CHAPTER 11
Future Travel Demand

11. FUTURE TRAVEL DEMAND

11.1. TRAVEL DEMAND MODEL

11.1.1. MODEL STRUCTURE

For estimating travelers' demand for transport facilities and services, the urban travel demand model commonly known as the "Four-Step Method" was employed in the Study. The four-step method is used to predict (1) the number of trips made within the Study Area by purpose, (2) zonal origin-destination (OD) pair, (3) the mode of travel used to make these trips, and (4) the routes taken through the transport network by these trips.

In the Lima metropolitan area, it was disclosed from the data analysis that car ownership considerably influences the determination of modal choice between private car and public bus. The modal choice is somewhat made on the basis of the travel time or travel cost on the route to destination. In this Study, the urban travel demand model was made taking into consideration the trip characteristics such as demand structure and modal choice.

The flowchart of forecasting model is shown in Figure 11.1-1. The model was composed of Estrato rank of households, by trip purpose and by mode corresponding to each step, as shown in Table 11.1-1. Estrato closely relates to household income level. A household with higher rank's Estrato takes high income and high car ownership ratio. The number of daily trips for high Estrato household members is higher than the low Estrato which means non-motorized, and the ratio of passenger car trip to the all motorized trips by the high Estrato is considerably higher than the low Estrato. In the Study, in order to take into account trip characteristics by Estrato rank, the travel demand model by Estrato rank was made based on 446 traffic zones in which 427 zones are within the Study area and 19 zones are outside of the study area.

As for forecasting of truck demand, a truck demand model was made in another way in which the airport, Callao port, and truck company survey data as well as the person trip survey data was collected and taken due to the fact that the truck trip data from the person trips survey is insufficient. The following four step model is excluded for the truck mode.

The classifications of Estrato rank's households, trip purposes and transport modes are shown below.

1) Classification of households into Estrato rank
    a) Estrato A and B: highest household income group
    b) Estrato C: lower than Estrato A and B group
    c) Estrato D: lower than Estrato C group
    d) Estrato E: lowest household income group
2) Trip Purposes
    a) To work
    b) To school
    c) Business
    d) Private/Shopping
    e) To home
3) Classification of Modes
    a) Private Mode: Car and Taxi
    b) Public Mode: Bus and Railway

Table 11.1-1 Model Structure

Step	By Estrato	By Purpose	By Mode
1) Trip Production Model	O	-	-
2) Trip Generation/ Attraction Model	O	O	-
3) Trip Distribution Model	O	O	
4) Modal Split Model	O	O	O
5) Traffic Assignment	-	-	O

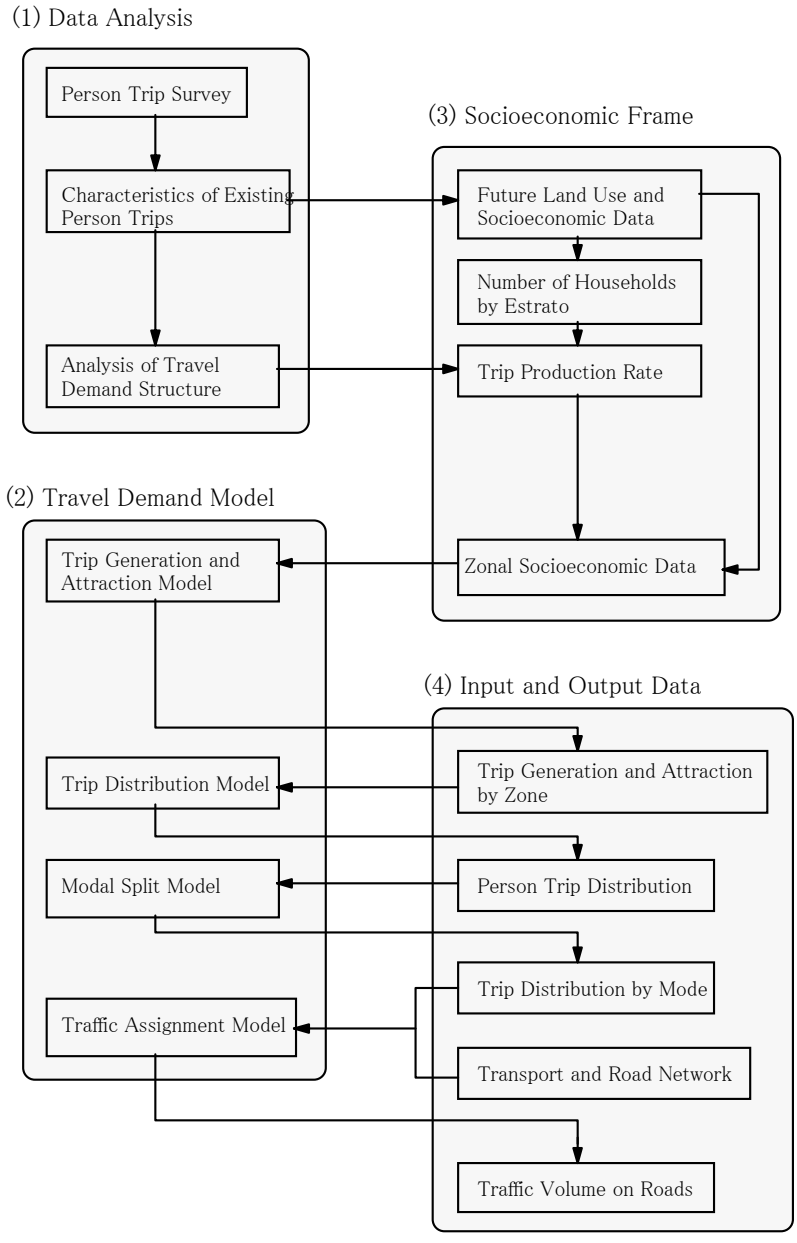


Figure 11.1-1 Flowchart of Forecasting Model

11.1.2. TRIP PRODUCTION MODEL

Trip production model is to estimate the total trip production for an entire zone. Future total trip production in the Study Area was estimated by using trip production rate (number

of trips per person) on the assumption that the rate will be an unchangeable factor in the future. The total trip production was estimated by classified Estrato household members due to the fact that the production rate between the Estrato is considerably different. Table 11.1-2 shows the trip production rate by Estrato, which is for car, taxi and public transport trips per population who is 6 years old or over.

Table 11.1-2 Trip Production Rate

Estrato	Trip Production rate (trips/person/day)
Estrato-AB	2.153
Estrato-C	1.752
Estrato-D	1.470
Estrato-E	1.227

$P = \Sigma PRi \times Popi$

P: Total Trip Production

PRi: Trip Production Rate by 4 Estrato Households

Popi: Population (6 years or above) by 4 Estrato Households

i: 4 Estrato

11.1.3. TRIP GENERATION AND ATTRACTION MODEL

Trip generation and attraction model is to estimate zonal generated and attracted trips, which are adjusted into agreement with the total trip production, i.e., control total. Trip generation and attraction by zone are forecasted by Estrato and by trip purpose (exclusive of "to home") as before-mentioned. As for "to home" purpose, the trip generation is reflected as the total sum of attracted trips of other purposes exclusive of "business" purpose. On the other hand, the trip attraction is as the total sum of generated trips in the same manner.

Linear type regression models were developed to estimate trip generation and attraction. The equation is shown below;

$Gi = a + b1*Xi1 + b2*Xi2$

$Aj = a + b1*Xj1 + b2*Xj2$

where;

Gi: Generation trip from zone i

Aj: Attraction trip to zone j

Xin, Xjn: Socioeconomic data in zone i or j

a, b1, b2: model parameters

Parameters of variables and zone with dummy variable are shown in Table 11.1-3.

Table 11.1-3 Parameter of Trip Generation and Attraction Model

Y=a+b1*x1+b2*x2+b3*x1*x2

		a	b1	b2	b3	X1	X2	r
1) Estrato:AB								
(1) Generation	To Work	-20.395	1.140			ER_Ter	y	0.930
	To School	-111.412	1.014			SR_Total	y	0.905
	Business	107.414	0.168	874.464	0.136	JW_Ter	dummy	0.887
	Private	138.709	0.809	3865.421	0.219	ER_Ter	dummy	0.893
(2) Attraction	To Work	-536.267	1.497			JW_Ter		0.977
	To School	-216.991	1.112			SS_Total		0.975
	Business	-127.006	0.333			JW_Ter		0.932
	Private	-94.010	1.136			JW_Ter		0.909
2) Estrato:C								
(1) Generation	To Work	91.926	0.919			ER_Ter		0.943
	To School	96.165	0.692			SR_Total		0.922
	Business	115.943	0.088	503.484	0.001	JW_Total	dummy	0.863
	Private	607.979	0.356	2851.157	-0.071	JW_Total	dummy	0.857
(2) Attraction	To Work	-297.126	1.203			JW_Ter		0.964
	To School	-307.584	0.980			SS_Total		0.956
	Business	-46.611	0.226			JW_Ter		0.912
	Private	-154.557	1.071			JW_Ter		0.899
3) Estrato:D								
(1) Generation	To Work	14.999	0.759			ER_Total		0.966
	To School	153.588	0.547			SR_Total		0.930
	Business	117.690	0.059	642.294	0.020	ER_Total	dummy	0.850
	Private	377.118	0.659	3228.856	-0.308	ER_Ter	dummy	0.859
(2) Attraction	To Work	-560.629	1.228			JW_Ter		0.924
	To School	-547.051	0.843			SS_Total		0.886
	Business	-158.144	0.175			JW_Total		0.862
	Private	-649.732	1.140			JW_Ter		0.863
4) Estrato:E								
(1) Generation	To Work	-62.271	0.742			ER_Total	y	0.965
	To School	97.555	0.331			SR_Total	y	0.865
	Business	69.279	0.045	222.864	0.030	ER_Ter	dummy	0.845
	Private	165.376	0.618	1190.719	0.096	ER_Ter	dummy	0.869
(2) Attraction	To Work	127.819	0.712	998.205	0.455	JW_Ter	dummy	0.882
	To School	180.528	0.166	802.394	0.156	SS_Total	dummy	0.850
	Business	15.073	0.105	426.964	0.078	JW_Total	dummy	0.857
	Private	65.346	0.727	2642.092	0.377	JW_Ter	dummy	0.867
5) Total								
(1) Generation	To Work	390.615	0.934			ER_Ter		0.949
	To School	760.358	0.532			SR_Total		0.878
	Business	375.569	0.101	2132.879	-0.013	JW_Ter	dummy	0.857
	Private	1007.351	0.681	9020.123	-0.277	ER_Ter	dummy	0.855
(2) Attraction	To Work	-1826.880	1.335			JW_Ter		0.964
	To School	-1376.367	0.926			SS_Total		0.916
	Business	-418.410	0.251			JW_Ter		0.947
	Private	-1058.189	1.117			JW_Ter		0.912

11.1.4. TRIP DISTRIBUTION MODEL

Voorhees-type gravity models were developed to estimate interzonal trips by Estrato and by purpose. The "to home" trip was estimated in the same manner as generated and attracted "to home" trip.

(1) Interzonal Trips

$$Tij = Gi \frac{Aj * Dij^{a}}{\sum_{j=1}^{n} (Aj * Dij^{a})}$$

where;

Tij: OD trips between zone i and j

Gi: Generated trips from zone i

Aj: Attracted trips to zone j

Dij: Travel time distance between zone i and zone j (hr)

a: Parameter

The model parameters show in Table 11.1-4.

(2) Intrazonal Trip Model

$Tii = K \cdot Gi^{a} \cdot Ai^{b} \cdot Li^{c} \cdot Di^{d}$

where;

Tii: OD trips inside zone i

Gi: Generated trips from zone i

Ai: Attracted trips to zone i

Li: Area of zone i (km2)

Di: Dummy variable

K,a,b,c,d : Parameters

The model parameters show in Table 11.1-5.

Table 11.1-4 Parameters of Trip Distribution Model

Estrato	Trip Purpose	Parameter	Correlation R
AB	To Work	-0.943	0.758
	To School	-1.554	0.706
	Business	-1.018	0.599
	Private Matter	-1.453	0.736
	To Home	-1.005	0.769
C	To Work	-0.864	0.707
	To School	-1.454	0.704
	Business	-0.721	0.472
	Private Matter	-1.583	0.722
	To Home	-0.934	0.754
D	To Work	-1.329	0.787
	To School	-1.865	0.793
	Business	-1.303	0.536
	Private Matter	-1.824	0.828
	To Home	-1.181	0.756
E	To Work	-1.206	0.723
	To School	-2.106	0.697
	Business	-1.570	0.577
	Private Matter	-1.754	0.778
	To Home	-1.301	0.741

Table 11.1-5 Parameters of Intrazonal Model

Estrato	Trip Purpose	Parameter					Correlation R
		K	a	b	c	d	
AB	To Work	-0.7857	0.4055	0.2774	0.2257	1.0895	0.88
	To School	-0.9655	0.6640	0.0909	0.3837	0.9805	0.83
	Business	0.9671	0.4029	0.1300	0.1180	1.2691	0.84
	Private Matter	-2.8758	0.8533	0.1959	0.2653	0.5651	0.89
	To Home	-5.3282	0.3741	0.8785	0.4466	0.0000	0.90
C	To Work	-2.7300	0.5448	0.3650	0.4052	1.0054	0.85
	To School	-2.1222	0.6410	0.2694	0.4106	0.8957	0.85
	Business	2.1839	0.2319	0.1153	-0.0008	0.9959	0.88
	Private Matter	-1.1714	0.6129	0.2194	0.2129	0.9389	0.86
	To Home	-3.3311	0.3246	0.7257	0.3883	0.6455	0.89
D	To Work	-3.6592	0.6993	0.3325	0.4099	0.6533	0.90
	To School	-3.8328	0.8446	0.3252	0.3304	0.7471	0.91
	Business	1.0975	0.2680	0.2300	0.0998	1.0997	0.88
	Private Matter	-4.0136	0.7864	0.3688	0.4245	0.6931	0.87
	To Home	-4.7554	0.4199	0.7950	0.3685	0.5880	0.93
E	To Work	-0.1571	0.4528	0.2093	0.1634	1.0292	0.89
	To School	-1.9357	0.5897	0.4025	0.3083	0.6421	0.87
	Business	1.2700	0.3407	0.1232	0.1535	0.8271	0.78
	Private Matter	-2.5234	0.7321	0.2712	0.3094	0.9061	0.88
	To Home	-2.2473	0.3136	0.6212	0.3750	0.8188	0.85

11.1.5. MODAL SPLIT MODEL

(1) Introduction

The modal choice between car, taxi and public transport is forecasted after estimating the OD trips by all modes. The disaggregated model was employed in the study in which multinomial logit model was developed. In the modal split model, the transport modes were split into 3 modes: car, taxi and public transport (conventional bus, trunk bus and rail) as shown in Figure 11.1-2.

The logit model was developed based on the data of a stated preference (SP) survey in which modal choice of people is surveyed on the assumption that nonexistence transport mode such as railway is served in the metropolitan area. This is since railway and trunk bus systems, which do not exist now, will be proposed in the study, the preference mode of people on the proposed plan must be forecasted among from several transport modes.

In the study, forecasting the travel demand of nonexistence transport mode needs the SP data in order to take factors for modal choice among from existence and nonexistence modes. On the other hand, a revealed preference (RP) data is for actual behavior such as the data of person trip survey. The SP survey data is mainly used for modal split model of public transport such as bus, railway and other new public transport.

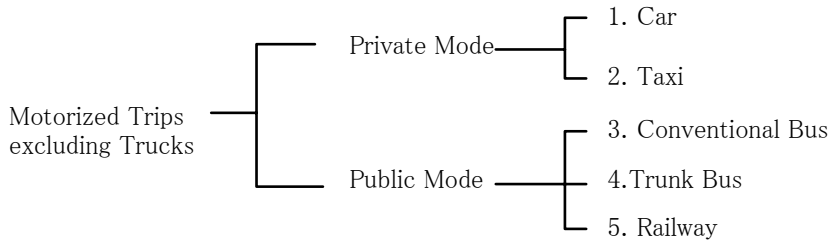


Figure 11.1-2 Classification of Modal Split

(2) Multinomial Logit Model

In order to collect the SP data, the SP survey was carried out in August 2004 before making the modal split model. The interviewed samples were approximately 2,400 samples, in which 1200 samples are for the home interview survey, 300 samples for shopping centers, and 900 samples for companies. The home interview survey was carried out according to the households sampled in proportion to ratio of number of households classified by Estrato rank.

As for the company interview and the shopping place interview in Destination Survey, the Estrato of company employees and shoppers are roughly classified by the location of company and shopping place. Therefore, the shopping centers in which those household members of particular Estrato will shop were also selected in the same manner as that of Estrato. The company was selected according to the company scale sampled in proportion to ratio of a company scale.

In the SP survey, modal choice of interviewee was surveyed among from variables of the Level of Service (LOS) composed of travel time, travel cost, waiting time at public transport facility, and transfer times for public transport.

A utility function in the logit model is following.

$$Ucar = \alpha 1 + \beta_1 * \text{Travel Time} + \beta_2 * \text{Travel Cost}$$

$$Utaxi = \alpha 2 + \beta_1 * \text{Travel Time} + \beta_2 * \text{Travel Cost} + \beta_3 * \text{Waiting Time}$$

$$Ubus = \alpha 3 + \beta_1 * \text{Travel Time} + \beta_2 * \text{Travel Cost} + \beta_4 * \text{Waiting Time} + \beta_7 * \text{Transfer Times}$$

$$Utrunk\ bus = \alpha 4 + \beta_1 * \text{Travel Time} + \beta_2 * \text{Travel Cost} + \beta_5 * \text{Waiting Time} + \beta_8 * \text{Transfer Times}$$

$$Utrain = \beta_1 * \text{Travel Time} + \beta_2 * \text{Travel Cost} + \beta_6 * \text{Waiting Time} + \beta_9 * \text{Transfer Times}$$

Where:

Ui: Utility of mode i: mode option (car, taxi, conventional bus, trunk bus and rail)

$\beta_1, \beta_2, \beta_3, \beta_4$: coefficient of mode

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

Where:

Pi: probability to choose the mode i

The modal split model was made by Estrato and by trip purpose in exclusive of business and private matters. This is because the business and private matter trips were collected from the companies and shopping centers and it is difficult to identify Estrato from personal property. Table 11.1-6 shows the model structure of the logit model. Table 11.1-7 shows model coefficient of utility function by mode, which is composed of car, taxi, conventional bus, trunk bus and rail modes. However, projection of modal split is estimated for three modes: car, taxi and public transport.

Table 11.1-6 Model Structure of Logit Model

Estrato	To work	To school	Business	Private Matters	To home
Estrato-AB	○	○	○	○	○
Estrato-C	○	○			
Estrato-D	○	○			
Estrato-E	○	○			

Table 11.1-7 Coefficient of Utility Function

Parameter		To Work				To School				Business	Private
		AB	C	D	E	AB	C	D	E		
$\alpha 1$	Constant of Car	0.115441	−0.64226	−2.13831	−6.1184	−1.39669	−3.15167	−2.93072	−17.6804	0.3471	−0.6354
$\alpha 2$	Constant of Taxi	−0.74594	−0.12552	19.72594	−2.3969	−0.06398	−0.50542	−0.12662	−1.90519	0.544	−0.9215
$\alpha 3$	Constant of Bus	−2.03669	−1.84094	−1.77197	−1.6149	−1.95645	−1.56448	−3.32377	−2.40073	−1.0117	−1.0558
$\alpha 4$	Constant of Trunk Bus	−0.52926	−0.39475	0.360476	−0.0955	0.398972	0.98331	−0.81261	−0.1716	0.5053	0.3746
β_1	Travel Time	−0.04731	−0.04424	−0.0427	−0.0137	−0.04042	−0.03464	−0.07463	−0.02336	−0.0489	−0.0321
β_2	Travel Cost	−0.49946	−0.73031	−1.05803	−0.4262	−0.50185	−0.63095	−1.82666	−0.72227	−0.5774	−0.5224
β_3	Taxi Waiting Time	−0.27453	−0.0492	−6.47302	−0.0894	−0.17321	−0.2525	−0.40582	−0.16175	−0.2558	−0.1691
β_4	Bus Waiting Time	−0.01153	−0.09872	−0.29461	−0.2363	−0.20322	−0.28052	−0.03401	−0.15275	−0.2152	−0.2397
β_5	Trunk Bus Waiting Time	−0.11284	−0.19818	−0.30624	−0.3026	−0.30513	−0.54616	−0.52028	−0.39436	−0.2632	−0.2576
β_6	Train Waiting Time	−0.19173	−0.31836	−0.22523	−0.3387	−0.34043	−0.48827	−0.71069	−0.3418	−0.211	−0.2152
β_7	Bus Transfer Time	−0.31423	−0.08871	−0.79207	−1.3487	−0.67551	−0.92612	−2.84733	−0.16528	−0.2672	−0.4302
β_8	Trunk Bus Transfer Time	−0.04974	−0.10234	−0.24623	−0.2951	−0.8612	−0.55828	−0.36232	−0.16542	−0.1053	−0.253
β_9	Train Transfer Time	−0.17349	−0.01601	−0.42127	−0.2146	−0.18783	−0.1097	−0.36236	−0.58555	−0.1054	−0.3269

11.1.6. TRAFFIC ASSIGNMENT MODEL

The last step in the four-step method is the assignment of the predicted modal flows between each origin-destination pair to actual routes through the given mode's network. In this study, the traffic assignment model has two systems. One is for private vehicle such as cars and trucks inclusive of taxis on roads. The private vehicle passes on minimum distance/time route chosen in this model. The other is for public transport (bus) on fixed routes. The buses are assigned on fixed routes prepared in the model. Both assigned traffic volumes were combined together on the same road network after conducting traffic assignment separately.

(1) Average Occupancy and Passenger Car Unit (PCU)

The person base trip OD tables (trip/person) by mode have to be modified into passenger car unit (trip/PCU). These OD tables were firstly modified into vehicle base unit divided by average number of passengers (occupancy) and then, multiplied by PCU factor. The average occupancy and PCU factor used for the conversion are shown in Table 11.1-8.

Table 11.1-8 Average Occupancy and PCU

Vehicle Type	Average Occupancy	PCU Factor
Car	1.91	1.0
Taxi	1.07	1.0
Bus	29.4	3.0

Note: PCU factor of bus is for Omnibus

(2) Traffic Assignment Model for Private Mode

Traffic assignment is to predict traffic volume on roads chosen by minimum distance/time route. The speed of vehicle to select minimum-time route is governed by the relation of traffic volume to the capacity. Hence, the speed of vehicle is determined according to the speed-flow curves which are governed according to number of lanes, one-way and dual-way traffic flows, and land-use conditions along roads classified into urban area, rural area and unpaved roads.

The traffic assignment model for private mode is "capacity restraint" method as shown below:

a) OD matrices are divided into following 5 lots to make the phased assignment of the traffic : 1st 30%, 2nd 20%, 3rd 20%, 4th 20% and 5th 10%.
b) Minimum time-route is selected on roads.
c) The 1st lot of trips is assigned to the selected route, and the number of trips passing over each link of network is counted.
d) Travel speed on each road is modified according to speed-flow curves.
e) The above four steps are iterated.

As mentioned before, cars, taxis and trucks are assigned in this model. On the other hand, buses are assigned under the transit model. Finally, after assigned on roads separately, both modes, public and private transport, are combined together to estimate transport facilities.

(3) Traffic Assignment Model for Public Mode

Minimum bus and railway routes from among several alternative routes by OD pair is chosen taking into account the waiting time at bus stops and stations when passengers transfer buses and railway, and public transport passengers are assigned on this route. This

assignment system calls transit assignment system. In this model, the assigned public transport route is determined by each lot according to frequency of service instead of the speed-flow curve. When the frequency is exceeded by the assigned number of buses and rail transit, this transport is not chosen in next lot.

Method of the model is outlined as follows:

a) OD matrices are divided into the following 5 lots to make the phased assignment of the traffic: 1st 30%, 2nd 20%, 3rd 20%, 4th 20% and 10%.
b) Minimum-distance route is selected on the assumption that minimum-time bus and railway route was selected from among the alternative routes. When the minimum pass is selected, waiting time and transfer time at bus stops and stations are taken into account.
c) The 1st lot of trips is assigned to the selected route, and the number of trips incrementally loaded onto transport network is counted.
d) Frequency of service by each transport route (input data) is compared to assigned number of transports derived from the assigned number of passengers. When the number of transports exceeds the frequency, this route is not chosen in the next lot.
e) The above 4 steps are iterated.

11.2. ESTIMATION OF FUTURE HOUSEHOLDS BY ESTRATO RANK

Since the travel demand model is structured by households classified by Estrato as mentioned before, the number of households by Estrato in future must be estimated. There is a close relationship between Estrato and household income according to the analysis of the Person Trip Survey data. This relationship was used for the estimation of the number of households by Estrato, by inputting both the future income distribution estimated and number of households in the same Estrato.

The procedure of estimation is shown below.

a) Estimation of relationship between Estrato and household income at the present.
b) Estimation of distribution of number of households against the income in the same Estrato at the present.
c) Estimation of distribution of the number of households against the future income (proportion to GRDP/capita) in the same Estrato.
d) Estimation of difference between the present and future numbers of households in the same Estrato.
e) This different value is number of households to move to a higher rank of Estrato.

The estimated figures are shown in Table 11.2-1and Figure 11.2-1. The growth ratio of Estrato AB is the highest at 2.27 times, followed by Estrato C (1.98). Estrato D and E are decreased in the ratio and number. According to future economic growth (1.78 times in 2025), population of Estrato AB and C are increase, while Estrato D and E are decrease.

The share of population by Estrato to the total in 2025 considerably fluctuates. The share of Estrato D accounts for 41% of the total in 2004. Estrato AB and C are a share of 21% and 23%, respectively. In 2025, the shares of Estrato AB and C increase at 35% and 34%, respectively. Estrato E is estimated at a share of 9% in 2025.

Table 11.2-1 Number of Population (6 years or above) by Estrato in 2004 and 2025

(Unit: persons)

Items	Years	Estrato Rank				
		AB	C	D	E	Total
Population	2004	1,539,017	1,730,615	3,038,230	1,063,523	7,371,385
	2025	3,499,419	3,432,055	2,223,444	923,354	10,078,272
Composition	2004	0.21	0.23	0.41	0.14	1.00
	2025	0.35	0.34	0.22	0.09	1.00
Growth Ratio/2004		2.27	1.98	0.73	0.87	1.37
Different between 2004		1,960,402	1,701,440	-814,786	-140,169	2,706,887

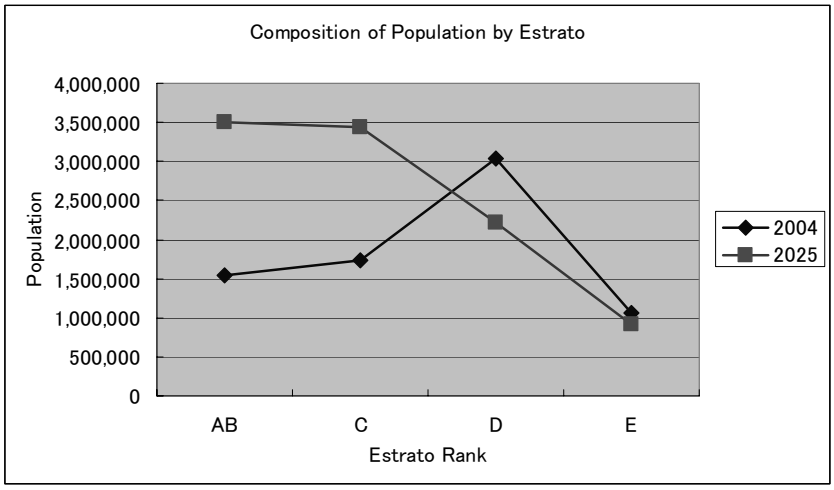


Figure 11.2-1 Composition of Population by Estrato

11.3. PROJECTION OF TRAVEL DEMAND

11.3.1. TOTAL NUMBER OF TRIPS

Table 11.3-1summaries socioeconomic indices and travel demand in 2004 and 2025. The total number of trips per day in the Study Area in 2025 is approximately 17.95 million. The trip increase ratio from the year 2004 to 2025 is approximately 1.48, in contrast to 1.37 of the population growth ratio. The trip production rate in terms of number of trips per person aging 6 years or above rises from 1.64 to 1.78. This indicates that in 2025, the share of the higher Estrato household ratio to the total contributes to the increase of the production rate.

Table 11.3-2 shows travel demand by Estrato in 2004 and 2025. The trip shares of Estrato AB and C in 2025 are increase, while Estratos D and E are decrease. In 2025, the composition ratio of Estrato AB is approximately 42% and its increase ratio is 2.27 times. On the other hand, trip share of Estrato E is as low as 6% in 2025, in contrast to 11% in 2004.

Table 11.3-1 Summary of Socioeconomic Indices and Travel Demand

Items	2004	2025	2025/2004
Population (6 years or more)	7,371,385	10,078,272	1.37
GRDP/capita (S./ in 1994)	7,563	13,467	1.78
Number of Trips by Motorized modes (Numbers)	12,118,571	17,950,737	1.48
Number of Vehicles (Cars) owned by Households (Vehicle)	419,851	1,039,143	2.48
Vehicle (Car) Ownership (/1000) by Household	52.2	94.5	1.81
Trip Production Rate / pop (6 years or more) (Trip/day) (Car, Taxi and Public Transport)	1.64	1.78	1.08

Note: trips including car, taxi and public transport by the residents dwelled in the study area

Table 11.3-2 Travel Demand by Estrato

(Unit: trip/day)

Items	Years	Estrato Rank				
		AB	C	D	E	Total
Number of Trips	2004	3,313,545	3,032,537	4,467,270	1,305,219	12,118,571
	2025	7,534,343	6,013,951	3,269,247	1,133,195	17,950,737
Composition	2004	0.27	0.25	0.37	0.11	1.00
	2025	0.42	0.34	0.18	0.06	1.00
Increase Ratio/2004		2.27	1.98	0.73	0.87	1.48

11.3.2. TRIP GENERATION AND ATTRACTION

Estimated trip generation and attraction in 2025 according to the integrated zone are shown in Table 11.3-3 and Figure 11.3-1 in which those projections are for all purposes and all Estrato in which "to home" trips are excluded to clearly show the characteristics of generation and attraction. As can be seen, trip generation and attraction in zone No. 1 (Lima) are larger volume of trips, especially, trip attraction is the largest. Second larger zone in generation and attraction is No.4 (Miraflores). In 2025, traffic and transport demands concentrate in those zones. This is because work-place/school-place base population (employment) is substantially concentrated in the central area when the distribution of population in nighttime is compared.

The trip generation in the years 2004 and 2025 according to the integrated zone are shown in Table 11.3-3 and Figure 11.3-2. Those table and figure show a comparison between the figures in 2004 and 2025 As seen, the increase rates of trip generation between 2004 and 2025 in zone Nos. 4 (Miraflores: 1.6) and 5 (La Molina: 2.2), and suburb areas (No.12: 3.6, No.13: 2.6 and No.14: 4.9) are considerably higher, while in central area (Nos. 1, 2 and 3) they are somewhat lower (1.3-1.5) than the average.

As for trip attraction as shown in Table 11.3-3 and Figure 11.3-2, the increase rate of the peripheral areas (Nos.7, 8, 9 and 11) is higher (1.7-3.2), in contrast to 1.3-1.8 in the generation. In the central area, the figures are lower (1.2-1.3). However, the trip attraction volumes in the central area (Nos.1 and 4) are remarkably heavy.

Table 11.3-3 Trip Generation and Attraction by Integrated Zones in 2004 and 2025

(Exclusive of "to home" purpose)

(Unit: trips/day)

zone	Name of District	2004		2025		2025/2004	
		Gen	Att	Gen	Att	Gen	Att
1	Lima	1,043,351	2,122,933	1,586,727	2,613,326	1.52	1.23
2	Callao	429,260	425,068	627,671	569,848	1.46	1.34
3	Los Olivos	932,606	645,221	1,216,391	846,827	1.30	1.31
4	Miraflores	919,517	1,282,176	1,473,307	1,660,782	1.60	1.30
5	La Molina	157,910	167,693	352,511	202,288	2.23	1.21
6	Chorrillos	206,510	154,648	300,236	222,396	1.45	1.44
7	Villa Salvador	733,912	423,682	921,783	738,783	1.26	1.74
8	Ancon	287,411	164,287	512,385	526,106	1.78	3.20
9	Carabayllo	477,548	260,992	627,566	470,949	1.31	1.80
10	San Juan de Lurigancho	590,971	308,339	712,960	437,057	1.21	1.42
11	Lurigancho	621,994	461,118	987,966	1,055,960	1.59	2.29
12	Cieneguilla	11,219	6,593	39,830	7,910	3.55	1.20
13	Lurin	43,929	33,944	114,510	165,651	2.61	4.88
14	San Bartolo	13,854	7,089	68,517	11,388	4.95	1.61
15	Outside of Study Area	282	6,491	421	13,510	1.49	2.08
Total		6,470,274	6,470,274	9,542,781	9,542,781	1.47	1.47

Gen: Generation
Att: Attraction

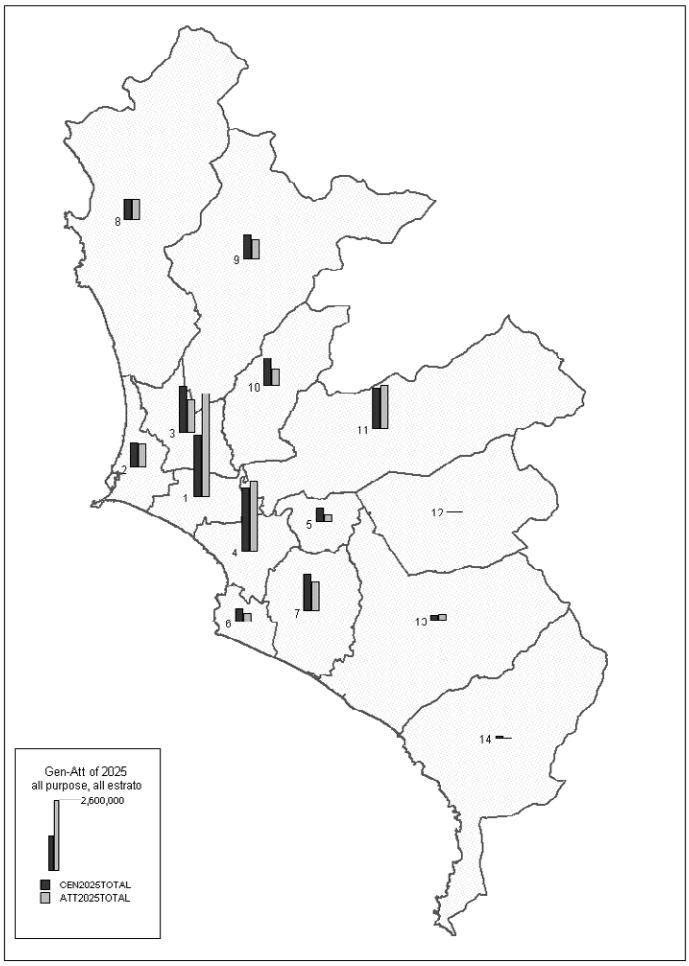


Figure 11.3-1 Trip Generation and Attraction in 2025 (All Purposes exclusive of To home)

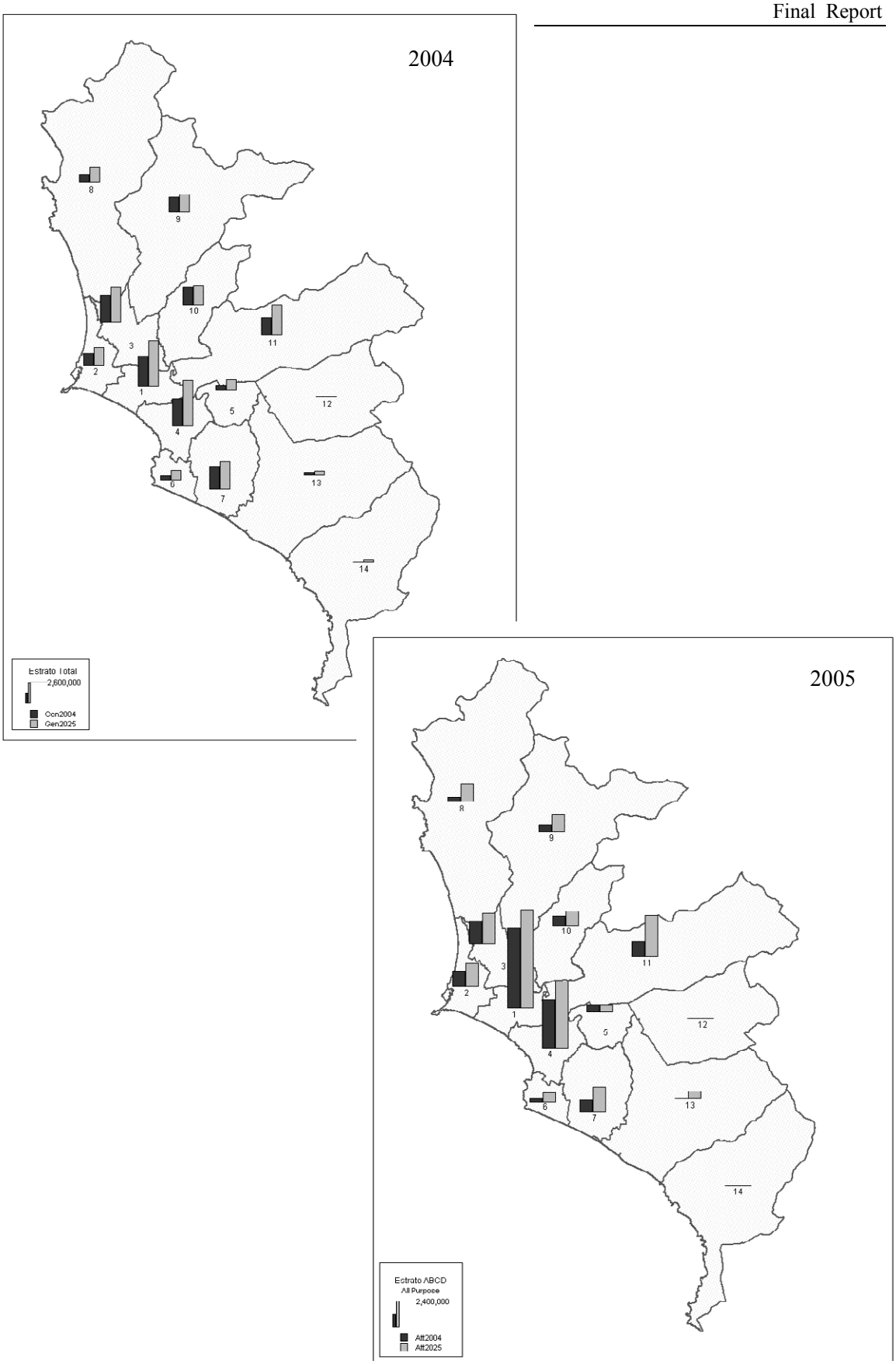


Figure 11.3-2 Trip Generation and Attraction (exclusive of To home) in 2004 and 2025

11.3.3. TRIP DISTRIBUTION

Figure 11.3-3 illustrates the desire lines by all purposes for interzonal trips in 2004 and 2025. As seen, heavy trip flows in 2025 cover the whole Study Area, and invade into the northern and eastern areas to a particularly high degree. Compared to the strong desire lines, which are predominant within the central area in 2004, OD trips in 2025 linked between the central and suburban areas in the fringe of the study area increase considerably.

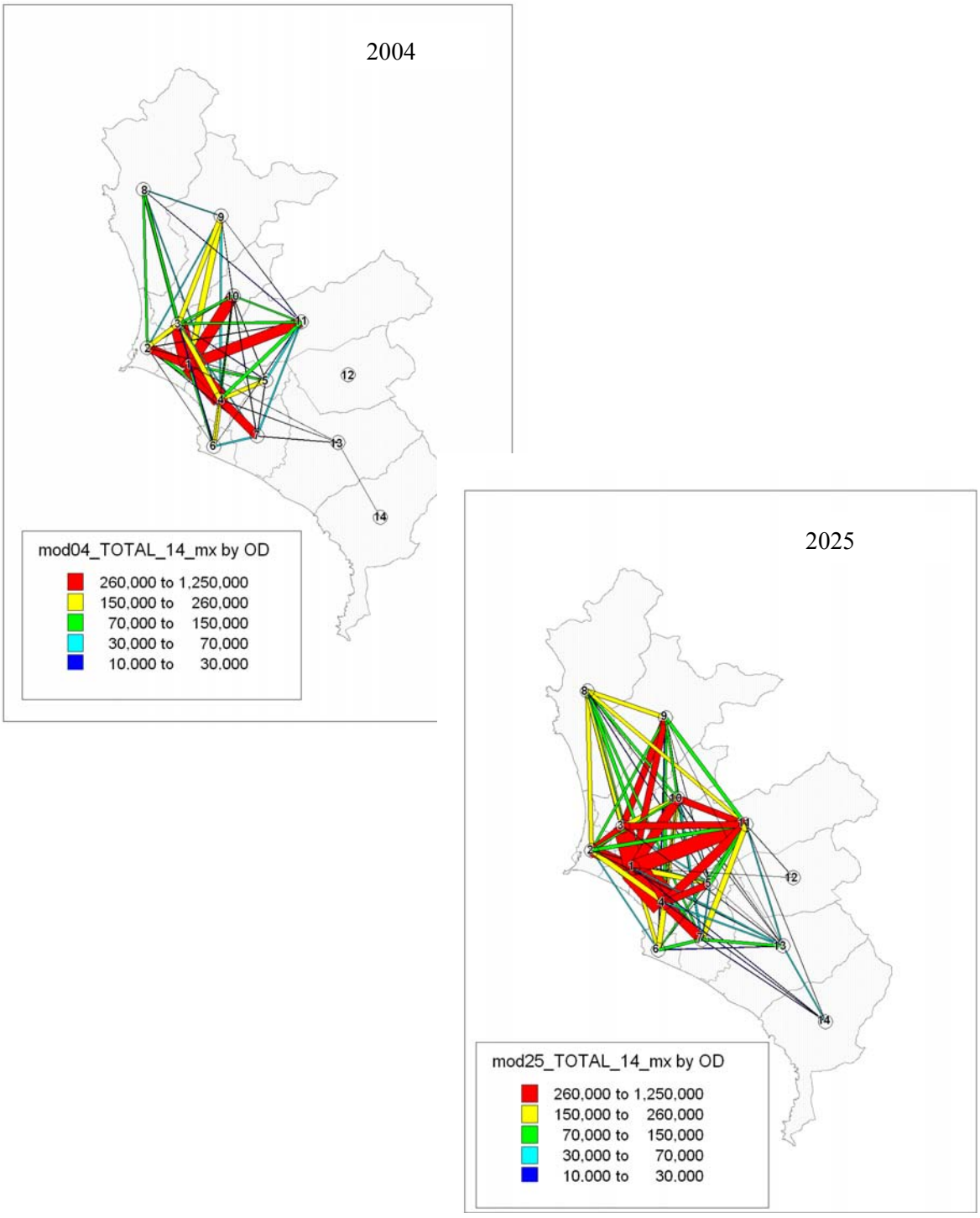


Figure 11.3-3 Trip Desire Line by All Purposes in 2004 and 2025

11.3.4. MODAL SPLIT

The number of trips by three modes, car, taxi and public transport, is shown in Table 11.3-4. The table shows the number of persons calculated from the PT data. In 2025, the modal shares of car, taxi and public transport are 23%, 7% and 70%, respectively. The increase ratios of each mode between 2004 and 2025 are 2.2 for car, 1.4 for taxi and 1.3 times for public transport. In 2025, car trips on person base raise at approximately 2 times, while public transport trips somewhat low in increase ratio, compared to car trips.

The desire lines by the private (car and taxi) and public mode (conventional bus, trunk bus and railway) are shown in Figure 11.3-4 and Figure 11.3-5, which also compares the desire lines in 2004 and 2025. In 2025, the desire lines by the public mode strongly cover entire Study Area, while in 2004 they cover mainly the central business/ commercial areas (zone Nos. 1, 2, 3, 4 and 5) and suburban areas. On the other hand, the private mode in 2025 links the central and its surrounding area with strong desire lines.

Table 11.3-4 Modal Share of Person Trips (persons/day)

(Unit: persons/day)

Trips by Modes		Car	Taxi	Public	Total
Trips	2004	1,853,295	900,138	9,365,138	12,118,571
	2025	4,041,689	1,261,286	12,647,761	17,950,737
	2025/2004	2.18	1.40	1.35	1.48
Composition	2004	15.3%	7.4%	77.3%	100.0%
	2025	22.5%	7.0%	70.5%	100.0%

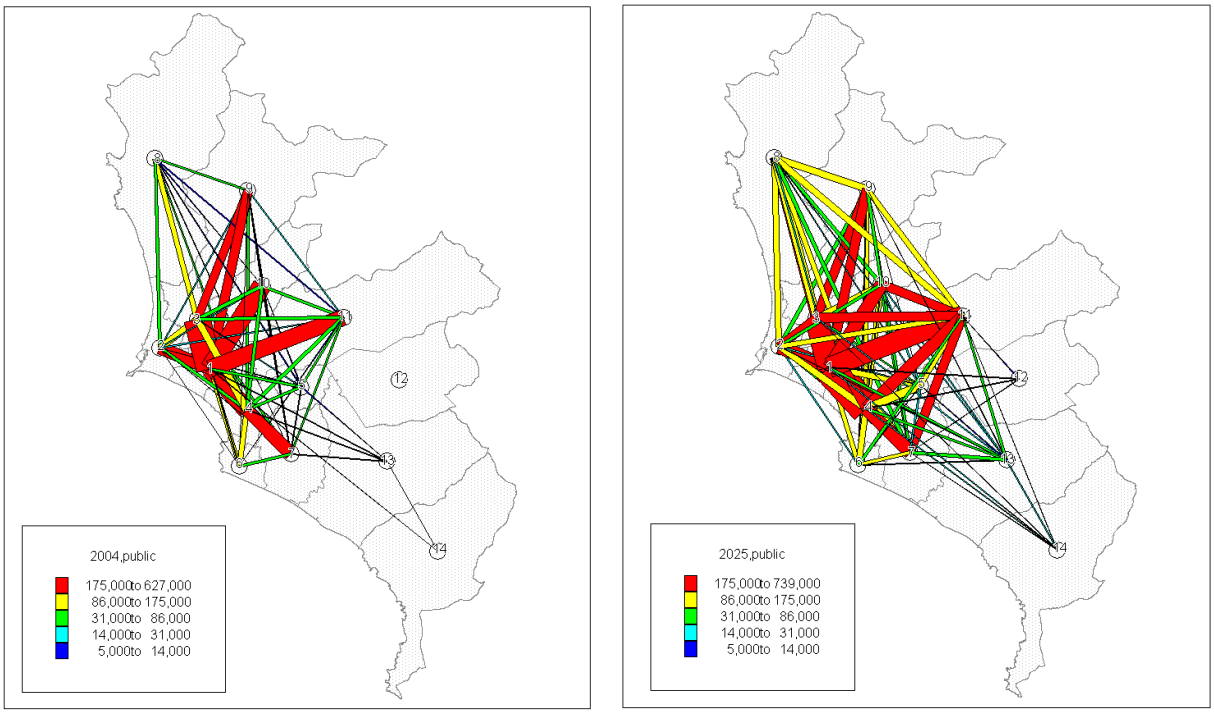


Figure 11.3-4 Daily Trip Desire Line by Public Modes in 2004 and 2025

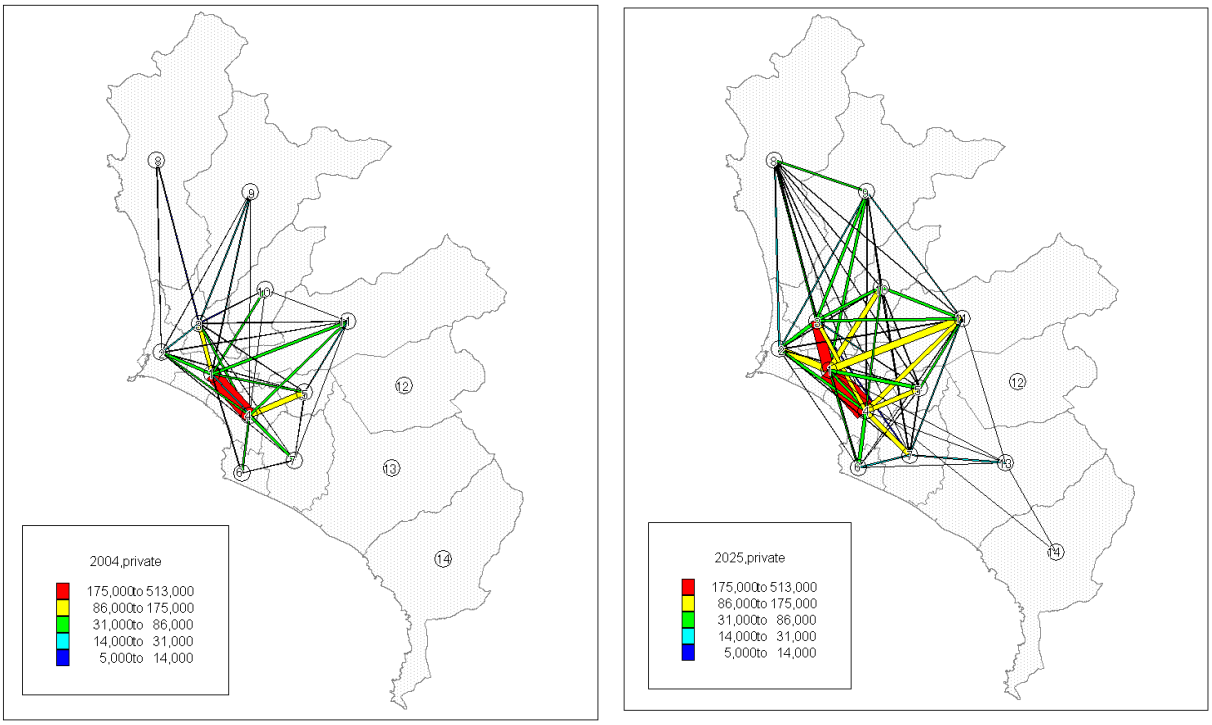


Figure 11.3-5 Daily Trip Desire Line by Private (Car and Taxi) Modes in 2004 and 2025

11.3.5. TRAFFIC AND TRANSPORT DEMAND ON ROAD AND TRANSPORT NETWORKS

(1) Travel Demand on Transport Networks

Traffic assignment was made under the conditions on which the OD trips in 2025 roads on the present network to disclose traffic demand on major corridors. The traffic demands in 2004 and 2025 are shown in Figure 11.3-6 and Figure 11.3-7. In those figures, the traffic volume on each road transport facilities drawn by a narrow band whose width is proportional to the assigned traffic volume. When comparing traffic volume in both figures, in 2025, the traffic volume-capacity ratio exceeds 1.0 on almost all the roads. The future traffic conditions will be severe if no improvements are made in the transport network.

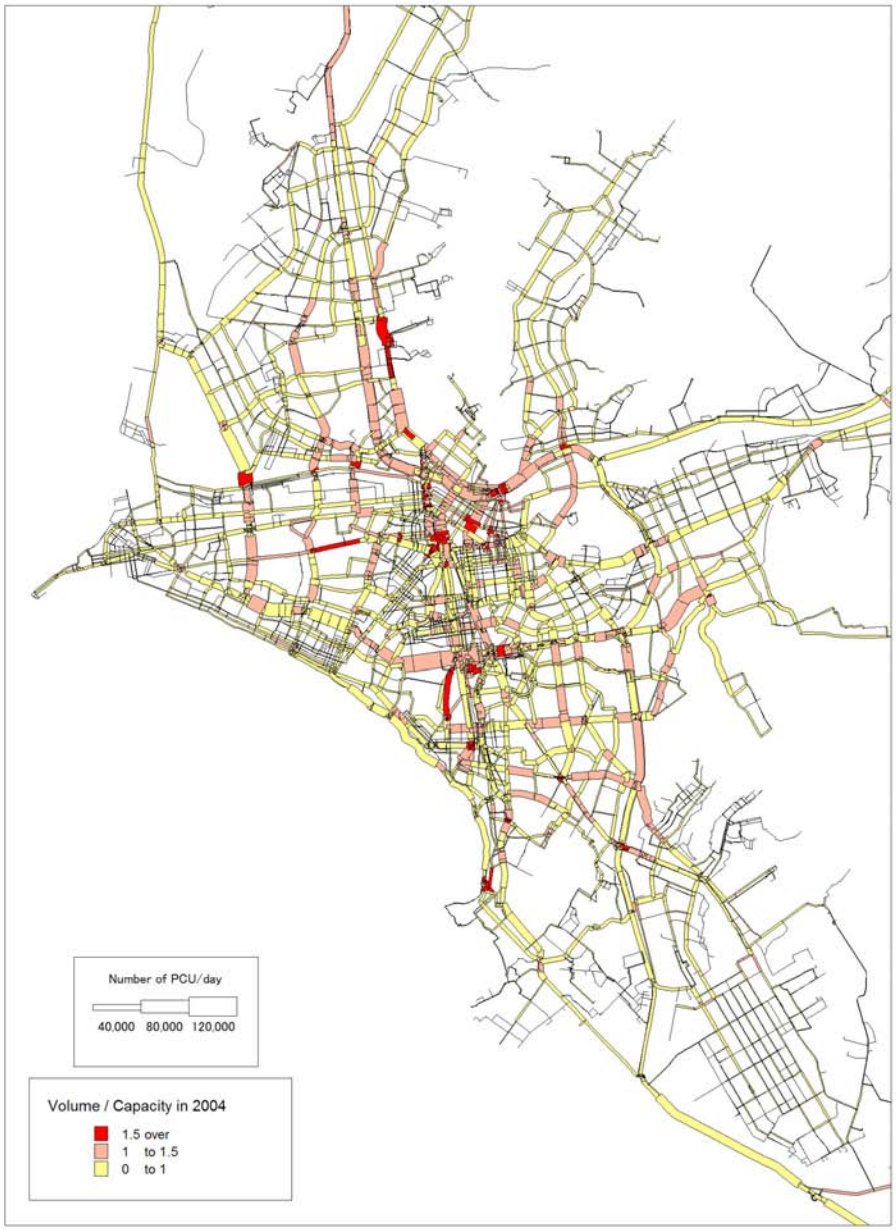


Figure 11.3-6 Traffic Demand on Present Road and Transport Networks in 2004

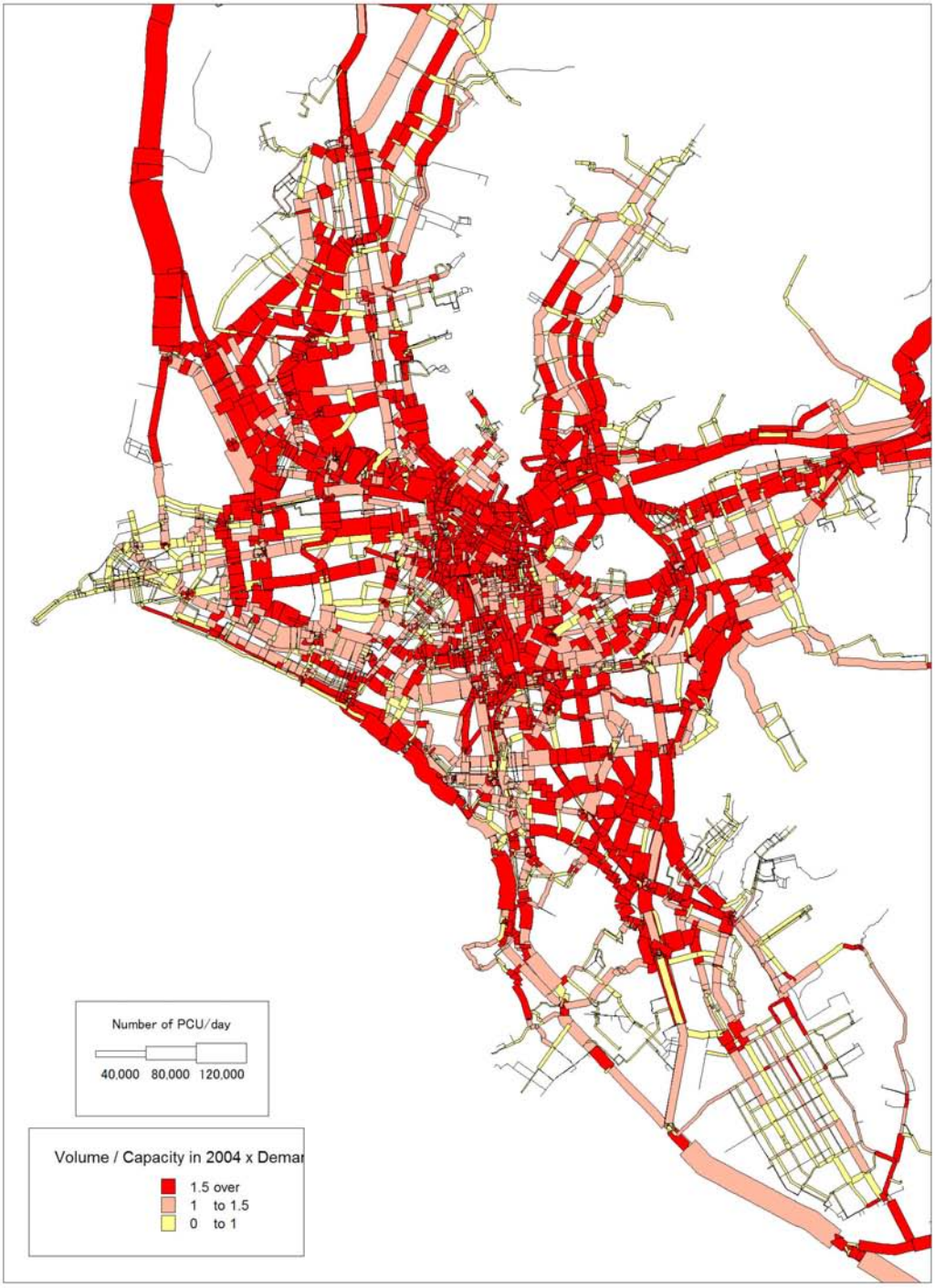


Figure 11.3-7 Traffic Demand on Present Road and Transport Networks in 2025 (Without Case)

11.3.6. HOURLY TRIP OD TABLES IN PEAK HOUR

(1) Procedure

The estimation of the rapid transit system is based on the travel demand in the peak hour. The transit operation plan such as transit service frequency on transit route, transit fleet operational needs, busway lanes/railway, bus stop/railway station facility, etc. is conducted on the bases of demand in the peak hour, exclusive of economic evaluation on the daily base demand.

Therefore, the peak hour OD trip table is estimated based on the Person Trip survey data, which has departure and arrival time in each trip data. The peak hour trips are for a period of 7:00 a.m. to 8:00 a.m. in the morning. Only trip data, traveled during the peak hours are selected from Trip Master data and the peak hour OD trip table is made from these trip data. The OD trips are finally adjusted to the traffic volume in the same peak hour on the screen line.

The future peak hour OD trips are forecasted by multiplying the ratio of present peak hour OD trips to daily OD trips by future daily OD trips estimated in the Master Plan.

The peak hour OD trips are estimated on the unit of person trip by mode.

(2) Projection of Travel Demand

1) Number of Trips at Peak Hour

The total number of person trips in the morning peak hour in the Study Area in 2004 is forecasted at approximately 1.10 million in inclusive of the external and external trip of the study area. The peak hour trip ratio is 8.7%. Summary of travel demand is shown in Table 11.3-5. As for the trips by mode: private and public modes, numbers of trips by mode (private and public) in the year 2004 are 820,000 for public mode and 275,000 for the private (excluding truck). Ratios of peak hour trips to daily trips by mode are 8.7 % for public mode and 8.8 % for the private, respectively.

As for the composition of trip modes in 2004, the shares of private and public transport are approximately 25% and 75% in the morning peak hour. Those shares are the similar as those in daily trips. In 2025, the total number of person trips is approximately 1.63 million/hour of which 533 thousands are for the private and 1.10 million are for the public. The increases in ratios of trips in the peak hour from 2004 to 2025 by mode are 1.34 for public mode and 1.92 for the private.

Table 11.3-5 Future Travel Demand in Peak Hour

(Unit: Person trips trips/hour, and day)

Year	Period	Car	Taxi	Private	Public	Total
2004	Peak	153,574	121,832	275,406	820,377	1,095,783
	Day	1,772,188	1,366,240	3,138,428	9,395,779	12,534,207
	Ratio	8.7%	8.9%	8.8%	8.7%	8.7%
2010	Peak	201,610	124,810	326,420	885,598	1,212,018
	Day	2,352,520	1,426,574	3,779,095	10,109,118	13,888,213
	Ratio	8.6%	8.7%	8.6%	8.8%	8.7%
2025	Peak	358,765	171,091	529,856	1,097,912	1,627,768
	Day	4,042,874	1,940,371	5,983,245	12,685,983	18,669,228
	Ratio	8.9%	8.8%	8.9%	8.7%	8.7%

(Note: the trip includes the external-external trip of the study area)

2) Trip Generation and Attraction at Peak Hour

Figure 11.3-8 and Figure 11.3-9 show the trip generation and attraction in the morning peak hour in 2004 and 2025 by public and private modes, respectively. The trip generation and attraction by the public mode are considerably different in trip volume. The trip attraction in 2004 and 2025 in the central commercial areas: Zones No. 1 and 4, is dramatically higher than the generation in the same zones, while other zones surrounding those zones: residential areas, show that the trip generation is considerably higher than the attraction. This indicates that almost all the bus passengers concentrate into the central commercial areas: above-mentioned zones, by means of public transportation.

3) Trip Distribution at Peak Hour

Trip distribution in the morning peak hour in 2004 by the public and private modes is shown in Figure 11.3-10 and Figure 11.3-11 by desire line charts. Those figures show by inbound and outbound directions which are to or from a central commercial area: zone No. 1 In these figures, the movement between the zone blocks where trip attraction is predominant: zones No. 1 and 4 and the others surrounding those zone blocks: mainly residential areas, is shown in order to clear the directional movement between each OD pair. The width is proportional to the number of trips between zone blocks.

As can be seen in those figures in 2004, large inbound movements by the public and private modes from every residential area located in north, northeast and southeast regions to the central commercial areas can be seen in the morning peak hour. On the other hand, outbound movement is low in the trip volume. This indicates that people living in surrounding areas travel into the central areas by means of public transport.

Figure 11.3-12 and Figure 11.3-13 show the desire line charts in 2025 by the public and private modes. Those movements show similar patterns with higher volumes than those in 2004. Especially, the movement of the private mode is wider in volume and area than that in 2004 when the movement is only one direction between zones No. 1 and 4.

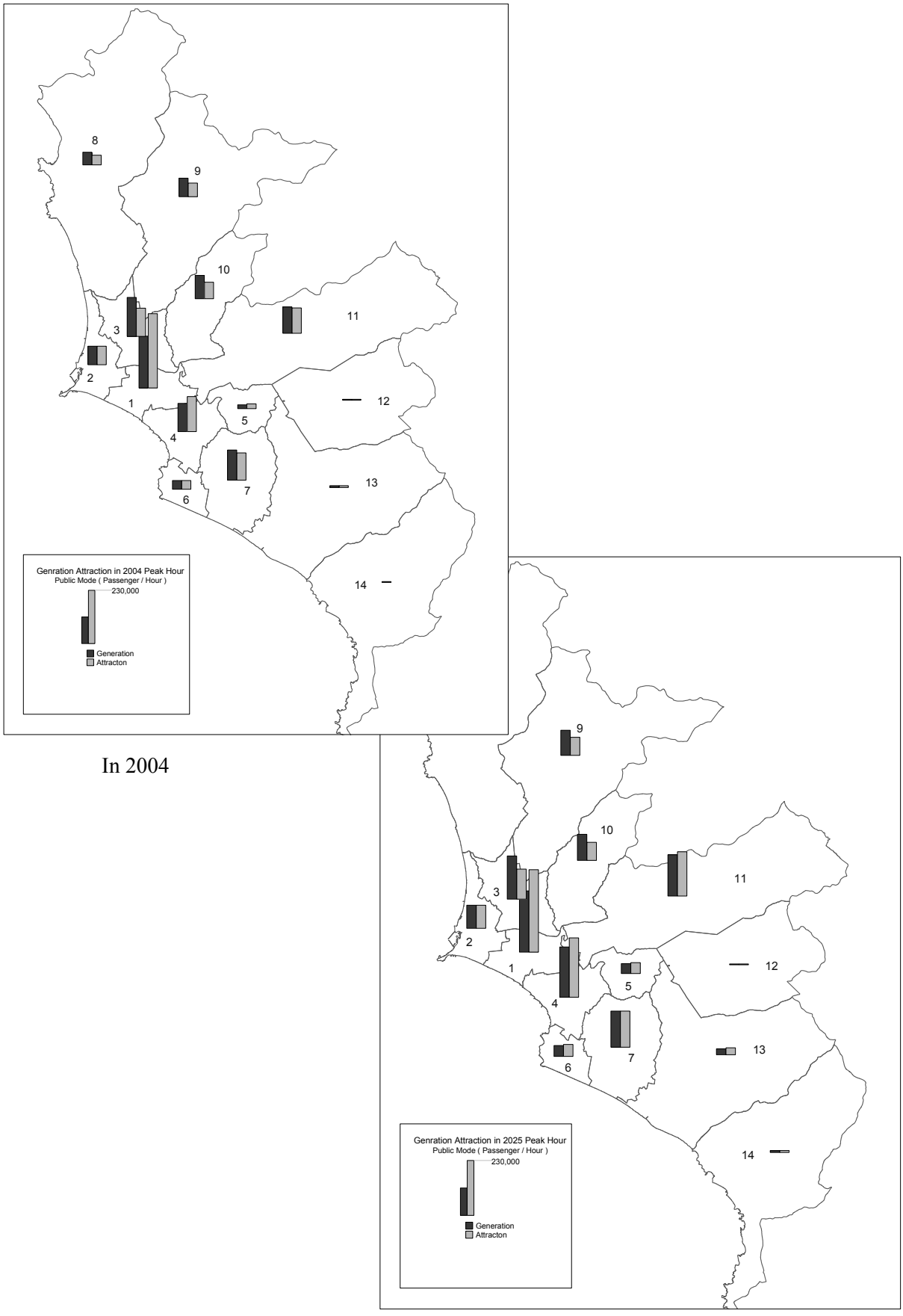


Figure 11.3-8 Peak Hour Trip Generation and Attraction by Public Mode in 2004 and 2025

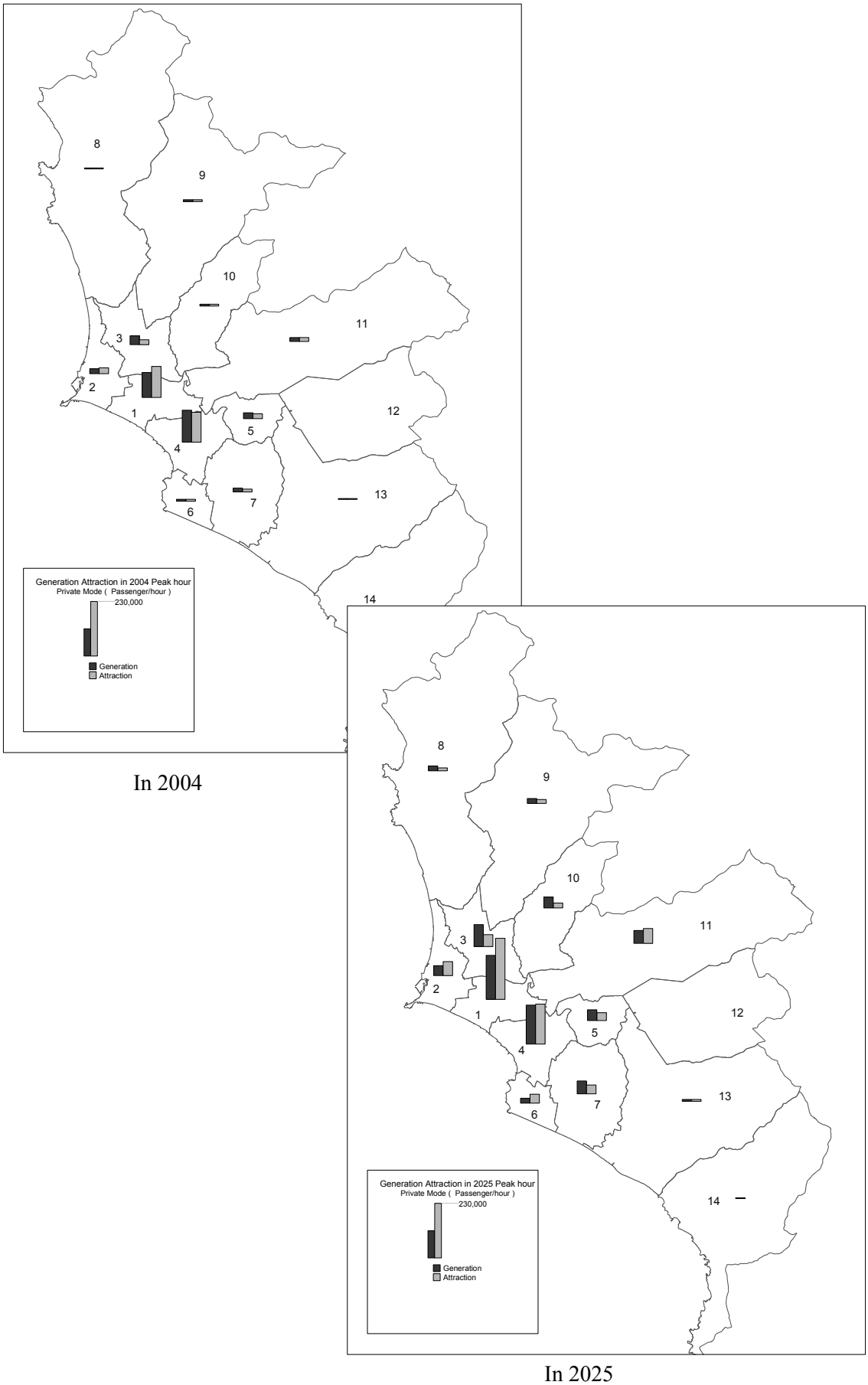
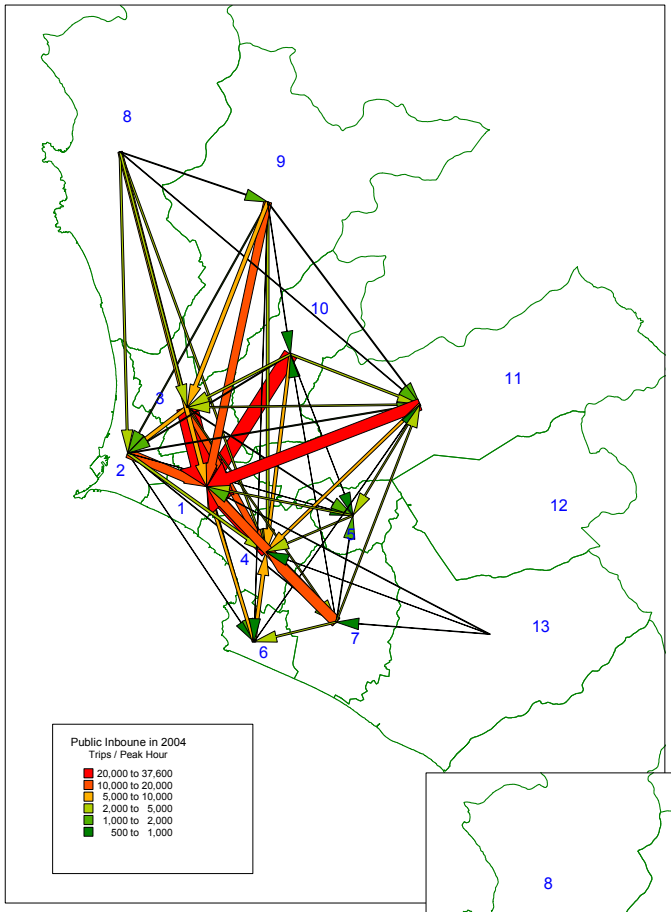
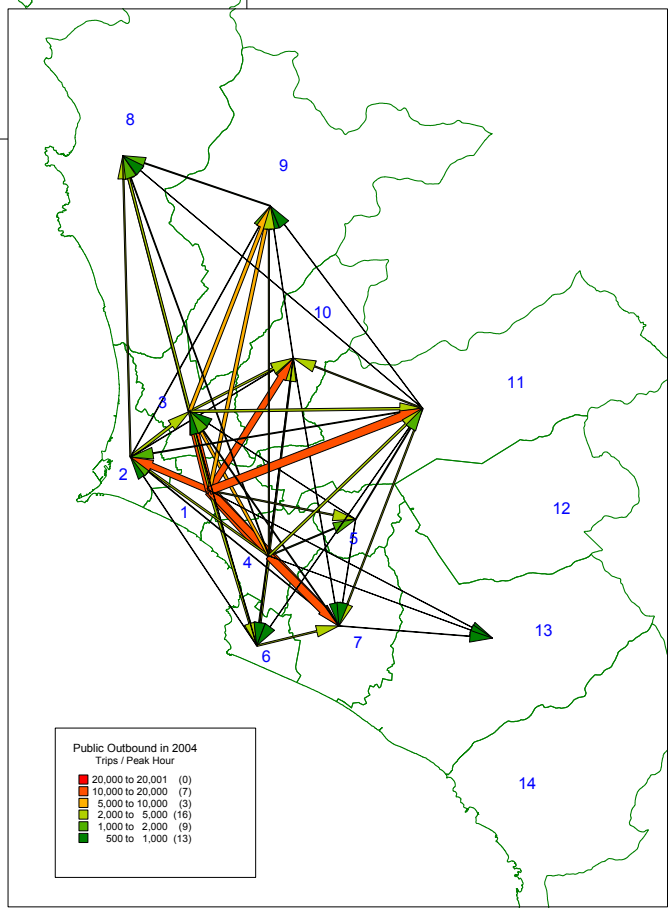


Figure 11.3-9 Peak Hour Trip Generation and Attraction by Private Mode in 2004 and 2025



Inbound Direction



Outbound Direction

Figure 11.3-10 Peak Hour Trip Desire Lines by Public Modes in 2004

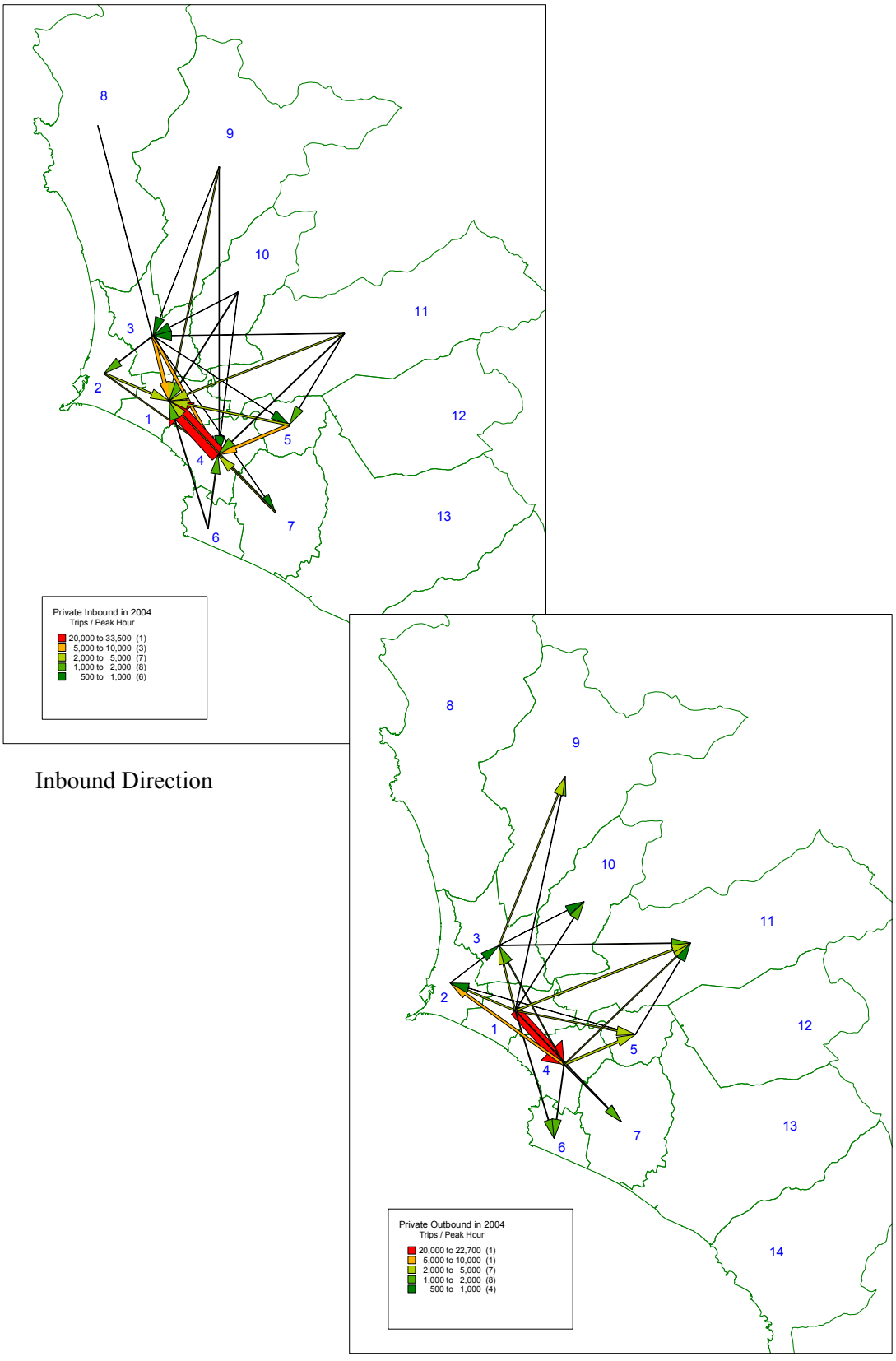
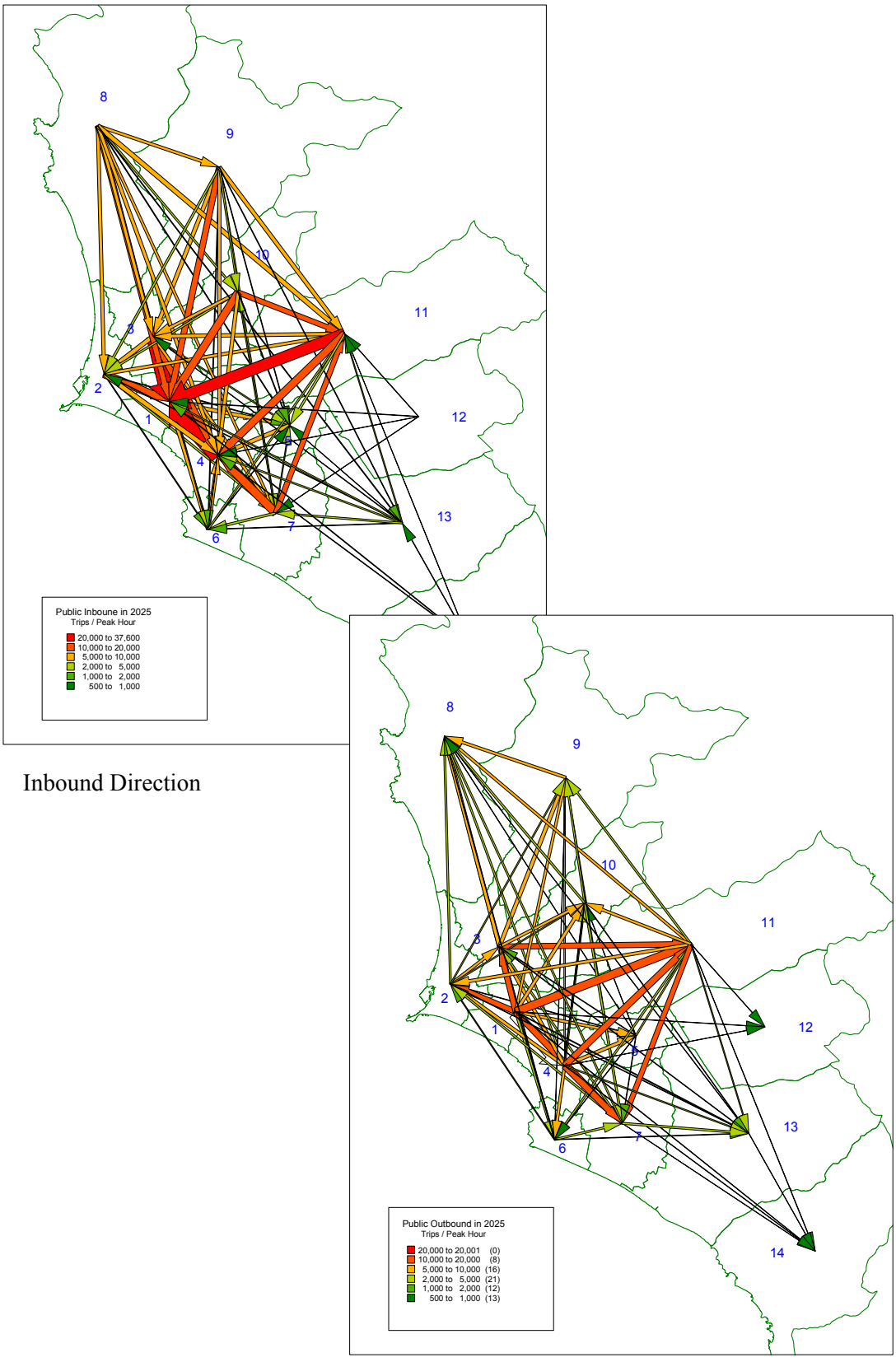


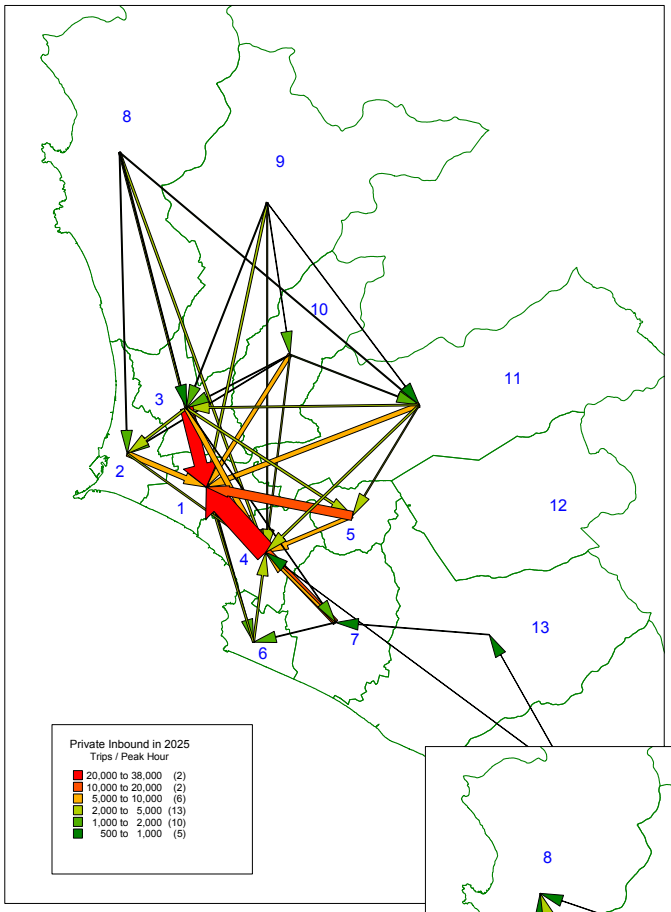
Figure 11.3-11 Peak Hour Trip Desire Lines by Private Modes in 2004



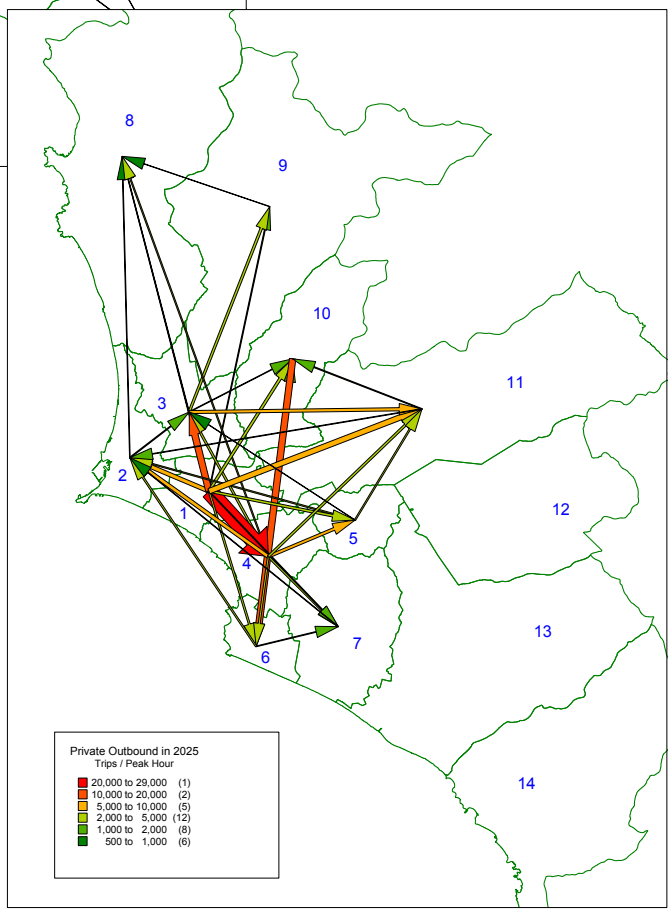
Inbound Direction

Outbound Direction

Figure 11.3-12 Peak Hour Trip Desire Lines by Public Modes in 2025



Inbound Direction



Outbound Direction

Figure 11.3-13 Peak Hour Trip Desire Lines by Private Modes in 2025

CHAPTER 12
Future Transport Network Analysis

12. FUTURE TRANSPORT NETWORK ANALYSIS

12.1. GENERAL PLANNING CONDITIONS IN THE STUDY AREA

12.1.1. GENERAL CONDITIONS OF THE STUDY AREA IN 2025

(1) Transfiguration of General Conditions

The transfiguration of the general transport and traffic conditions of the study area in the period of year 2004 to 2025 is summarized based on the results of previous study and its analysis.

1) Population and Income

The number of population in 2004 in the study area is estimated about 8.0 million, and the number of future population in 2025 is estimated at about 11.0 million as 3.0 million population increased compare with population in 2004 (the detailed calculation are shown in Chapter 10 of this report). According to the increasing of the economic activities in the study area, the average monthly family income also will be forecasted to increase from about S./2,000 soles in 2004 to about S./3,000 soles in 2025.

2) Land-use Pattern

The three alternative land-use patterns are prepared, and the alternative evaluation study is conducted in Chapter 10 in this report. Among three alternative patterns, the decentralized land-use pattern is selected as the basic future city structure of the Study area in 2025. In this pattern, for realization of the decentralize of city functions and activities, three large size development areas are planned at each direction which are located at the 1) north direction (entrance of Comas), 2) east direction (Santa Anita), and 3) south direction (Villa El Salvador).

3) Numbers of Vehicle Registered

Based on the socio-economic indicator in the future, population growth ratio, and historical numbers of vehicle registered, the numbers of vehicle registered in 2025 is estimated as about 2,017,000 vehicles. This numbers of vehicle is the 2.5 times compare with numbers of vehicle in year 2004.

4) Numbers of Total Person Trips

The numbers of total person trips per day, and the average numbers of person trips per person per day with all modes in 2004 are estimated about 11.4 million trips per day, and 1.4 times per person per day based on the results of Person Trip Survey conducted by JICA Study Team in 2004. According increased socio-economic activities increased family income, the numbers of total person trip per day, and the average numbers of person trip per parson in 2025 is estimated as 24.3 million and 1.8 trip respectively.

5) Future Traffic Flows Conditions Expected

Considering the above mentioned transport and traffic conditions, the future traffic volume of the private car on the trunk roads will be expected 2.2 to 2.4 times compare with the traffic volume in 2004. Taking into account the future traffic flow conditions on the trunk roads in 2025, it is obviously expected that many traffic congestions will be occurred and running speed of vehicles also will be decreased.

(2) Future trip Characteristics

1) General Characteristics

In order to review socioeconomic and travel demand in 2025 and its growth rate to that in 2004, summary of those indices is shown in Table 12.1-1. As can be see, the trip increase ratio from the year 2004 to 2025 is approximately 1.48, in contrast to 1.37 of the population growth ratio. Car trip increase ratio in the same period is approximately 2.2, while public transport is somewhat low (1.35) in increase ratio. These increase ratios by mode relate with economic growth which is 1.78 per capita in the study area. These indicate that in 2025, the share of the motorized household ratio (Estrato A, B, C) to the total contributes to the increase of car mode.

Table 12.1-1 Summary of Socioeconomic and Travel Demand

	2004	2025	2025/2004
Population (6 years or more)	7,371,385	10,078,272	1.37
GRDP/capita	7,563	13,467	1.78
Number of Trips by Motorized modes	12,118,571	17,950,737	1.48
Number of Vehicles (Cars) owned by Households	419,851	1,039,143	2.48
Vehicle (Car) Ownership (/1000) by Household	52.2	94.5	1.81
Trip Production Rate /pop (6 years or more) (Car, Taxi and Public Transport)	1.64	1.78	1.08
Trips by modes			
Car	1,853,295	4,041,689	2.18
Taxi	900,138	1,261,286	1.40
Public	9,365,138	12,647,761	1.35
Modal Share			
Car	15.3%	22.5%	
Taxi	7.4%	7.0%	
Public	77.3%	70.5%	

In the morning peak hour, those trips concentrate in the short period. Figure 12.1-1 shows hourly trip generation, which is the hourly fluctuation of trips and the departure time. As can be seen, the morning peak hour ratio is approximately 15%, which occur between 7:00 a.m. and 8:00 a.m. At noon, the generation trips also rise due to return.

The peak hour percentage for "to work" trip rises by approximately 30% in the morning from 7:00 a.m. and 8:00 a.m. The "to school" trip fluctuation indicates the same pattern as that of "to work". Since in future generated trips will rise at 2.2 times for car and 1.4 times for public transport and approximately 15% of those travel demand will concentrate in the morning peak hour, adding to the present traffic congestion in urban area, future traffic condition will become more severe if no improvement is made in the urban transport.

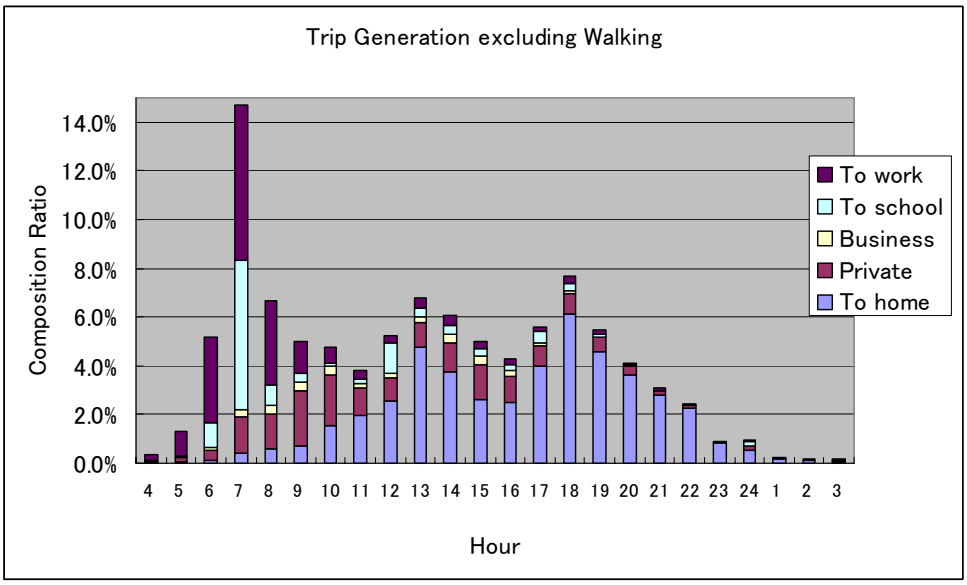


Figure 12.1-1 Hourly Trip Generation by Purpose in 2004 from Person Trip Survey

2) Trip Characteristics by Estrato

Trip characteristics are different in Estrato classification, in which car ownership of Estrato AB, higher income group, is higher than that in Estrato D and E, low or lower income groups, and the share of car mode for people of those Estratos is higher in proportion to car ownership. On the other hand, public transport share is higher in Estrato D and E. It shows a close relationship between Estrato level and used mode. Table 12.1-2 shows number of trips according to Estrato classified into ABCD and E in order to identify trip characteristics of Estrato E and others. This is because in future transport master plan, public transport plan oriented toward poor people, especially Estrato E, is necessary. Therefore, trip characteristics of Estrato E and other Estrato were analyzed in this section.

Table 12.1-2 Number of Trip by Estrato

Items	Years	Estrato		Total
		ABCD	E	
Number of Trips/day	2004	10,813,352	1,305,219	12,118,571
	2025	16,817,541	1,133,195	17,950,737
Composition	2004	0.89	0.11	1.00
	2025	0.94	0.06	1.00
Increase Ratio/2004		1.56	0.87	1.48

As can be seen, number of trips in Estrato E in 2025 is approximately 1.1 million per day and its figure decreases at 87% in 2004. The trip share of Estrato E to the total decreases in 2025. This is because GRDP/capita in 2025 grows at 1.78 times of the present figure.

Figure 12.1-2 shows modal share by Estrato for “to work” purpose in 2025. As can be seen, car trip share of Estrato AB to the total is the highest and public transport share of Estrato E is the highest. The public transport share of even Estrato AB accounts for 50%. In future, public transport mode will play an important role in the morning peak hour in the metropolitan area. As for business and private purposes, public transport mode also plays an important role as shown in Figure 12.1-3.

Figure 12.1-4 shows comparison of modal share by Estrato between 2004 and 2025. The modal shares of private mode by Estrato A,B,C and D in 2025 rise, while the public mode share decreases. On the other hand, Estrato E is increase in the share of public mode, and is constant in the private.

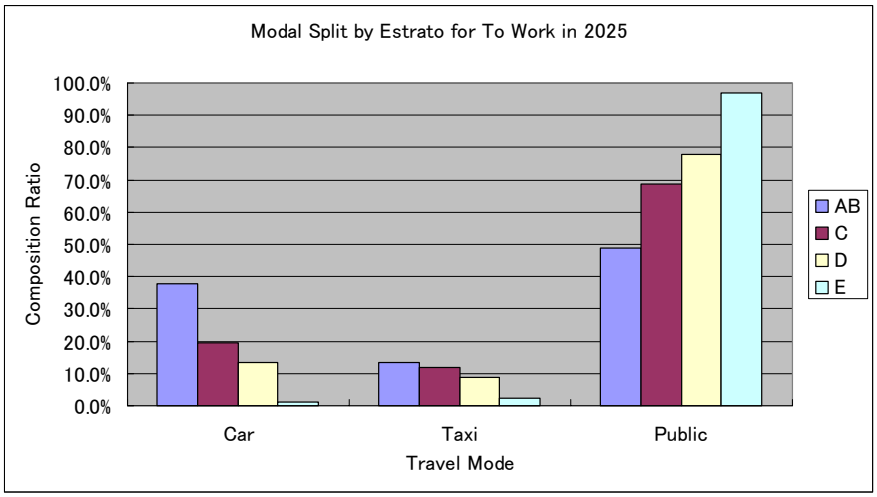


Figure 12.1-2 Modal Split by Estrato for "To work" in 2025

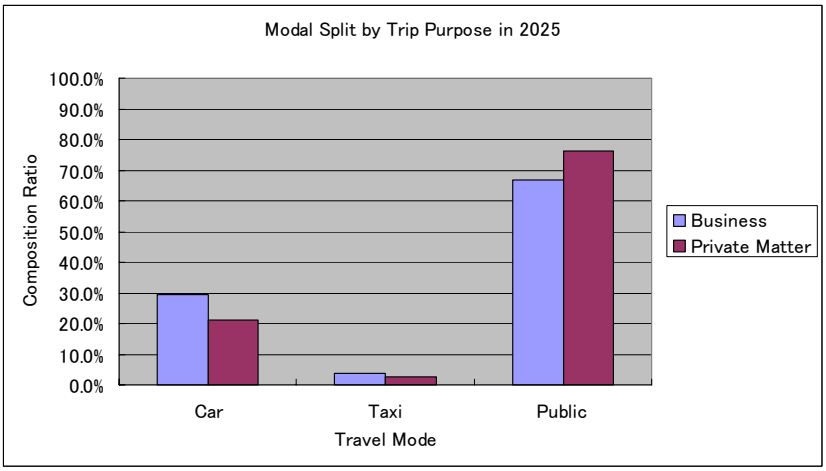


Figure 12.1-3 Modal Split by Trip Purpose (Business and Private) in 2025

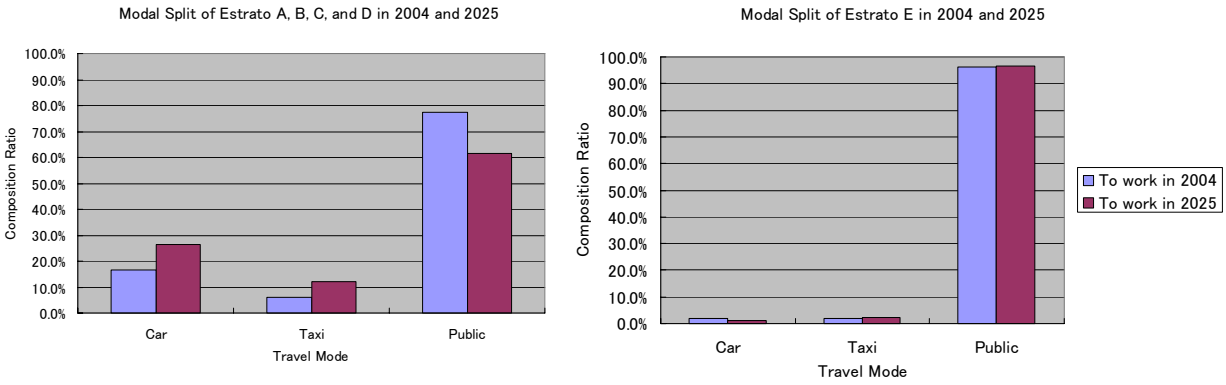


Figure 12.1-4 Modal Split by Estrato in 2004 and 2025

3) Zonal Trip Characteristics

Figure 12.1-5 and Figure 12.1-6 show trip generation and attraction of Estrato E and its composition ratio to the total in 2025 by integrated zone. As can be seen, the trip generation of Estrato E in zone Nos.7, 8, 9, 10 and 11 is somewhat higher than others. Its volumes are a range of 700 thousands to 1400 thousand trips and those zones are also higher in the composition ratio of E to all Estrato (10% to 16%). As can be seen in Figure 12.1-8, trip generation of Estrato E estimated in 2025 by integrated zones is similar as that in 2004 due to that the total trip production volumes of E in both 2004 and 2025 are the same volume. Figure 12.1-7 shows trip generation and attraction of Estrato A, B, C and D in 2004 and 2025.

As for the attraction, zone Nos. 1, 7 and 11 are heavy volumes, compared to others. As can be seen in Figure 12.1-8, trip attraction of Estrato E in 2025 by integrated zones is also similar in that in 2004. However, zones No. 1 (Lima) and 4 (Miraflores) in 2025 are decrease in attraction volume, while zones Nos. 7, 8, 9, 11 in 2025 are somewhat increase. The trips generated by residents of Estrato E will concentrate into those zones.

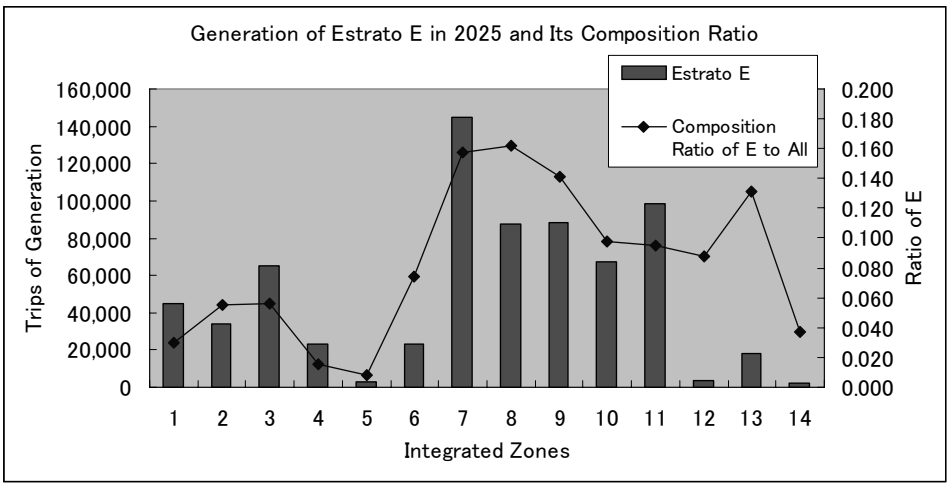


Figure 12.1-5 Generation of Estrato E and Its Composition Ratio

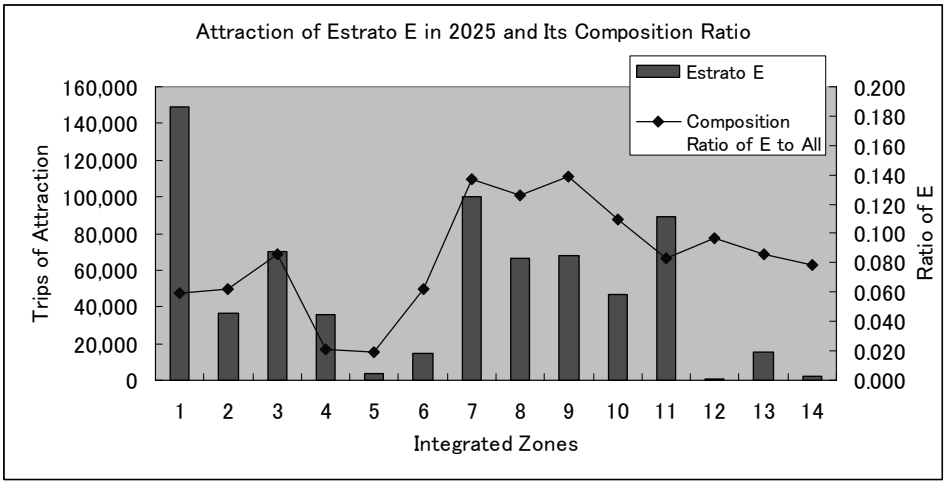


Figure 12.1-6 Attraction of Estrato E and Its Composition Ratio

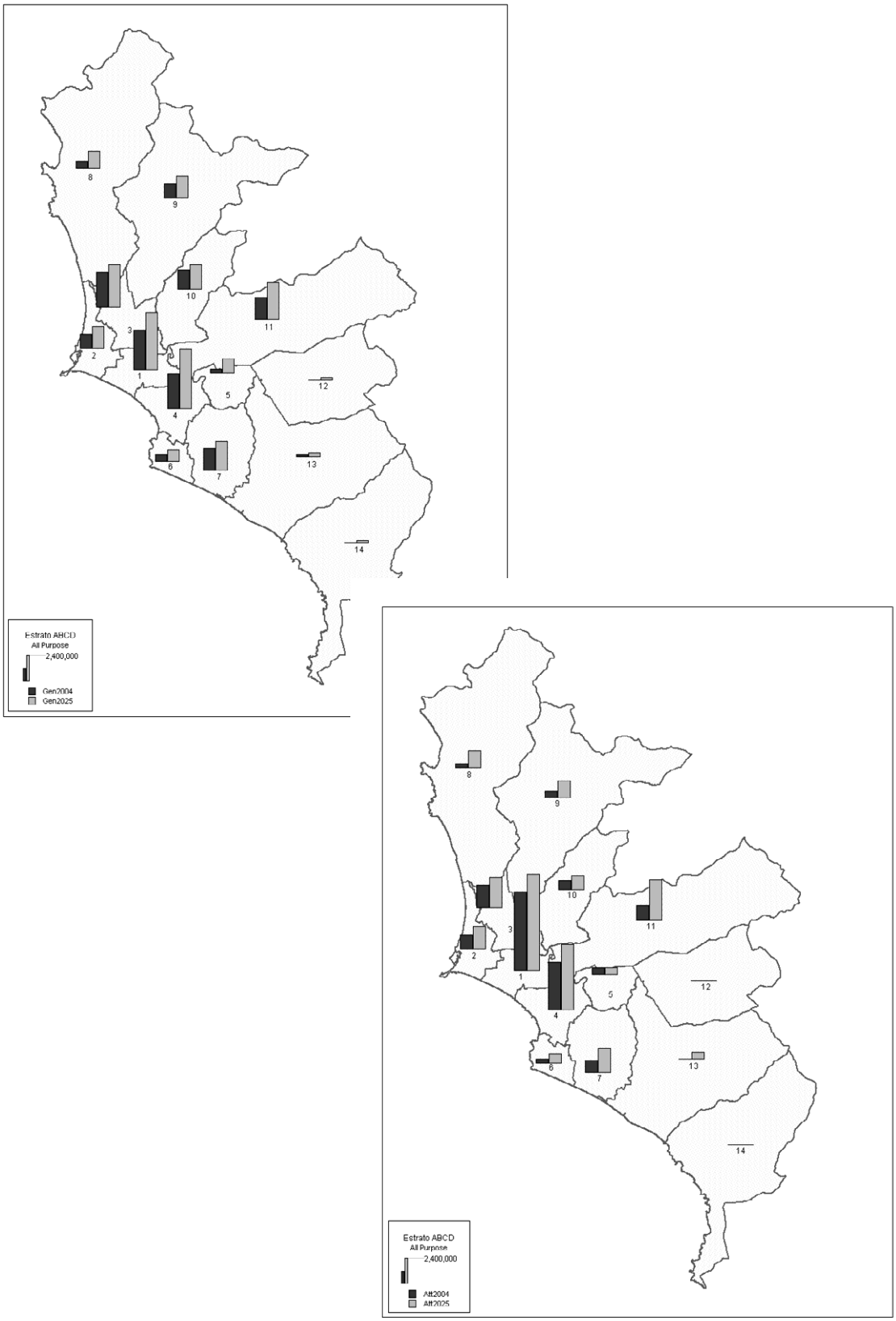


Figure 12.1-7 Trip Generation and Attraction in Estrato A, B, C and D by Trip Purpose (exclusive of To home) in 2004 and 2025

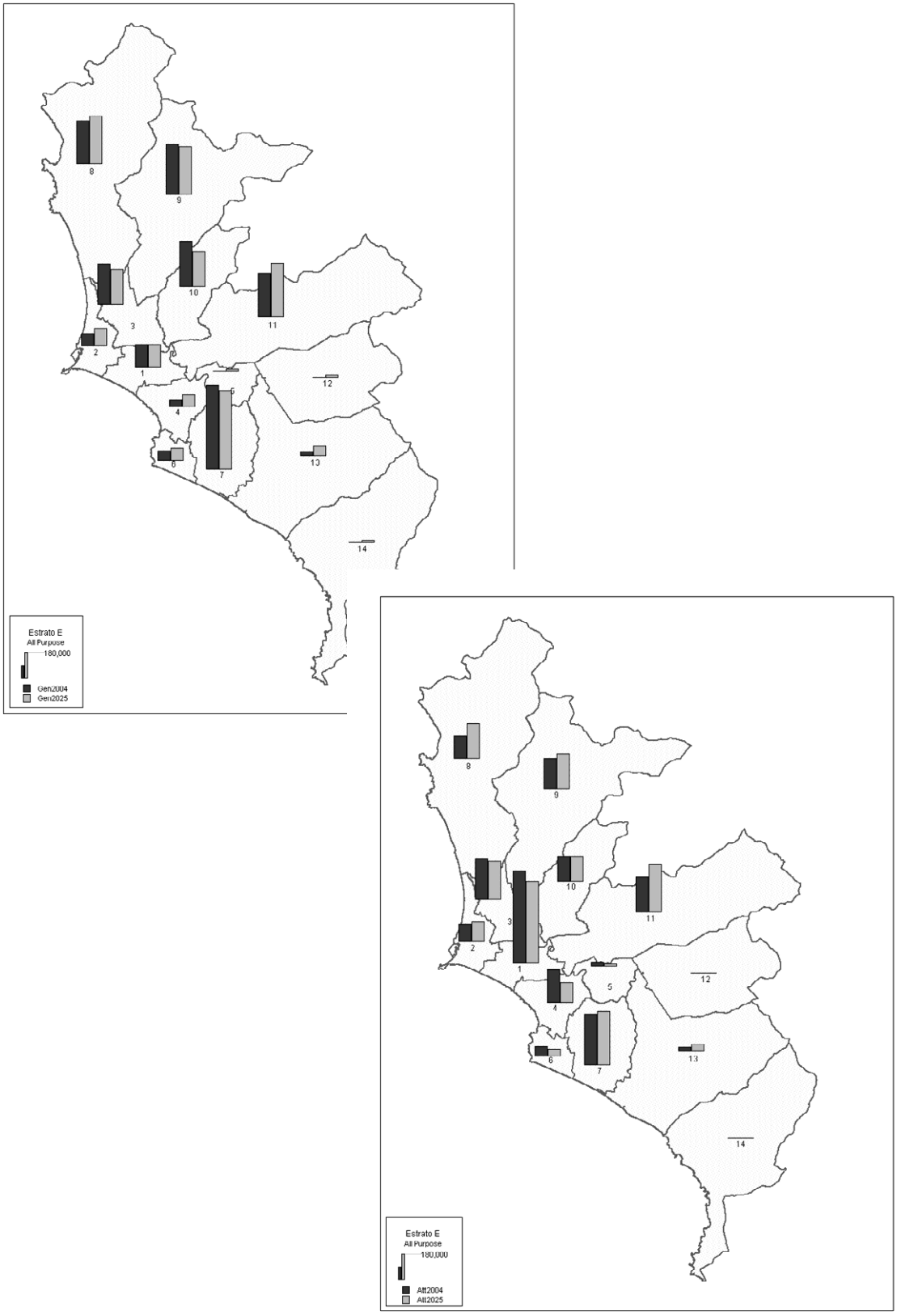


Figure 12.1-8 Trip Generation and Attraction in Estrato E (exclusive of To home) in 2004 and 2025

4) OD Trip Pattern

The desire lines by the Estrato A,B,C,D, and the Estrato E are shown in Figure 12.1-9 and Figure 12.1-10, which also compares the desire lines in 2004 and 2025. In 2025, the desire lines by All Estratos (exclusive of E) strongly cover entire Study Area, while in 2004 they cover only the area within the central area. On the other hand, the desire lines by Estrato E in 2025 links the central business/ commercial area (zone Nos. 1 and 3) and surrounding residential areas (zone Nos. 7: Villa Salvador, 9: Carabayllo, 10: San Juan de Lurigancho and 11: Lurigancho) with strong desire lines. The trip pattern of Estrato E is considerably similar as that in 2004. Figure 12.1-11 and Figure 12.1-12 also show the desire lines of "to work and to school" by Estrato. The desire lines by those purposes by All Estratos (exclusive of E) are similar to the all purposes, while Estrato E is considerably difference between all purposes and "to work and to school" purposes.

Since the trips of Estrato E in 2025 distribute over surrounding residential areas with weak desire lines, those OD trip pattern must be considered in future public transport plan.

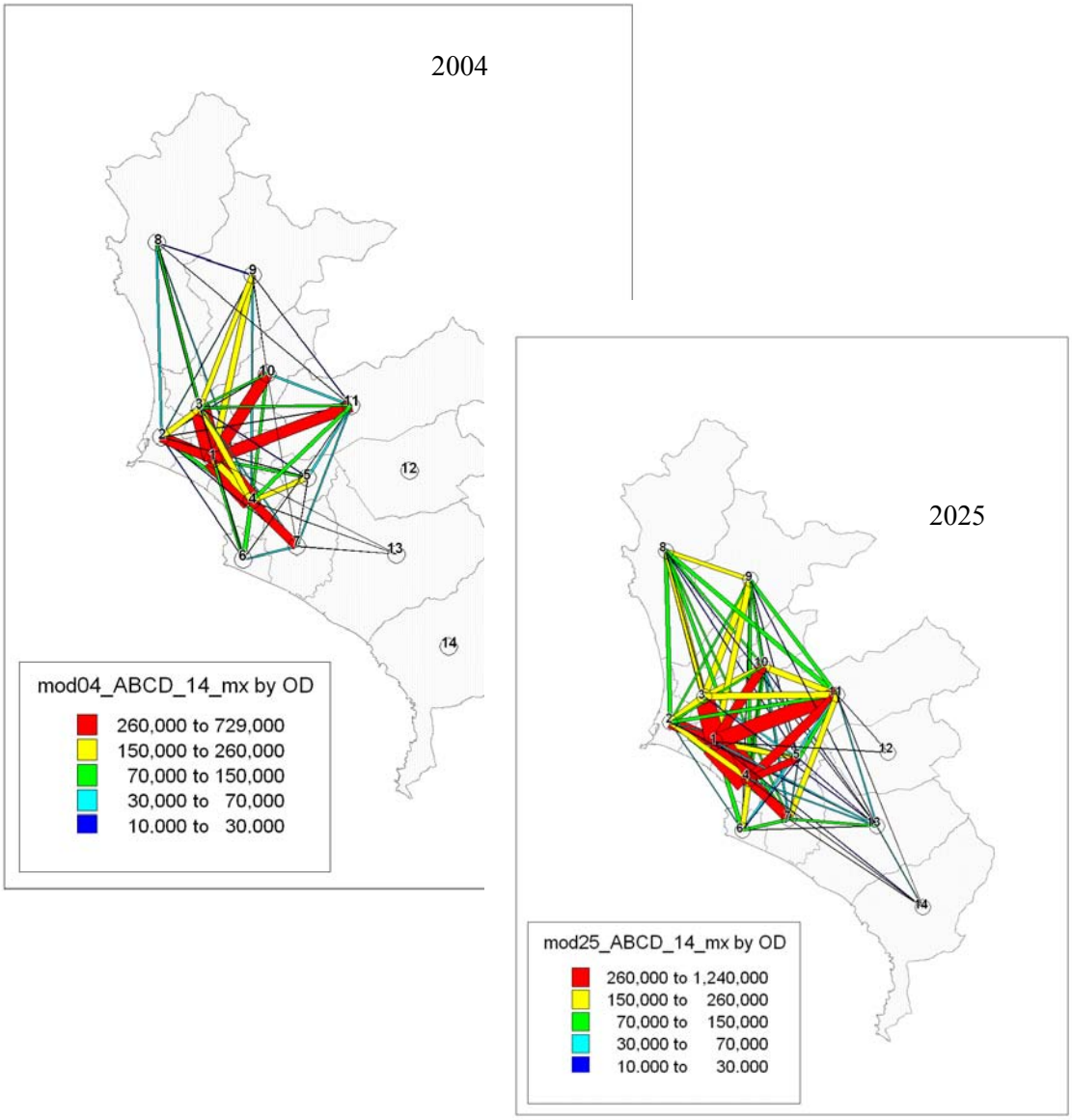


Figure 12.1-9 Trip Desire Line in Estrato A, B, C, D by All Purposes in 2004 and 2025

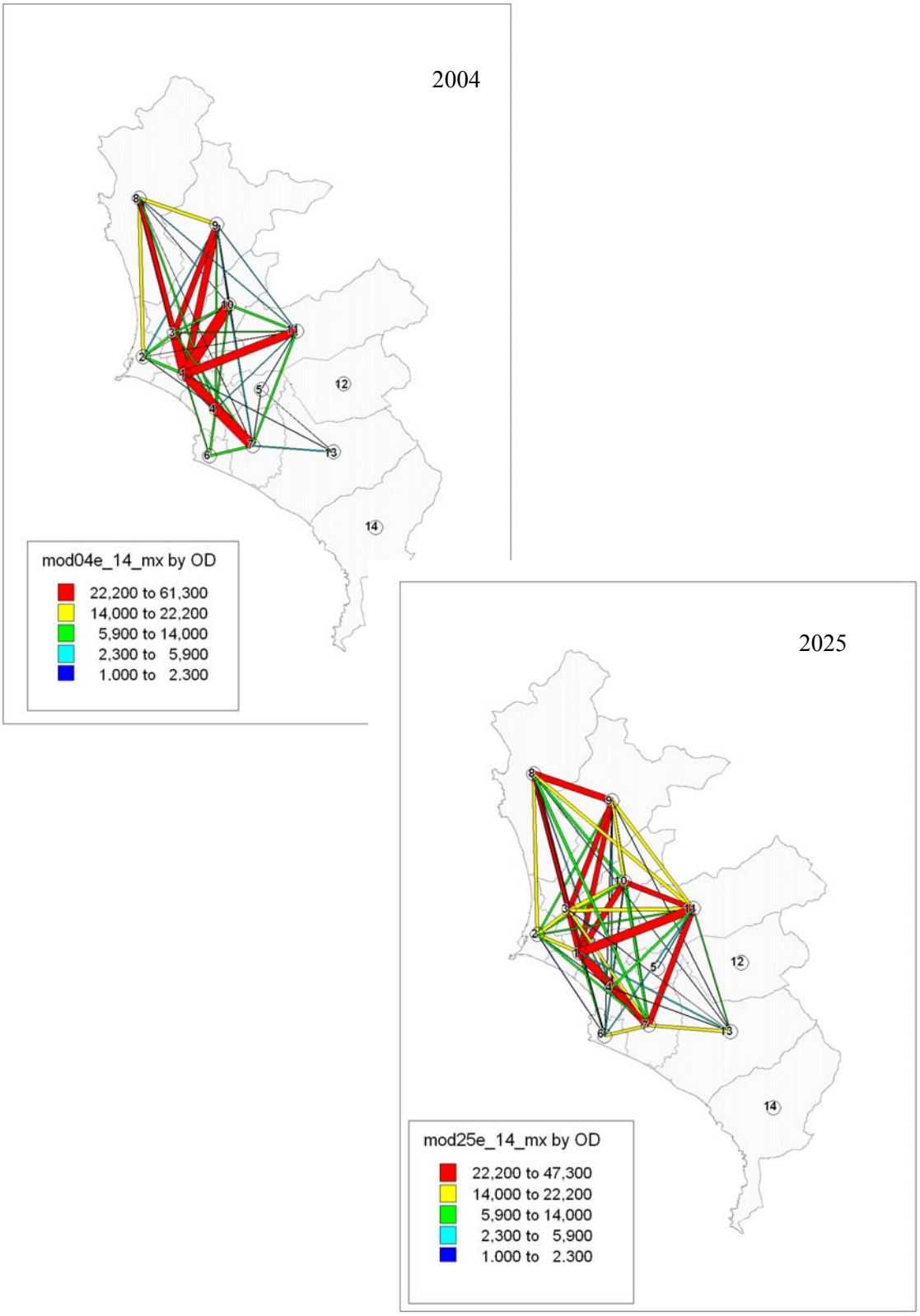


Figure 12.1-10 Trip Desire Line in Estrato E by All Purposes in 2004 and 2025

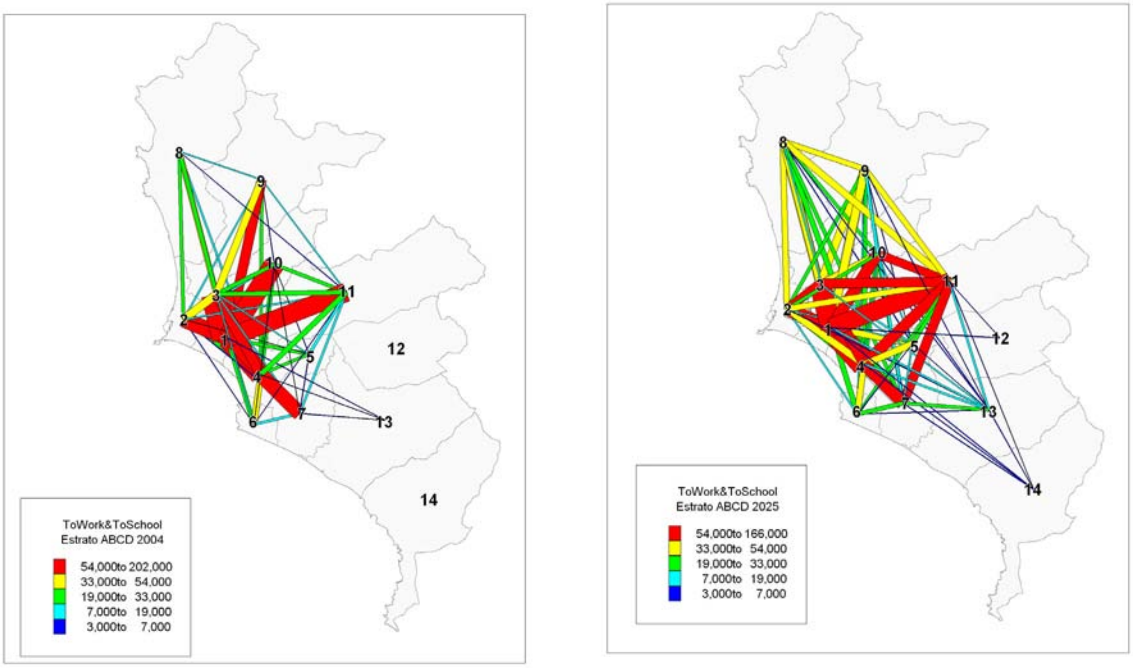


Figure 12.1-11 Trip Desire Line in Estrato A, B, C and D by “to work/to school” in 2004 and 2025

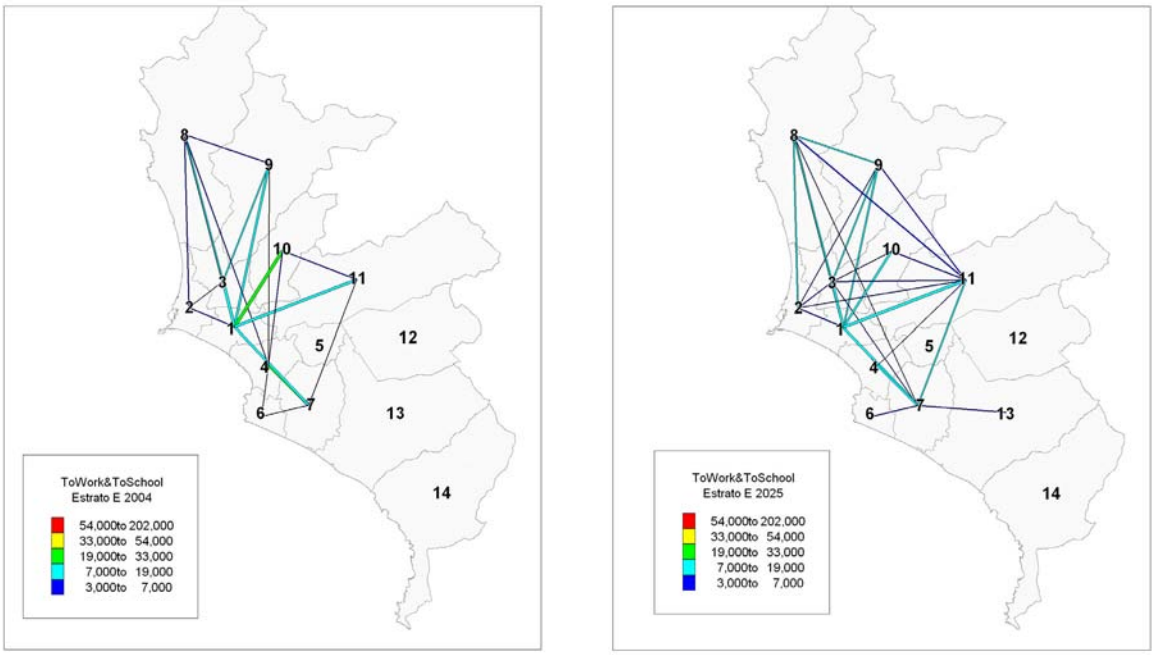


Figure 12.1-12 Trip Desire Line in Estrato E by “to work/to school” in 2004 and 2025

12.1.2. NECESSITY OF PREPARATION OF TRANSPORT MASTER PLAN

Major contents of the Study are to prepare the Comprehensive Urban Transport Mater Plan in Lima and Callao Metropolitan Area with planning target year in 2025. In this chapter, the necessity or the reasons of why formulation of the comprehensive urban transport master plan needed are identified.

(1) Now, Re-examination of Former Comprehensive Urban Transport Master Plan Prepared by IMP is needed. (For changing socioeconomic activities)

In 1988, the comprehensive urban transport master plan that is "Plan de Desarrollo Metropliotano de Lima y Callao 1990 – 2010" was formulated by IMP Lima. However, since in 1990, the full scale re-examination of the comprehensive urban transport master plan which was prepared by IMP Lima in 1988 have not been done, in spit of the transport and traffic flows conditions and characteristics of the Study area in 2004 have been changed rapidly.

Now, the comprehensive urban transport master plan prepared by IMP Lima in 1988 should be re-examined according to meet the current socio-economic conditions, and current transport and traffic characteristics.

(2) For Promotion of Realization of Projects Recommended

Since in year 1990, many road improvement plans, bus operation improvement plans, and mass transit system introduced plans have been prepared by the individual related organizations of Lima and Callao municipalities. Many projects or plans prepared by municipalities have not been realized yet, due to shortage or weak of the implementation schedule among these projects or plans, as well as shortage of projects implementation budget. For delay of the realization of the projects and plans prepared, the heavy traffic congestions have been occurred on many trunk roads and major intersections.

Now, due to the promotion of realization of projects recommended, the formulation of comprehensive urban transport master plan is needed.

(3) For Solution of Transport and Traffic Problems in Early Stage

At present, because the public transport system in the Study area is very weak, the heavy traffic congestions have been occurred on the many trunk roads and major intersections, as well as the slow running or travel speed are decreased unavoidably. The transport and traffic conditions of Lima and Callao metropolitan area have became worst day by day. In addition above, according to the increasing of socio-economic activities and family income in Lima and Callao Metropolitan area, the future traffic volume in 2025 on the trunk roads will be expected to increase rapidly as about 2.2 times compare with traffic volume in 2004. If any urban transport or traffic improvement projects or plans will not be implemented (without projects), on the many trunk roads in Lima and Callao metropolitan area will be expected to occupy the full of vehicles. And finally, the almost all vehicles can not be operated.

For solution of future transport and traffic conditions expected, a comprehensive urban transport master plan especially reinforcement of the public transport system should be prepared as soon as passively.

12.1.3. URBAN TRANSPORT PLANNING POLICY AND STRATEGIES

(1) General

The existing and future socio-economic conditions, transport and traffic flows conditions and the future traffic demand are examined in the Chapter 10 in this Report. Based on the results of the existing and future traffic condition examination, the following three (3) problems or issues to be solved are identified clearly.

a) In spite of the great numbers of population (approximately 8 million in 2004) are living in the study area, the public transport system is very poor.
b) The heavy traffic congestions have been occurred on the major trunk roads and on the major intersection, due to increasing the traffic volume rapidly and very poor public transport system introduced.
c) According to the increasing traffic volume rapidly, environmental conditions, especially air pollution will be became harmful.

(2) Urban Transport Planning Policy

The most important objectives of the urban transport planning in the Study area are to mitigate the heavy traffic congestion, and to ensure the sound city functions and activities. Basically, a public transport priority policy should be introduced for achievement of planning objectives. In addition the above mentioned basic planning policy, the following four (4) planning policies are identified for mitigation of traffic congestions and to ensure the sound city based on the transport environmental conditions. The planning policies, strategies for achievement of policies, and planning goals are summarized in Figure 12.1-13.

1) Policy-1: To Improve Poverty's Life Conditions
2) Policy-2: To Maintain Good Environmental Aspects
3) Policy-3: To Control of Traffic Demand
4) Policy-4: To Increase Transport Facilities Capacity

(3) Strategies for Achievement of Planning Policy

In order to achieve the planning policies mentioned above, the following strategies are identified.

1) Strategy for Policy-1: To improve poverty's life conditions.
    a) To insured usefulness public transport system
    b) To improve public transport tariff
    c) To accommodate free public transport system
2) Strategy for Policy-2: To maintain good environmental aspects
    a) To make the best use of CNG energy
    b) To transfer user from car to public transport
    c) To insure traffic safety and to decrease traffic accidents
    d) To improve bus fleets
3) Strategy for Policy-3: To control traffic demand
    a) To reinforce public transport system (to introduce mass rapid transit system)
    b) To improve bus transport system
    c) To transfer user from car to public transport
    d) To introduce traffic demand management (TDM) system
4) Strategy for Policy-4: To increase traffic facilities capacities

a) To reinforce road network
b) To improve road facilities
c) To improve public transport system

(4) Targets or Goals for Urban Transport Master Plan

The Urban Transport Master Plan study is conducted based on the above mentioned policies and strategies. The following final targets and goals for the Urban Master Plan are identified, considering the future transport and traffic conditions expected.

1) Targets or goals for policy-1: to Improve Poverty's Life Conditions

   a) To achieve faster travel time compare with existing condition.
   b) To achieve cheaper transport tariff compare with existing condition.
   c) To achieve shorter walking distance compare with existing condition.
   d) To achieve more safety transport system

2) Targets or goals for policy-2: to Maintain Good Environmental Aspects

   a) To achieve better air pollution compare with existing conditions
   b) To create modern transport facilities
   c) To achieve safety transport system and facilities.

3) Targets or goals for policy-3: to Control of Traffic Demand

   a) To achieve faster travel time compare with existing condition.
   b) To achieve cheaper transport tariff compare with existing condition.
   c) To achieve shorter walking distance compare with existing condition.
   d) To create more comfort and convenience transport system
   e) To achieve more safety transport system

4) Targets or goals for policy-4: to Increase Transport Facilities Capacity

   a) To mitigate traffic congestion compare with existing conditions
   b) To achieve more smooth traffic flows compare with existing conditions

(5) Urban Transport Plan to be studied

Due to achieve the planning policies, strategies, and planning targets and goals, the following four (4) development plans are studied.

a) Bus Transport Development Plan
b) Railway Transport Development Plan
c) Road Facility Development Plan
d) Transport Management Plan

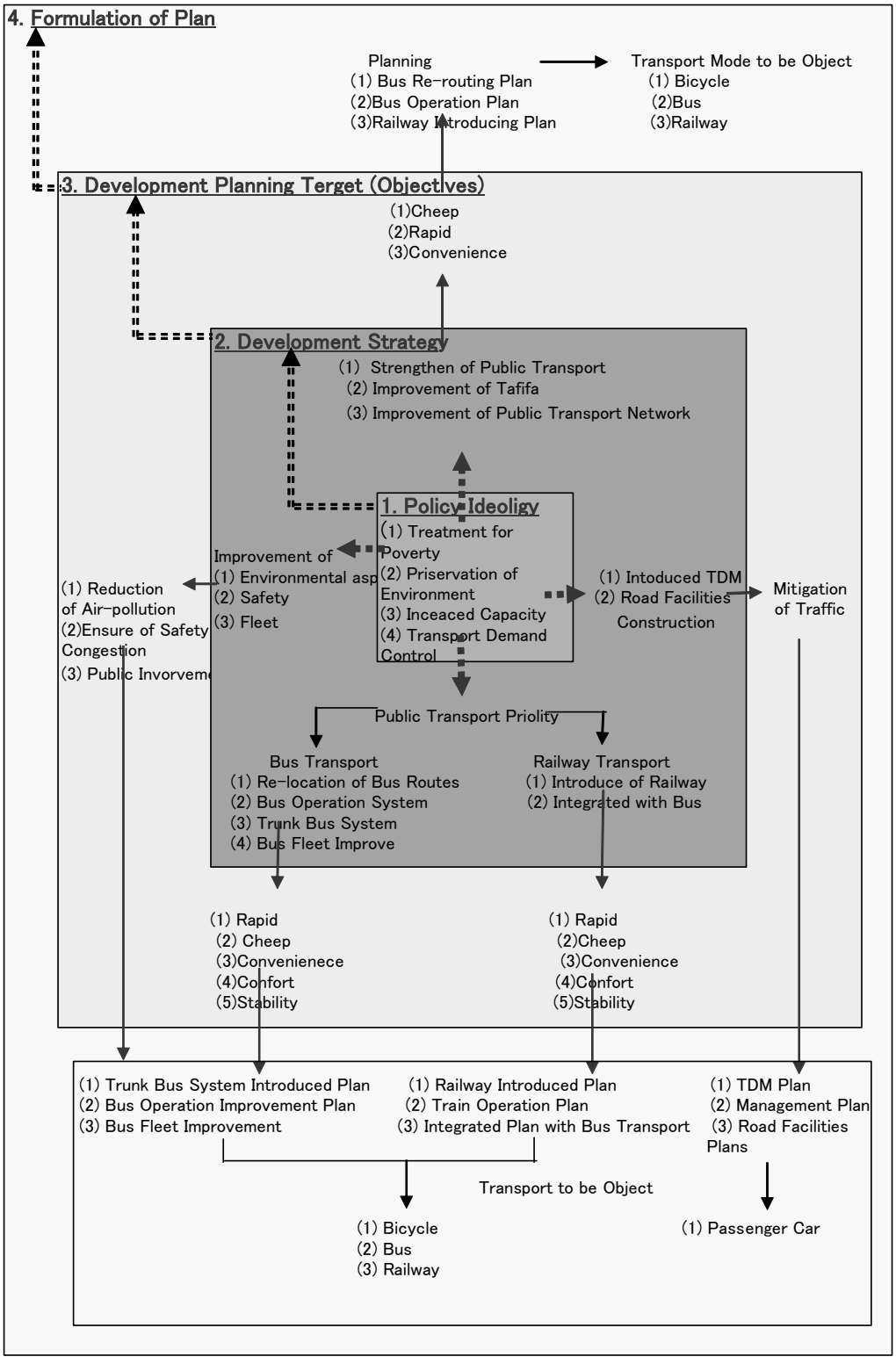


Figure 12.1-13 Urban Transport Policies, Strategies, and Targets

(6) Basic Transport System in the Study Area

The existing trunk road network is basically formulated by the six (6) radial roads and three (3) ring roads. The future trunk road network prepared by IMP Lima is also formulated by the radial roads and ring roads. The great numbers of bus passengers and bus routes are located to concentrate at the above mentioned radial and ring trunk roads. The public transport passenger characteristics in the future also may not be changed based on the results of the future socio-economic forecasted.

On the other hand, inter urban bus transport and cargo transport (large vehicles) flows from Lima centre or Callao port to the other cities passing through within urban area. These transport flows is one of the reason to occur the heavy traffic congestion in the urban area. Taking into account the above mentioned conditions, the following transport system is identified as the basic transport system in the Study area as shown in Figure 12.1-14.

a) Mass rapid transit system (railway system or trunk bus system) should be operated on the radial and ring trunk roads.
b) Cargo transport system should be operated to avoid passing through in urban area.
c) Inter urban bus transport system should be transferred to intra urban bus on a bus terminal which will be located at the boundary of urban area.
d) The large scale development areas should be connected by mass rapid transit system
e) The core area of Lima and Callao should be connected by mass rapid transit system.
f) The trunk road network system should be formulated as radial and ring roads.

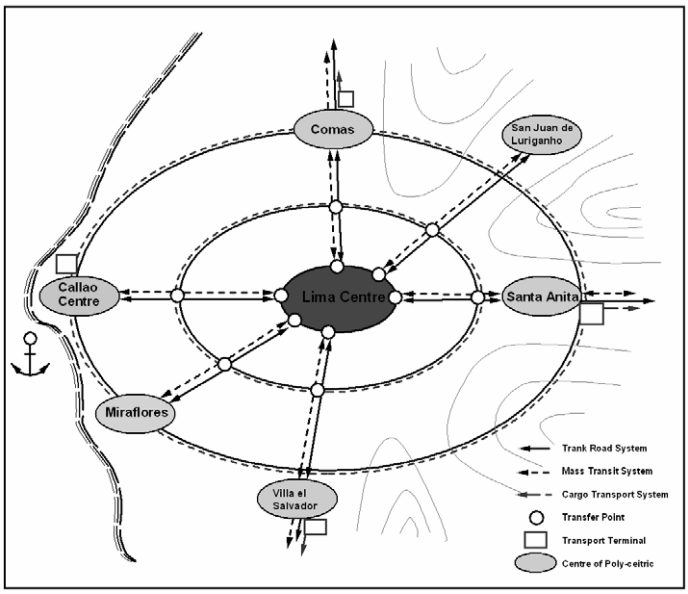


Figure 12.1-14 Basic Transport Network in the Study Area

(7) Basic Consideration for Improvement of Extremely Poverty's Life Conditions

The field interview survey of the Extremely Poverty is conducted by JICA Study Team for understanding the characteristics and behaviors of the Extremely Poverty in the Study area. As the results of the field survey, the following characteristics and conditions are identified as shown in Table 12.1-3.

Table 12.1-3 Characteristics and Conditions of Extremely Poverty

Items	Characteristics and Conditions of Extremely Poverty
1. Numbers of population of Extremely Poverty	According to the INEI data in 2002, the numbers population of Extremely Poverty in 2001 is estimated at about 2.3 % of the total population in Lima metropolitan.
2. Housing Area	The housing areas are not specified, however, in generally many Extremely Poverty have been living at the comparatively steep slope hill terrain.
3. Income	The income is very low. The life maintain under the daily income in cash.
4. Working Condition	Full time worker=54%, Part time worker=28%, Jobless=18%
5. Working Type	Street Bender=73%, Temporally Worker=2%, Housemaid and other=25%
6. Transport Mode to be Used	Walk=35%,Mototaxi and bicycle=12%,Bus=50%, Other=3%
7. Average Travel Time(min)	Walk=18, Bicycle=24, Bus=30 to 40
8. Major Problems	1) They are very poor and also they have not steady work. 2) They have not sufficiently money for using the bus transport 3) Bus fare is very high 4) Shortage the bus operation routes

Taking into account of the characteristics and conditions of Extremely Poverty, the following three (3) basic considerations should be examined in the Study for improvement of Extremely Poverty's life conditions.

1) For mitigation of the shortage of bus operation routes, effectiveness bus operation system and re-location of bus operation routes plans should be examined in the Study.
2) For improvement of the transport costs, creation of bicycle transport system (non motorized transport system) plans should be supported in the Study.
3) For decreasing the transport cost, bus fare system plans should be examined in the Study.

12.2. ROAD NETWORK PLAN

12.2.1. ROAD NETWORK PLANNING POLICY AND STRATEGIES

(1) Road Network Planning Policy

The examination of road network plan is conducted based on the urban transport planning policy and strategy previous mentioned in chapter 12.1.3. The road network planning basic policy is identified for mitigation of the traffic congestion of the Study area. Considering the problems and issues to be solved for the existing road network and the future traffic conditions, the road network planning policy are identified as follows,

a) To mitigate the traffic congestions
b) To complete the effective road network by road hierarchy
c) To ensure the smooth traffic flows based on future traffic demand
d) To keep the sound city environmental conditions
e) To ensure the traffic safety and to decrease the traffic accidents
f) To harmonize the public transport system and network

(2) Strategies for Achieving Road Network Planning Policies

To achieve the road network planning policies the mentioned above, the following strategies are identified based on the traffic analysis and the existing road network configuration.

1) Strengthening of Radial Transport Axis

As the results of various traffic studies such as 1) the existing and future traffic demand assignment, 2) examination of future traffic characteristics analysis, 3) desired line for the person trip, the heavy traffic volume are concentrated on the six (6) radial transport axis as shown in Figure 12.2-1. Therefore, the radial transport axis should be reinforced to mitigate the traffic congestions.

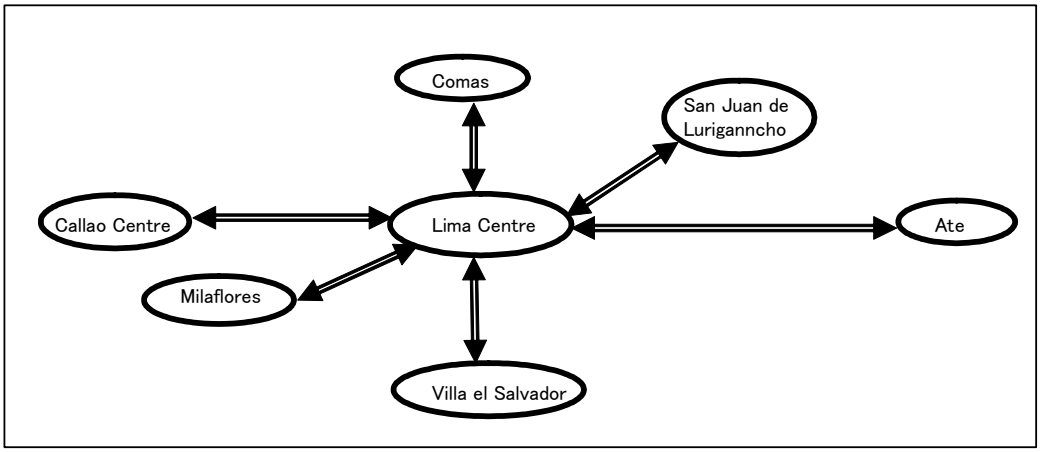


Figure 12.2-1 Transport Axis to be Reinforced

2) Strengthening of Ring Trunk Road Network Pattern

The heavy traffic congestions also have been occurred on the trunk ring roads. Some road segments of the ring roads are not linked perfectly. In addition, the cargo traffic from Callao to other cities has been operated without to avoid passing through in the urban area. To decrease the traffic accidents and to keep the sound city environment conditions in the urbanized area, the diversion roads for cargo traffic should be reinforced as shown in Figure 12.2-2.

Cargo handled volume in 2004 and 2025 at the Callao port is estimated by ENAPU,S.A at about 12,000 and 26,000 tons of 2.24 times compare with 2004. The heavy traffic volume in 2025 is also estimated at about 2.3 times compare with 2004. Taking into account of future traffic flows conditions, three cargo transport routes will be prepared for a cargo transport by heavy vehicle from/to Callao Port and outside area of Lima and Callao to avoid passing through inside urbanized areas due to mitigate the traffic congestion and to ensure the traffic safety in the urban area.

a) Callao--- North direction = Passing through on the Av.Callao-Canta
b) Callao---Ease direction= Passing through on Ring road as new construction road.
c) Callao---South direction=Passing through on Coastal road as new construction road.

Considering the problems of the existing ring road network and the diversion for cargo transport network, the ring road network should be reinforced.

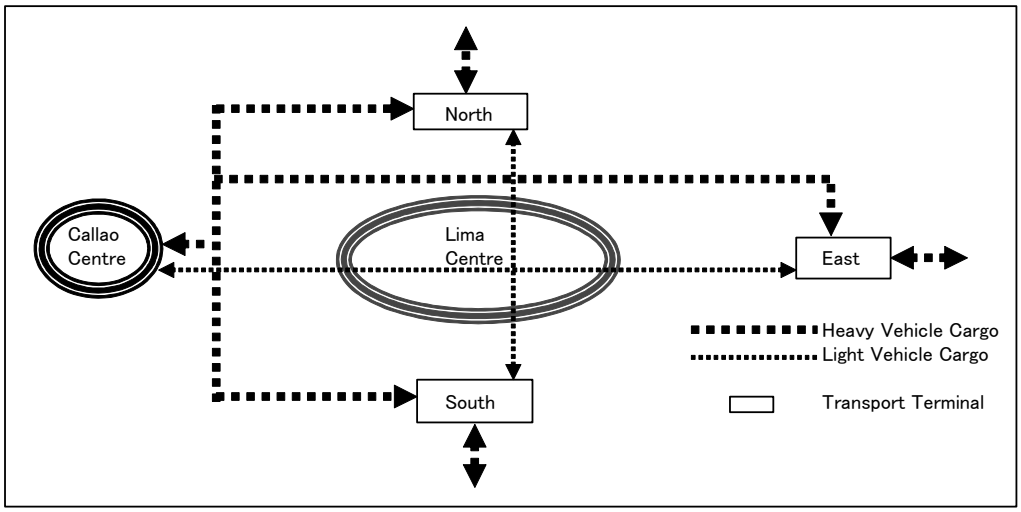


Figure 12.2-2 Conceptual Plan for Cargo Diversion Routes

3) Strengthening of the Existing Road Function in Urbanized Area

As the results of future traffic assignment, the heavy traffic flows are concentrated on the trunk roads which are located in the urbanized area. For mitigation of the traffic congestion and to keep the smooth traffic flows, the roads which are located should be reinforced.

4) Re-location of Inter Urban Bus Transport

Urban bus will be operated within urban area and Intra Urban bus will be operated intra urban city. Three inter urban bus terminals will be prepared at a point of about 10km east direction from Lima central area, about 10km north and 15km south direction of Lima central area. The bus passengers of inter urban bus and intra urban bus used should be transferred the bus route between each other in this bus terminal.

12.2.2. FUTURE ROAD NETWORK TO BE ADOPTED FOR THE STUDY

The future road network plan with a target year 2025 was prepared by IMP Lima in 1989. The basic planning concept of this plan is to reinforce the radial and ring transport axis due to mitigation of traffic congestion in urban area. The future road network plan is formulated by the various road development plans such as 1) Express way, 2) Arterial, 3) Collector, and Local road.

In 1990, the above mentioned future road network plan was already approved by Lima and Callao municipalities. Therefore, this future road network plan is adopted for the Study.(The Urban Transport Master Plan for Lima and Callao Metropolitan Area).

12.3. PUBLIC TRANSPORT PLAN

12.3.1. PUBLIC TRANSPORT ISSUES

(1) Bus System

1) Bus Route

The bus route in the Lima and Callao municipalities is too many in numbers at 574 routes in 2004. This is because the bus routes gradually increased against the original bus routes authorized by DMTU in accordance with the request of bus companies. At the same time, the route configuration and the route distance change in route location and route length. And then, the bus service level such as service frequency is gradually lower due to the increase of operation cost.

The average bus route distance in Lima is approximately 64 km in the round route. The ratio of routes to exceed 80km in the round route to the total number is approximately 24% and the maximum route distance is 163km. The route distance is very long in comparison with that in Bogotá, Colombia in which the average distance is approximately 50km in the round. In general, it is said that short route distance is better in operation efficiency. From the viewpoint, the operation efficiency becomes worse in Lima.

The bus route configuration makes it possible for bus passengers to arrive at many destinations without transfer from suburb areas. As a result, the number of bus routes increase. Moreover, the bus companies are forced to operate bus under keen competition with other companies. This means that the efficiency of bus operation and traffic condition on roads become worse.

Figure 12.3-1 shows a cycle of cause and result on public transport problems mentioned above.

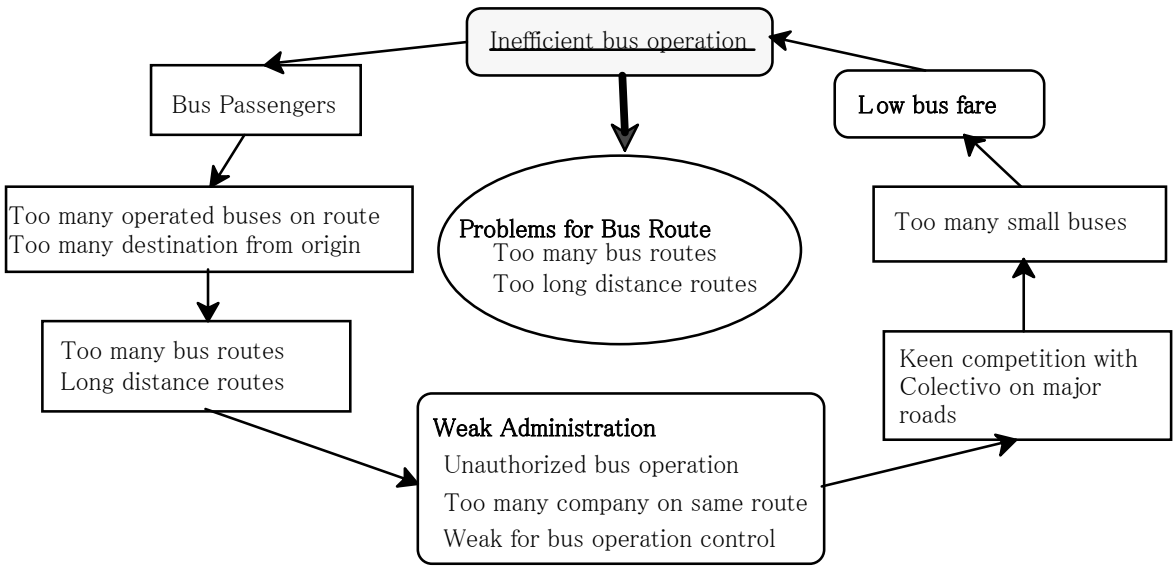


Figure 12.3-1 Problems for Bus Routes

2) Bus Company

The numbers of operated buses, taxies and Colectivos are many and these operation routes concentrate on major roads. Those conditions cause a keen competition with each

transportation company. The bus company is hard in management such as income and expenditure balance. Small bus companies are increase year by year. The bus company and owner are a different organization. The bus owner owns two or three bus fleets, and operates a bus after payment of operation fee (Quota) to the bus company. The bus company obtains profit from Quota rather than that from bus proceeds. This is because the fare rate is lower and it is difficult to raise the rate due to competition with each other.

Therefore, in order to raise the profit of the owners, the owner requests the extension of route distance to the bus company. The company requests the demand of the owner to DMTU. As the result, the number of routes and long distance route are increase in accordance with the demand of owners.

The current bus system is not oriented to bus users and is to bus companies. It will be difficult to change the direction of the system in a short term. Figure 12.3-2 shows a cycle of cause and result on public transport problems mentioned above.

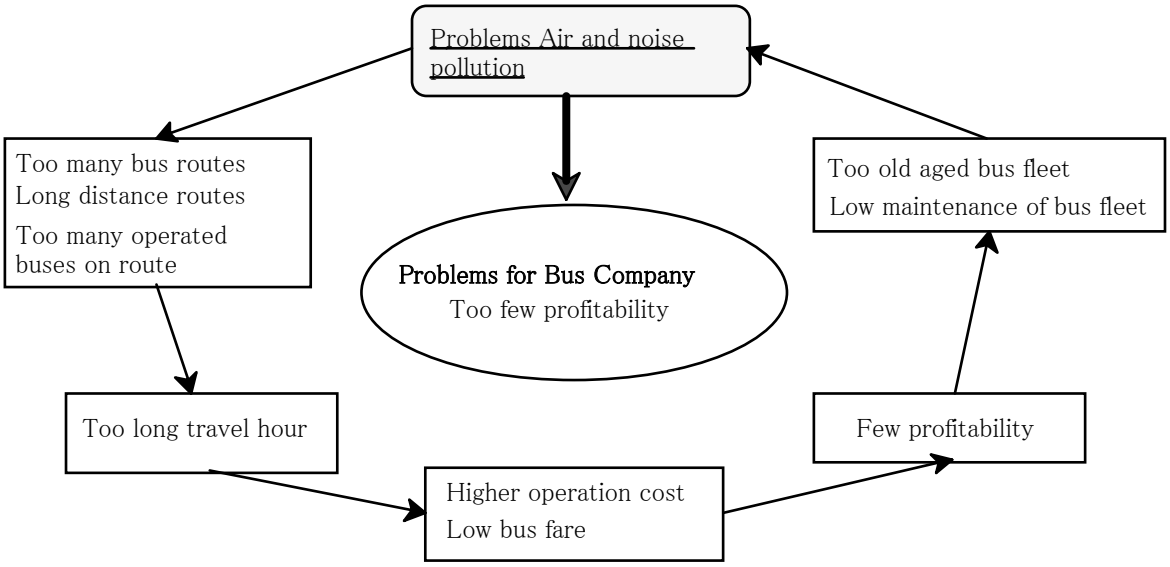


Figure 12.3-2 Problems for Bus Companies

3) Shift toward Small Bus

According to the number of registered buses since 2001, the number of Omnibuses (ordinary bus) reduces by 10% per annum. Since Omnibus age is old, Omnibuses are scrapped year by year and replaced to Microbus. This is because Microbus has the advantage of operation performance in higher operation speed and movement to cope with desire of bus passengers. In the same reasons, Colectivo and taxi are increasing in the number. Under the situations, traffic congestion occurs in the metropolitan area. For example, the highest traffic volume composition ratio of the total on Av. Arequipa is buses at 54% in the morning peak hour, followed by Colectivo / taxi (35%) and car (9%). It is obviously that the ratios of Colectivo and taxi are higher. Figure 12.3-3 shows the circular flowchart of the cause and results under the situations.

The situations to shift toward the small bus are against the direction of bus improvement plan in DMTU, which plans the introduction of large bus instead of small bus against future passenger growth. Under the plan, DMTU implies the reduction of number of small buses to alleviate traffic congestion.

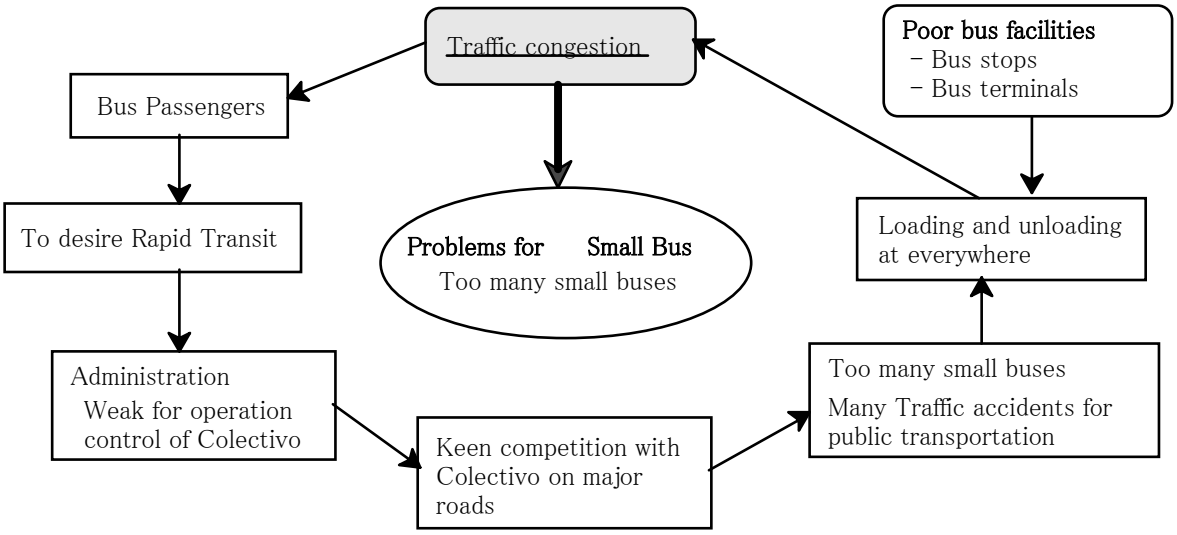


Figure 12.3-3 Problems for Small Buses

4) Old Age Bus

At the present, the bus ages are different between the types of buses. In Lima, the average bus ages of Omnibus, Microbus and Camioneta are approximately 20 years, 18 years and 15 years, respectively. Omnibus, which uses over 15 years accounts for 78% of the total. Microbus and Camioneta reach 68% and 53%, respectively. Therefore, the old buses are close to a scrap due to not enough for maintenance of those buses. This is because bus company and owner can not afford the expenses of the bus maintenance and prefer to expense the survival of company.

As the results of the situations, the environment conditions become worse. Especially, the air and noise pollution are severe. Though the environmental standards of them are enacted, it is not enough to control them.

5) Summary of Current Public Transport Issues

The current public transport has many problems as mentioned above. In Lima metropolitan area, where road traffic volume is high in relation to road capacity, buses suffer from the congestion and delay caused by other road users, and priority measures are needed to release buses from congestion of traffic and bus transport itself. In order to comprehensively improve the public transport system such as bus, taxi, Colectivo and moto-taxi, the main current issues, which have to solve are shown below.

a) To integrate a bus route
b) To construct a busway network segregated a private vehicle to actualize a higher bus operation speed
c) To prepare a bus facility such as bus terminal and bus stop
d) To introduce a large articulated bus with a higher capacity to alleviate a traffic congestion and problems for air and noise pollution caused by bus fleets
e) To propose a new tariff system
f) To reorganize a private bus organization

(2) Taxi, Colectivo and Moto-taxi

1) Taxi

There are many operated taxies inclusive of authorized and unauthorized taxies in the metropolitan area. The operation conditions of the unauthorized taxi such as number of trips, trip distance, and working hours, are the similar as that of authorized taxi. In the morning peak hour, approximately 30% of the total vehicle volumes on major roads are taxies in the counting. The ratio of the authorized and unauhtorized taxies operated on the roads is approximately 1 to 1. Taxi is used for many travel purposes in comparison to bus, which is used for specialized purpose: "to work and to school" in the morning peak hour. Approximately 26% of the total taxies are the empty taxi without passengers in the morning. Although taxi volumes are many on roads, the empty ratio is not high. This shows that taxi is used by many citizens in the metropolitan area.

On the other hand, taxi company desires the strong administrative control for unauthorized taxi, while the company does not desire a reduction of authorized taxi. This is because the company suffers a disadvantage of operation for authorized taxi from too many unauthorized taxies. However, it is difficult to restrict the unauthorized taxi due to unemployment of driver.

The main current issues, which have to solve are shown below.

a) To reduce total number of taxies to well balance demand and supply, and to be diverted for a taxi passenger to a rapid mass transit in future.
b) To control an unauthorized taxi and to force registration of the taxi in consideration to unemployment of driver.
c) To improve traffic safety and security problems of taxi.

2) Colectivo

Colectivo functions as a fixed-route taxi like a bus, and operates on a major bus route in competition with buses. A station wagon is mainly used for Colectivo. The operation conditions such as working hours, working pattern and type of possession are the similar as that of taxi. The advantage of Colectivo against the bus transport is to provide a rapid operation taking a seat. In the reason of Colectivo use, "Faster than bus service" takes the highest reason. Colectivo uses for specialized purpose: "to work and to school" in the morning peak hour. This is the same as that of bus. The passenger uses a Colectivo for a middle distance trip between bus for long trip and taxi for short trip. As a result, Colectivo completely competes with bus transport in the middle travel.

The main current issues, which have to solve are shown below.

a) To remove Colectivo from operation service in future to completely competes with bus transport in the middle travel.
b) To force registration as a taxi and to operate as a normal taxi.

3) Moto-Taxi

Within the suburb of Lima and Callao, the moto-taxi service operates as a paratransit. The moto-taxi is motorcycle taxi with a three-wheeler and space for two passengers in the rear of a car.

A Moto-taxi is used for many purposes in comparison to bus and Colectivo, which is used for specialized purpose: "to work and to school" in the morning peak hour. A travel time is as short as 10 minutes or less. The fare rate is a quarter or half times of bus fare rate. Moto-taxi is easily used as an alternative of walking due to a low fare.

The function of Moto-taxi is summarized as following.

a) In case of alternative mode of a bus: Moto-taxi is used for travel from house to destination as a main mode.
b) In case of terminal mode: Moto-taxi is used for travel from house to bus stop and then, user transfers to bus mode.

The main current issues are shown below.

a) In case of alternative mode, current Moto-taxi service shall be removed to feeder bus service in future.
b) In case of terminal mode, part of current Moto-taxi service shall be removed to feeder service and the remained service gradually reduces with increasing of feeder bus route.

(3) Railway

Railway facility, of which a length of 10.2km is constructed with 3 stations and a central operation center, is prepared but served for commercial operation in the weekday. However, the railway construction is not in progress due to difficulty of finance. At present, AATE makes several railway construction plans, and out of the plans, the extension plan of 1st line of north-south railway is now in progress by a concession method.

In future, the population in the Lima metropolitan area will continue to grow and reach to approximately 11.0 million. Moreover, the travel demand will increase at approximately 1.47 times. The present public transport system will exceed its capacity sooner or later.

The main issues are shown below.

a) In foreign cities with a population of 10 million, the railways or subways are constructed. In general, the system capacity of elevated or underground metros and suburban railways is approximately 30,000-40,000 passengers/hr/direction with a commercial speed of 30-50km/h. Since the current bus transport on some major road segments take 30,000 passengers/hr/dir or more, it will be necessary to introduce the railway system in the metropolitan area in the near future.
b) In the metropolitan area, transport policy and planning targeting the transport needs of the poor people should be provided for means of transport with low investment and operating costs due to easy construction.

12.3.2. PUBLIC TRANSPORT PLANNING POLICY AND STRATEGY

(1) Necessity of Mass Transit System

The metropolitan area has experienced steady growth in population and employment, particularly over the past twenty years. Projections between 2004 and 2025 indicate that this trend will accelerate, resulting in population, household, employment, and vehicle trip increases of 1.47 times, in contrast to 1.37 times in population. The travel demand of public transport and private modes will increase at approximately 1.3 times and 2.1 times, respectively.

Although the public transport demand is anticipated to increase in future, public transport share is projected to decrease slightly, from 77% in 2004 to 70% of all trips in 2025. This is primarily due to the fact that the number of trips made by private vehicles is also anticipated to increase. This overall increase in private vehicle trips tends to increase the demand for more and wider roadway and parking facilities. The problems recognize that increasing roadway capacity is both difficult due to geographic constraints and undesirable due to environmental, land use, and neighborhood impacts. Major public transport improvements are identified as possible options to address these problems.

Therefore, with the increased trips of public and private modes adding to the already congested major travel corridors, a mass transit system will be one option for increasing mobility using existing transport facilities such as roadway.

There are two main options for the mass transit systems: railway, which has a high capacity, but at high cost: and trunk busway, which have good carrying capacity, have flexibility and are cheap to install. In the study, a new rapid public transport included a trunk bus and rail transit systems will be proposed under a public transport priority policy. These alternatives of the rapid transit system will be proposed on major heavy transport corridors according to future travel demand. Those alternatives make a good transport performance such as a reduction of travel time, reasonable fare and comfortable travel, especially for a (extremely) poor people in the metropolitan area who are difficult in use of public transport.

(2) Planning Policy and Strategy

1) Fundamental Policy

In the Master Plan Study, taking into account the existing problems and issues of current bus system, the planning objectives pursues the following fundamental policy:

a) To provide a rapid, economic and reliable public transport system

The passenger demand will exceed the bus supply in the current system sooner or later, especially in the peak hours. The current buses are not comfortable for travel. In order to shift the car owners to public transport, it is necessary to improve the level of the service through concrete measures.

Therefore, a new rapid public transport system must be proposed to improve the commercial speed and service frequency. Under the proposed public transport system, it will be possible to reduce the number of current operated buses and to improve operation efficiency from the economic point of view. And also it is indispensable to maintain bus or railway coach punctuality by on-schedule operation from the reliability point of view.

2) Planning Policy

The plan takes the following policies.

a) To give priority to public transport for public space usage
b) To maintain present level of fare system, especially trunk bus system
c) To minimize negative impact on existing public transport business
d) To minimize project cost for public transport planning

The public transport needs a space for many types of facilities for railway system such as railway, stations, yard, and trunk bus system such as bus terminals, bus stops, bus operation lanes, bus parking. The high priority of public space usage for both system facilities must be given for the rapid public transport system.

Many bus passengers are sensitive for the level of transport fare. The passengers select those routes in consideration of travel time and fare. Therefore, the level of fare must be maintained at the present level when the rapid public transport system will be introduced.

As for the current bus transport system, there are approximately 460 companies operating bus transport with approximately 570 bus routes. Approximately 31,500 buses (Omnibus, Microbus and Camioneta) are operated by many employers. Therefore, the negative impacts must be minimized in the rapid public transport system. Restructuring of existing bus system will face difficult problems and opposition. Therefore, generally accepted development scenario should be proposed for discussion with related authorities.

The projects with low investment cost should be proposed by the Study due to the limited budget of both Lima and Callao municipalities for development of infrastructure.

3) Planning Strategy

Figure 12.3-4 shows a planning strategy in the improvement of current bus system, which shows the relation between planning direction and its effectiveness. The planning direction covers next items:

a) To operate the mass transit as well as to improve current bus operation with integration of bus routes
b) To construct a mass transit facility for a trunk bus system such as segregated busway, bus stop facility and bus terminal, and for railway system such as railway, station and yard.
c) To introduce a integrated tariff system
d) To reorganize a existing bus operation unit to solve keen competition and little profitability
e) To strengthen control of public transport by administration

Since the large number of the current bus routes cause to get worse the efficiency of bus operation, the integration of the current bus routes needs. At the same time, it is necessary to reduce the number of operated buses by introduction of a large capacity bus to alleviate traffic congestion.

In order to reduce the travel time, it is necessary to construct the mass transit priority facilities inclusive of railway, segregated busway, bus stop facility, etc., to release the mass transit from congestion of traffic and the mass transit itself. For example, the segregated busway is constructed on major roads to segregate a private vehicle and maintain a higher speed operation. The large articulated bus stops at bus stop facility and at bus terminal where bus passengers transfer a bus without payment of additional bus fee under a new integrated tariff system.

As for the private bus company, reorganization of current bus operation unit will be proposed to solve the current problems such as keen competition and little profitability. Old aged bus will be scrapped and small bus will be used as a feeder bus.

In order to smoothly operate the proposed mass transit system, the control of public transport by administration must be strengthened.

By actualization of those plans, effectiveness is reached as shown below.

a) The improvement of bus operation reaches simplicity of bus route configuration, shorter route length and profitable route network.
b) The construction of the mass transit facility reaches reduction of travel time by high-speed operation.
c) The introduction of the integrated tariff system maintains the present level of fare rate.
d) The reorganization of a bus operation unit reaches reduction of operation cost and promotes preferable competition each other.
e) The strengthening the control of public transport reaches control of a taxi and a Colectivo and promotes combination with a moto-taxi and a feeder bus.

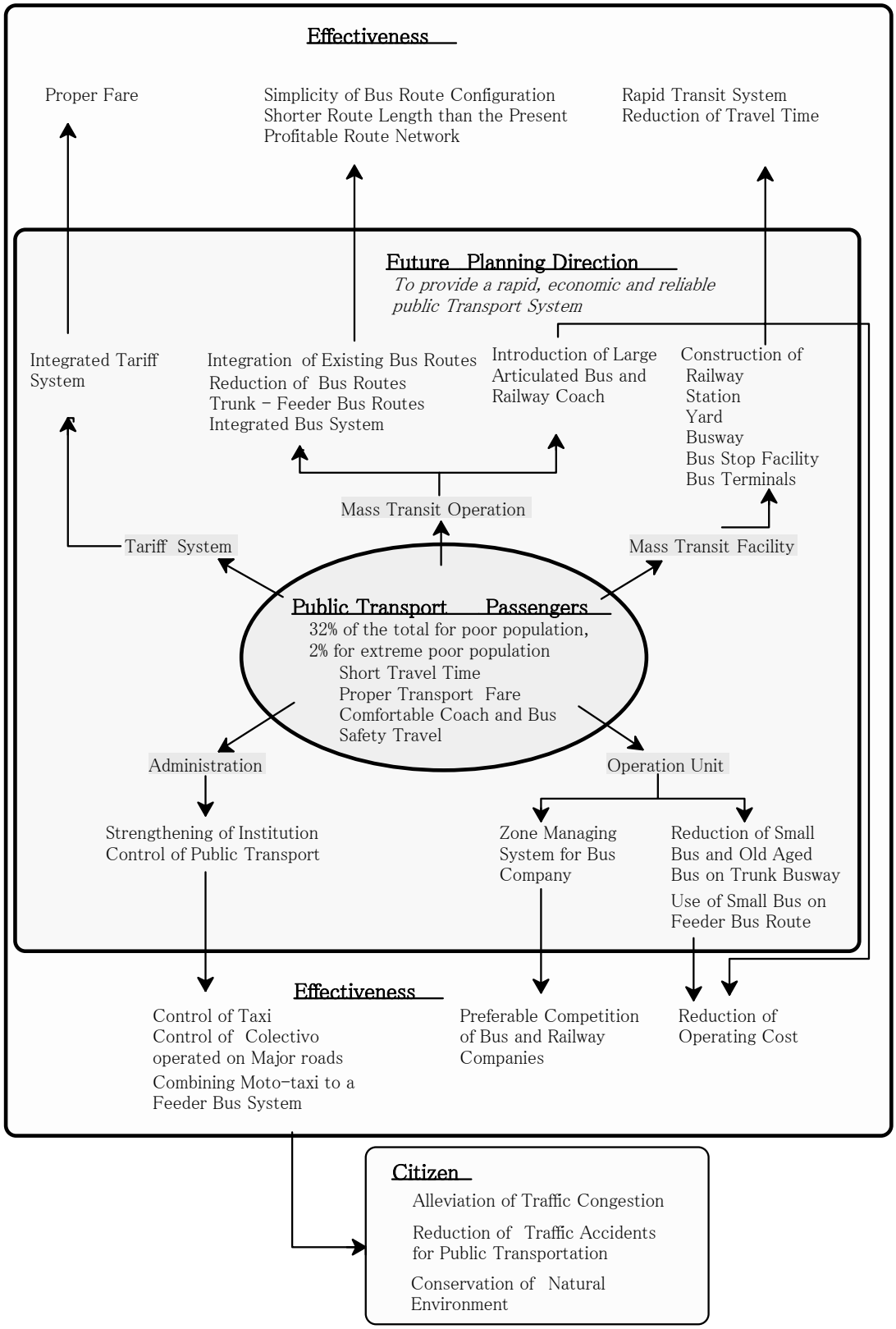


Figure 12.3-4 Future Planning Strategy

12.4. FORMULATION OF TRANSPORT NETWORK ALTERNATIVE PLAN

The transport network alternative study is carried out to identify the most optimum transport network among road transport and railway transport and bus transport of Lima and Callao Metropolitan Area in 2025. In this chapter, fifteen (15) transport network alternative plans based on the transport scenario are prepared, and to evaluate based on the economic analysis, technical analysis, and traffic demand analysis.

12.4.1. TRANSPORT MODE TO BE EXAMINED IN THE STUDY

The Comprehensive Urban Transport Master Plan in Lima and Callao Metropolitan Area is formulated by the public transport and private transport systems. Taking into account of the existing transport system, the future transport and traffic demand, numbers of population in the Study area, as well as the planning policy and strategies of the Study, basically the following transport mode are examined in the Study. However, the air transport and sea transport and river transport are not included in the Study.

1) Public Transport

a) Railway Transport
b) Bus Transport

2) Private Transport

a) Car Transport
b) Taxi Transport
c) Bicycle Transport (The Master Plan Study for Bicycle Transport is conducting by FONAM (Fondeo Nacional del Ambiente Peru) from period on November 2004 as individual study. Therefore, the bicycle transport is not included in the Study)

12.4.2. CONCRETE CONDITIONS FOR PREPARATION OF TRANSPORT NETWORK ALTERNATIVE PLAN

When, the formulation of transport network alternative plan, the important transport axis to be reinforced should be identified for route location of transport mode. For identification of the transport to be reinforced, the following seven (7) viewpoints are examined based on the results of Person Trip survey and its analysis, the future transport demand forecasted, and future traffic demand assignment on the road network.

a) From Viewpoint Desired Line Based on the Person Trip Flow
b) From Viewpoint of Transport Demand
c) From Viewpoint of Numbers of Bus Route Operated.
d) From Viewpoint of Numbers of Population
e) From Viewpoint of Large Scale Institutional Areas.
f) From Viewpoint of Large Scale Development Areas.
g) From Viewpoint of Existing Road Conditions.

(1) From Viewpoint Desired Line Based on the Person Trip Flow

The person trip flow desired line in 2025 based on the all transport mode with all trip purpose, and also based on the only public transport purpose are illustrated in Figure 12.4-1 and Figure 12.4-2 respectively. From these figure, both desired line can be obviously observed to concentrate the six (6) radial directions from the center of Lima city, and one circle (ring) direction in urban area. Therefore, the six (6) radial roads and ring roads located in urbanized area are identified as the very important transport axis to be reinforced for the study area. From viewpoint of the person trip characteristics in 2025, the

following concrete six (6) radial road and the trunk ring roads should be reinforced for securing the smooth traffic flows in2025.

a) Radial direction from center of Lima to center of Callao
b) Radial direction from center of Lima to Ventanilla
c) Radial direction from center of Lima to Comas
d) Radial direction from center of Lima to San Juan de Lurigancho
e) Radial direction from center of Lima to Villa el Salvador and Chorrillo
f) Radial direction from center of Lima to Santa Anita and Ate
g) Circle direction within urban area

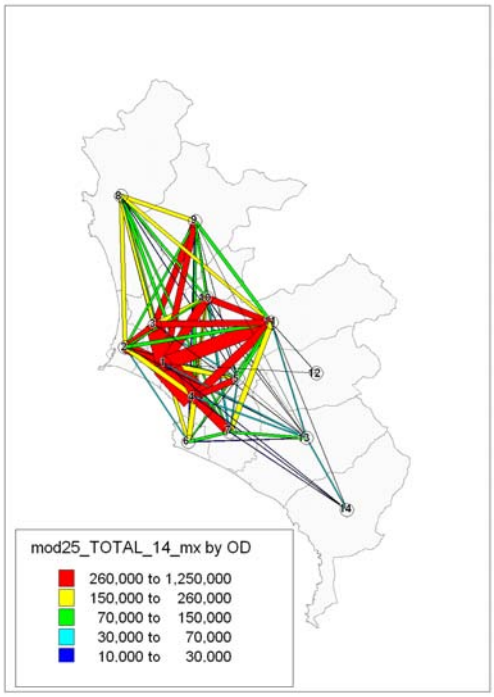


Figure 12.4-1 Desired line for all purpose in 2025

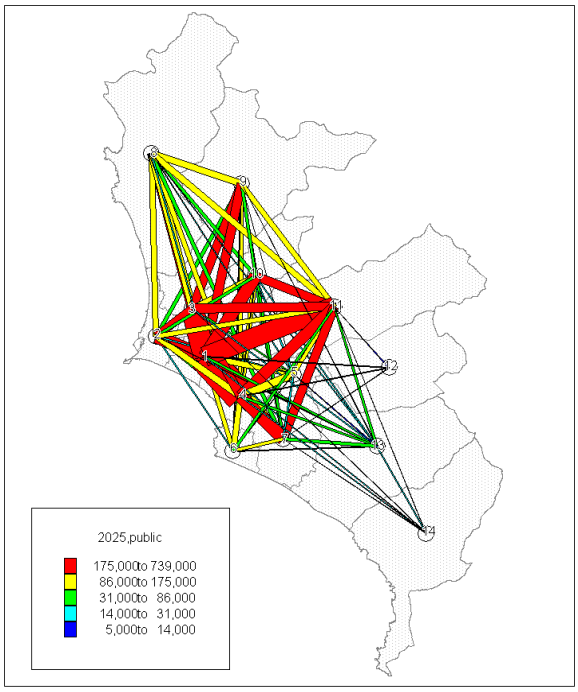


Figure 12.4-2 Desired line for public transport in 2025

(2) From Viewpoint of Transport Demand

As the results of person trip assignment on the road network in 2025 as shown in Figure 12.4-3, the large numbers of person trip is concentrated on the following radial and ring roads. These roads are formulated as the trunk road network in Lima and Callao Metropolitan Area. Taking into account the mitigation of traffic congestions in the area, a mass rapid transport system should be introduced to utilize on the following trunk roads.

Table 12.4-1 Number of Bus Passenger on each trunk road

Corriror	road	Passengers Peak Hour AM (person)		
		2004	2010	2025
Lima - Ventanilla	Faucett	6,664	10,945	26,116
Lima - Comas	Tupac Amaru	24,878	29,543	36,896
Lima - San Juan de Lurigancho	Proceses de la Independencia	20,691	18,537	21,566
Lima - Villa El Salvaldor	Aviacion	9,069	12,487	17,640
Lima - Chorrillos	Via expresa	14,671	14,235	17,585
Lima - Santa Anita - Ate	Carretela Central	17,060	27,308	40,007

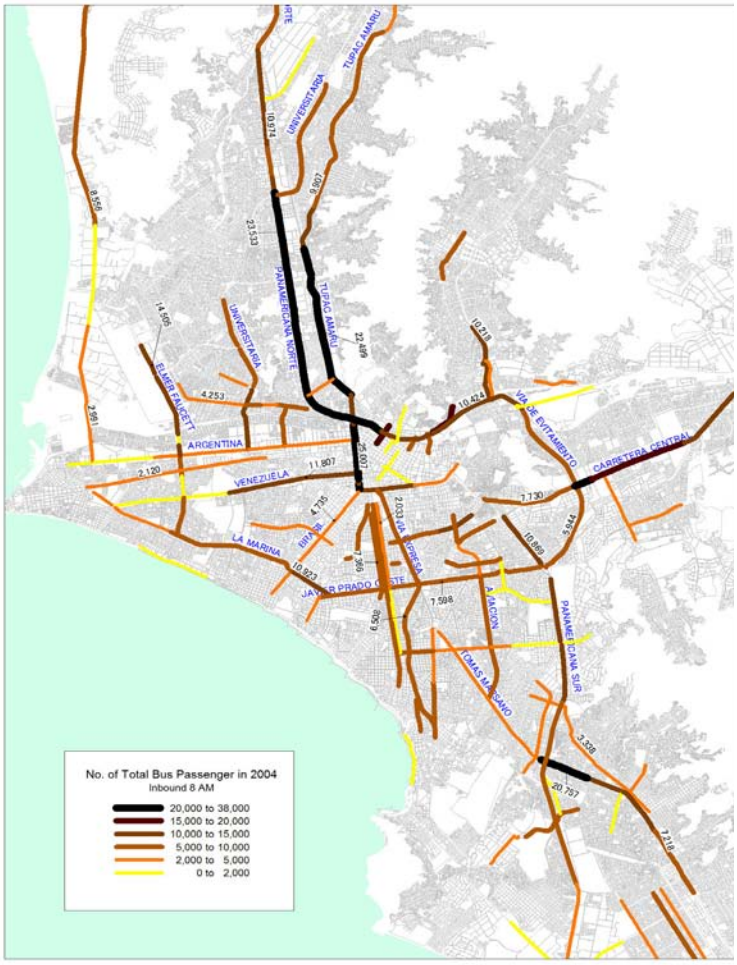


Figure 12.4-3 Location of Heavy Person Trip Roads

(3) From Viewpoint of Numbers of Bus Route Operated.

The existing bus operation routes are located to concentrate on the existing radial and ring trunk roads as shown in Figure 12.4-4 because the socio-economic activities have been developing along the existing radial and ring trunk roads. The heavy traffic congestions with low travel speed are occurred on these trunk roads. For mitigation of traffic congestion, a mass rapid transit system should be introduced to utilize on the following trunk roads.

1) Radial direction from center of Lima to center of Callao
    a) Av. Argentina
    b) Av. Colonial
    c) Av. Venezuera
2) Radial direction from center of Lima to Ventanilla
    a) Av. Nestro Gambetta
    b) Av. Elmer Faucett
3) Radial direction from center of Lima to Comas
    a) Av. Tupac Amaru
    b) Av. Panamericana Norte
    c) Av. Univetstaria
4) Radial direction from center of Lima to San Juan de Lurigancho
    a) Av. Independencia
5) Radial dirección from center of Lima to Villa el Salvador and Chorrillo
    a) Av. Panamericana Sur
    b) Av. Aviación
    c) Av. Paseo de República
6) Radial direction from center of Lima to Santa Anita and Ate
    a) Carr. Central
    b) Autopista Ramiro Prialé
7) Circle direction within urban area
    a) Av. Grau
    b) Av. Javier Prado

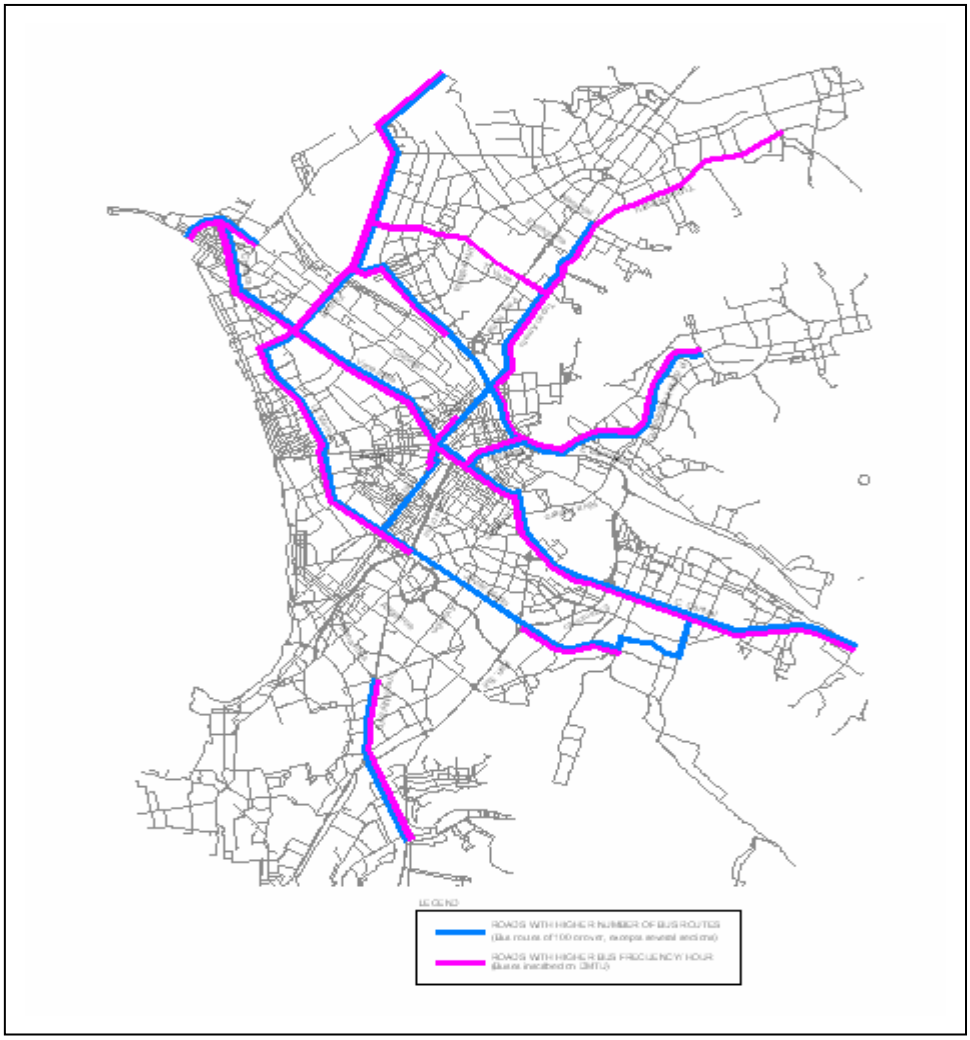


Figure 12.4-4 Location of Heavy Bus Route and Frequency

(4) From Viewpoint of Numbers of Population

The numbers of population in 2004 and in 2025 of the Study area is estimated as approximately 8 million and 11 million respectively. The comparison of population size by area in 2004 and 2025 is shown in Table 12.4-2. From this table, the area which is living over 800,000 inhabitants is only one existed in 2004, however, increasing the total population in the Study area, the area with over 800,000 inhabitants will be became two (2) areas in 2025. Three (3) areas which are living 300,000 to 500,000 inhabitants are existed in 2005, however, five (5) areas increased in 2025.

Considering the socio-economic activities of the above mentioned large scale inhabitants areas, a mass rapid transit system should be introduced to connect among large scale development areas directly. Based on the results of population distribution analysis in 2025, the high increased population areas will be developed on the three (3) directions such as for the east, north and south from the center of Lima. From viewpoint of numbers of population distribution, east-west transport axis and north-south transport axis should be reinforced in 2025.

Table 12.4-2 Comparison of Area Size by Population between 2004 and 2025

No. of Person	Covered Area in 2004	Covered Area in 2025
Over 800,000	1) Lima central area	1) Lima central Área 2) San Juan de Lurigancho
500,000 to 800,000	1)Comas 2)Independencia 3)San Juan de Lurigancho	1)Comas 2)Independencia 3)San Martín de Porres 4)Ate Vitarte 5)Callao central area
300,000 to 500,000	1)San Martín de Porres 2)Los Olivos 3)San Juan de Miraflores 4)Villa Maria del Triunfo 5)Villa el Salvador 6)Ate Vitarte 7)Callao central área	1)Puente Piedra 2)Los Olivos 3) San Juan de Miraflores 4) Villa Maria del Triunfo 5) Villa el Salvador 6)Chorrillos 7)Lurigancho 8)La Molina 9)Ventanilla

(5) From Viewpoint of Large Scale Institutional Areas

As shown in Figure 12.4-5, there are many large scale institutional areas and facilities along the existing trunk roads. The mass rapid transit system should be connected directly among these large scale institutional areas. It is required that the mass rapid system directly connect to following institutional areas.

a) International airport
b) International seaport
c) Large scale playing ground
d) Large scale university

(6) From Viewpoint of Large Scale Development Areas

As shown in Figure 12.4-5, three (3) large scale commercial development areas are recommended on 10km long way of the northern direction from Lima center, on 10 km long way of the eastern direction from Lima center, and on 15 km long way of the southern direction from Lima center.

Taking into account the activities of these large scale commercial development areas, a mass rapid transit system should be connected directly among three (3) development areas.

(7) From Viewpoint of Existing Road Conditions

Considering the smooth and easy realization of projects or plans to be recommended by the Master Plan, the projects or plans should be identified to avoid the additional land acquisition without re-settlement of inhabitants as possible. Therefore, projects or plans will be prepared to use the space of the existing right of way width.

For introduction of a mass rapid transit system on the existing roads without additional land acquisition, over 40m of cross section width (pedestrians width=5m*2= 10m, carriageways width= 8m*2=16m, mass transit ways width= 5m*2=10m, central reservation and related facilities width=4m) is required for minimum right way width. The

existing road network with over 40m right of way width prepared are shown in Figure 12.4-5, a mass rapid transit system should be introduced to use on these road network.

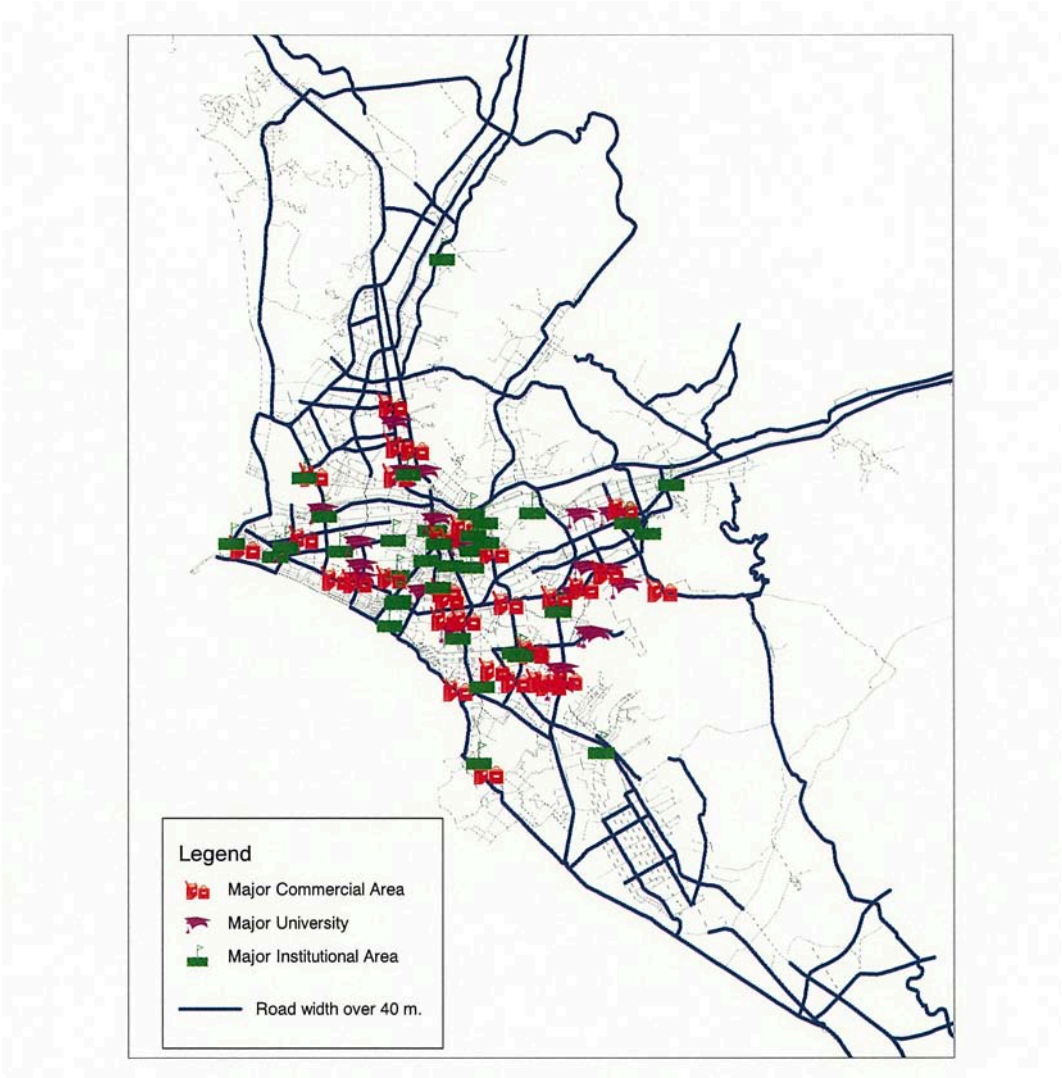


Figure 12.4-5 Road Facilities and Institutional Facilities Location Map

12.4.3. TRANSPORT SCENARIO OF LIMA AND CALLAO METROPOLITAN AREA IN 2025

(1) Existing Transport System

1) Existing Railway Transport System

About 9.8km length railway (North-South No.1 Line) infrastructures including railway-bet, railway-stations, operation and management center, and marshaling yard were already constructed by AATE, however, full railway service is not operated yet. The expansion of North-South No.1 Line will be constructed by the Concession System in year 2004. In addition, there are many railway development plans such as East-West Line and strengthen of North Corridor Line have been employed by AATE for mitigation of traffic congestion of Lima and Callao metropolitan area.

2) Existing Bus Transport System

The existing transport system in the Study area have been operating with mainly three type of bus such as Omnibus, Microbus, and Camioneta, car and taxi, and there is no full-scale

operating railway transport .At present, three segregated trunk bus roads were constructed already to utilize at the place of central carriageway of the existing roads. As mitigation of traffic congestion on the North-South traffic corridor (axis), a Newly Segregated trunk bus road namely COSAC project will be constructed in year 2004 by Protransporte. In addition, many bus operation improvement plans are developed by DMTU and Protransporte.

(2) Transport Scenario in 2025

Based on the existing transport system conditions in the Study area mentioned above, and the priority public transport development policy, the following three deferent transport scenarios are examined for selection of the mast optimum transport scenario in the Lima and Callao Metropolitan Area.

1) Priority Railway Transport System Introduced Scenario

Transport system of the Study area in 2025 basically will be operated by the railway transport system, and the feeder bus and original bus Systems will be operated as one of supplementary transport for the railway transport. Therefore, the railway system will be developed as the highest priority transport project.

2) Priority Trunk Bus System Introduced Scenario

Transport system of the Study area in 2025 basically will be operated by the trunk bus transport system, and the feeder bus and original bus Systems will be operated as one of supplementary transport for the trunk bus transport. Therefore, the trunk bus system will be developed as the highest priority transport project.

3) Combination Transport System Introduced Scenario

Transport system of the Study area in year 2025 basically will be operated by the railway transport and trunk bus transport system with keeping balance between both systems, and the feeder bus and original bus Systems will be operated as one of supplementary transport for the combination transport system. Therefore, the railway and trunk bus will be developed by paralleled.

(3) Staging Transport Mode Planning Scenario for in Short and Middle Term

The identification of transport modes that is railway and trunk bus and ordinal bus in 2025 are examined based on the competition analysis between transport mode capacity and transport demand. When the transport demand is low in 2004, the ordinal bus mode is adopted. When the demand exceeding the capacity of the ordinal bus in Middle Term period, the trunk bus transport mode is adopted, and then, the demand exceeding the capacity of the trunk bus mode in Middle Term or Long Term period, the railway transport mode is adopted as shown in Figure 12.4-6. Therefore, the transport mode selected will be changed from the ordinal bus to the trunk bus, and also from the trunk bus to railway transport accordance with the future transport demand.

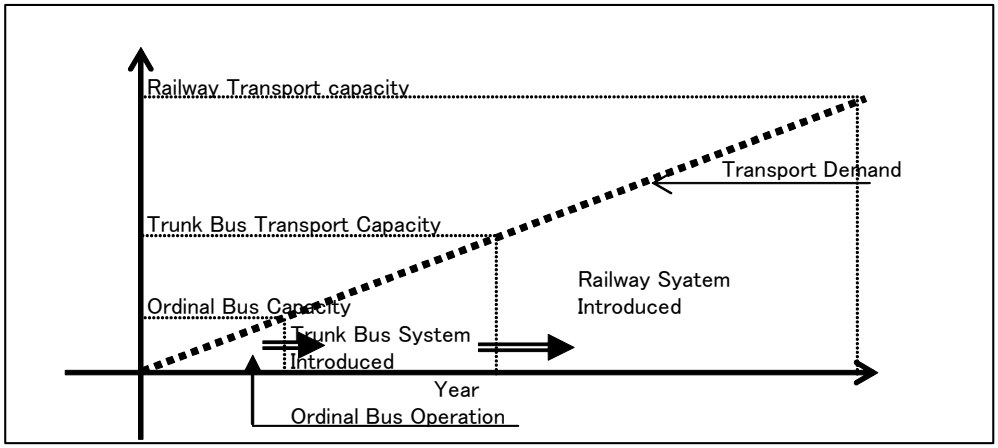


Figure 12.4-6 Scenario for Transport Mode Selected

12.4.4. IDENTIFICATION OF BASIC TRANSPORT NETWORK CASE BY SCENARIO

For evaluation of the above mentioned three transport scenarios, the following transport network cases by scenario are identified.

(1) Consideration for Identification of Study Case

Considering the following conditions, transport network case should be prepared.

1) To mitigate traffic congestion on the trunk roads
2) To strengthen traffic axis
3) To meet traffic demand and housing development
4) To consider project size and implementation schedule
5) To meet the on-going project and future development plan approved.

(2) Transport Network Case for Priority Railway Transport Introduced Scenario

The population of the Study Area in the year 2004 and 2025 are estimated as about 8.043 Million and 19,990 Million persons respectively. The total numbers of person trip per day in year 2004 and 2025 are also estimated as about 12,000,000 and about 20,000,000 person trips, and the areas of which are living about 800,000 to 1,000,000 inhabitants will be developed in 2025.

Considering the future population growth and economic activity of the Study area in 2025, the priority railway transport introduced system is required for the mitigation of traffic congestion and decreasing traffic accidents and keeping a good environmental condition in the study area.

This scenario is basically to develop or introduce the railway transport network as the highest priority transport system in the study area. Taking into account the future traffic and transport demand and results of seven viewpoint of selection of reinforced traffic axis analysis mentioned previous, the following 3 cases of railway routes are identified as the highest priority transport scenario.

1) Case F-1: Railway directly connects to the over 800,000 inhabitants' areas as shown in Figure 12.4-7.
2) Case F-2: Railway directly connects to the over 800,000 inhabitants' with combined area as shown in Figure 12.4-8.
3) Case F-3: Railway directly connects to the over 500,000 inhabitants' areas as shown in Figure 12.4-9.

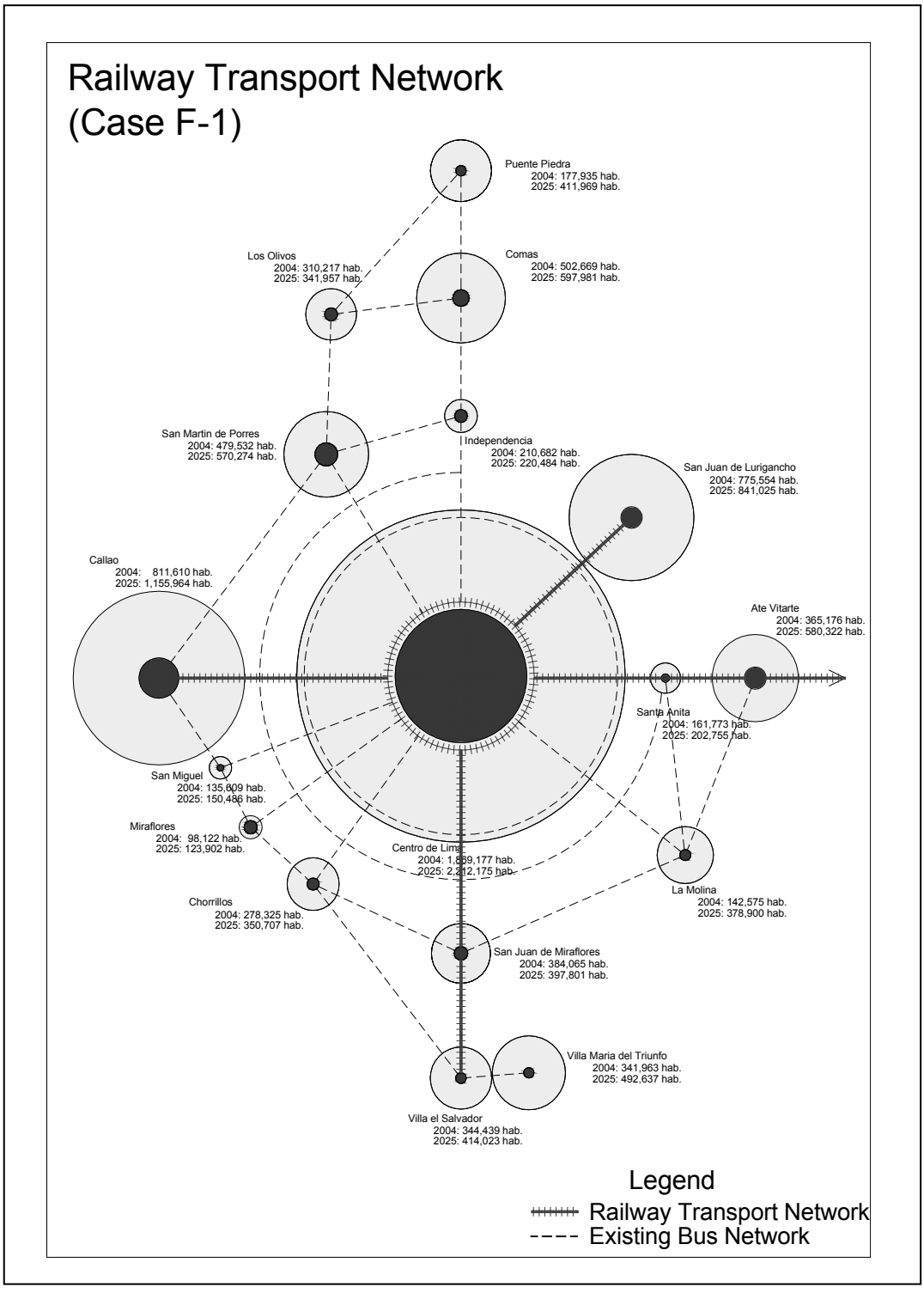


Figure 12.4-7 Railway Development Priority Scenario Case F-1

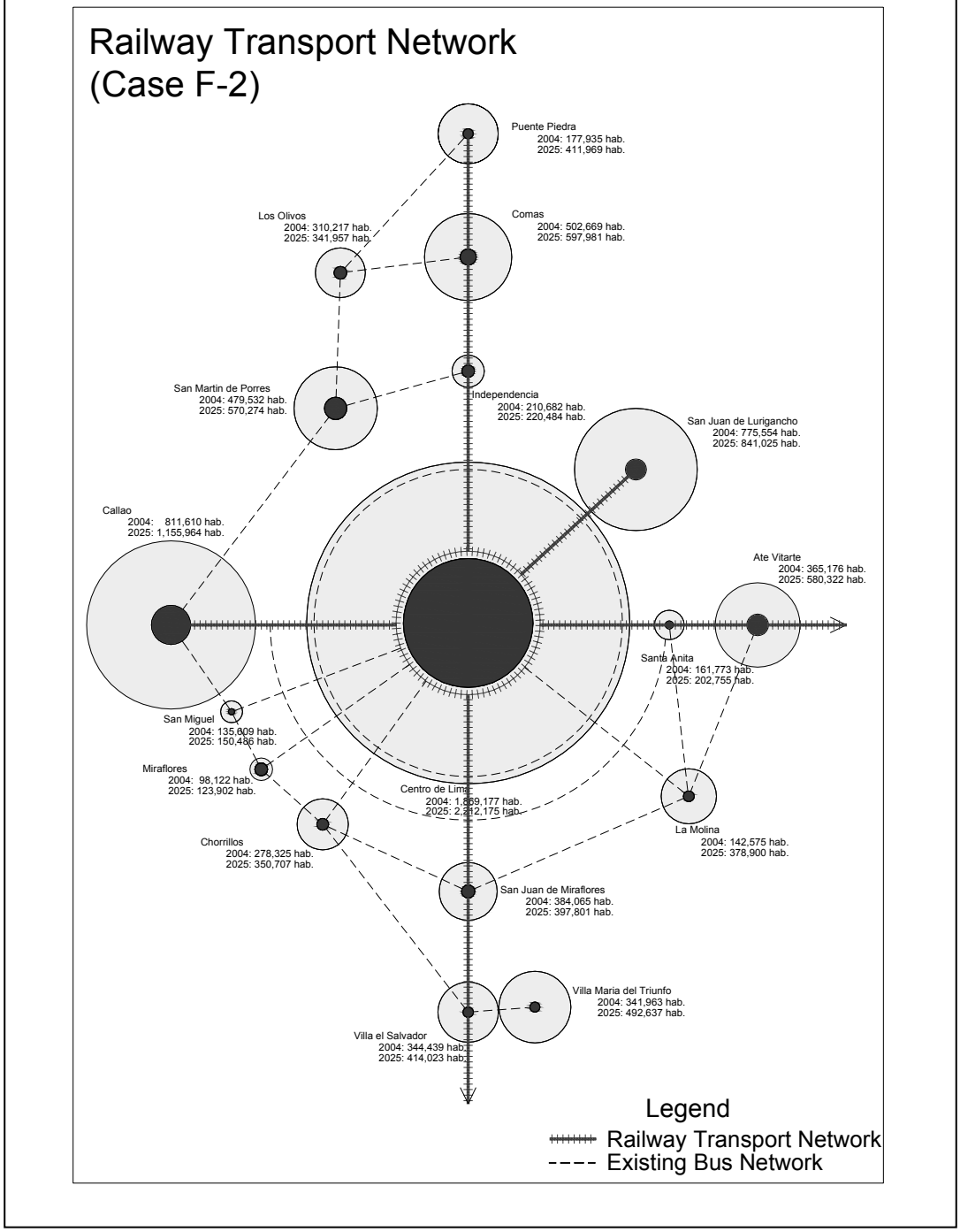


Figure 12.4-8 Railway Development Priority Scenario Case F-2

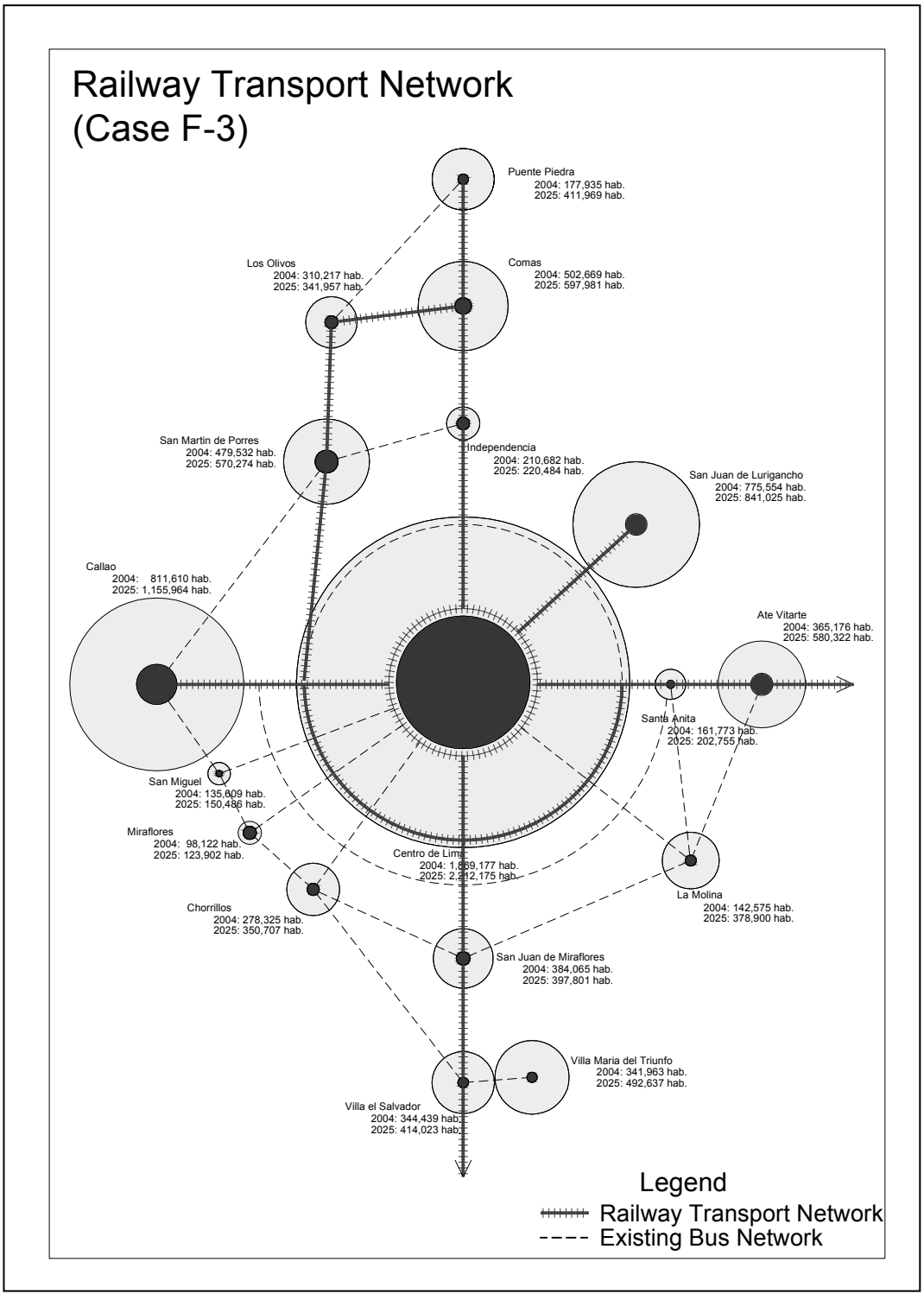


Figure 12.4-9 Railway Development Priority Scenario Case F-3

1) Transport Network of Case- F-1

Based on the viewpoint of transport axis reinforced mentioned in previous, the concrete route location of Case F-1 are summarized, and the basic transport network is shown in Figure 12.4-10.

a) Railway routes will be connected directly from Lima center to areas which are estimated as about 1,000,000 inhabitants in 2025.
b) The routes will be reinforced on the major important of traffic axis.
c) As results above mentioned matter, Lima center-Villa el Salvador, Lima center-Callao, Santa Anita and Ate Vitarte, and Lima center-San Juan de lurigancho are connected.
d) The route of Lima-Villa el Salvador is employed as the same of North-South No.1 railway route.
e) The route of Callao-Lima Center-Santa Anita and Ate Vitarte is employed as the same of the existing railway line.

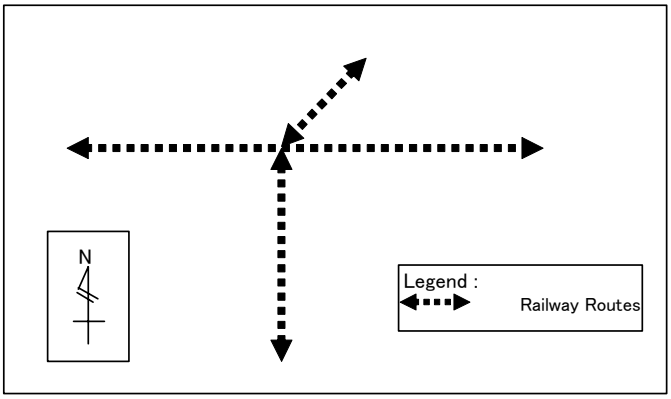


Figure 12.4-10 Basic Railway Network on Case-F-1

2) Transport Network of Case-F-2

Based on the viewpoint of transport axis reinforced mentioned in previous, the concrete route location of Case F-2 are as follows, and the basic transport network is shown in Figure 12.4-11.

a) Railway routes will be connected directly from Lima center to areas which are estimated as about 1,000,000 inhabitants in 2025.
b) The routes will be reinforced on the South, East-West, and North-East Traffic Corridor Axis
c) The routes will be reinforced on the North Traffic Corridor Axis
d) As results above mentioned matter, Lima center-Villa el Salvador, Lima center-Callao, Santa Anita and Ate Vitarte, and Lima center-San Juan de Lurigancho, and Lima center-Comas and Puente Piedra are connected
e) The route of Lima-Villa el Salvador is employed as the same of North-South No.1 railway route
f) The route of Callao-Lima Center-Santa Anita and Ate Vitarte is employed as the same of the existing railway line.

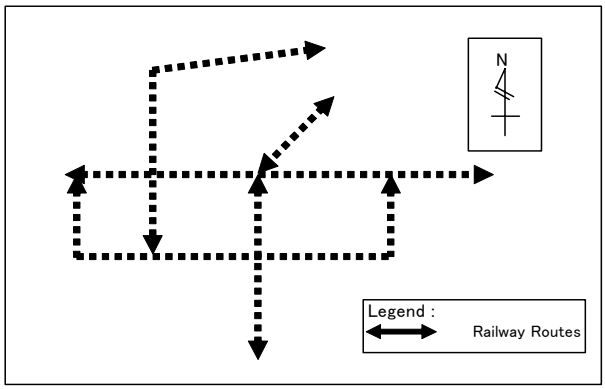


Figure 12.4-11 Basic Railway Network on Case F-2

3) Transport Network of Case-F-3

Based on the viewpoint of transport axis reinforced mentioned in previous, the concrete route location of Case F-3 are presented below and the basic transport network is shown in Figure 12.4-12.

a) Railway routes will be connected directly from Lima center to areas which are estimated as over 500,000 inhabitants in 2025.
b) The routs will be reinforced as the same of Case-F-1 and Case-F-2, in addition will be reinforced inside urban area and San Martin areas.

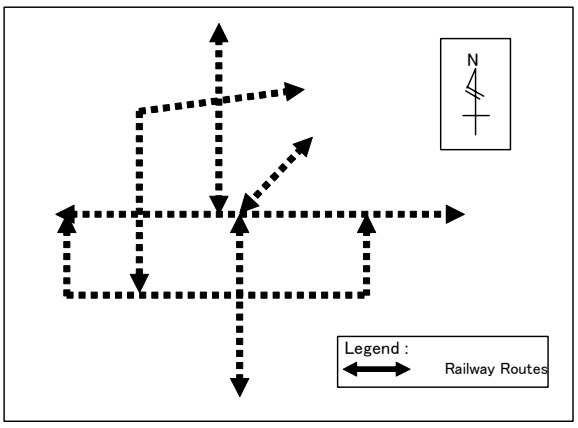


Figure 12.4-12 Basic Railway Network on Case F-3

(3) Basic Transport Network Case for Priority Trunk Bus Transport Introduced Scenario

This scenario is basically to develop or to introduce the trunk bus system as the highest priority transport network in the study area for mitigation of traffic congestion, and maintaining traffic safety, as well as keeping good social and natural environmental aspects.

The considering the future transport demand and viewpoint of transport axis reinforced, the following 3 Cases for trunk bus transport network (Case B-1, Case B-2, and Case B-3) are identified.

Case B-1: Trunk bus directly connects to the over 800,000 inhabitants' areas as shown in

1) Figure 12.4-13.
2) Case B-2: Railway directly connects to the over 500,000 inhabitant's area as shown in Figure 12.4-14.
3) Case B-3: Railway directly connects to the over 300,000 inhabitants' areas as shown in Figure 12.4-15.

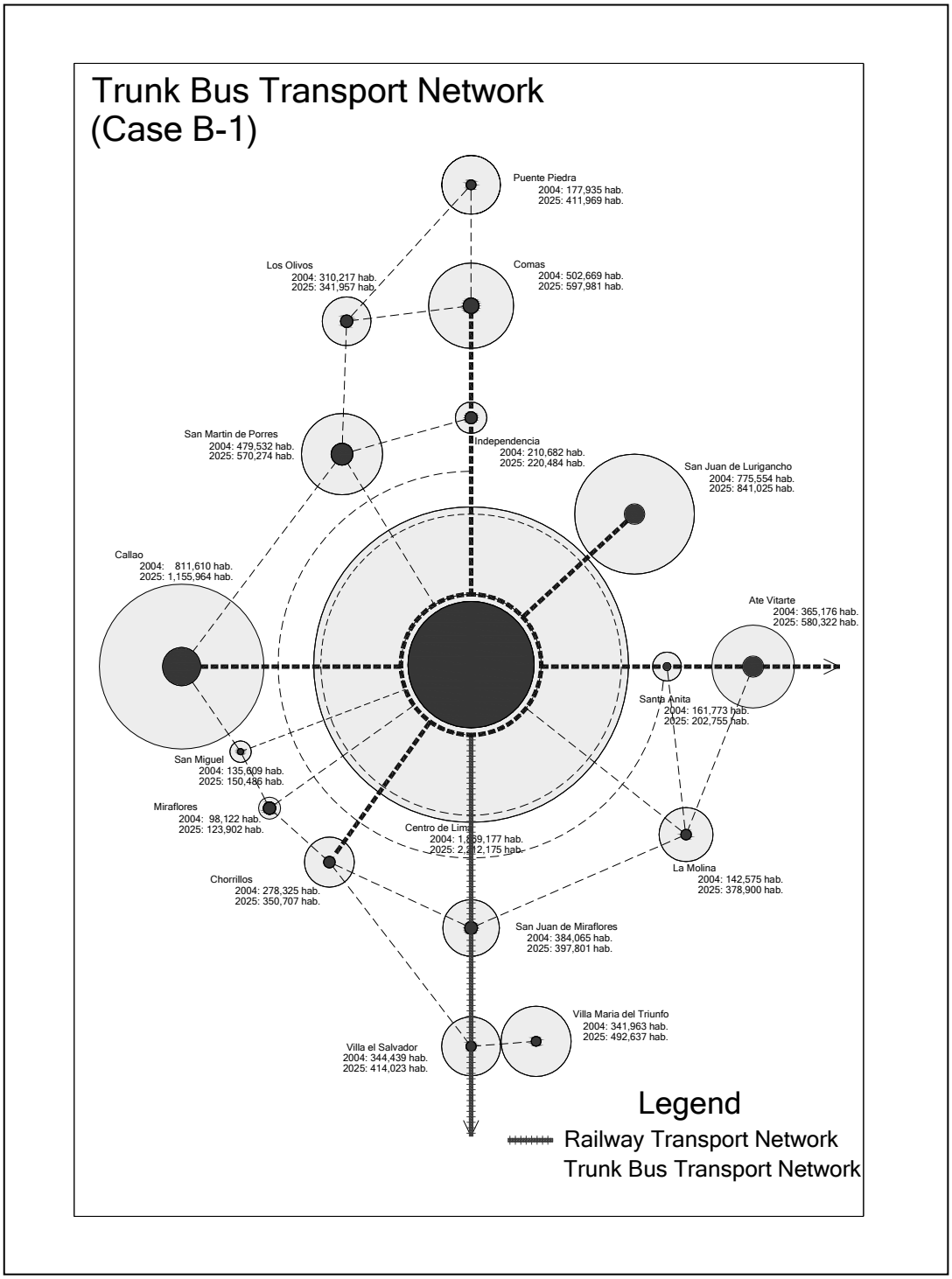


Figure 12.4-13 Trunk Bus Development Priority Scenario Case B-1

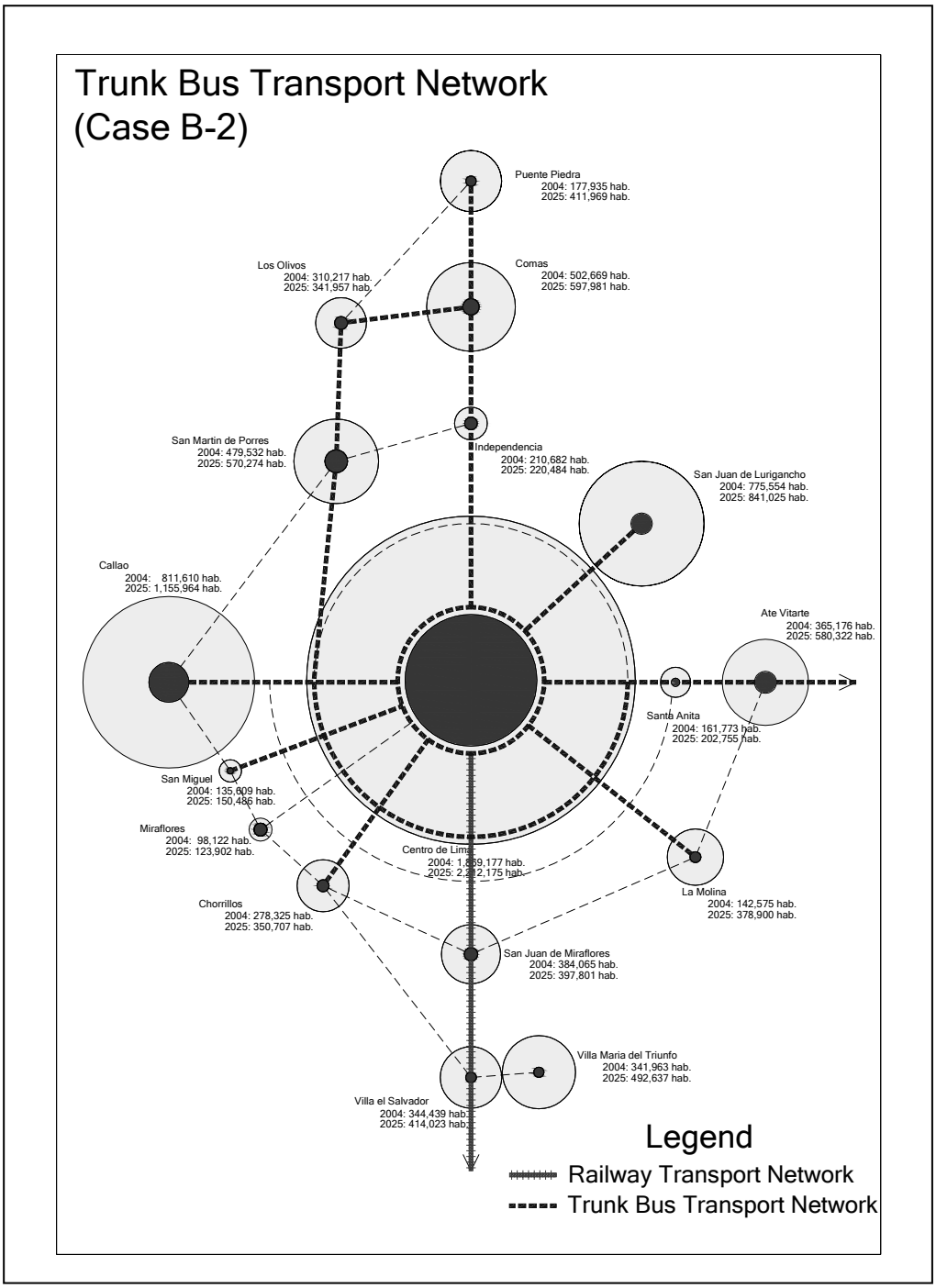


Figure 12.4-14 Trunk Bus Development Priority Scenario Case B-2

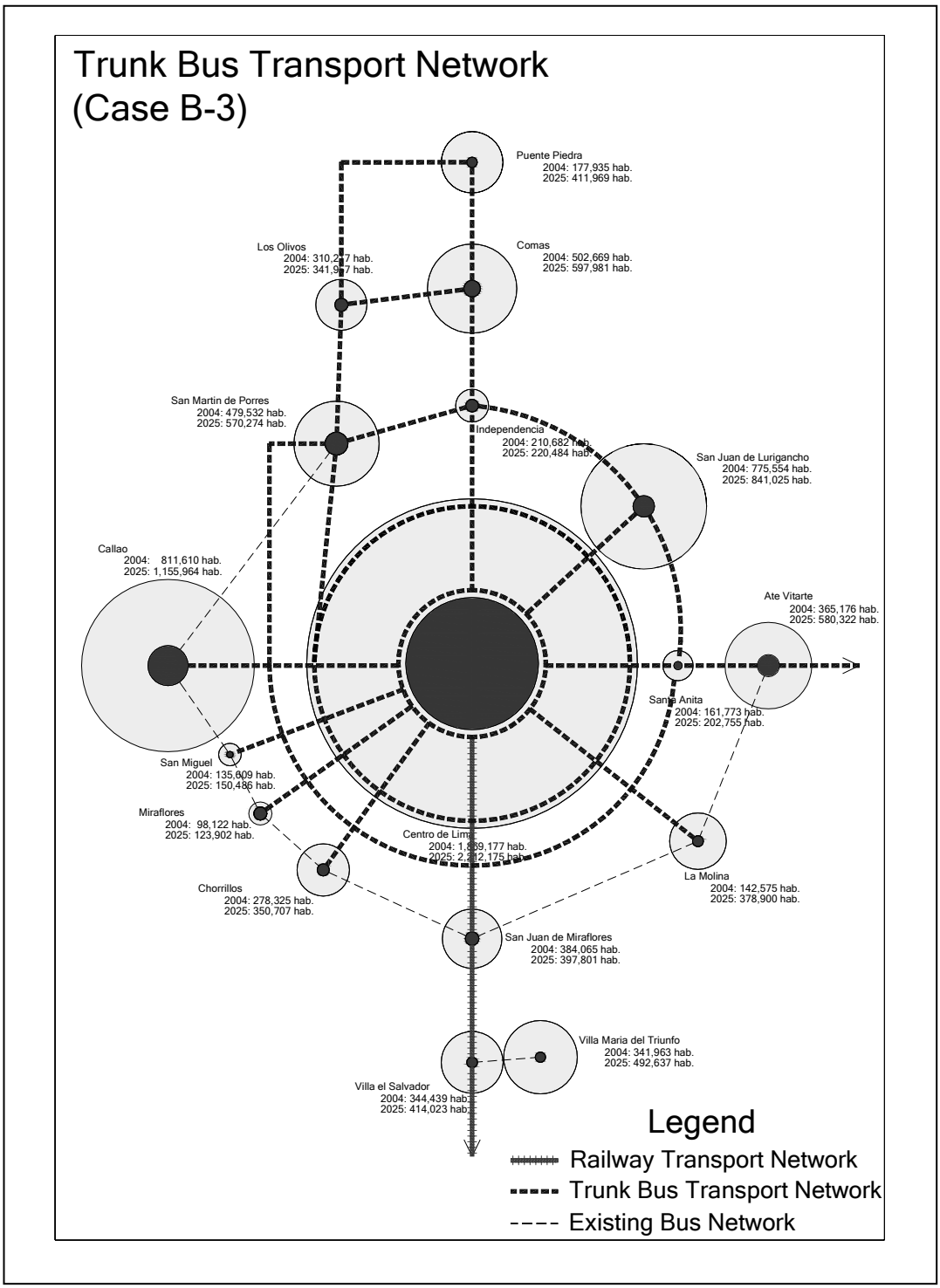


Figure 12.4-15 Trunk Bus Development Priority Scenario Case B-3

1) Transport Network of Case B-1

Based on the viewpoint of transport axis reinforced mentioned in previous, the concrete route location of Case B-1 are presented below, and the basic transport network is shown in Figure 12.4-16.

a) Segregated Trunk Bus routes will be connected directly from Lima center to areas which will be estimated as about 1,000,000 inhabitants in 2025.
b) The routes mainly will be developed or reinforced on the radial traffic axis.
c) COSAC project is employed
d) North- South No.1 railway route is employed
e) The routes has cover at Lima central area
f) These Bus routes can be reinforced on North, South, East-West, and North-East Traffic Axis.

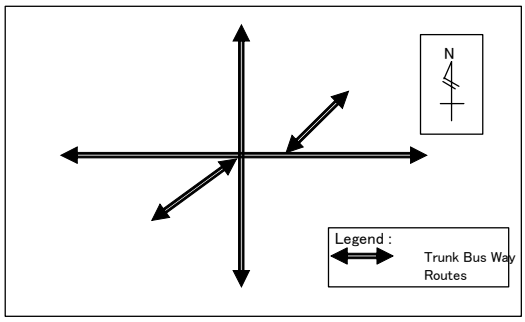


Figure 12.4-16 Basic Trunk Bus Network on Case B-1

2) Transport Network of Case-B-2

Based on the viewpoint of transport axis reinforced mentioned in previous, the concrete route location of Case B-2 are presented below, and the basic transport network is shown in Figure 12.4-17.

a) Segregated Trunk Bus routes will be connected directly from Lima center to areas which are estimated as about over 300,000 inhabitants in 2025.
b) The routes will be reinforced at Santa Martin and Los Olivos areas
c) Routes selected are almost same as the Case-B-1, in addition of Case-B-1, two radial routes and two ring roads are selected for mitigation of traffic congestion within urban area.

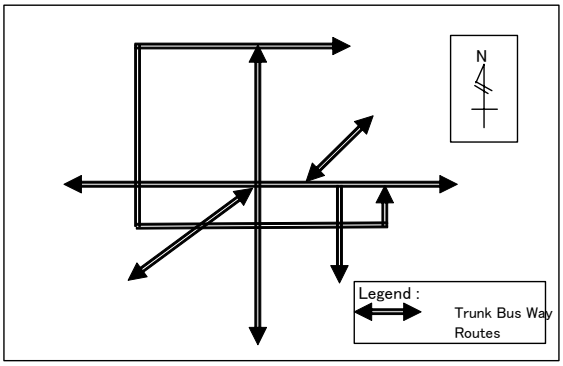


Figure 12.4-17 Basic Trunk Bus Network on Case B-2

3) Transport Network of Case-B-3

Based on the viewpoint of transport axis reinforced mentioned in previous, the concrete route location of Case B-3 are described below, and the basic transport network is shown in Figure 12.4-18.

a) Segregated Trunk Bus routes will be connected directly from Lima center to areas which are estimated as about over 150,000 inhabitants in 2025.
b) Routes selected are almost same as the Case B-2; in addition Case B-2, two radial routes and one ring road are selected for mitigation of traffic congestion within urban area.

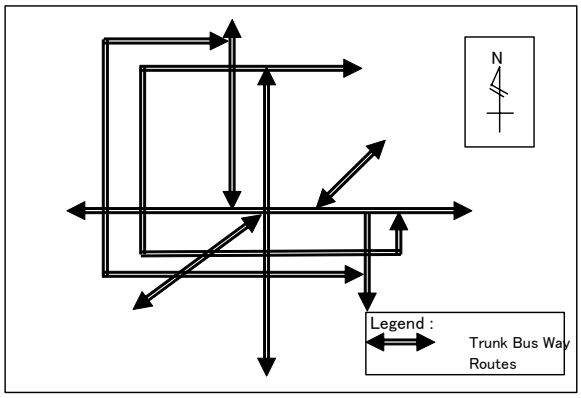


Figure 12.4-18 Basic Trunk Bus Network on Case B-3

(4) Characteristics Case Identified on Each Scenario

The characteristics of each Case shown in Scenario, is shown in Table 12.4-3.

Table 12.4-3 Major Concept and Solution Traffic Axis of Case

Scenario	Case	Major Concept	Major Solution
1) Priority Railway System Introduced	F-1	1) Railway Routes are directly connected from Lima center to high development areas (1.0 Million inhabitants). 2) Utilization of existing railway infrastructure and facilities	Solution of traffic axis. 1)South 2)East-West 3) North/East
	F-2	1) Railway routes are directly connected from Lima center to areas which are of which 1.0 Million inhabitants lived. 2) Utilization of existing railway infrastructure and facilities 3) Railway route is located to avoid the COSAC project route	Solution of traffic axis. 1)North-South 2)East-West 3) North/East ,
	F-3	1) Railway routes are directly connected from Lima center to areas which are over 0.5 Million inhabitants lived as radial railway network 2) Utilization of existing railway infrastructure and facilities 3) Railway route is located within urban area	Solution of traffic axis. 1)North-South 2) East-West 3) North/East 4) San Martin/Los Olivos 5) Within urban area
2) Priority Trunk Bus System Introduced	B-1	1) Trunk bus is directly connected from Lima center to areas which are about1.0 Million inhabitants lived. 2) Utilization of COSAC Project 3) Trunk bus route is located at urban central area	Solution of traffic axis. 1)North-South 2) East-West 3)North/East 4)Within urban area
	B-2	1) Trunk bus routes are directly connected from Lima center to areas which are over 0.3 Million inhabitants lived as radial railway network 2) Utilization of COSAC project 3) Two ring bus routes are located within urban area	Solution of traffic axis. 1)North-South 2) East-West, 3) North/West 4) Within urban area 5) San Martín/Los Olivos
	B-3	1) Trunk bus routes are directly connected from Lima center to areas which are over 0.2 Million inhabitants lived. 2) Utilization of COSAC project 3) Three ring bus routes are located within urban area.	Solution of traffic axis. 1)North-South 2) East-West, 3) North/West 4) Within urban area 5) San Martín/Los Olivos

12.4.5. FORMULATION OF ALTERNATIVE FOR TRANSPORT NETWORK PLAN IN 2025

For evaluation of among three transport network scenario described in previous section, the fifteen (15) Alternatives are prepared as shown in Table 12.4-4. The horizontal axis of Table 12.4-4 is shown as Priority Railway Introduced Scenario, vertical axis is shown as Priority Trunk Bus Introduced Scenario, and close column of vertical and horizontal axis is shown as Combination Transport Introduced Scenario.

Within 15 Alternatives, the Alt.-A, Alt.-B, and Alt.-C are classified as the Priority Railway Introduced Scenario, Priority, and the Alt.-D, Alt.-H, and Alt.-L, are classified as the Trunk Bus Introduced Scenario. The rest of Alternatives are classified as the Combination Transport Introduced Scenario. The basic transport network on each Alternative is shown in Figure 12.4-19 to Figure 12.4-22.

Table 12.4-4 Alternative for Basic Transport Network

Trunk Bus System	Railway Transport (Priority railway introduced scenario)				
(Priority trunk bus introduced scenario)	Existing Network	Case-F-1	Case-F-2	Case-F-3	Remarks
Existing Network	Base Case	Alt.-A	Alt.-B	Alt.-C	N-S Railway Line COSAC Project
Case-B-1	Alt.-D	Alt.-E	Alt.-F.	Alt.-G..	-------
Case-B-2	Alt.-H	Alt.-I	Alt.-J	Alt.-K.	--------
Case-B-3	Alt.-L	Alt.-M	Alt.-N.	Alt.-O	--------

12.4.6. PROJECTS FORMULATED BY ALTERNATIVE TRANSPORT PLAN

Fifteen (15) Alternative Transport Networks such as the Alternative A to the Alternative O are formulated in previous section. The each Alternative includes the various road development projects, trunk bus development projects, and railway development projects. The Alternative Plan A consists of 33 road development projects and 2 railway development projects, and the Alternative Plan-O consists of 33 road development projects, 11 trunk bus development projects, and 5 railway development projects as shown in Table 12.4-5.

Table 12.4-5 Relationship between Alternative Plan and Projects

Name of Alternative	Projects Formulated		
	Road Projects	Trunk Bus Projects	Railway Projects
Base Case	0	0	0
Alternative –A	33 Projects	0	2 Projects
Alternative –B	33 Projects	0	4 Projects
Alternative –C	33 Projects	0	5 Projects
Alternative –D	33 Projects	6 Projects	0
Alternative –E	33 Projects	6 Projects	2 Projects
Alternative –F	33 Projects	6 Projects	4 Projects
Alternative –G	33 Projects	5 Projects	5 Projects
Alternative –H	33 Projects	12 Projects	0
Alternative –I	33 Projects	11 Projects	2 Projects
Alternative –J	33 Projects	8 Projects	4 Projects
Alternative –K	33 Projects	7 Projects	5 Projects
Alternative –L	33 Projects	17 Projects	0
Alternative –M	33 Projects	16 Projects	2 Projects
Alternative –N	33 Projects	14 Projects	4 Projects
Alternative –O	33 Projects	11 Projects	5 Projects

12.4.7. PROJECT COST ESTIMATE IN ALTERNATIVE PLANS

(1) Projects Cost for Road Development Project

The each road project cost among 33-project is estimated based on the project construction cost estimated by the Peruvian related authorities, and to refer the past construction experience in the Study area. The road construction cost consists of direct construction const and in-direct construction cost for construction of the road. The project cost consists of the following items.

a) Construction cost (A)
b) Engineering Cost (A*10%)
c) Administration Cost (A*10%)
d) Contingency (A*15%)

The detailed project cost estimated of each 33-project is presented in Chapter 13.4.3 in this Report.

(2) Project Cost for Trunk Bus Development Project

The each trunk bus project cost among 17-project is estimated based on the past experience of construction cost in the Study area and discussion with the Peruvian counterparts. The construction cost of the trunk bus project is covered to construct the only 2-Lane trunk bus road, and without improvement of the existing road construction cost. The construction items of the trunk bus project are as follows,

a) Construction of only 2-Lane bus exclusive road on the center of the existing road
b) Construction of only 2-Lane grate separated intersection needed for only trunk bus operation.
c) Construction of bus stop , small bus terminal, and related facilities
d) Without construction cost for the improvement or betterment of existing road such as sidewalk, widening, and over-lay of passenger car's carriageway.

The project cost consists of the following items.

a) Construction cost (A)
b) Engineering Cost (A*10%)
c) Administration Cost (A*10%)
d) Contingency (A*15%)
e) Article bus fleets purchase cost

The numbers of bus fleet needed in 2025 are estimated based on the comparison between the future passenger demand in 2025 and the transport capacity of article bus.

The detailed project cost estimated of each 17-project is presented in Chapter 14.9 in this Report.

(3) Project Cost for Railway Development Project

The each railway project cost among 5-project is estimated based on the past experience of construction cost in the Study area and discussion with the Peruvian counterparts (AATE). The construction cost of the railway project is covered to construct the only railway structure, and related facilities without improvement of the existing road construction cost. The construction items of the railway project are as follows,

a) Construction of only railway structure on the center of the existing road
b) Construction of only grate separated intersection needed for only railway operation.
c) Construction of railway stations, depot, terminal and electric facilities
d) Without construction cost for the improvement or betterment of existing road such

as sidewalk, widening, and over-lay of passenger car's carriageway.

The project cost consists of the following items.

a) Construction cost (A)
b) Engineering Cost (A*10%)
c) Administration Cost (A*10%)
d) Contingency (A*15%)
e) Wagon purchase cost

The numbers of wagon needed in 2025 are estimated based on the comparison between the future passenger demand in 2025 and the transport capacity of article bus.

The detailed project cost estimated of each 5-project is presented in Chapter 15.8.2 in this Report.

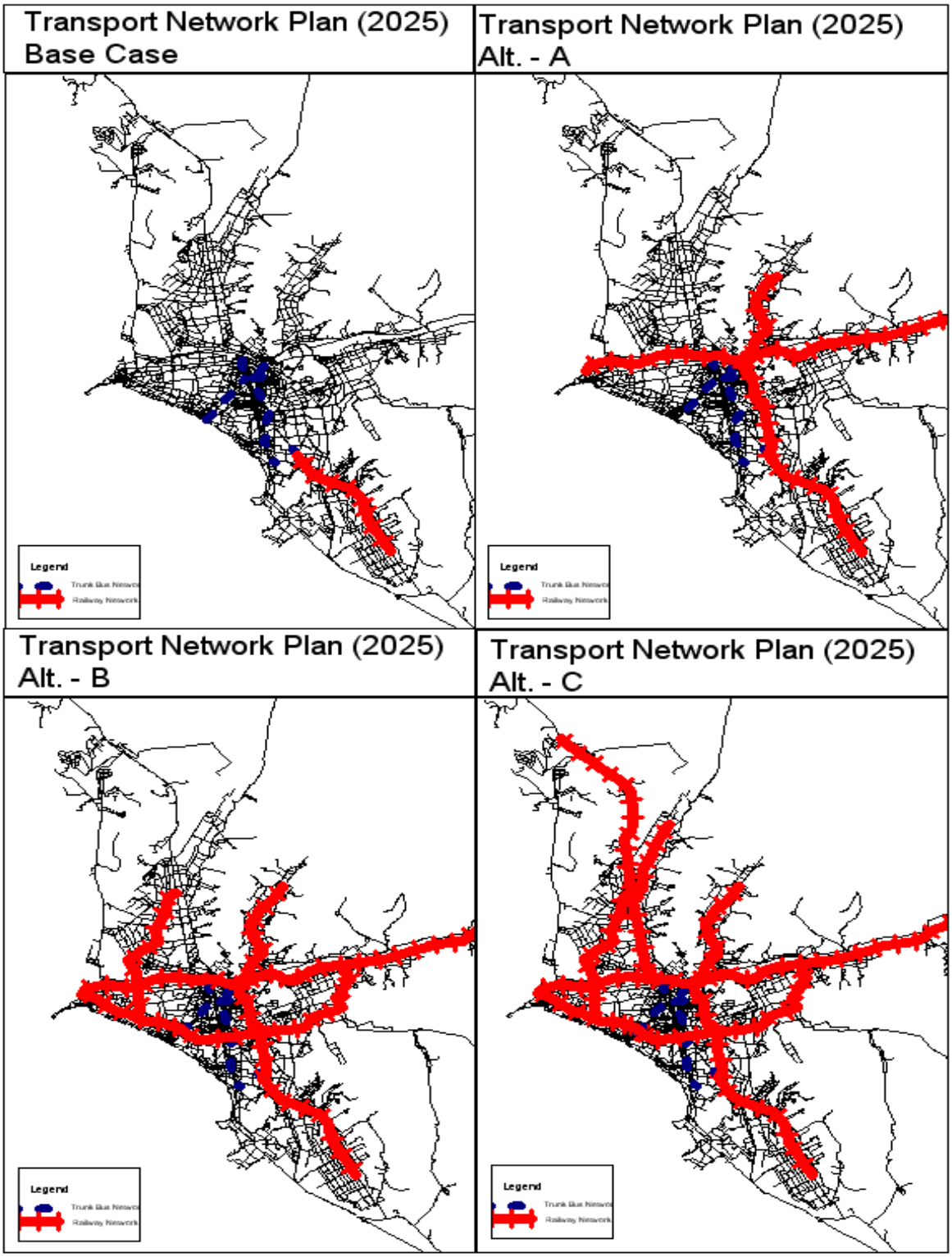


Figure 12.4-19 Basic Transport Network on Alternatives (1)

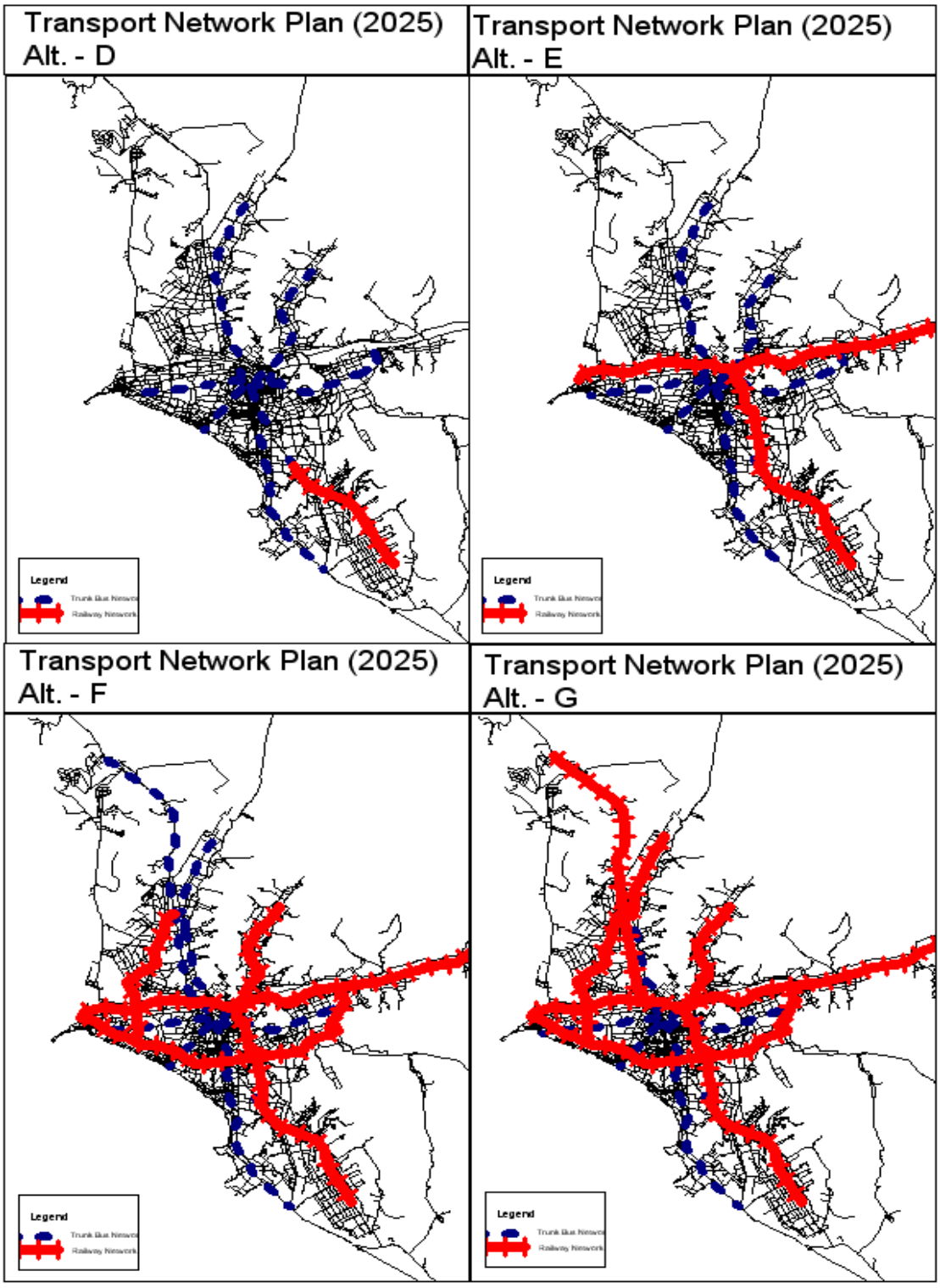


Figure 12.4-20 Basic Transport Network on Alternatives (2)

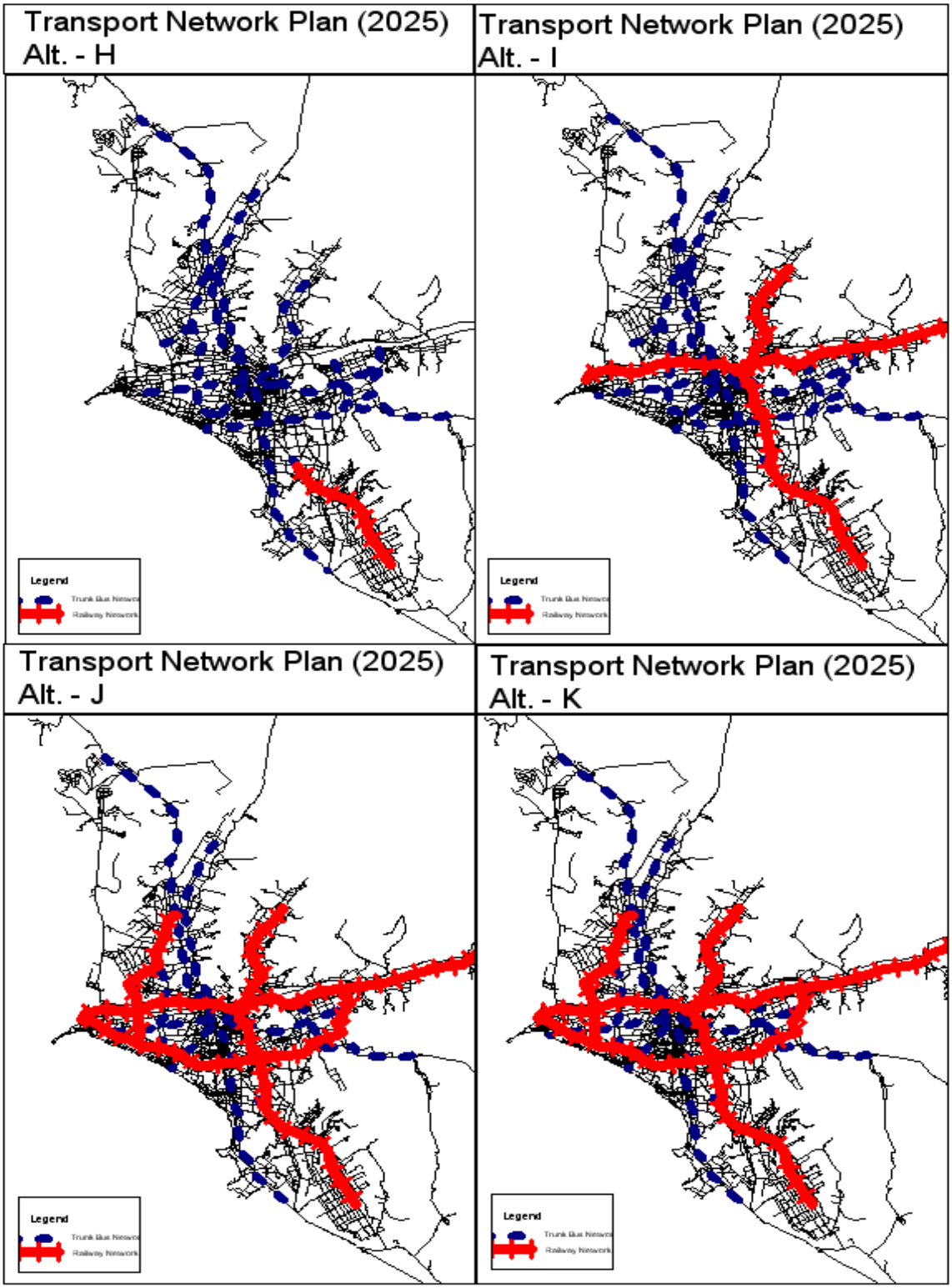


Figure 12.4-21 Basic Transport Network on Alternatives (3)

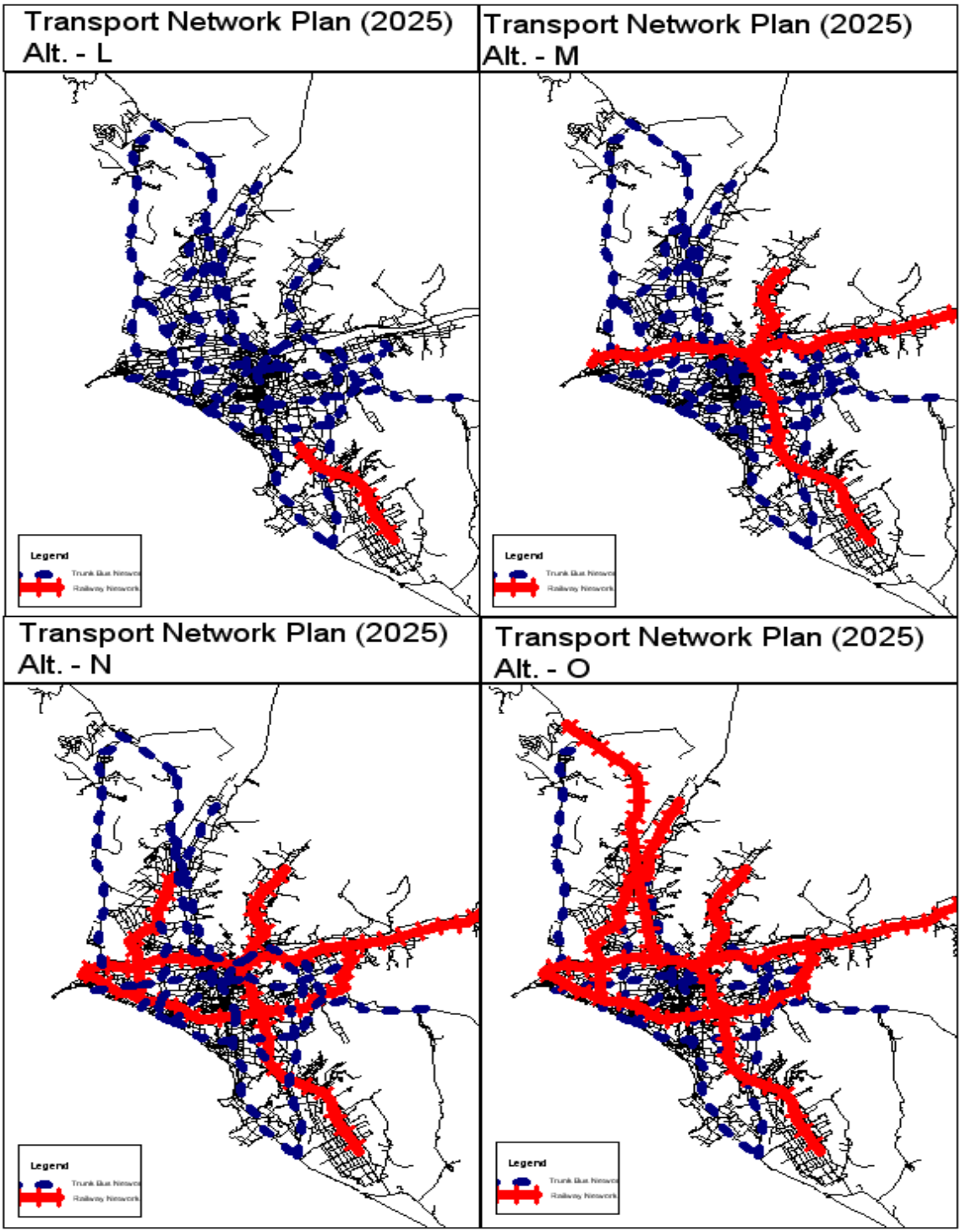


Figure 12.4-22 Basic Transport Network on Alternatives (4)