245	0.43
CO-76	Circunvaracion	2265	55	2724	4	2732	1.00
CO-86	Argentina	1242	66	1420	6	4330	0.33
CO-87	Argentina	903	49	1116	4	3246	0.34
CO-88	Argentina	572	85	688	6	4015	0.17

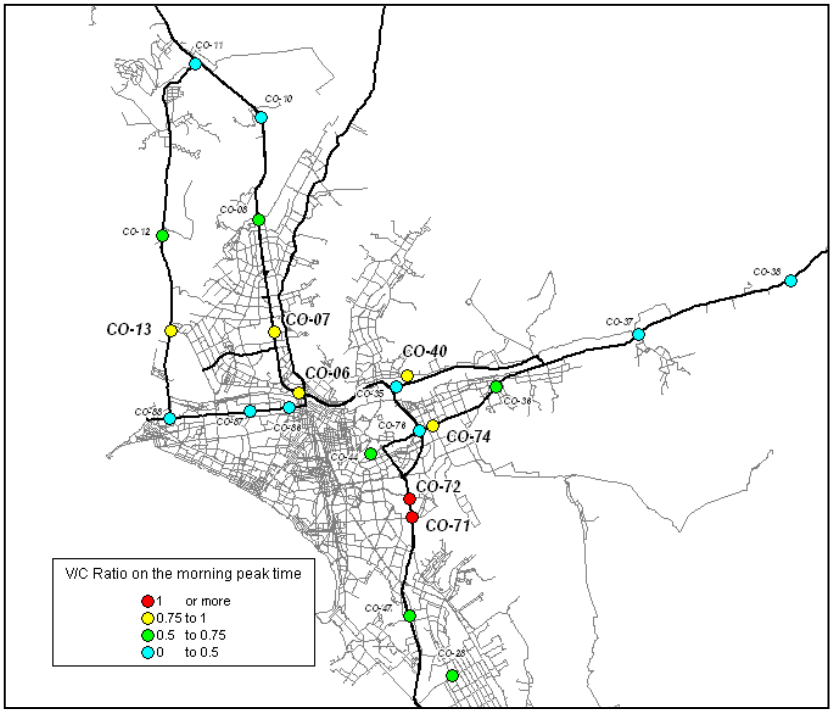


Figure 14.1-13 Volume and Capacity Ratio on the Selected Roads in the Morning Peak Hour

14.1.8. SUMMARY OF THE PRESENT CARGO TRANSPORT IN LIMA AND CALLAO

(1) Cargo Characteristics

- The agricultural products are transported into the Lima metropolitan area, while the industrial products are sent to the outside of Lima.
- The loading ratio of trucks that pass through the boundary of the municipality ranges between 40% and 60%.
- As for the hourly fluctuation of large trucks on the boundary of the municipality, there is no remarkable fluctuation by the restriction of large trucks. The large trucks are not influenced by the restriction. In the hourly fluctuation in the port Callao, the truck volume does not fall at night time. It may indicate that the large trucks avoid traffic congestion on the roads without the restriction in the day time.

(2) Cargo Transport Situation

- As for the influence to road traffic, the heaviest large truck volumes which are more than 3,000 veh/day, are counted on the roads without the restriction. These roads are Panamericana Norte (Near the intersection with Av. Alfonso Ugarte) and Panamericana Sur (South of the intersection of Av. Circunvalacion).
- The higher ratios of large trucks concentrate on the roads without the restriction. The highest ratio is recorded on Av. Nestor Gambetta at a ratio of 19.6 %.
- There are a few roads in which the traffic volume is more than 3,000 veh/day and the ratio of large trucks is 10% or more. Almost all of the roads are below the above criteria.
- At the present, the influence of the traffic congestion by large trucks is low. In the road segments which have the heavier traffic volume and the higher ratio of large trucks, the traffic congested roads are few and concentrate on the Panamericana Norte, Sur and Carretera Central.
- The present road network system for the restriction of large trucks is in balance between the large truck volume and its road network in consideration of the characteristics of cargo transportation.
- In the future, the influence of traffic congestion by the large trucks under the present restriction system will increase due to the fact that the traffic volume rises. In the Study, the present restriction system is examined under the 2010 traffic volume. The cargo transportation control and road network system are recommended to realize smooth traffic flows by separating truck and other vehicle traffic on major roads.

14.2. TECHNICAL ANALYSIS FOR URGENT COUNTERMEASURES

In this section, technical analysis related to the freight transport is implemented based on the current freight transport situations, problems and issues discussed in Section 14.1. The sustainability of the present control system for cargo transportation is examined and then, urgent countermeasures are proposed.

14.2.1. ANALYSIS POLICY

In order to solve freight traffic issues under the present control system, the following two countermeasures are proposed. Figure 14.2-1 shows the procedure of analysis.

(1) Improvement of the Freight Road Network

There are no roads to connect from the Callao Port/Jorge Chavez Airport to the southern area and from the Callao coastal industrial area to eastern area in the present freight road network system shown in Figure 14.1-1. The new freight roads to connect those areas are examined and the improvement of traffic conditions in 2010 is analyzed in the new freight network system. The necessity of new freight roads is discussed based on the analysis.

(2) Possibility of Time Zone Control of Freight Traffic

There is no time zone control for traveling on the permitted roads. After the above discussion, the possibility of the time zone control is discussed to improve freight traffic conditions.

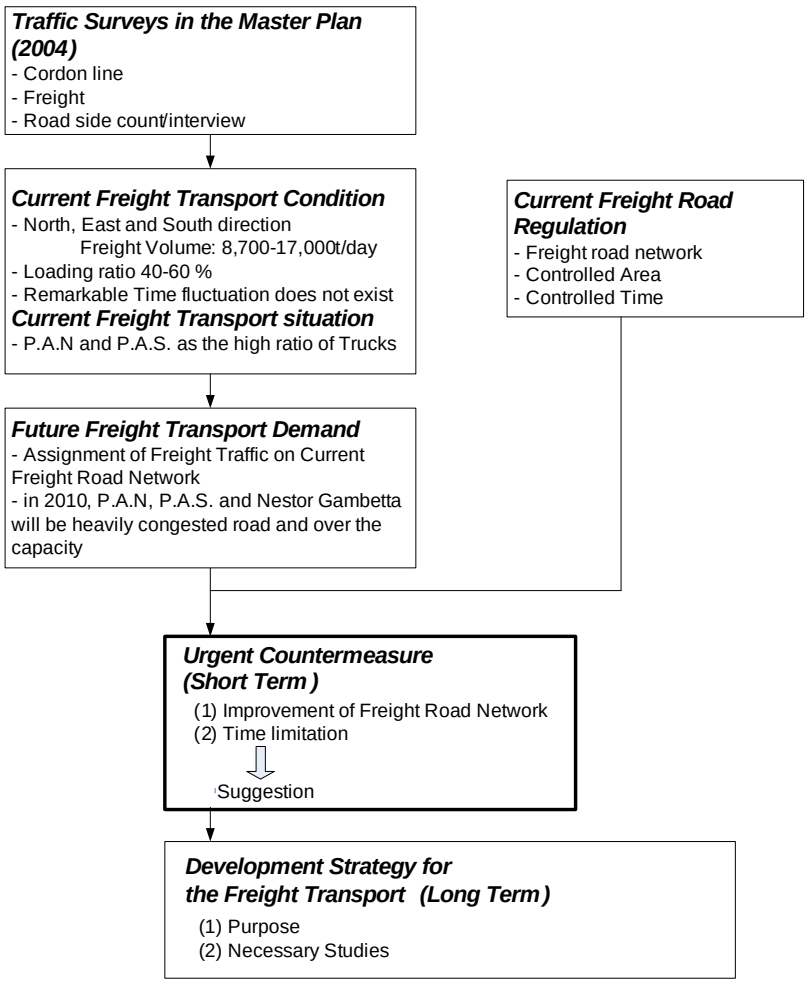


Figure 14.2-1 Analysis Procedure of Urgent Countermeasure in Freight Network System

14.2.2. FREIGHT TRANSPORT NETWORK ANALYSIS

To mitigate heavy congestion at peak hours, the two new trunk roads which are a missing link of current freight roads are examined as a freight road shown in Figure 14.2-2 in which the color red represents those proposed roads.

1) Av. de la Marina- Av. Javier Prado (to Panamericana Sur)
2) Av. Elmer Faucett (a section of Av. Nestor Gambetta to Av. Tomas Valle) - Av. Canta Callao – Av. Naranjal (to Panamericana Norte)

Table 14.2-1 shows the freight traffic assignment cases used to evaluate the new freight vehicle road network system. Large cargo trucks are only assigned to the freight road network, while other vehicles are assigned to all roads in the traffic assignment.

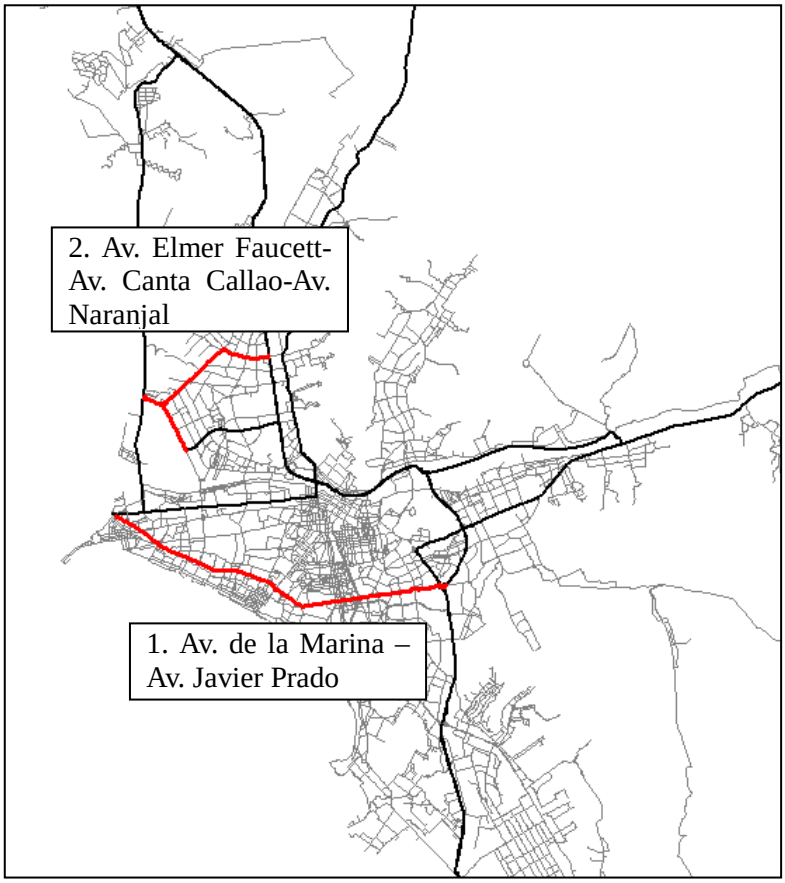


Figure 14.2-2 Trunk Roads Examined as New Freight Vehicle Road in 2010

Table 14.2-1 Alternative Cases for Freight Transport Network

Corridor(s)	2004	2010 without (case-0)	2010 with (case-1)	2010 with (case-2)
Current Freight Roads	○	○	○	○
Av. Javier Prado			○	○
Av. Elmer Faucett				○

Figure 14.2-3 and Table 14.2-2 show a volume-capacity ratio in the morning peak hour on the freight roads in 2010 by the alternative cases in which the color red represents a ratio of 1.5 or more, yellow is a ratio of 0.8-1.0 and green is a ratio of 0.8 or less.

The highest VC ratio is assessed on Av. Nestor Gambetta at 1.45 in the Without Case, in contrast to 0.8 in 2004. Roads with a higher VC ratio of 1.0 or more are Pan American Sur and Javier Prado in the Without Case.

In comparison between the without and with cases, the VC ratios on Av. Nestor Gambetta (CO-13) and Circunvalación (CO-76) are somewhat reduced in the With Case-1 or Case-2 due to the new freight roads, though the VC ratios exceed more than 1.0 (see in the hatch parts in Table 14.2-2).

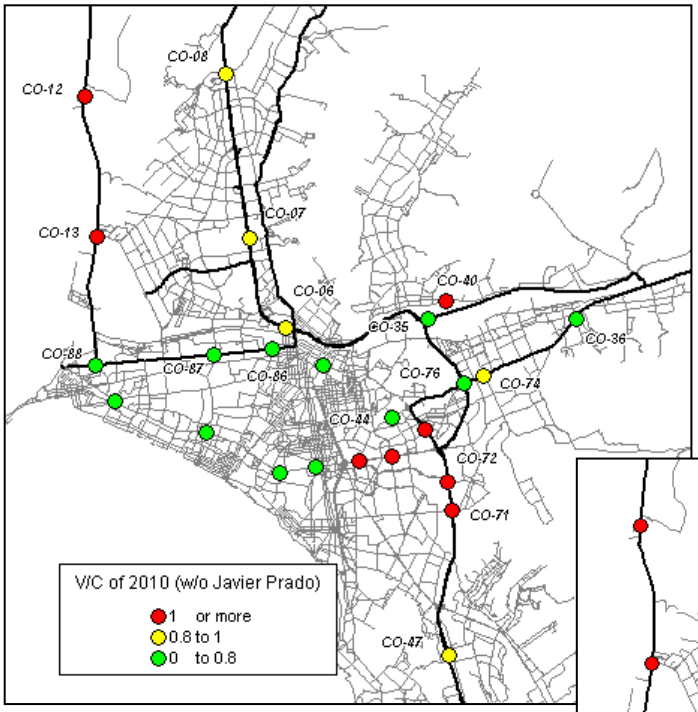
Panamericana Norte (all the section in study area) and Carretera Central (Santa Anita) remain in a ratio range of 0.8 to 1.0, even though new roads are add onto the freight road network. This is because the ratio of the freight traffic volume to all vehicles in the morning peak in 2010 is at most approximately 20%. And road congestion largely depends on the bus and taxi traffic volumes, which occupy approximately 60%.

Av. Javier Prado- La Marina and Av. Elmer Faucett which are new freight roads show no congestion in the Without and With Cases.

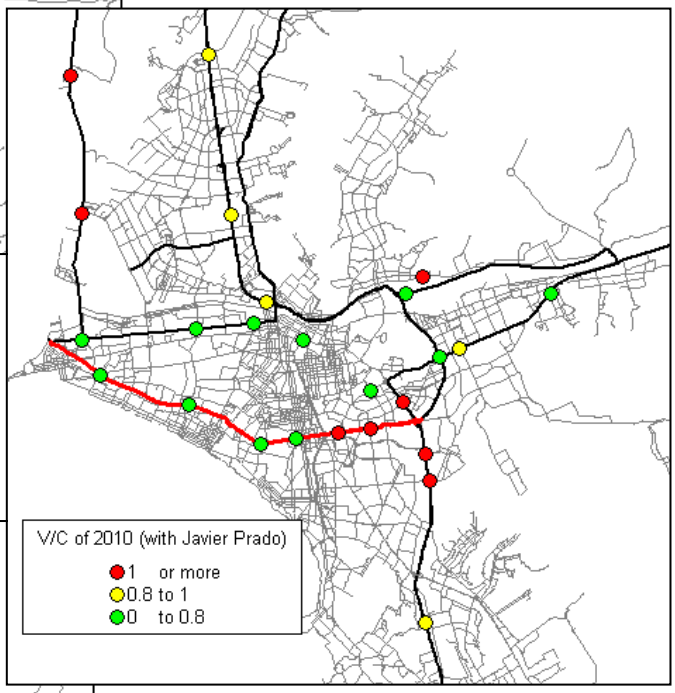
Since the effect of new freight roads on traffic congestion is low from the above examination, the necessity of expansion of freight road network is low in 2010 due to the increase in passenger car and public transportation demands and its composition ratios.

Table 14.2-2 Peak Hour Volume-Capacity Ratio by Alternative Cases in 2004 and 2010

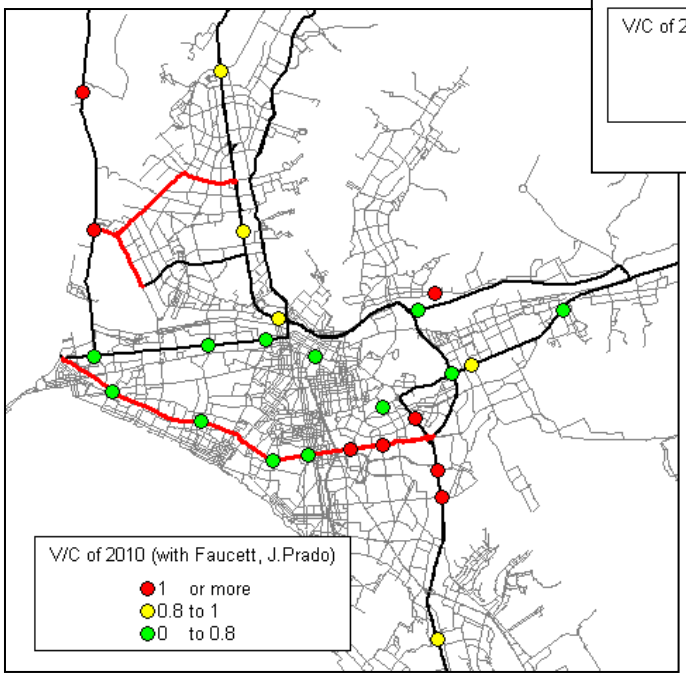
section NO	Road	V/C 2004	V/C 2010 without	V/C 2010 with case-1	V/C 2010 with case-2
CO-06	Pan Americana Norte	0.92	1.00	1.00	0.99
CO-07	Pan Americana Norte	0.75	0.85	0.86	0.86
CO-08	Pan Americana Norte	0.64	0.92	0.91	0.92
CO-10	Pan Americana Norte	0.40	0.59	0.58	0.58
CO-11	Pan Americana Norte	0.31	0.45	0.46	0.45
CO-12	Nestor Gambetta	0.63	1.14	1.15	1.16
CO-13	Nestor Gambetta	0.79	1.45	1.48	1.32
CO-23	Av. La Morina	0.31	0.34	0.34	0.35
CO-24	Av. La Morina	0.63	0.68	0.67	0.65
CO-25	Av. La Morina	0.56	0.58	0.59	0.59
CO-28	Mariano Pastor Sevilla	0.55	0.76	0.76	0.76
CO-35	Ramiro Priare	0.30	0.37	0.37	0.37
CO-36	Carretera Central	0.75	0.83	0.82	0.82
CO-37	Carretera Central	0.31	0.38	0.38	0.38
CO-38	Carretera Central	0.26	0.35	0.35	0.35
CO-39	Carretera Central	0.59	0.77	0.77	0.77
CO-40	Miguel Checa Eguiguren	0.79	1.32	1.32	1.32
CO-44	Nicoras Arriola	0.59	0.60	0.64	0.64
CO-47	Alipio Ponce Vasquez	0.58	0.83	0.83	0.83
CO-55	Javier Prado	1.13	1.01	1.05	1.01
CO-56	Javier Prado	1.06	1.01	1.02	1.00
CO-57	Javier Prado	0.47	0.47	0.48	0.48
CO-58	Javier Prado	0.42	0.40	0.41	0.41
CO-71	Pan Americana Sur	1.04	1.05	1.05	1.05
CO-72	Pan Americana Sur	1.12	1.15	1.15	1.15
CO-74	Pan Americana Sur	0.43	0.44	0.41	0.42
CO-76	Circunvaracion	1.00	1.11	1.05	1.07
CO-86	Argentina	0.33	0.34	0.34	0.34
CO-87	Argentina	0.34	0.47	0.48	0.45
CO-88	Argentina	0.17	0.28	0.25	0.23



Without case



With case-1



With case-2

Figure 14.2-3 Volume-Capacity Ratio on Main Freight Roads in 2010 by Without, With Case-1 and With Case-2

14.2.3. TIME ZONE CONTROL ANALYSIS

It is disclosed that the VC ratio on the freight road network in 2010 does not significantly reduce even though the new two freight roads are added. Therefore, the possibility is analyzed for the time zone control in the morning or evening peak hour in which large freight vehicles are controlled for traveling through a road permitted for the travel of large trucks. The question is whether large truck control in the peak hour alleviates traffic congestion on the freight roads, or not. Therefore, large truck volumes in the peak hour on the freight roads are analyzed and the possibility of the zone control is discussed in this section.

(1) Procedure

Hourly fluctuation of large trucks refers to the 24-hour freight vehicle count data in the Master Plan Study (2004). The hourly fluctuation in 2010 assumes that the ratio of hourly volume is the same as that in the 2004 counting data, and the total volumes in 2010 are proportioned to the 2010 projection.

The hourly fluctuations of traffic volume by type of vehicles at the following 5 points on the freight roads are estimated.

1) Av. Nestor Gambetta (North)
2) Av. Panamericana Norte (North)
3) Carretera Central (East)
4) Av. Circunvalación (South)
5) Av. Panamericana Sur (South)

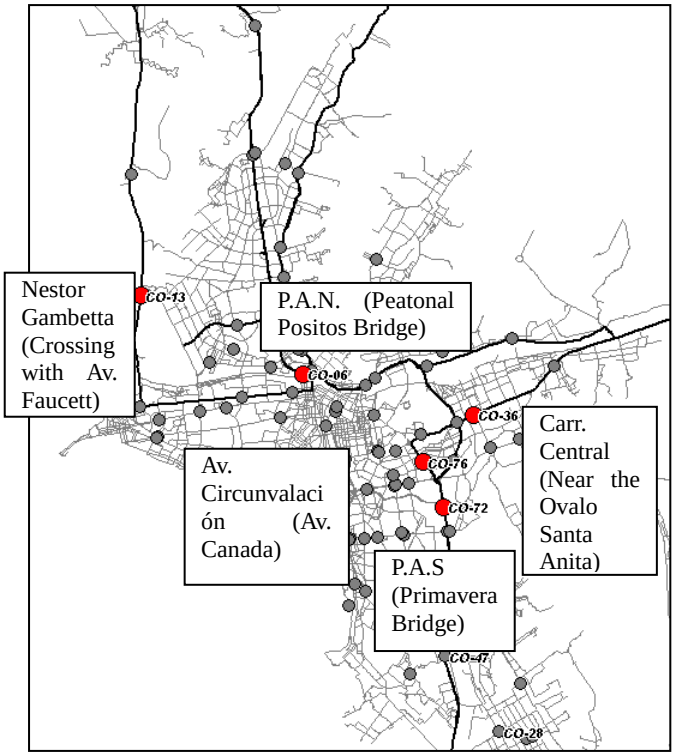


Figure 14.2-4 Analyzed point for time fluctuation of the freight corridor

(2) Av. Nestor Gambetta (crossing with Av. Faucett)

Figure 14.2-5 shows the hourly traffic volume in PCU by all vehicles and large trucks, together with the VC ratio in which a VC ratio of 1.0 is shown in yellow and 0.8 is shown in blue. As can be seen, the ratio of large trucks to the total is considerably higher at 58.1 % in the evening peak hour between 18:00 and 19:00. In the evening peak hour from 16:00 to 21:00, the V/C ratio exceeds 1.0. When the time zone control is applied in the evening peak hour, it is possible to reduce the freight truck volume in this time period and to travel in the off-peak hour.

However, it must be introduced carefully because of the existence of economically very important facilities, e.g. port facilities and oil refinery, exist near Av. Nestor Gambetta and the introduction of time control must consider these economic activities.

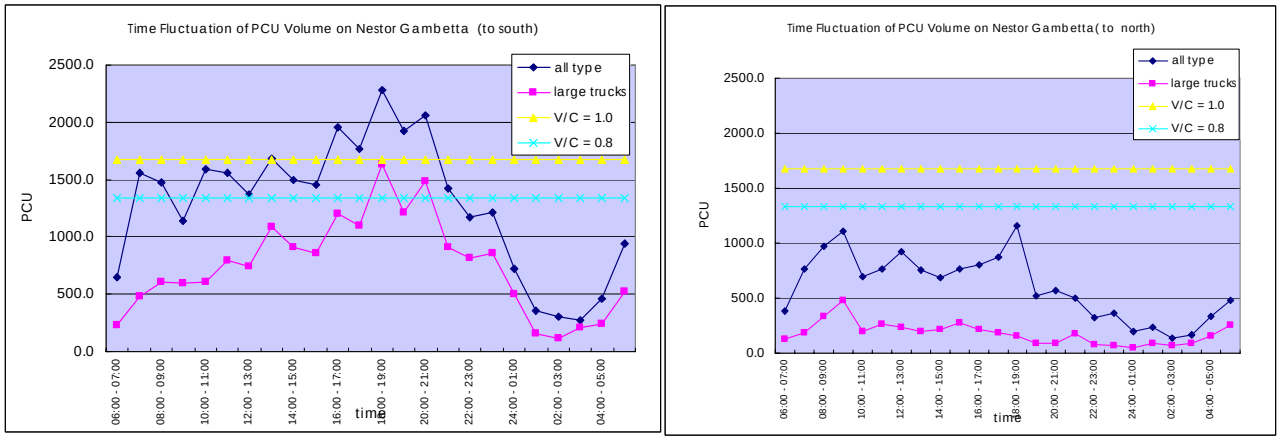


Figure 14.2-5 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Gambetta in 2010

(3) Av. Pan Americana Norte (peatonal positos bridge)

As can be seen in Figure 14.2-6, in the morning peak from 7:00 to 10:00 and the evening peak from 17:00 to 20:00 on the inbound (south direction), the V/C ratio exceeds 1.0. In the outbound (north direction), the evening peak from 17:00 to 20:00 has a maximum point of inflection in volume and its V/C ratio exceeds 1.0. This peak time is a time period to be controlled in the inbound direction.

However the composition ratio of the freight vehicle to all vehicles in the peak hour is as low as 12.7 % on the inbound. Therefore, the effect of introduction of the time control is limited on the inbound. On the outbound, the introduction of the evening peak control has something of an effect.

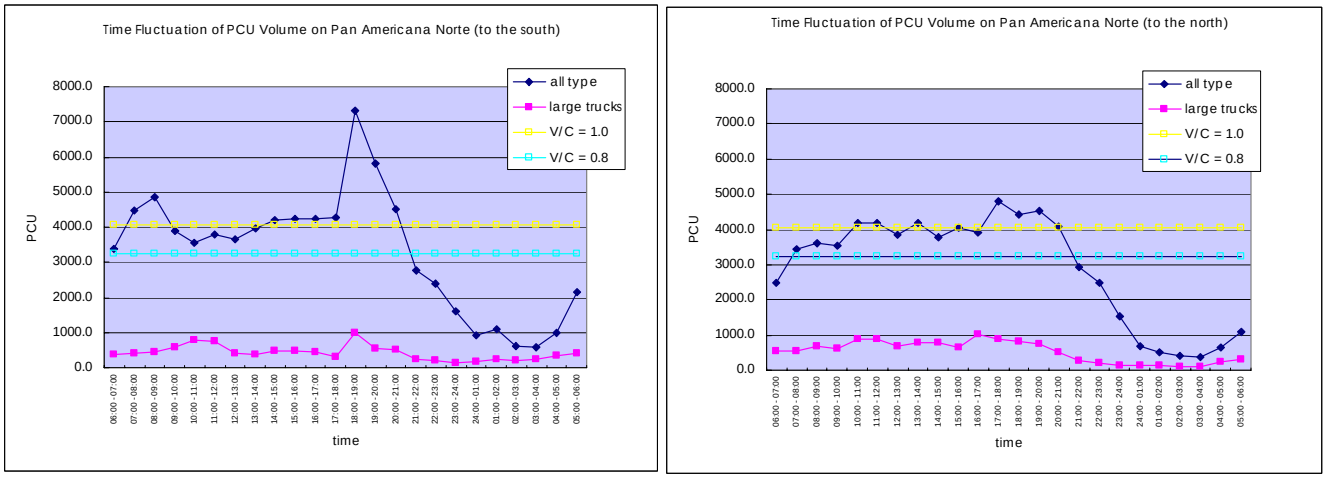


Figure 14.2-6 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Panamericana Norte in 2010

(4) Carretera Central (near Ovalo Santa Anita)

As can be seen in Figure 14.2-7, the morning peak volume remarkably appears from 6:00 to 10:00 on the inbound (the east direction). However the installation of the time zone control is difficult. Since the ratio of the freight truck to the total is as low as 5-10%, the control of only freight trucks is not effective.

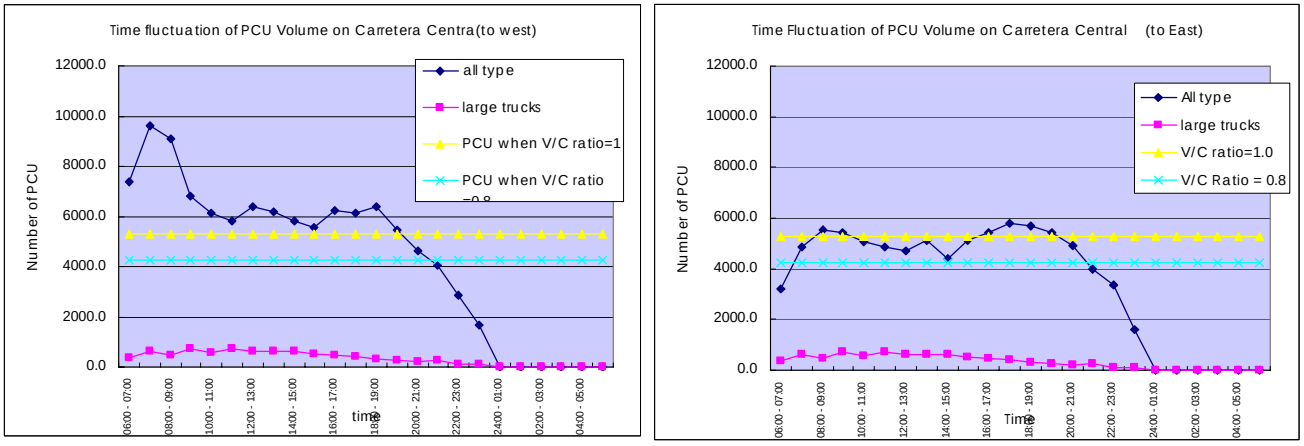


Figure 14.2-7 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Carretera Central in 2010

(5) Pan Americana Sur (south of Derby bridge)

Figure 14.2-8 shows the hourly fluctuation at the point entering/exiting to/from the Central City and Coastal area from/to southern district on Panamericana Sur. Morning peak time is shown from 7:00 to 10:00 and evening peak time is from 17:00 to 20:00 in both directions.

Table 14.2-3 shows composition ratio of large trucks to the total, volume-capacity ratio and the VC ratio excluding large truck volume by the morning and evening peak hours. When the restriction of large truck is applied, the VC ratio reduces to 1.0 or less. Therefore, the time control is expected to be effective.

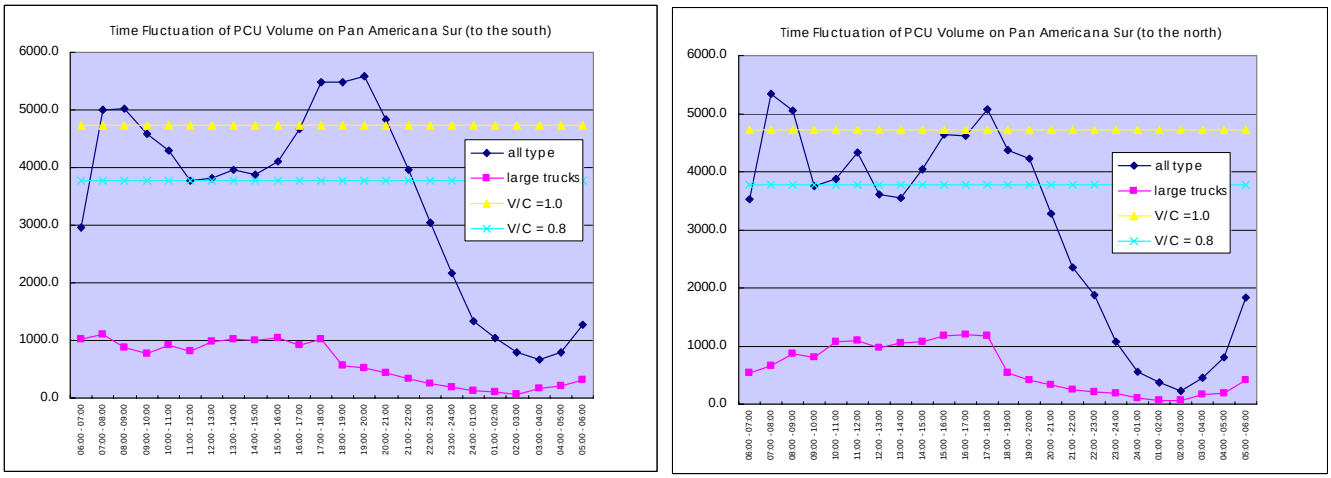


Figure 14.2-8 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Panamericana Sur in 2010

Table 14.2-3 Large Truck Composition Ratio and Volume-Capacity Ratio in the Peak Hours

Period	Items	Outbound	Inbound
Morning peak	Composition ratio of Large Trucks to Total	0.22	0.12
	Volume-Capacity Ratio	1.05	1.12
	Volume-Capacity Ratio excluding Large Truck	0.83	1.00

	Volume		
Evening peak	Composition ratio of Large Trucks to Total	0.18	0.28
	Volume-Capacity Ratio	1.16	1.07
	Volume-Capacity Ratio excluding Large Truck Volume	0.98	0.79

(6) Circunvalación

As can be seen in Figure 14.2-9, in the southerly direction from 7:00 to 10:00 the V/C ratio exceeds 1.0. Meanwhile, heavy congestion in the northerly direction is found from 17:00 to 20:00 in the same manner of that in the morning peak.

The time zone control has little effect in the peak hours because the ratio of large truck volume does not account for the major portion.

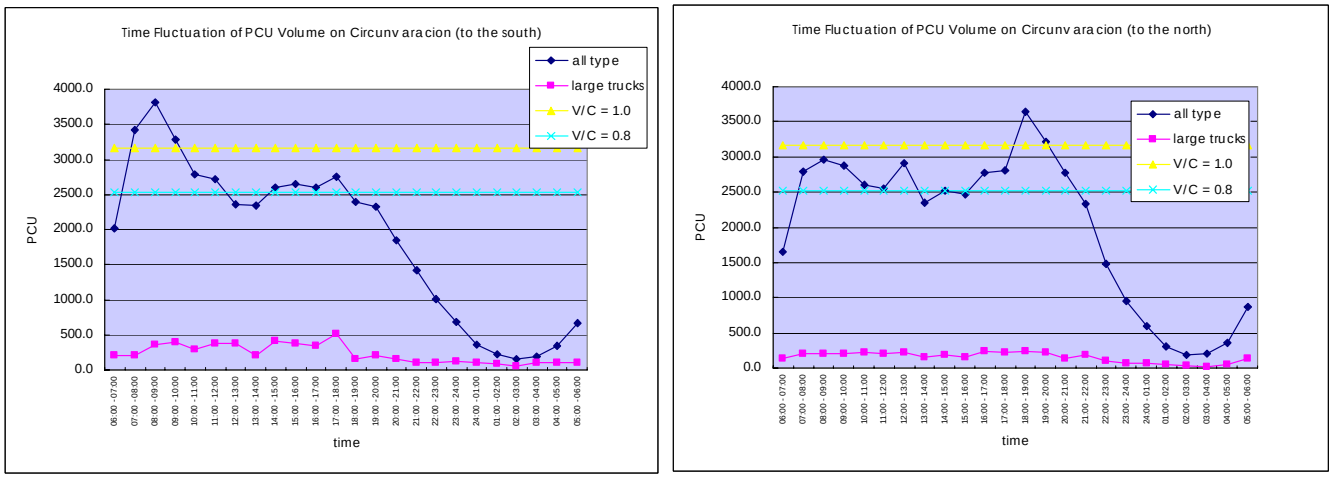


Figure 14.2-9 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Circunvalación in 2010

(7) Summary of the time zone control

Table 14.2-4 shows the possibility of introducing the time zone control on each road.

Table 14.2-4 Possibility of the Time Zone Control (Prohibition to enter) on Large Truck Road Network

Road	Direction	Peak time	Possibility of Prohibition	Direction	Peak time	Possibility of Prohibition
N. Gambetta	N-S	16-21	-	S-N	16-21	-
P.A.N.	N-S	7-10 17-20	- +	S-N	17-20	+
Carretera Central	E-W	6-10	-	W-E	-	-
P.A.S.	S-N	7-10 17-20	+ +	N-S	7-10 17-20	+ +
Circunvalación	S-N	17-20	-	N-S	7-10	-

Note: + high possibility; – low possibility

1) Av. Panamericana Sur has the possibility of large freight vehicles being prohibited from entering in the morning (7:00-10:00) and evening peak hours (17:00-20:00).

2) Av. Panamericana Norte has the possibility of entry being prohibited only in the evening peak hour (17:00-20:00).

14.2.4. SUGGESTION ON URGENT COUNTERMEASURES

As a result of the analysis based on the demand of large freight vehicles in 2010, the following countermeasure is suggested as shown in Table 14.2-5. The three road sections to be suggested for time zone control are shown in Figure 14.2-10

Table 14.2-5 The comparison between present control and suggested control

Countermeasure	Present Control	Suggested Control
1. Improvement of Freight Road Network	(permitted to travel on the following roads without any documentation) - Av. Panamericana Norte - Av. Tupac Amaru - Av. Nestor Gambetta - Autopista Ramilo Priale - Av. Argentina - Via de Evitamiento - Carr. Central - Av. Circunvalación - Av. Panamericana Sur	(permitted to travel on the following roads without any documentation) - Av. Panamericana Norte - Av. Tupac Amaru - Av. Nestor Gambetta - Autopista Ramilo Priale - Av. Argentina - Via de Evitamiento - Carr. Central - Av. Circunvalación - Av. Panamericana Sur ***No change is suggested.***
2. Time Zone Control	The road shown in 1. Improvement of Freight Road Network does not have a prohibited time zone for transit.	On the following roads, time zone control is implemented. - Av. Panamericana Norte ((The section from Av. Tomas Valle to Av. Caqueta) *Prohibited to enter from 17:00 to 20:00* - Circunvalación (Av. 28 de Julio – Av. Javier Prado Este), P.A.S. (Carretela Central – Av Primavera), Carretera Central (Av. Evitamiento – Av. Aviación) *Prohibited to enter from 7:00 to 10:00 and 17:00 to 20:00* - Av. Elmer Faucett,, Av. Canta Callao, Av. Naranjal *Permitted to enter from 17:00 to 20:00* (Considering the impact if the time zone control is implemented in P.A.N.)
		The other road permitted to enter currently does not have a prohibited time zone.

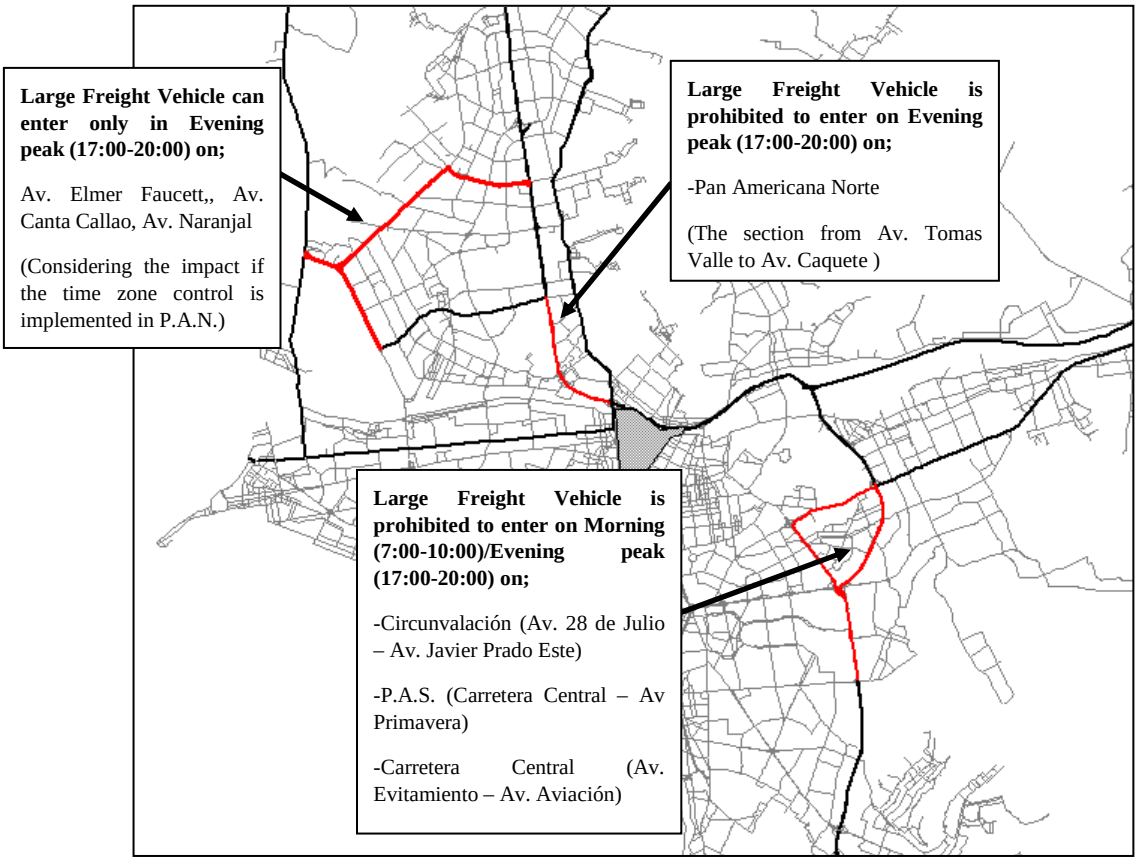


Figure 14.2-10 Suggestion for Time Zone Regulation

14.3. FREIGHT TRANSPORT STUDY

14.3.1. NECESSITY OF FREIGHT TRANSPORT MASTER PLAN

Figure 14.3-1 shows a flowchart of the freight transport master plan. There is no freight transport master plan in the Lima and Callao Metropolitan Area. In the Urban Transport Master Plan in Lima and Callao Metropolitan Area, daily trip characteristics of residents are oriented to passenger car and public transportation is close observation, while the cargo transportation is rather weak in attention. Therefore, the previous suggestion for cargo transportation is tentative, not comprehensive.

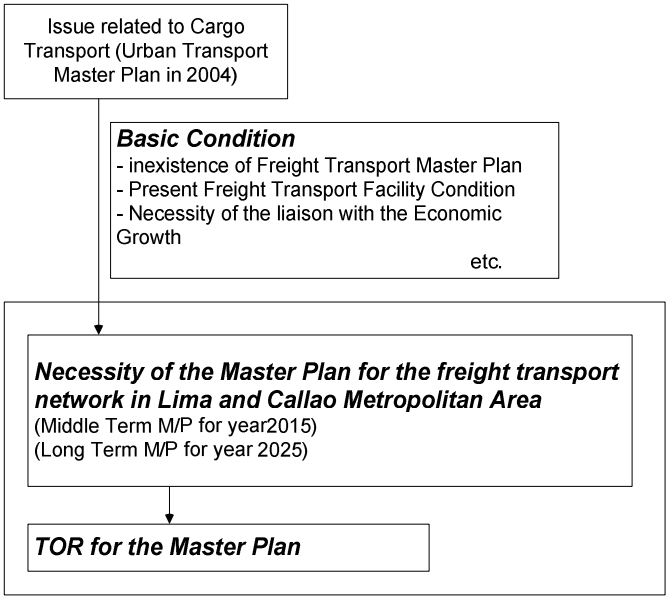


Figure 14.3-1 Flowchart for the Freight Transport Master Plan

A cargo transportation plan should be considered with regard to the following.

- Future cargo facility and distribution plans, such as cargo terminals
- Future economic activities
- Future flows of Freight volumes by items
- Future freight vehicle flows
- Plans of cargo transport system
- Improvement plan of roads for freight vehicles

It is indispensable to develop the freight transportation master plan in Lima and Callao Metropolitan Area.

14.3.2. SUGGESTION OF NECESSARY SURVEYS FOR THE MASTER PLAN

The main contents of the study are as follows.

- Freight transportation and company survey to collect its volume, items and flows
- Strategic plans for freight transport master plan
- Sector plans
  1) Freight terminals/port/airport plan
  2) Wholesale market plan
  3) Freight road corridor plan
  4) Freight railway network plan
  5) Freight transport management plan

Term of Reference for the Freight Transport Master Plan is shown in Appendix 14-1.

Appendix 14-1

Terms of Reference (TOR)
For
The Mater Plan Study of Cargo Transportation
On
The Lima and Callao Metropolitan Area
In
The Republic of Peru

1. Background of The Study

The numbers of population of the Lima and Callao Metropolitan Area is estimated at about 8.0 million in 2004, and about 11.0 million in 2025. According to increase the population and economic activities, the cargo transportation volume and car traffic volume have been increased at year by year. The heavy traffic congestions in the Lima and Callao Metropolitan Area have been occurred. The tendency of this traffic situation will be reinforced in the future.

In the year 2004 to 2005, the Urban Transportation Master Plan in the Lima and Callao Metropolitan Area was conducted by Consejo de Transporte Lima Y Callao under Ministry of Transport and Communications for mitigation of the heavy traffic congestion in Metropolitan Area.

In addition the above mentioned, the Ministry of Transport and communications is diced to conduct the Cargo Transportation Master Plan in the Lima and Callao improvement of the existing cargo transportation system, and mitigation of the traffic congestion in the Metropolitan Area.

2. The Study Objective

The objective of the Study is to conduct the Cargo Transportation Master Plan in the Lima and Callao Metropolitan Area.
Specific objectives include the following items below;

- To built of Cargo Transport Database in Lima and Callao Metropolitan Area
- To make the Strategy of the Cargo Transport policy
- To built the Cargo Transport Master Plan
- To categorize the priority project for the Cargo Transport Project

3. The Study Area

The Study Area for planning of Master Plan covers the Lima and Callao Metropolitan Area, and for projection of the future cargo transportation volume covers all Peru country.

4. Planning Target Year

The planning target year is in 2015 for middle term Master Plan and in 2025 for long term Master Plan.

5. Stage of the Study

The Study is divided the following four stages.

1) Stage -1 of the Study
The existing data and information collection and its analysis, and various field cargo transportation surveys conducted. In addition, the existing cargo transportation problems and issues should be identified.

2) Stage -2 of the Study
Based on the stage -1 of the study and social and economic analysis, the future cargo transportation volume in 2010 and in 2025 should be forecasted.

3) Stage -3 of the Study
Based on the results of the stage -1 and stage -2 of the study, the cargo transportation developing policies and strategies should be identified.

4) Stage -4 of the Study
Based on the results of the stage -1 to stage -3, the Master Plan of Cargo Transportation Plan should be prepared.

6. Major Study Components

6.1 Stage -1 of the Study

The following working items for the stage-1 of the study should be conducted.

(1) Cargo Transportation Related Facility Survey

The following cargo transportation related facility survey should be conducted to understand the existing cargo transportation facilities functions and characteristics, and to identify the problems and issues of the existing cargo transportation facilities.

1) Callao International Sea Port Facility
2) Lima International Air Port Facility
3) Railway and Railway Stations Facility
4) Wholesale Markets, Retail Markets, and Supper Markets Facilities (Sampling Rate=50% of total facilities)
5) Transportation Companies Facilities (Sampling Rate = 30% of total facilities)
6) Factories and Industrial Companies Facilities (Sampling Rate=30% of total facilities)
7) Warehouse and Companies Facilities (Sampling Rate=30% of total facilities)
8) Truck terminal Facilities (Sampling Rate=100% of total facilities)
9) Cargo Distribution Center Facilities (Sampling Rate=50% of total facilities)

(2) Cargo Transportation Origin and Destination (OD) Survey

The origin and destination survey by each cargo items should be carried out to identify the cargo transportation characteristics and transportation volume by each cargo item based on the above mentioned facilities. Basically, this survey is conducted by interview of the cargo transportation organization authorities and companies. The cargo OD survey should be included the following working items.

1) Origin and destination of each cargo item
2) Cargo transportation Volume by each cargo item
3) Imported and exported material volume by each cargo items.
4) Stopping or staying time in transportation facility by each cargo item.
5) Arrival time and departure time of each item at transportation facility
6) Transportation mode (coming in and going out of each cargo item) at transportation facility,
7) Transportation time from/to origin and destination by each cargo item.
8) Annual cargo volume transition by ach cargo items.

The cargo transportation item should be divided at the following classification

1) Foods (agriculture ad marine products)
2) Publication, book and printing materials
3) Daily used materials
4) Light industrial material
5) Forest and mining industrial products
6) Metal industrial products
7) Machine industrial products
8) Chemical industrial products
9) Mixed material (mail materials)
10) Others

(3) Truck and Railway Transportation Survey

The cargo transportation for the trucks and railway survey should be conducted based on the road side traffic interview and railway related organization to identify the conditions of cargo transportation volume passing through on the each transportation mode. Basically, the survey should be observed the following items. The truck transportation survey is conducted at 100 survey points as well as cordon line points and screen line points. The number of sampling is 10% of the each truck traffic volume on the each survey point during 24 hours.

1) Truck (small sized truck, large sized truck, and trailer) traffic volume
2) Cargo transportation volume and items by each truck
3) Origin and destination by each cargo item
4) Transportation time (departure time, arrival time, and travel time)
5) Transportation frequency per week or per month
6) Number of driver and assistants in the truck

6.2Stage-2 of the Study

The following working items for the stage-2 of the study should be examined, and future cargo transportation volume in year 2010 and in year 2025 should be

forecasted.

1) Examination of tendency on introduced free trade system between Peru and other countries
2) Examination of tendency of the future development on the Callao International Sea Port
3) Examination of tendency of the future development on the Lima International Air Port
4) Examination of the future socio economic conditions of Peru country and Lima and Callao Metropolitan Area
5) Preparation of existing OD table based on the cargo transportation by each cargo transportation item
6) Preparation of the future flame work (in 2010, and 2025) by each cargo transportation item
7) Forecasted future cargo transportation volume in 2010 and in 2025 by each cargo transport item
8) Forecasted future truck traffic volume by each cargo transportation item in 2010 and in 2025
9) Forecasted future truck traffic volume on major roads in the Lima and Callao Metropolitan Area
10) Examination of effectiveness of future truck traffic on major roads in the Lima and Callao Metropolitan Area

6.3 Stage-3 of the Study

The following cargo transportation development policy and strategy should be identified during the stage-3 of the Study based on the results of stage-1 to stage-2 of the study.

1) Future cargo transportation development policy and strategy of the Peru all the country
2) Future cargo transportation development policy and strategy of the Lima and Callao Metropolitan Area
3) Future development policy and strategy of Callao International Sea Port
4) Future development policy and strategy of LIMA International Air Port
5) Future development policy ad strategy of cargo transportation system in Lima and Callao Metropolitan Area
6) Future development policy and strategy of wholesale in Lima and Callao Metropolitan Area
7) Future development policy and strategy of truck terminal system in Lima and Callao Metropolitan Area
8) Future development policy and strategy of cargo transportation mode system and network system in Lima and Callao Metropolitan Area
9) Future development policy and strategy of cargo transportation laws and regulation in Lima and Callao Metropolitan Area

6.4 Preparation of Cargo Transportation Master Plan

In the cargo transportation Master Plan, the following plan and study should be included.

1) In the year 2015 Master Plan for middle term Plan
2) In the year 2025 Master Plan for long term Plan
3) The following sector plans should be prepared
   a) Callao International Sea Port development plan
   b) Lima and Callao International development plan
   c) Wholesale development plan
   d) Truck terminal development plan
   e) Truck road development plan
   f) Railway development plan
4) Environmental study
5) Project cost estimate
6) Benefit estimate
7) Implementation plan including privatization
8) Program of Investment in a Short, Medium and Long term
9) Project cost procurement
10) Economic and financial evaluation
11) Implementation organization
12) strategies of Management, Monitoring and Control
13) Laws and regulations

7. Study Schedule

The study is conducted during period within 24 months including submission of Final Report. The study schedule is shown in below table.

	Items/Month	3	6	9	12	15	18	21	24
Stage-1									
	Data Collection	═══	═══						
	Field Survey	═══	═══	═══					
	Analysis	═══	═══	═══					
Stage-2									
	Socio Economic		═══						
	Framework			═══	═══				
	Demand			═══	═══	═══			
	Assignment					═══			
Stage-3									
	Policy & strategy				═══	═══	═══		
Stage-4									
	Sector plan					═══	═══	═══	
	Master plan						═══	═══	
	Benefit							═══	
	I/P							═══	
	Economic/Financial							═══	
Report		▲	▲		▲		▲	▲	▲ ▲
		IC/R	PG/R(1)		PG/R(2)		IT/R(1)	IT/R(2)	F/R F/R

8. Assigned Specialist Field

The following 13 specialists should be assigned in the Study.

1) Project manager
2) Cargo Transportation Surveyor and Analyst (1)
3) Cargo Transportation Surveyor and Analyst (2)
4) Cargo Transportation Planner
5) Socio Economic Analyst

6) Sea Port Planner
7) Air Port Planner
8) City Planner
9) Traffic and Transport Planner
10) System Engineer
11) Environmental Analyst
12) Economic & Financial Analyst
13) Organization Analyst

9. Submission of the Report

The following Reports should be submitted.

1) Inception Report (within 1 month after commenced the study)
2) Progress Report (1) (within 3 months after commenced the study)
3) Progress Report (2) (within 9 months after commenced the study)
4) Interim Report(1) (within 15 months after commenced the study)
5) Interim Report(2) (within 18 months after commenced the study)
6) Draft Final Report (within 22 months after commenced the study)
7) Final Report (within 24 months after commenced the study)

CHAPTER 15
Conclusion and Recommendations

15. CONCLUSION AND RECOMMENDATIONS

(A) The East-West Trunk Bus System should be executed in accordance with the Implementation Schedule Recommended.

The population of the Lima and Callao metropolitan area in the year 2004 was estimated at about 8.0 million people, and by the year 2025 the population will reach a level of about 11.0 million, thus becoming one of the world's major cities.

Considering the size of population and socio-economic activities, the reinforcement of the effectiveness of public transportation systems such as the East-West trunk bus system should be carried out so as to establish the fundamental public transportation network in the Lima and Callao metropolitan area.

Upon completion of the East-West trunk bus system recommended in the Feasibility Study, the following contributions and improvements in effectiveness are expected. Therefore, the East-West trunk bus system should be executed in accordance with the implementation schedule recommended by the Feasibility Study.

1) Mitigation of the heavy traffic congestion, and improvement in traffic service level on existing roads as a result of the introduction of the rerouting plan of conventional buses, and articulated bus fleets.
2) Increased socio-economic activities as a result of major benefits expected, from reduced travel times, and increased travel speed.
3) Reduction in Carbon Dioxide (CO_2) emissions as a result of introduction of new articulated bus and single bus fleets.
4) Formulation of the fundamental public transportation network.
5) Promotion of good environmental urban transportation conditions as a result of the introduction of a modernized public transportation system.

(B) Recommended East-West Trunk Bus System

The following recommendations and suggestions of the East-West trunk bus system are made as a result of the Feasibility Study.

B-1) Trunk Bus Operation System

1) The trunk bus system is formed by the trunk bus and feeder bus. The trunk bus is operated on the trunk bus-way which is constructed on the existing Av. Venezuela, Av. Arica, Av. Grau, Av. Ayllon, and Carretera Central, and the feeder is operated on the existing roads which are located along the trunk bus-way in the cities of Callao and Lima.
2) The trunk bus and feeder bus are integrated in the bus terminals which are planned in the city of Callao and the Santa Anita area of the city of Lima. However, it is not integrated at the bus stops which are located on the trunk bus-way. The operational headway of trunk buses is estimated at intervals of about 45 seconds to 60 seconds in peak hours.

B-2) Re-routing of Conventional Bus Routes

1) About 30 % of the existing bus routes (conventional bus routes) which operate on the East-West trunk bus-way are concentrated or assimilated.
2) The remaining 70 % of conventional bus routes operate as in the existing operation system.

B-3) Bus Fleet

1) An articulated bus fleet with CNG engines is adopted for operation of the trunk bus-way, and a single bus fleet with CNG engines is adopted for operation of the feeder bus.

2) The floor height of articulated buses is adopted at 90 cm. so as to ensure the smooth and rapid operation of trunk buses, and the doors are located on the left hand side of the bus fleet. The floor height of the single bus fleet is adopted at a low level, and the doors are located on the right hand side of the bus fleet.

3) Before the operation of the trunk bus system, about 100 new articulated bus fleets and 300 new single bus fleets should be prepared.

B-4) Bus Fare System

1) A flat bus fare system is suggested for the operation of the trunk bus and feeder bus, to ensure smooth and rapid operation of the trunk bus system, also in addition to which, the operation bus route length is less than 20 km.

2) The bus fare ticket of the trunk bus can be sold at each bus stop and bus terminal before entering these facilities, to ensure the smooth and rapid operation of the trunk bus. Generally, however, the feeder bus ticket will be sold in the bus fleet.

B-5) Organization of Execution of Trunk Bus System

1) It is suggested that Protransporte be responsible for the execution of the East-West trunk bus system, and that it should also conduct the promotion, management, supervision, and instruction for operation of the East-West trunk bus system in Lima and Callao metropolitan area.

2) Protransporte has to reinforce the execution organization structures, administration staffs and engineers for the execution of the East-West trunk bus system and various trunk bus systems in Lima and Callao metropolitan area, in close cooperation with the related authorities in Lima and Callao.

B-6) Organization of Operation of Trunk Bus System

1) It is suggested that the private cooperative bus company be responsible for the operation of the East-West trunk bus system.

2) Protransporte should identify the detailed current conditions of the trunk bus operation, and also create the conditions and detailed bus operation organization structures of the private cooperative bus company, before the operation of the East-West trunk bus system, with close cooperation with the organizations and companies involved.

B-7) Trunk Bus-way Facilities Design

The following trunk bus way facilities are recommended.

1) Trunk busway with 2-lanes will use the central traffic lanes on the existing Av. Venezuela, Av. Arica, Av. Ayllon, and Carretera Central, separated by concrete structures from the private vehicle lanes as the exclusive trunk bus-way.

2) The bus stop facility is planned on the left hand side of the exclusive trunk lane with a 90cm. platform height.

3) 21 bus stops are planned at the major intersections of Av. Venezuela, Av. Arica, Av. Ayllon, and Carretera Central.

4) Two bus terminals are planned in the city of Callao and Santa Anita in the city of Lima.

5) All the intersections of the trunk bus-way are planned as At-grade with signalized intersection type.

B-8) Project Cost

The total project cost of busway infrastructures including construction cost and land acquisition cost, and contingency and tax is estimated at about US$ 61.5 million.

The total purchase cost of articulated and single bus fleets for operation of the East-West trunk bus system is estimated at about US$ 52.0 million respectively.

B-9) Financial Resources

The total investment required to realize the East-West trunk bus way in 2010 is estimated at US$ 113.5 million. This required investment apparently exceeds the historical budget of the municipalities of Lima and Callao. Taking into account the burden share of benefits, the following financial resources should be promoted.

1) Use of ODA loan

2) Introduction of privatization system

3) Reduction of the project cost.

(C) Recommended Traffic Management Plan

C-1) Traffic Safety Education Plan

The following matters or conditions are recommended based on the results of traffic safety education improvement analysis in the study.

1) Preparation of execution information and materials

2) Reinforcement of execution organization structure

3) Securing of staff, engineers and budget

4) Execution of traffic safety education plan in accordance with implementation schedule in the study.

C-2) Traffic Accident Improvement Plan

The following matters or conditions are recommended based on the results of traffic accident monitoring analysis in the study.

1) Reinforcement of execution organization structure

2) Establishment of traffic accidents (5-function) data base

3) Securing of staffs, engineers and budget

4) Execution of traffic accident improvement plan in accordance with implementation schedule in the study.

C-3) Signal Control Improvement Plan

The following matters or conditions are recommended based on the results of signal control improvement analysis in the study.

1) Synchronized traffic signals should be introduced on the major trunk roads in accordance with the improvement plan in the study.

2) Left turn traffic lanes should be installed in major at-grade intersections in accordance with the improvement plan in the study.

3) Traffic lane markings near intersections should be created in accordance with the improvement intersection plans in the study.

4) The traffic regulations or controls should be enforced at the major intersections.

C-4) Traffic Demand Management Plan

The following matters or conditions are recommended based on the results of traffic demand management analysis in the study.

1) Execution of license-plate numbering control system

2) Reinforcement of implementation organization

3) Securing of staff, engineers and budget

C-5) Car Parking System Improvement Plan

The following matters or conditions are recommended based on the results of car parking improvement analysis in the study.

1) Installation of paid parking facilities

2) Enforcement of patrol and inspection

3) Reinforcement of execution organization structure

4) Securing of staff and budget

(D) Suggestion of Para-Transit Transportation Modes

D-1) Taxi Transportation

The following conditions and activity are suggested for the planning strategy of the future taxi transportation development plan.

1) Easing or mitigation of restrictions for taxi registration regulations, so as to reduce the number of unregistered taxis.

2) Taxi fare meter machines should be installed in all taxi vehicles so as reduce problems between drivers and passengers.

3) Driving safety education should be reinforced to reduce traffic accidents

4) Taxi transportation mode is identified as the supporting transportation system of railway and bus transportation.

5) Taxi stands should be constructed at near the trunk bus stops and railway stations in the future.

D-2) Colectivo Transportation

The following conditions and activity are suggested for the planning strategy of the future Colectivo, transportation development plan.

1) The Colectivo transportation routes should be eliminated on the East-West trunk busway and other trunk bus routes.

2) The Colectivo transportation mode will be assimilated to the taxi transportation.

D-3) Mototaxi Transportation

The following conditions and activity are suggested for the planning strategy of the future mototaxi transportation development plan.

1) The Mototaxi should be supported to the conventional bus system in the community areas.

2) The mototaxi stations should be constructed at center of community areas.

3) The traffic safety education for the Mototaxi driver should be reinforced.

D-4) Cargo Transportation

The following conditions and activity are suggested for the cargo transportation development plan.

1) The large freight vehicles should be prohibited passing through on the Av. Pan Americana Norte and Sur during peak hours.

2) Considering the future truck traffic demand, the Cargo Transportation Master Plan should be conducted in accordance with the terms of reference for the cargo transportation master plan prepared in the study.

(E) Future Studies Needed

E-1) Final Design of East-West Trunk Bus System

To ensure smooth and prompt execution of the East-West trunk bus system, the final design of the East-West trunk bus system should be conducted in accordance with the Implementation Schedule recommended in the Feasibility Study.

E-2) Feasibility Study of Other Trunk Bus Routes

In the Urban Transportation Master Plan prepared in 2005, a total of ten (10) trunk bus routes by 2010 were recommended as the short term action plan. The feasibility study of the following remaining six (6) trunk bus routes should be conducted as soon as possible for the reinforcement of the public transportation system in the Lima and Callao metropolitan area.

1) Av. Universitaria Sur

2) Av. Callao - Canta

3) Av. Javier Prado

4) Av. Panamericana Norte

5) Av. Panamericana Sur

6) Av. Brasil

E-3) Execution Design of Traffic Management Plans

The following five (5) traffic management improvement plans were recommended in the Study. More detailed execution design should be conducted to mitigate the traffic congestion in Lima and Callao metropolitan area in accordance with the recommendations of the improvement plans.

1) Traffic safety education improvement plan

2) Traffic accident improvement plan

3) Traffic signal improvement plan

4) Traffic demand management plan

5) Car parking system improvement plan.