Republic of Peru
Ministry of Transport and Communications

DATA COLLECTION SURVEY ON URBAN TRANSPORT FOR LIMA AND CALLAO METROPOLITAN AREA

FINAL REPORT

JANUARY, 2013

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.
NIPPON KOEI LATIN AMERICA - CARIBBEAN CO., LTD.

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Exchange Rate (As of April 2012)

1 Nuevo Sol (S/.)	= 30.988 Japanese Yen (Yen)
1 Yen	= 0.03227 Nuevo Sol
1 US dollar (US$)	= 82.5 Yen
1 US$	= 2.662 Nuevo Sol

Table of Contents

List of Tables

List of Figures

Abbreviations

AATE	Electric Train Autonomous Authority
AC	Alternating Current
APEIM	Peruvian Association of Market Investigation Companies
APM	Automated People Mover
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATS	Automatic Train Stop
BPR	Bureau of Public Roads
BRT	Bus Rapid Transit
BTN	Backbone Transmission Network
CBTC	Communication Based Train Control
CCTV	Closed Circuit Television
CEPLAN	National Strategic Planning Center
CETPRO	Productive Technical Educational Center
CL	Cordon Line
CNG	Compressed Natural Gas
COSAC	High Capacity Segregated Corridor
CTLC	Lima and Callao Transport Committee
DC	Direct Current
EMU	Electric Multiple Unit
FORNAM	Peru National Environment Funding
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
HB	Home Base
HBO	Home Base Others
HBS	Home Base School
HBW	Home Base Work
HSST	High Speed Surface Transport
IMP	Metropolitan Institute of Planning
INEI	National Institute for Statistics and Information
IT	Information Technology
JICA	Japan International Cooperation Agency
KV	Kilo Volt
LRT	Light Rail Transit
MML	Metropolitan Municipality of Lima
MRT	Mass Rapid Transit
MTC	Ministry of Transport and Communications
NHB	Non Home Base
NSE	Socio-economic Level
OA	Office Automation

OCC	Operation Control Center
OD	Origin Destination
ONPU	National Office of Planning and Urban Development
O&M	Operation and Maintenance
PEA	Economically Active Population
PHPDT	Peak Hour Peak Direction Trip
PIS	Passenger Information System
PLAM de Lima	Metropolitan Territorial Plan and Urban Development Plan for Lima 2006-2021
PLANDEMET	Metropolitan Development Plan, Lima and Callao 1967-1980
PLANMET	Metropolitan Development Plan for Lima and Callao 1990-2010
PMTU	Master Plan for Lima and Callao Metropolitan Area Urban Transportation in the Republic of Peru
SL	Screen Line
STCTLC	Technical Secretary of Lima and Callao Transport Committee
TDM	Traffic Demand Management
TSAS	Traffic Safety Audit System
VOC	Vehicle Operating Cost
VOT	Value of Time
VVVF	Variable Voltage Variable Frequency

Chapter 1 Introduction

1.1 Background

Lima is the capital city of the Republic of Peru. The urban area of Lima and Callao forms the Lima and Callao Metropolitan Area, having a population of 8.48 million (2007 Census) which is approximately one third of the country's population. The population is estimated to reach 9.45 million in 2012. The metropolitan area produces a half of the country's Gross Domestic Product (GDP).

In 2005, Japan International Corporation Agency (JICA) conducted a series of traffic surveys in the metropolitan area including a Person Trip Survey covering interviews of 38,000 households. The Master Plan for Lima and Callao Metropolitan Area Urban Transportation (PMTU-2025) with the target year of 2025 was formulated in 2005.

PMTU-2025 proposed the future public transport network consisting of four railway lines and 15 trunk bus lines. A Trunk Bus System for East-West Corridor along Venezuela Ave. and Nicloas Allyon Ave. was studied in the F/S in 2007.

After the master plan and feasibility studies, the environment of transport system in Lime and Callao Metropolitan Area has been changed to a large extent. A Bus Rapid Transit (BRT) System was opened in 2010 with a total length of 27km along Paseo de la República. The Metropolitan Municipality of Lima had a plan to construct the second BRT line along the East-West Corridor, but it was cancelled in March 2012 after a controversy over the system selection between the BRT and a railway system.

On December 23rd, 2010, the basic plan of the metro network of Lima and Callao, having five routes, was formulated by the Ministry of Transport and Communications (MTC) and approved by the Presidential Decree (D.S. 059-2010-MTC). In January 2012, Electrical Train Autonomous Authority of Lima and Callao (AATE) inaugurated the fist metro line in Lima. MTC plans to construct a metro system along the East-West Corridor.

There are other proposals by private companies for the construction of mass transit system, such as monorail, along the same route.

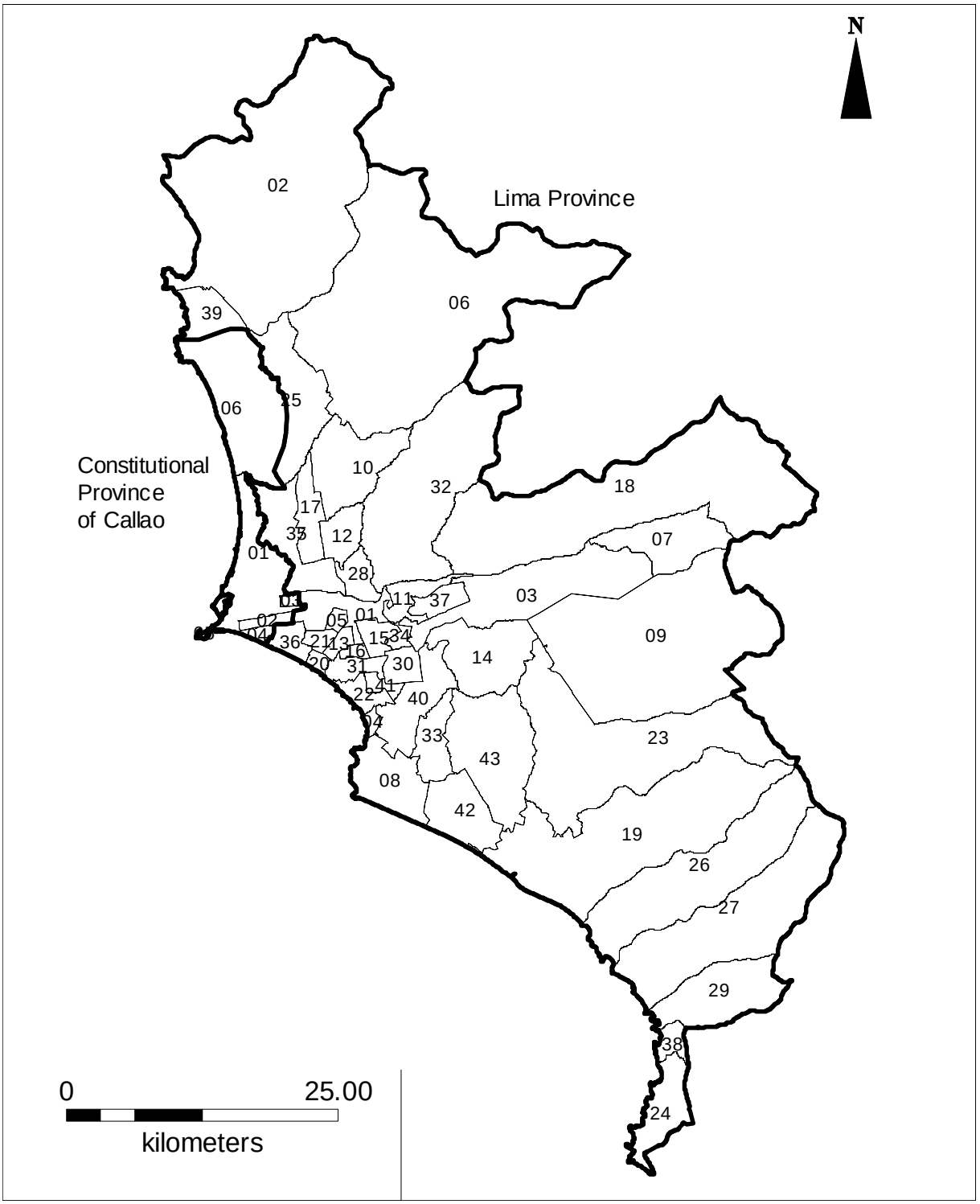
Meanwhile, Transport Council of Lima and Callao (CTLC) took over the JICA study and updated the basic transport database such as traffic volume and travel speed. The population in Lima and Callao Metropolitan Area, which was 8.04 million in 2005 when PMTU-2025 was formulated, has increased by more than one million in the last six years.

Under the above circumstances, JICA proposed to review PMTU-2025 by updating the data in the previous study including the Origin-Destination (O/D) matrices by conducting a new Person Trip Survey. JICA has employed a Japanese consultant consortium consisting of Nippon Koei Co., Ltd. and Nippon Koei Latin America (hereinafter referred to as the JICA Study Team) to conduct the update study.

1.2 Study Area

The Study Area covers the Lima and Callao Metropolitan Area. This area is the same as that in the study of PMTU-2025, consisting of Lima Province and Constitutional Province of Callao. Lima Province is one of 10 provinces in Lima Department. The Study Area has 2,800 km^2 of land and a population of 945 million in 2012. There are 49 Districts, 43 in

Lima Province and 6 in Constitutional Province of Callao, in the Study Area as shown in Figure 1.1.



Source: JICA Study Team

Figure 1.1 Study Area

1.3 Outline of the Study

1.3.1 Purpose

The Study's purpose is to identify issues and develop the basic database for the decision making in the urban transport sector in the Lima and Callao Metropolitan Area by updating the transport data and conducting the demand forecast for the Year 2030.

1.3.2 Output Data

1) Present O/D Matrix

2) Transport Demand Forecast

1.3.3 Activities

1. Collection of data on urban transport

1-1. Review of the existing study

1) Progress of the action plan and projects proposed in the Master Plan Study in 2005

2) Progress of the studied projects in the F/S in 2007

1-2. Present transport plans and institution

1-3. Socio-economic situation

1-4. Transport sector organizations (public and private)

1-5. Activities of international organizations on transport sector

2. Traffic surveys and demand forecast

2-1. Traffic surveys

2-2. Analysis of the results of the traffic surveys and preparation of O/D matrices

2-3. Future demand forecast

3. Identification of transport issues

3-1. Identification of the present urban transport issues based on the traffic surveys

3-2. Identification of the future urban transport issues based on the demand forecast

3-3. Analysis of introduction of new transport system

4. Seminars

4-1. Seminar on the results of traffic surveys

4-2. Seminar on the results of demand forecast and on urban transport issues

1.4 Work Items

The work items of this Study are listed below.

Code	Work Item	Sub-code	Sub Item
W1	Existing Data Collection	-	-
W2	Preparation for Traffic Surveys	2-1	Collection and Analysis of Existing Data
		2-2	Zoning
		2-3	Methodology of Demand Forecast
		2-4	Preparation of Work Plan
W3	Traffic Surveys	3-1	Selection of Survey Company
		3-2	Conduct of Traffic Surveys
W4	Analysis of the Results of Traffic Surveys	4-1	Making of Present OD Matrices
		4-2	Comparison of the Results of the Previous Surveys
W5	Socio-economic Framework	5-1	Population, Employment, and Students
		5-2	GDP and GRDP
		5-3	Land Use
W6	Future Demand Forecast	6-1	Preparation of Network Data
		6-2	Demand Forecast Modeling
		6-3	Scenario Analysis
W7	Concept Study of Monorail	7-1	Route Plan
		7-2	Review of System Selection Method
		7-3	Business Plan
W8	Review of MPTU-2025	8-1	Impact of PMTU-2025 on Transport Issues in 2030
		8-2	Identification of Issues using the JICA Research 2011
W9	Seminars	9-1	1st Seminar
		9-2	2nd Seminar

1.5 Work Flowchart

The Study has been conducted in accordance with the sequence shown in Figure 1.2.

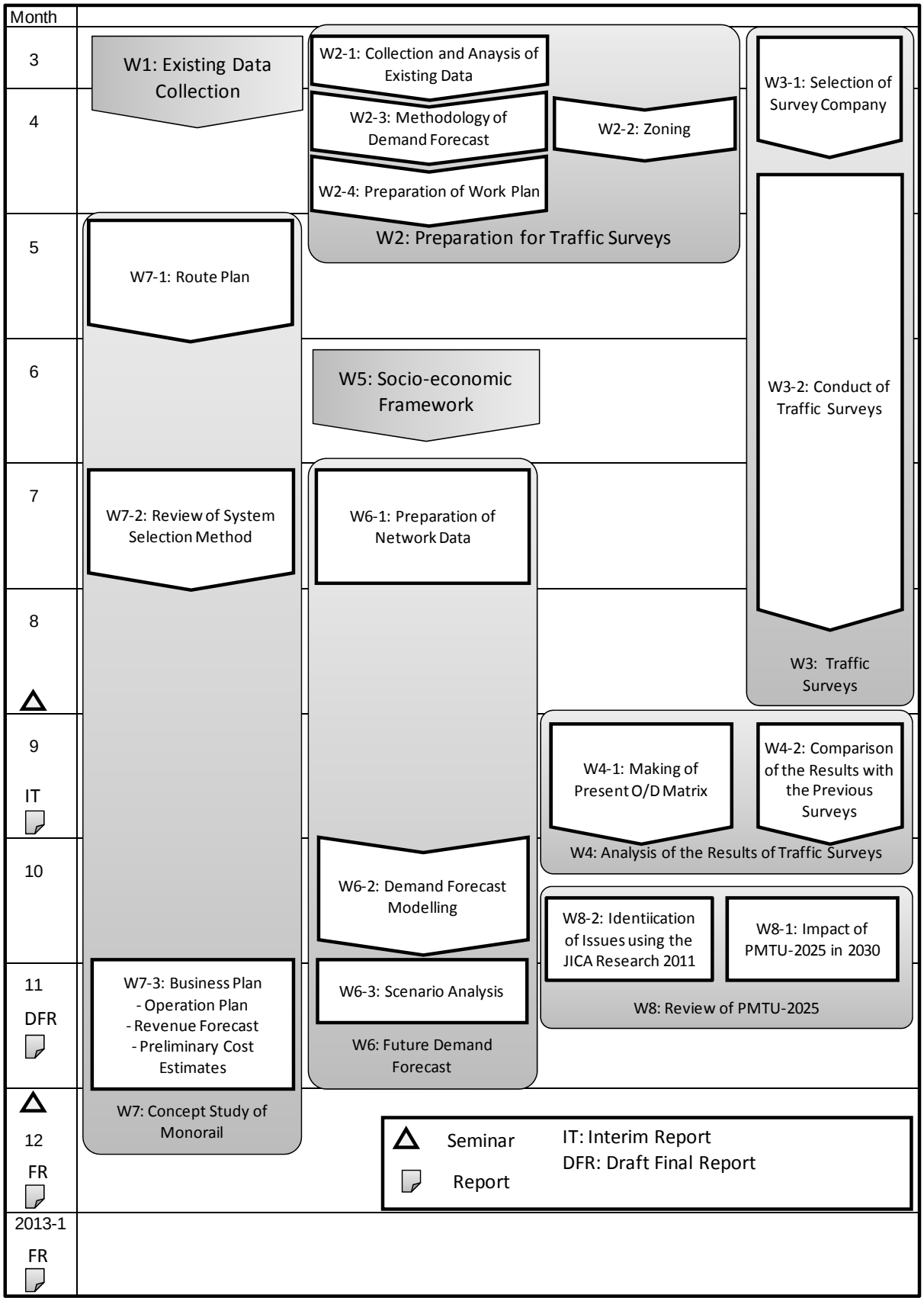


Figure 1.2 Work Flowchart

1.6 Transport Modes in the Study Area

Taxi "Station" (type Sedan)

Taxi "Station" (type Station Wagon)

There are 421 authorized taxi companies of this mode in the Study Area (2011, GTU-MML)

Taxi "SETAME"

There are 120,997 authorized taxis in the Study Area (SETAME). However, it is estimated that a total of 230,000 taxis exist.

Taxi "Remisse"

This type of taxi provides services for executives and tourists. There are 62 authorized taxi companies (2011, GTU-MML).

Taxi "Colectivo"

Taxi "Colectivo"

Collectivos are authorized taxis running on fixed routes like public transport. The route is placed on temporary signs (red circle in the photo).

Private car

Private car for students

Private cars include company vehicles for employees and executives and vans for students.

Camioneta Rural (Combi)

Camioneta Rural (Combi)

Camioneta Rural, also called “Combi”, is a small size bus with a door. The capacity of a Combi is 15-24 passengers (seated and standing). The number of authorized buses is 17,712 on 170 routes in the Study Area (as of December 31, 2012).

Microbus

Microbus

Microbus has a capacity of 37-50 passengers. The number of authorized microbuses is 23,667 on 168 routes in the Study Area (December 31, 2012).

Bus

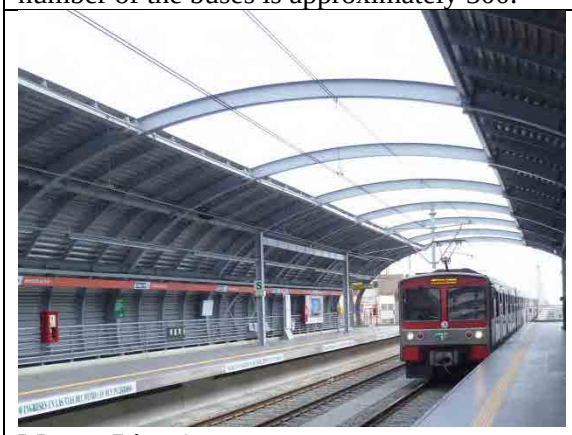
Bus

Conventional buses can accommodate up to 80 passengers, driven on regular routes throughout the city of Lima and Callao, representing 17% of the authorized fleet. There are 8,400 authorized buses on 67 routes in the Study Area as of October 31, 2012.

Metropolitano

Metropolitano

The articulated buses of Metropolitano, a BRT system, have a capacity of 160 passengers. The number of the buses is approximately 300.



Metro: Line 1

Metro: Line 1

The train is composed of six cars with a capacity of 200 passengers each, is currently operating at a frequency of 20 minutes.

Chapter 2 Traffic Surveys

2.1 Traffic Survey Schemes

2.1.1 Survey Frameworks

The Study Team carried out several traffic surveys to determine the existing transportation characteristics as shown in Table 2.1.

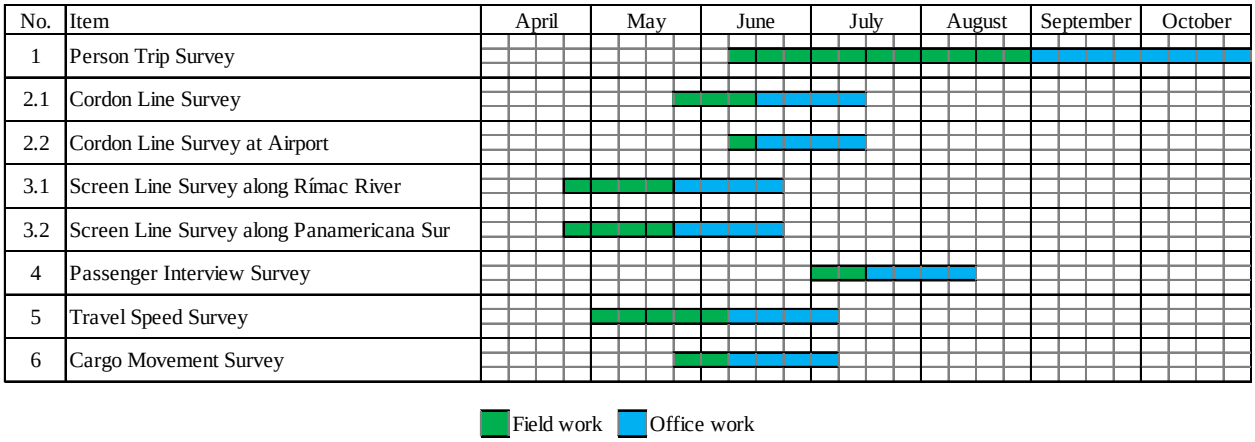
Table 2.1 Traffic Surveys

No.	Survey	Objective	Coverage	Method
1	Person Trip Survey	Socio-economic profile and information on resident trips	23,040 households surveyed in the Study Area (sampling rate 1.0%)	Direct interviews of all selected family members
2	Cordon Line Survey	Traffic volume and information on non-resident trips	7 stations on the Study Area boundary, including the Jorge Chávez International Airport	- 24-hour traffic counts - Direct interviews of passengers and drivers (14-hours)
3	Screen Line Survey	Traffic volume and vehicle occupancy in the Screen Line	15 stations along the Rímac River, and 7 stations along the Panamericana Sur (Southern Panamerican) Highway	- 24-hour traffic counts, - Observation of vehicle occupancy (14-hours).
4	Passenger Interview Survey	Stated preference with regard to selected modes	Interviews of 2,415 passengers	Direct interview at stations, bus stops, and parking area
5	Travel Speed Survey	Travel speed on major road sections	Monitoring during peak hours and off-peak hours along 22 major corridors.	3 round trips per route, by the floating vehicle method.
6	Freight Transportation Survey	Goods and freight flow characteristics	- Traffic counts & interviews at 7 stations - Interviews at 3 stations - Interviews of 5 major freight companies	- 24-hour traffic counts - Direct interviews of drivers (12-hours) - Direct interviews of selected freight companies.

Source: JICA Study Team

2.1.2 Survey Schedule

The traffic surveys were carried out in accordance with the schedule shown in Figure 2.1.



Source: JICA Study Team

Figure 2.1 Survey Schedule

2.2 Person Trip Survey

2.2.1 Methodology

The person trip survey is the most important of all surveys. The objective of "Person Trip Survey" is to gather information of socio-economic profile and trip behavior of household members on a particular day. Not that this chapter describes the contents of the survey, while the results are described in Chapter 3.

(1) Coverage

The Study Area covers the Lima and Callao Metropolitan area, including 49 districts. Initially, the Study Area was divided into 427 traffic zones; blocks were selected in each traffic zone in proportion to their population. The interviews include all selected household members but the information on trips was gathered only for people 6 years old and over.

(2) Sampling Method

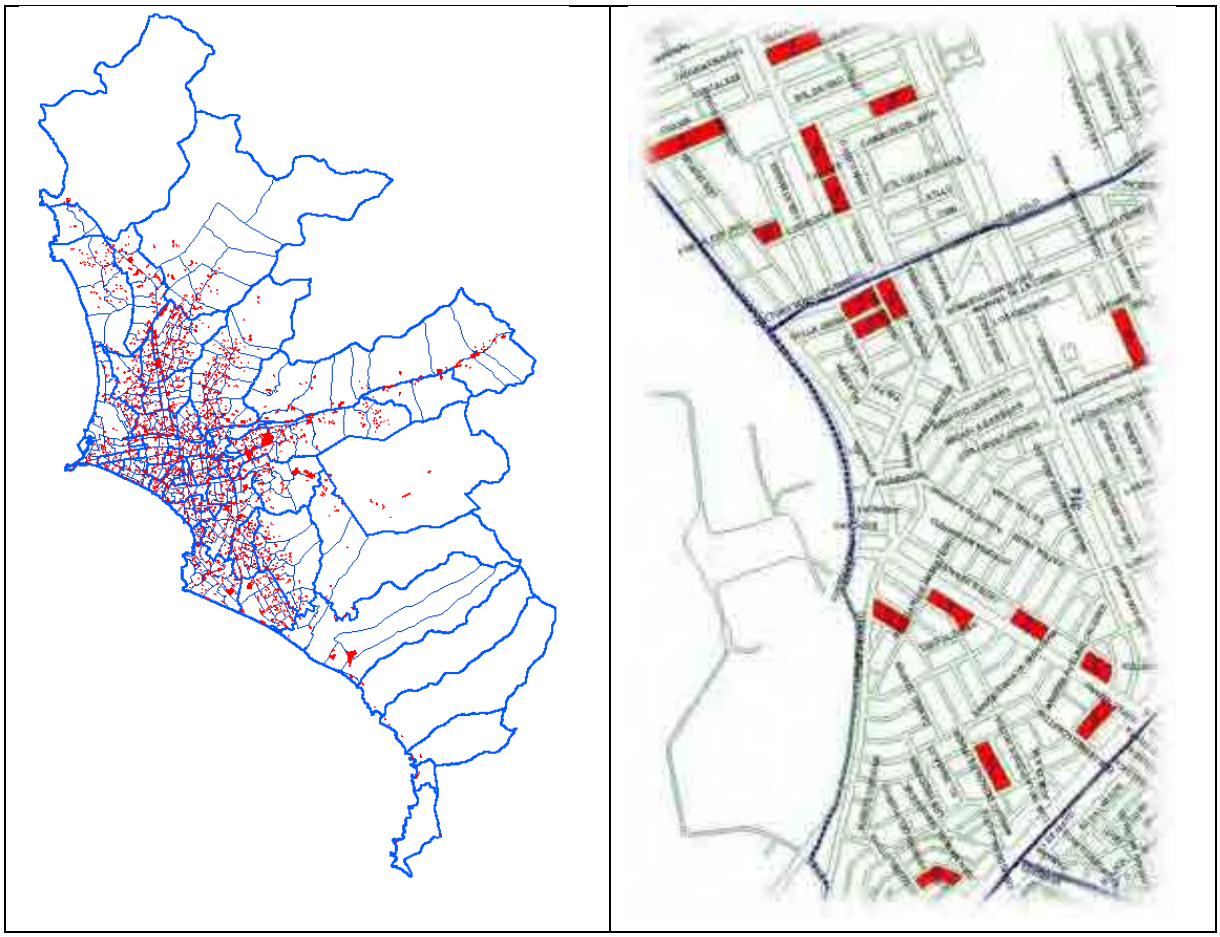
The target number of households by traffic zone was determined based on the information from the 2007 National Census and the population projection for the year 2012 (Chapter 4).

The households to be surveyed were selected in the following manner.

First, survey blocks are selected randomly by traffic zone. Secondly, the households to be surveyed are selected at a certain interval of houses in each block, until the target number is met.

Randomness can be assured by this method because it can be assumed that the socio-economic profile is very similar in the same block.

Direct interviews are carried out to all household members of 6 years old and more, and their answers are registered by the interviewers in their corresponding questionnaires. If not all household members are present during the visit, a new appointment for a later visit is requested. The left map in Figure 2.2 shows the selected blocks, while the right map shows an example of selected blocks.



Source: Person Trip Survey, 2012

Figure 2.2 Locations of Selected Blocks for Person Trip Survey

(3) Traffic Zones

For updating the study in PMTU-2025, the Study Team retained all 427 traffic zones, as shown in Figure 2.3.

Sample proportions were initially established by population, but there were locations with very small population, especially in the southern districts (beach resorts); therefore, a minimum sample of 32 households was applied for these districts.

Some traffic zones were not included in the surveys, due to their small or none population. For this reason, interviews were conducted for 410 traffic zones. The rest of 17 traffic zones, where the survey was not conducted, are listed in Table 2.2. The survey was conducted by 9 survey teams for each survey area.

Table 2.2 Traffic Zones Excluded from Interview

Traffic Zone	District	Characteristic
57	Carabayllo	Periphery of the northern part of Carabayllo, near the Huarangal Thermonuclear Central Plant.
58	Carabayllo	Periphery of the northern part of Carabayllo, near the outlet to Canta, unpopulated area.
61	Chorrillos	Aguadulce Beach and the Regatas Club
68	Chorrillos	Morro Solar ("Solar" Cliff), La Herradura Beach, plots of land on the unpopulated beach zone.
79	Chorrillos	Villa Swamp Ecological Protected Area
122	Jesús María	EsSalud Edgardo Rebagliati Martins Hospital, Gas Station and funeral company commercial area.
215	Rímac	National Engineering University
216	Rímac	Hoyos Rubio Army Camp
231	San Borja	Buildings of the "Pentagonito" ("Little Pentagon") Army Headquarters
305	San Miguel	"Las Leyendas" Zone and Zoo Park
324	Santa Rosa	Unpopulated zone, according to the 2007 Census
326	Santiago de Surco	Monterrico Racetrack and "Jockey Plaza" Mall
344	Santiago de Surco	"Las Palmas" Air Force Base
391	Callao	Warehouse and Gas station across the airport
396	Callao	Peruvian Navy Base
397	Callao	Callao Port Zone
427	Ventanilla	"La Pampilla" Refinery

Source: JICA Study Team

The zoning system consists of several layers as shown in Table 2.3. The zone codes of the traffic zone are listed from Table 2.4 to Table 2.7. The zone locations are shown in Figure 2.3, Figure 2.4, and Figure 2.5

Table 2.3 Zoning System

Name	Size
Traffic Zone	427 internal traffic zones (17 zones as trip attractors only) 19 external traffic zones
District	49 districts In Lima: 43 In Callao: 6
Study Areas	9 Areas: North 1, North 2, Center 1, Center 2, East 1, East 2, South 1, South 2, and Callao

Source: JICA Study Team

Table 2.4 Zoning System (1/4)

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
Lima	1	***0101***	***Centro 1***
	2	***0102***	
	3	***0103***	
	4	***0104***	
	5	***0105***	
	6	***0106***	
	7	***0107***	
	8	***0108***	
	9	***0109***	
	10	***0110***	
	11	***0111***	
	12	***0112***	
	13	***0113***	
	14	***0114***	
	15	***0115***	
	16	***0116***	
	17	***0117***	
	18	***0118***	
	19	***0119***	
	20	***0120***	
	21	***0121***	
	22	***0122***	
Breña	45	***0501***	
	46	***0502***	
	47	***0503***	
Jesús María	119	***1301***	
	120	***1302***	
	121	***1303***	
	122	***1304***	
	123	***1305***	
	124	***1306***	
	125	***1307***	
Magdalena del Mar	183	***2001***	
	184	***2002***	
	185	***2003***	
Pueblo Libre	186	***2101***	
	187	***2102***	
	188	***2103***	
	189	***2104***	
	190	***2105***	
San Miguel	303	***3601***	
	304	***3602***	
	305	***3603***	
	306	***3604***	
	307	***3605***	
	308	***3606***	
	309	***3607***	
	310	***3608***	
	311	***3609***	
	312	***3610***	

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
La Victoria	136	***1501***	***Centro 2***
	137	***1502***	
	138	***1503***	
	139	***1504***	
	140	***1505***	
	141	***1506***	
	142	***1507***	
	143	***1508***	
	144	***1509***	
	145	***1510***	
	146	***1511***	
	147	***1512***	
Lince	148	***1601***	
	149	***1602***	
	150	***1603***	
Miraflores	191	***2201***	
	192	***2202***	
	193	***2203***	
	194	***2204***	
	195	***2205***	
	196	***2206***	
	197	***2207***	
	198	***2208***	
San Borja	225	***3001***	
	226	***3002***	
	227	***3003***	
	228	***3004***	
	229	***3005***	
	230	***3006***	
	231	***3007***	
	232	***3008***	
	233	***3009***	
	234	***3010***	
	235	***3011***	
San Isidro	236	***3101***	
	237	***3102***	
	238	***3103***	
	239	***3104***	
	240	***3105***	
	241	***3106***	
	242	***3107***	
	243	***3108***	
	244	***3109***	
San Luís	285	***3401***	
	286	***3402***	
	287	***3403***	

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
Ancon	23	***0201***	***Norte 1***
Carabayllo	48	***0601***	
	49	***0602***	
	50	***0603***	
	51	***0604***	
	52	***0605***	
	53	***0606***	
	54	***0607***	
	55	***0608***	
	56	***0609***	
	57	***0610***	
	58	***0611***	
Comas	82	***1001***	
	83	***1002***	
	84	***1003***	
	85	***1004***	
	86	***1005***	
	87	***1006***	
	88	***1007***	
	89	***1008***	
	90	***1009***	
	91	***1010***	
	92	***1011***	
	93	***1012***	
	94	***1013***	
	95	***1014***	
	96	***1015***	
	97	***1016***	
	98	***1017***	
	99	***1018***	
	100	***1019***	
	101	***1020***	
	102	***1021***	
	103	***1022***	
Puente Piedra	203	***2501***	
	204	***2502***	
	205	***2503***	
	206	***2504***	
	207	***2505***	
	208	***2506***	
	209	***2507***	
	210	***2508***	
	211	***2509***	
	212	***2510***	
Santa Rosa	322	***3901***	
	323	***3902***	
	324	***3903***	

Source: JICA Study Team

Table 2.5 Zoning System (2/4)

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
Independencia	112	*1201*	*Norte 2*
	113	*1202*	
	114	*1203*	
	115	*1204*	
	116	*1205*	
	117	*1206*	
	118	*1207*	
Los Olivos	151	*1701*	
	152	*1702*	
	153	*1703*	
	154	*1704*	
	155	*1705*	
	156	*1706*	
	157	*1707*	
	158	*1708*	
	159	*1709*	
	160	*1710*	
	161	*1711*	
	162	*1712*	
	163	*1713*	
Rímac	215	*2801*	
	216	*2802*	
	217	*2803*	
	218	*2804*	
	219	*2805*	
	220	*2806*	
	221	*2807*	
	222	*2808*	
	223	*2809*	
San Martín de Porres	288	*3501*	
	289	*3502*	
	290	*3503*	
	291	*3504*	
	292	*3505*	
	293	*3506*	
	294	*3507*	
	295	*3508*	
	296	*3509*	
	297	*3510*	
	298	*3511*	
	299	*3512*	
	300	*3513*	
	301	*3514*	
	302	*3515*	

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
El Agustino	104	*1101*	*Este 1*
	105	*1102*	
	106	*1103*	
	107	*1104*	
	108	*1105*	
	109	*1106*	
	110	*1107*	
	111	*1108*	
San Juan de Lurigancho	245	*3201*	
	246	*3202*	
	247	*3203*	
	248	*3204*	
	249	*3205*	
	250	*3206*	
	251	*3207*	
	252	*3208*	
	253	*3209*	
	254	*3210*	
	255	*3211*	
	256	*3212*	
	257	*3213*	
	258	*3214*	
	259	*3215*	
	260	*3216*	
	261	*3217*	
	262	*3218*	
	263	*3219*	
	264	*3220*	
	265	*3221*	
	266	*3222*	
	267	*3223*	
	268	*3224*	
	269	*3225*	
	270	*3226*	
Santa Anita	313	*3701*	*Este 2*
	314	*3702*	
	315	*3703*	
	316	*3704*	
	317	*3705*	
	318	*3706*	
	319	*3707*	
	320	*3708*	

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
Ate	24	*0301*	*Este 2*
	25	*0302*	
	26	*0303*	
	27	*0304*	
	28	*0305*	
	29	*0306*	
	30	*0307*	
	31	*0308*	
	32	*0309*	
	33	*0310*	
	34	*0311*	
	35	*0312*	
	36	*0313*	
	37	*0314*	
	38	*0315*	
	39	*0316*	
	40	*0317*	
Chaclacayo	59	*0701*	
	60	*0702*	
Cieneguilla	81	*0901*	
La Molina	126	*1401*	
	127	*1402*	
	128	*1403*	
	129	*1404*	
	130	*1405*	
	131	*1406*	
	132	*1407*	
	133	*1408*	
	134	*1409*	
	135	*1410*	
Lurigancho (Chosica)	164	*1801*	
	165	*1802*	
	166	*1803*	
	167	*1804*	
	168	*1805*	
	169	*1806*	
	170	*1807*	
	171	*1808*	
	172	*1809*	
	173	*1810*	
	174	*1811*	
	175	*1812*	

Source: JICA Study Team

Table 2.6 Zoning System (3/4)

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
Callao	382	*5101*	*Callao*
	383	*5102*	
	384	*5103*	
	385	*5104*	
	386	*5105*	
	387	*5106*	
	388	*5107*	
	389	*5108*	
	390	*5109*	
	391	*5110*	
	392	*5111*	
	393	*5112*	
	394	*5113*	
	395	*5114*	
	396	*5115*	
	397	*5116*	
	398	*5117*	
	399	*5118*	
	400	*5119*	
	401	*5120*	
	402	*5121*	
	403	*5122*	
	404	*5123*	
	405	*5124*	
	406	*5125*	
	407	*5126*	
Bellavista	408	*5201*	
	409	*5202*	
	410	*5203*	
	411	*5204*	
	412	*5205*	
Carmen de la Legua	413	*5301*	
	414	*5302*	
La Perla	415	*5401*	
	416	*5402*	
	417	*5403*	
La Punta	418	*5501*	
Ventanilla	419	*5601*	
	420	*5602*	
	421	*5603*	
	422	*5604*	
	423	*5605*	
	424	*5606*	
	425	*5607*	
	426	*5608*	
	427	*5609*	

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
Barranco	41	*0401*	*Sur 1*
	42	*0402*	
	43	*0403*	
	44	*0404*	
Chorrillos	61	*0801*	
	62	*0802*	
	63	*0803*	
	64	*0804*	
	65	*0805*	
	66	*0806*	
	67	*0807*	
	68	*0808*	
	69	*0809*	
	70	*0810*	
	71	*0811*	
	72	*0812*	
	73	*0813*	
	74	*0814*	
	75	*0815*	
	76	*0816*	
	77	*0817*	
	78	*0818*	
	79	*0819*	
	80	*0820*	
San Juan de Miraflores	271	*3301*	
	272	*3302*	
	273	*3303*	
	274	*3304*	
	275	*3305*	
	276	*3306*	
	277	*3307*	
	278	*3308*	
	279	*3309*	
	280	*3310*	
	281	*3311*	
	282	*3312*	
	283	*3313*	
	284	*3314*	
Surquillo	347	*4101*	
	348	*4102*	
	349	*4103*	
	350	*4104*	
	351	*4105*	

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
Santiago de Surco	325	*4001*	*Sur 1*
	326	*4002*	
	327	*4003*	
	328	*4004*	
	329	*4005*	
	330	*4006*	
	331	*4007*	
Santiago de Surco	332	*4008*	
	333	*4009*	
	334	*4010*	
	335	*4011*	
	336	*4012*	
	337	*4013*	
	338	*4014*	
	339	*4015*	
	340	*4016*	
	341	*4017*	
	342	*4018*	
	343	*4019*	
	344	*4020*	
	345	*4021*	
	346	*4022*	

Source: JICA Study Team

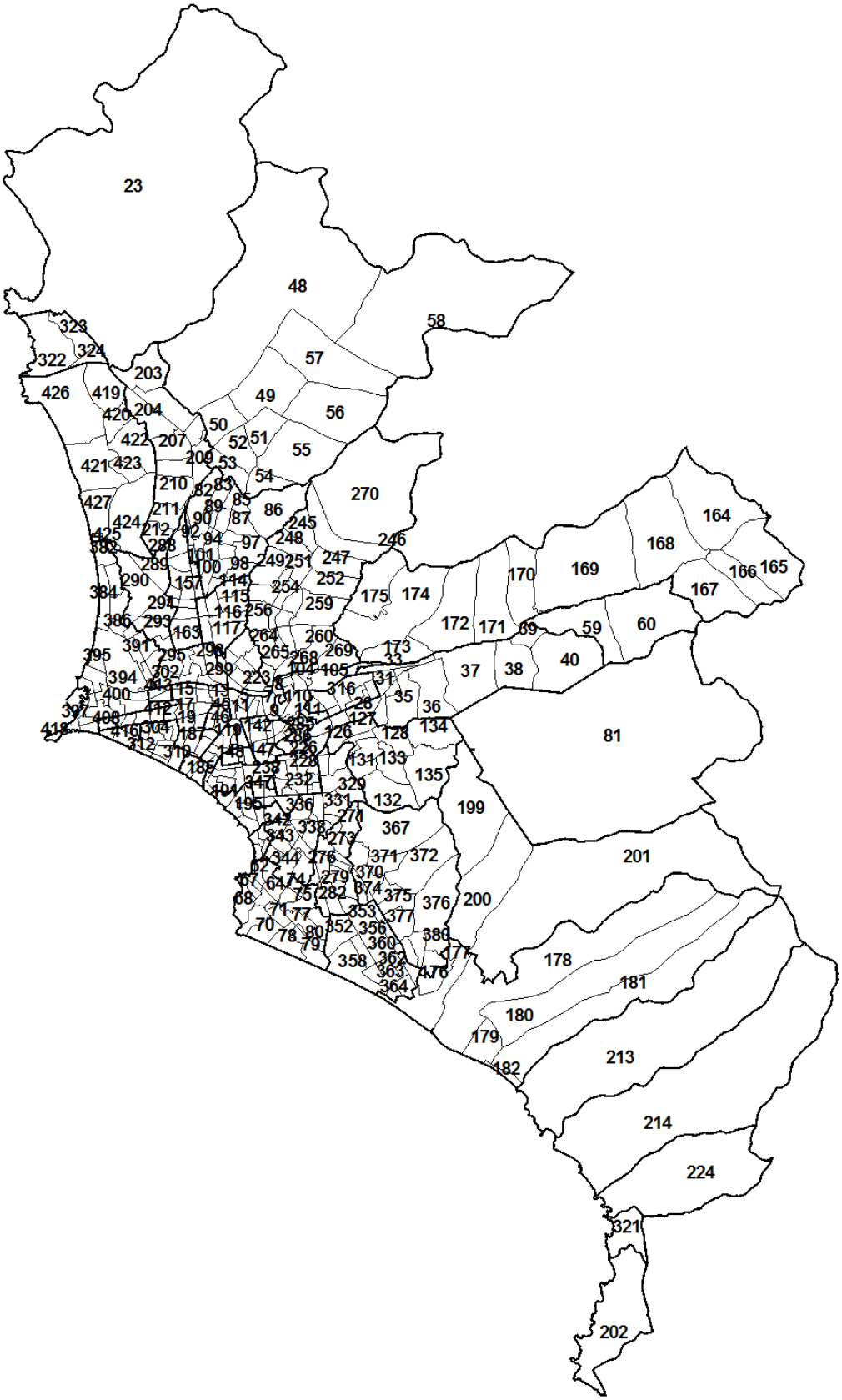
Table 2.7 Zoning System (4/4)

Distrito	No. of Zone	*Traffic Zone Code*	*Zona*
Lurín	176	***1901***	
	177	***1902***	
	178	***1903***	
	179	***1904***	
	180	***1905***	
	181	***1906***	
	182	***1907***	
Pachacamac	199	***2301***	
	200	***2302***	
	201	***2303***	
Pucusana	202	***2401***	
Punta Hermo	213	***2601***	
Punta Negra	214	***2701***	
San Bartolo	224	***2901***	
Santa María d	321	***3801***	
Villa el Salvador	352	***4201***	
	353	***4202***	
	354	***4203***	
	355	***4204***	
	356	***4205***	
	357	***4206***	
	358	***4207***	
	359	***4208***	***Sur 2***
	360	***4209***	
	361	***4210***	
	362	***4211***	
	363	***4212***	
	364	***4213***	
	365	***4214***	
	366	***4215***	
Villa María del Triunfo	367	***4301***	
	368	***4302***	
	369	***4303***	
	370	***4304***	
	371	***4305***	
	372	***4306***	
	373	***4307***	
	374	***4308***	
	375	***4309***	
	376	***4310***	
	377	***4311***	
	378	***4312***	
	379	***4313***	
	380	***4314***	
	381	***4315***	

Traffic Zone (External)

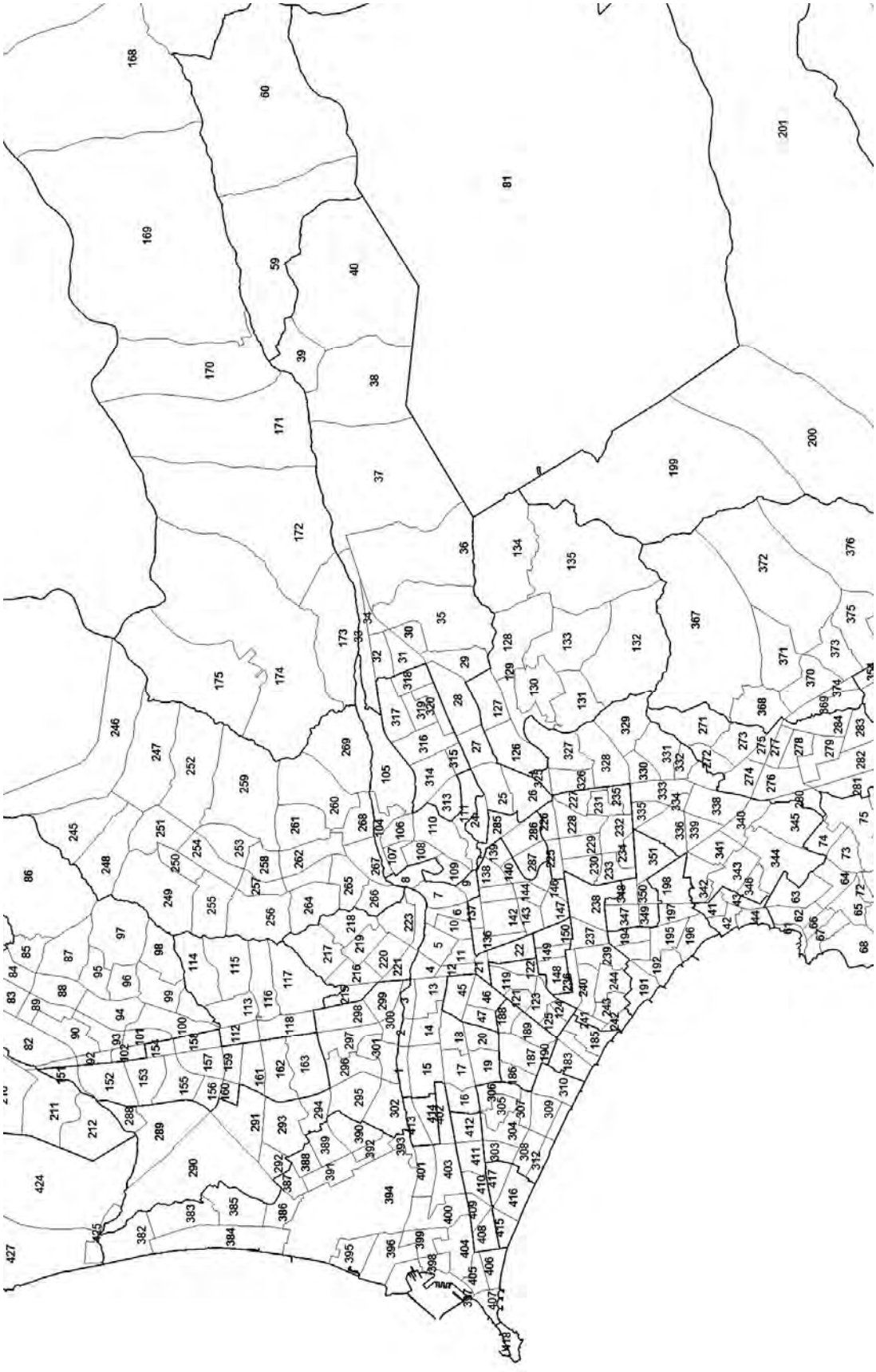
No. of Zone	Department	Province	*Traffic Zone*
428	Lima	Barranca	***6001***
429	Lima	Cajatambo	***6002***
430	Lima	Canete	***6003***
431	Lima	Canta	***6004***
432	Lima	Huaral	***6005***
433	Lima	Huarochiri	***6006***
434	Lima	Huaura	***6007***
435	Lima	Oyon	***6008***
436	Lima	Yauyos	***6009***
437	Ancash		***6101***
438	Huanuco		***6102***
439	Pasco		***6103***
440	Junin		***6104***
441	Huancavelica		***6105***
442	Ica		***6106***
443	Amazonas		***6201***
	Cajamarca		
	La Libertad		
	Lambayeque		
	Piura		
	San Martin		
	Tumbes		
444	Apurimac		***6202***
	Arequipa		
	Ayacucho		
	Cusco		
	Moquegua		

Source: JICA Study Team



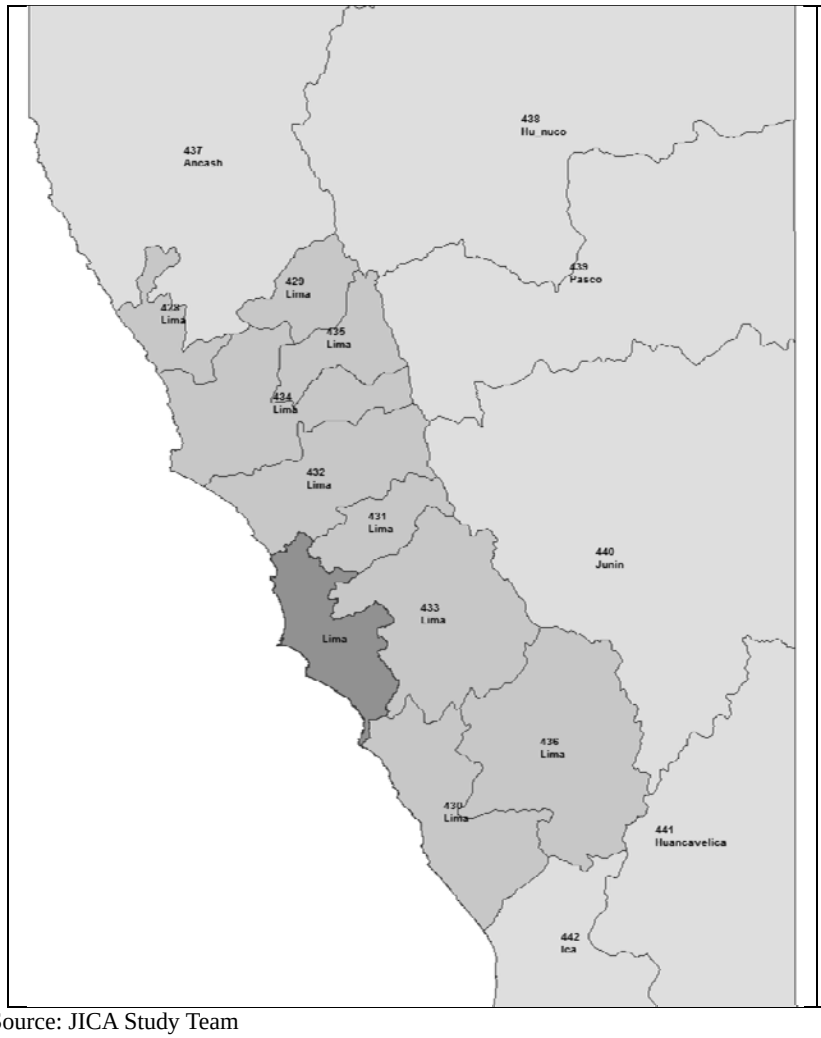
Source: JICA Study Team

Figure 2.3 Traffic Zone Locations (1)



Source: JICA Study Team

Figure 2.4 Traffic Zone Locations (2)



Zone	Department	
428	Lima	Barranca
429	Lima	Cajatambo
430	Lima	Cañete
431	Lima	Canta
432	Lima	Huaral
433	Lima	Huarochirí
434	Lima	Huaura
435	Lima	Oyón
436	Lima	Yauyos
437	Ancash	
438	Huánuco	
439	Pasco	
440	Junín	
441	Huancavelica	
442	Ica	

Source: JICA Study Team

Figure 2.5 Traffic Zone Locations (3)

(4) Survey Items

The information to be gathered from the survey is listed below:

a) **Household Information** covering socio-economic characteristics of household members, household structure, vehicle ownership, income level, dwelling location, dwelling characteristics, house equipment ownership, etc.

b) **Personal Information** covering socio-economic characteristics of household members, including age, sex, job or work, activities, disabilities, address of working place and / or school, etc.

c) **Trip information** covering characteristics of the trips made by the selected household members, including origin and destination, trip purpose, trip mode, transfers, fares, time of departure, time of arrival, etc.

d) **Information on the chosen mode** covering the perception characteristics with regard to the chosen mode, including the reasons for its selection.

2.2.2 Person Trip Survey Procedure

(1) Survey Schedule

The Person Trip Survey was carried out in accordance with the schedule shown in Table 2.8.

Table 2.8 Study Surveys

Activities	Schedule
Preparations (training, zoning, sampling, pilot survey, etc.)	May 5 – June 3 (4 weeks)
Field interview surveys	June 5 –July 31 (8.5 weeks)
Coding	June 18 –July 31 (6 weeks)
First data input	June 25 –August 7 (6 weeks)
Second data input	July 23 –August 20 (4 weeks)
Checking for mistakes and corrections	July 23 – September 15 (7 weeks)

Source: JICA Study Team

A daily control was carried out for field work, and progress measurements were made for every week. At the initial stage of the survey, especially during the first 2 weeks, a low progress against the schedule was observed, but gradually the actual progress caught up with the schedule.

Figure 2.6 shows the flow of the activities of the Person Trip Survey.

Source: JICA Study Team

Figure 2.6 Activities of Household Surveys

(2) Selected Samples

Table 2.9 shows the number of sampled households for the Person Trip Survey and the effective samples after their revision.

Table 2.9 Effective Samples

AREA	POPULATION IN 2012	No. of Households (000)	No. of Surveyed Households	No. of Valid Households	Productivity (%)	Sampling Rate (%)	No. of Effective Individuals
	A	B	C	D	E=D/C	F=D/B	G
NORTH 1	1,146,547	266.43	2,756	2,722	99%	1.02%	10577
NORTH 2	1,403,138	337.82	3,356	3,327	99%	0.98%	12925
EAST 1	1,215,853	281.91	2,840	2,812	99%	1.00%	11962
EAST 2	1,227,903	297.87	2,904	2,863	99%	0.96%	11184
CENTER 1	704,179	188.52	1,752	1,677	96%	0.89%	5754
CENTER 2	545,492	154.02	1,604	1,599	100%	1.04%	5185
SOUTH 1	1,159,543	286.14	2,812	2,787	99%	0.97%	9587
SOUTH 2	1,078,760	257.72	2,652	2,637	99%	1.02%	10577
CALLAO	969,170	240.81	2,364	2,280	96%	0.95%	9075
TOTAL	9,450,585	2,311	23,040	22,704	99%	0.98%	86,826

Source: INEI and Person Trip Survey

The sample size was 22,704 households, but 1% of which were not valid. The sample included a population of 86,826 (estimated from the number of household members), which showed a miniaturization of the average household size as compared to that in 2004. The number of trips made by the samples is 117,244.

The gross trip rate obtained from the Person Trip Survey was low in comparison with the rate in the study of PMTU-2025. This may be due to the biased samples of lower income groups.

2.3 Cordon Line Survey

Trips in the Study Area consists of not only those made by household members who reside within the Study Area, as obtained from the Person Trip survey data, but also those made by visitors living outside the Study Area. The Cordon Line survey was carried out to estimate these trips by visitors. This section describes the demand that was checked by the count.

It must be pointed out that for these trips to be counted and thus, the actual demand to be established, some points had to be displaced; these points were not necessarily the end points or boundaries that were originally established in 2004. The reason for this was the various characteristics and peculiarities that were taken into account, as a result of the city's expansion and the new developments in the urban area, such as the road to Canta, the Central Highway, and the road to Cieneguilla developments.

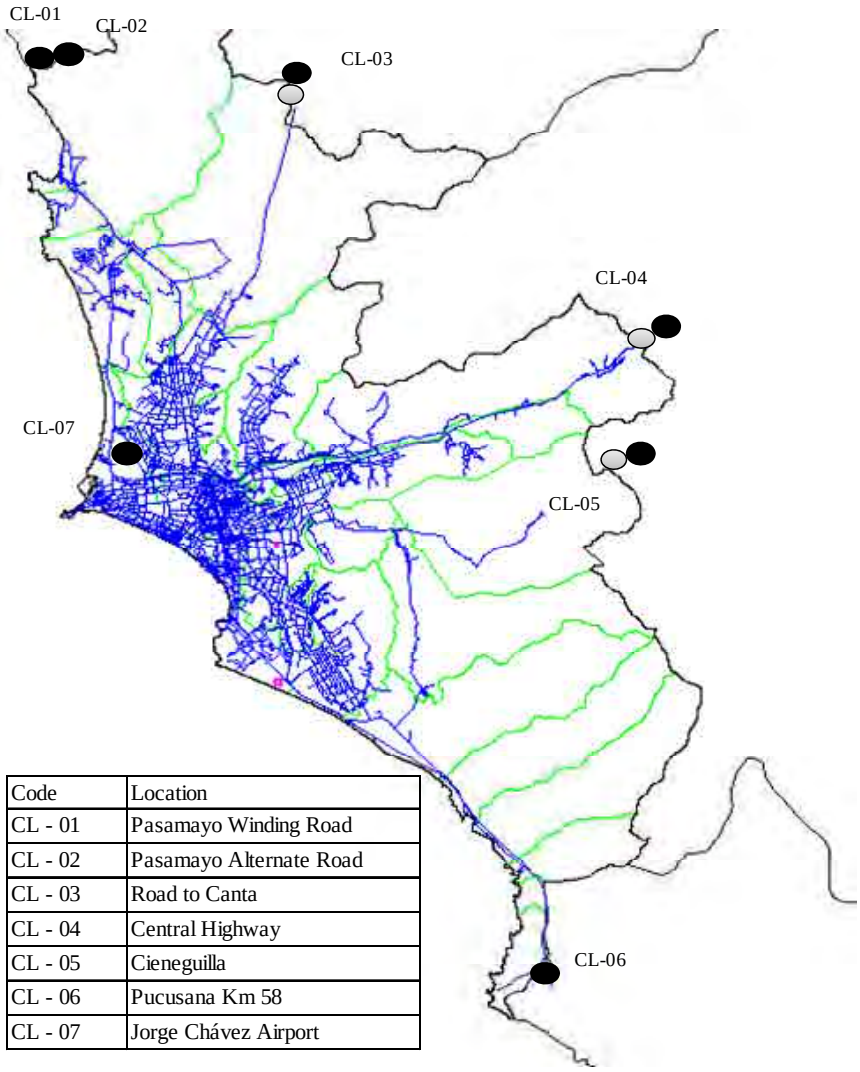
2.3.1 Survey Methodology

The Cordon Line is the borders of the Study Area. The Cordon Line Survey consists of the following two subcomponents.

1) Interview Survey: this survey is to interview car drivers on roadsides to collect information about the origin and destination of passengers in vehicles. Vehicles are flagged down for interview, and drivers are asked some questions in the survey. Since the survey forces drivers to stop on the road, cooperation of police is essential.

2) Traffic Count Survey: the number of vehicles at the same locations is counted by vehicle type.

The Cordon Line Survey was conducted at the locations shown in Figure 2.7.



Code	Location
CL - 01	Pasamayo Winding Road
CL - 02	Pasamayo Alternate Road
CL - 03	Road to Canta
CL - 04	Central Highway
CL - 05	Cieneguilla
CL - 06	Pucusana Km 58
CL - 07	Jorge Chávez Airport

Source: JICA Study Team

Figure 2.7 Location of the Counting Points along the Cordon Line

2.3.2 Preparation and Schedule of Survey

The subcontractor obtained police permission to carry out 24-hour traffic counting while the roadside interview was done for 14 hours (6:00 to 20:00). The number of vehicles was registered every 15 minutes and subtotaled per hour.

The interview items are: 1) Residence, 2) Origin and Destination, 3) Vehicle type and 4) Number of passengers

In the traffic counting, vehicles were classified into the following 17 types.

1. Bicycle 2. Motorcycle 3. Sedan and station wagon 4. Motorcycle taxi 5. Taxi 6. Colectivo Taxi 7. Combi (rural wagon) 8. Microbus 9. Ómnibus	10. Interprovincial bus / touristic bus 11. Lightweight truck 12. 2 axle truck 13. 3 axle truck 14. Garbage truck 15. Trailer 16. Tank truck 17. Others

The interview survey and traffic counting were carried out on the same day in all the points except the passengers' interview at CL-07 Jorge Chavez Airport as shown in Table 2.10.

Table 2.10 Survey Schedule

Point	Counting	Passenger OD	Cargo OD
CL-01	May 29, 2012	May 30, 2012	May 30, 2012
CL-02	May 29, 2012	May 30, 2012	May 30, 2012
CL-03	May 29, 2012	May 30, 2012	May 30, 2012
CL-04	May 29, 2012	May 30, 2012	May 30, 2012
CL-05	May 29, 2012	May 30, 2012	May 30, 2012
CL-06	May 29, 2012	May 30, 2012	May 30, 2012
CL-07	May 29, 2012	June 13, 2012	May 30, 2012

Source: Cordon Line Survey 2012

The number of interviews carried out in this Study is as shown in Table 2.11.

Table 2.11 No. of Interviews in the Cordon Line Survey

Interview Point		CL-01	CL-02	CL-03	CL-04	CL-05	CL-06	CL-07
Passenger	Interviewed	313	777	283	516	24	521	3782
	Valid	313	777	283	516	21	521	3540
Cargo	Interviewed	643	62	248	249	36	426	170
	Valid	643	62	248	249	27	426	170

Source: Cordon Line Survey 2012

2.3.3 Results of Cordon Line Survey

(1) Survey Summary

Table 2.12 shows the result of the traffic count in the Cordon Line Survey. A considerable increase was observed at CL-6 in comparison with the data of 2004. In the southern area of the Study Area, there was a rapid expansion trend, including the southern districts which have been considered as summer resort beaches in the past.

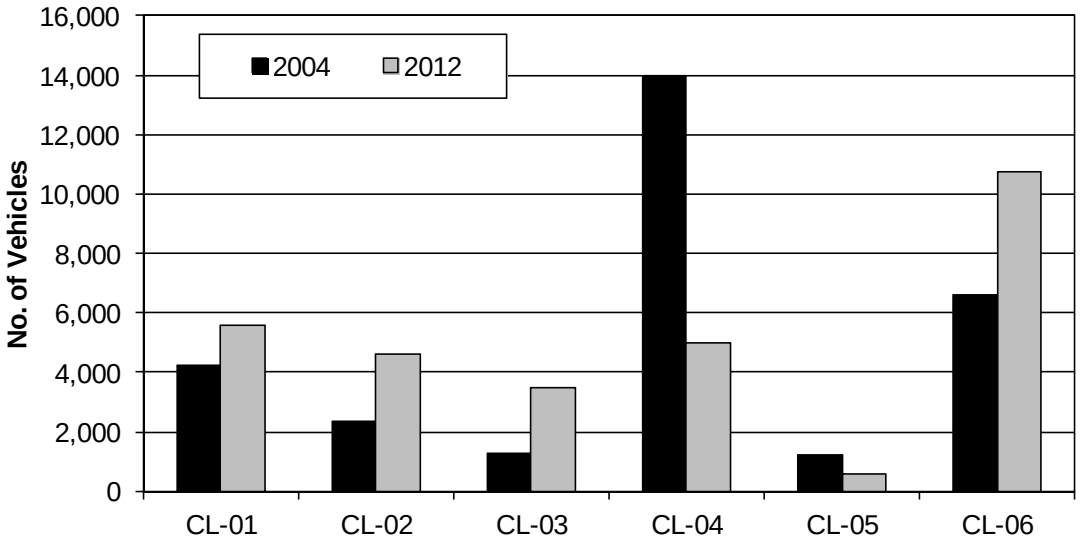
Decreases in the number of vehicles were observed in comparison with the study of PMTU-2025 for the areas of Central Highway (CL-04) and Cieneguilla (CL-05). The survey points were shifted away from small bus terminals to avoid counting of internal traffic at these CL locations. It is judged that numbers in 2004 included considerable volume of internal traffic.

Table 2.12 Counted Traffic Volume (Vehicles / Day)

Code	M/C		Automobile / Taxi		Public Traffic		Truck		Total	
	2004	2012	2004	2012	2004	2012	2004	2012	2004	2012
CL - 01	1	2	1	33	1,590	2,244	2,632	3,293	4,224	5,572
CL - 02	7	27	1,593	3,776	92	719	691	85	2,383	4,607
CL - 03	57	225	333	1,554	317	1,476	555	239	1,262	3,494
CL - 04	460	61	6,230	1,952	4,514	1,227	2,762	1,729	13,966	4,969
CL - 05	61	50	612	387	429	96	116	36	1,218	569
CL - 06	54	408	2,280	5,178	1,579	2,283	2,692	2,890	6,605	10,759
Total	680	773	25,084	12,880	10,172	8,045	9,946	8,929	45,882	30,627

Source: Cordon Line Survey, 2012

The bar chart of Figure 2.8 shows the comparison of the traffic count survey between 2004 and 2012.



Source: PMTU 2025 and Cordon Line Survey, 2012

Figure 2.8 Comparison of Traffic Volume Cordon Line

2.4 Screen Line Survey

2.4.1 Methodology

The Screen Line Survey consists of the traffic count survey and the passenger occupancy survey. The obtained data is used for the calibration of the transport model.

The traffic count survey and the passenger occupancy survey were carried out for 24 hours and 14 hours, respectively, on 15 locations along Rimac River and on 7 locations of Panamericana Sur highway.

(1) Traffic Count

The number of vehicle by type and direction was counted for every hour. The same 17 vehicle types as those used for the Cordon Line Survey were also used in the traffic count of the Screen Line Survey.

(2) Passenger Occupancy

The number of passengers per vehicle was estimated by visual observation from roadsides. Classified occupancy rates such as empty, 1/4 seated, 1/2 seated, 100% seated, 1/2 standings, and full loading were observed for colectivos, combis, microbuses, and buses. The survey period was 14 hours (7:00- 21:00).

Table 2.13 shows the conversion factors to be used to estimate the number of passengers from the classified occupancy rates. The factors are different from those used in the study of PMTU-2025, reflecting the increase in seating capacity of vehicles.

Table 2.13 Factors for Passenger Occupancy

Mode	Full	100% seated 50% standing	100% seated	50% seated	Almost empty	Empty
Omnibus	80	57	33	17	8	0
Microbus	50	37	23	12	4	0
Rural Wagon	24	20	15	8	2	0

Source: JICA Study Team

(3) Preparation and Schedule of Survey

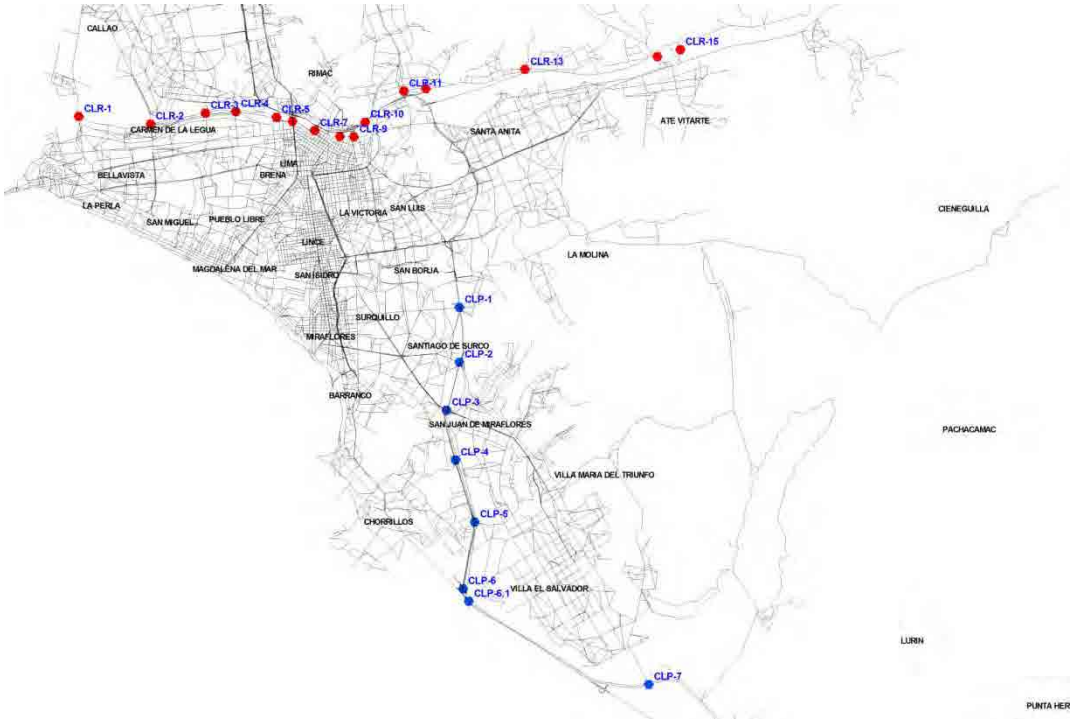
The survey was done simultaneously for each Screen Line. The surveys were conducted at 15 bridges along the Rimac River and 8 points along Panamericana Sur highway as shown in Table 2.14.

Table 2.14 Screen Survey Locations

CODE	Name (Rimac River Screen)
CLR1	Puente Gambeta
CLR2	Puente Faucet
CLR3	Puente Universitaria
CLR4	Puente Dueñas
CLR5	Puente Santa María
CLR6	Puente Ejercito
CLR8	Puente Ricardo Palma
CLR7	Puente Santa Rosa
CLR9	Puente Huánuco
CLR10	Puente Huáscar
CLR11-1	Puente Nuevo (Av. Chinchaysuyo)
CLR11-2	Puente Nuevo (Av. Pirámide del Sol)
CLR12	Puente Las Lomas
CLR13	Puente Prialé
CLR14	Puente Huachipa
CLR15	Puente Bayles Santa Clara

CODE	Name (Panamericana Sur Screen)
CLP1	Angamos
CLP2	Benavides
CLP3	Tomas Marsano (Tren Eléctrico)
CLP4	Alipio (Panamericana y Salida)
CLP5	Mateo Pumacahua
CLP6	Huaylas (Rampa)
CLP6-1	El Sol
CLP7	Dv. Lurín (Carretera)

Source: JICA Study Team



Source: JICA Study Team

Figure 2.9 Screen Line Survey Locations

(4) Schedule of Screen Line Survey

The survey was carried out in accordance with following schedule.

Table 2.15 Survey Schedule

Point	Counting
Screen Line on Rimac River	May 8, 2012 (Tue) at 6:00 am to May 9, 2012 at 6:00 am (24 hours)
Screen Line on Panamaricana	May 10, 2012 (Thu) at 6:00 am to May 11, 2012 at 6:00 am (24 hours)

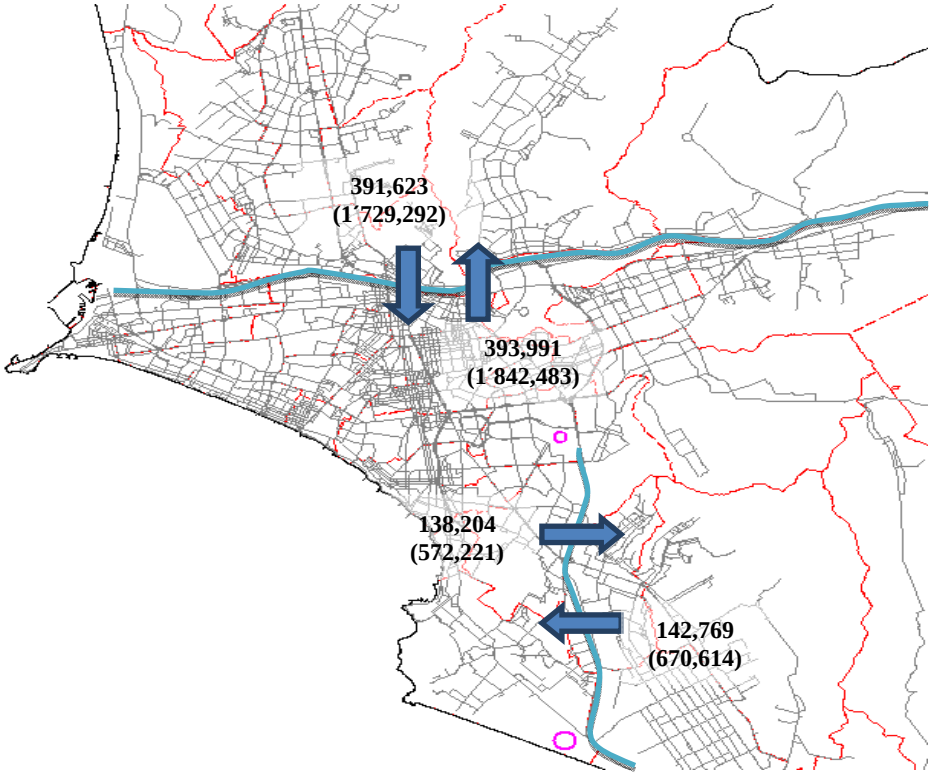
Source: JICA Study Team

2.4.2 Result of Screen Line Survey

The total numbers of vehicle trips along the Rímac River and the Panamericana Sur (Southern Panamericana Highway) Avenue were 785,614 and 280,973 vehicles/day, respectively, running on both directions. These volumes have increased by 24.4 % and 68 %, respectively from 2004.

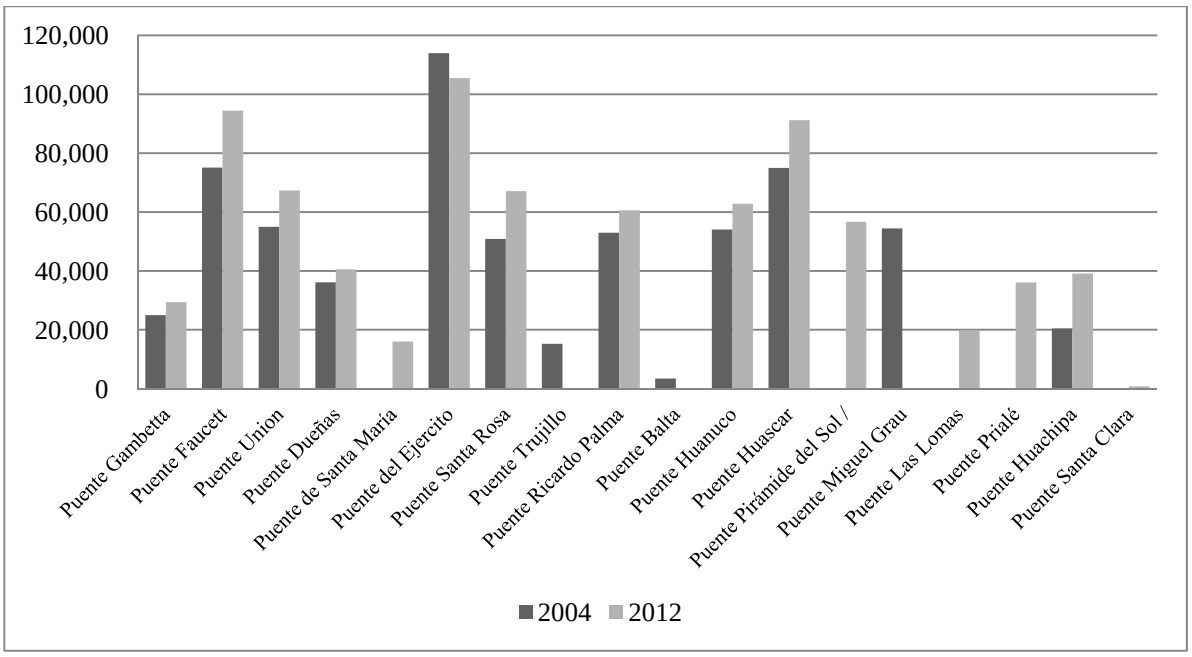
Figure 2.10 and Figure 2.11 show the traffic volume on each station along the Screen Lines. On the Screen Line along the Rímac River, traffic volume on the Del Ejército Bridge was the highest with 105,494 vehicles, followed by the traffic volume on the Faucett Bridge with 92,696 vehicles, and Huáscar Bridge on the Vía de Evitamiento (the beltway) with 91,222 vehicles. In comparison with those recorded in 2004, the order of traffic volume from highest to lowest remained the same but and in general terms, the traffic volumes have increased.

However, the order of passenger volume has changed. It was found that the passenger volume on the Santa Rosa Bridge was the highest with 453,040 passengers/day, followed the new bridge (Piramide and Chinchaysuyo) with 452,815 passengers/day and Ricardo Palma Bridge with 402,215 passengers/day.



Unit: Vehicles per day (above) and passengers per day (below)
Source: Screen Line Survey, 2012

Figure 2.10 Traffic Volumes Crossing the Screen Lines

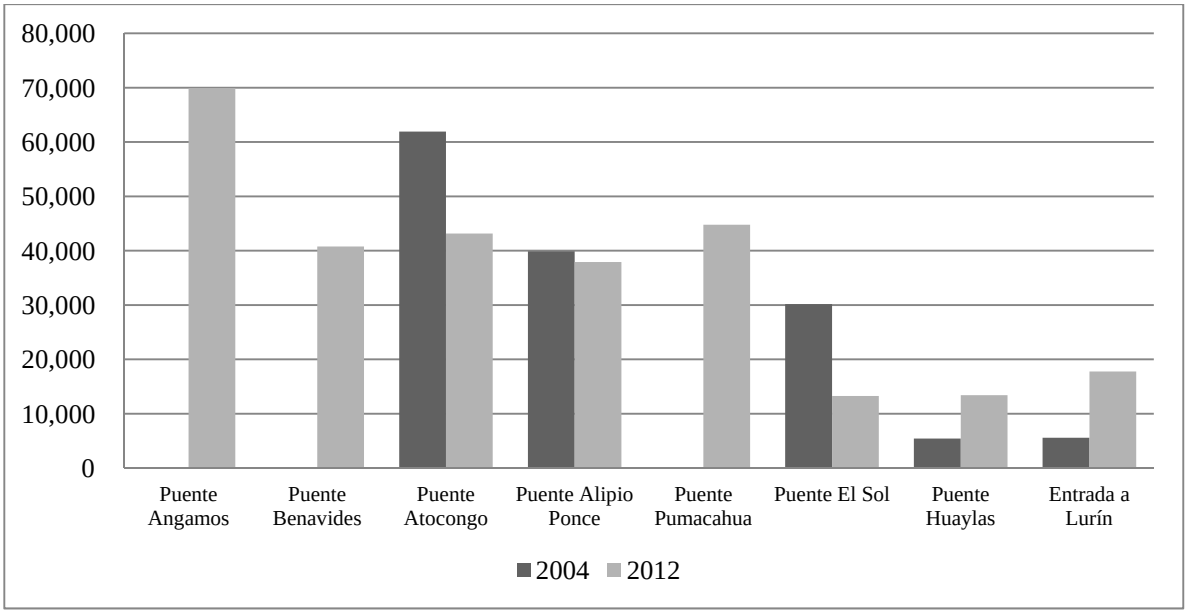


Unit: Vehicles per day
Source: Screen Line Survey, 2012

Figure 2.11 Traffic Volume Change on the Rímac River Screen Line

Figure 2.12 shows the traffic volume on the Screen Line along the Panamericana Sur (Southern Panamerican Highway) Avenue. The highest traffic volume was observed on the Primavera

Bridge (Angamos Avenue, with 69,924 vehicles/ day) followed by the Mateo Pumacahua Bridge with 44,782 vehicles/day, and the Atocongo Bridge with 43,144 vehicles/day. The observed volume in 2004 at the Atocongo Bridge seems to be absorbed by the newly constructed Metro Line-1 at this point. With regard to the number of passengers, the Atocongo Bridge had the largest number with 336,857 passengers/day followed by the Mateo Pumacahua Bridge with 222,503 passengers/day.



Unit: Vehicles per day
Source: Screen Line Survey, 2012

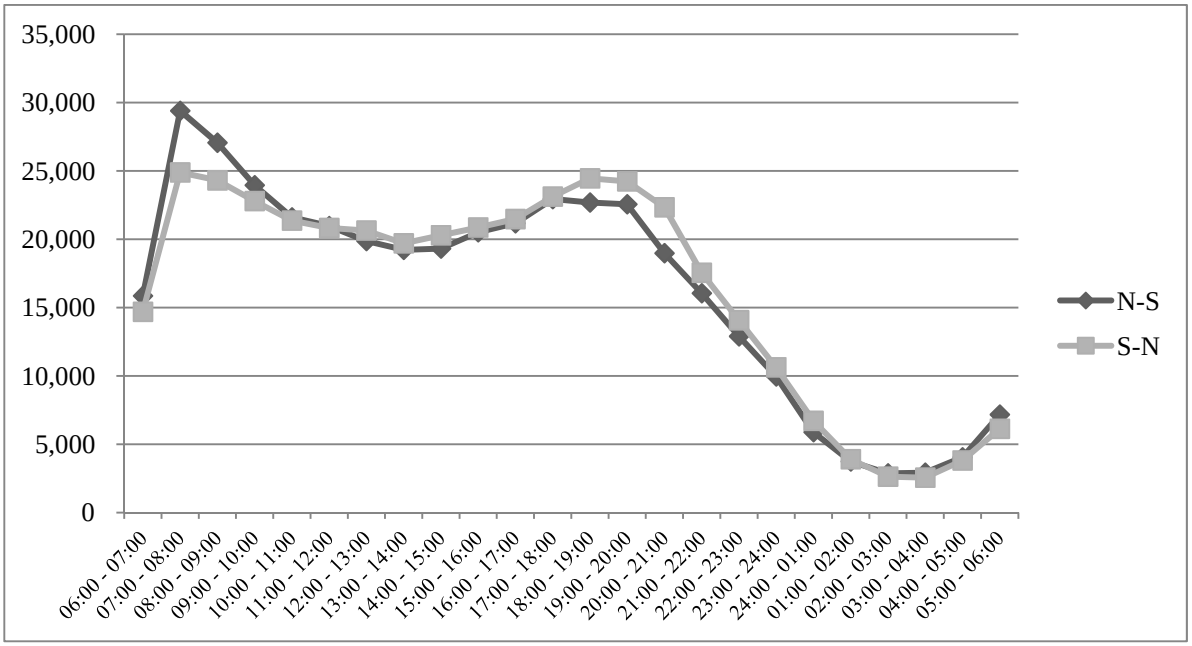
Figure 2.12 Traffic Volume on the Southern Panamerican Highway Screen Line

The traffic volumes at each station can be summarized in Table 2.16. In general, all stations had a quite low peak ratio value, except for a few stations. This means that there is no evidence of traffic concentrations or traffic congestions throughout the day. The public transportation traffic ratio ranged between 4.20 % and 20 %, except for three stations where public transportation was not allowed. Hourly traffic fluctuations, as counted on both Screen Lines, are illustrated in Figure 2.13 and Figure 2.14.

Table 2.16 Summary of Traffic Volumes at the Screen Line Stations

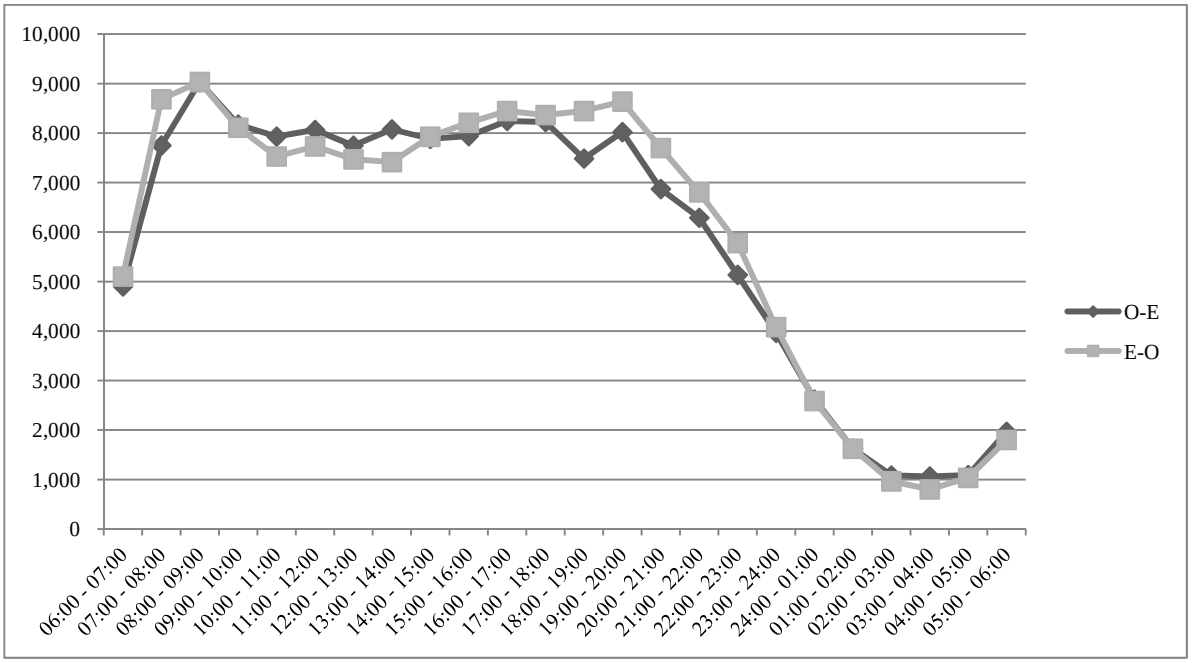
Code	Station Name	Vehicle / Day				
		Total	**M/C**	**Auto/Taxi**	**Public Transportation**	**Truck**
SL - 01	Gambetta Bridge	29,366	1,220	15,938	3,489	8,719
		100.0%	4.2%	54.3%	11.9%	29.7%
SL - 02	Faucett Bridge	92,696	3,554	62,403	15,389	11,350
		100.0%	3.8%	67.3%	16.6%	12.2%
SL - 03	Unión Bridge	67,353	3,283	48,836	9,436	5,798
		100.0%	4.9%	72.5%	14.0%	8.6%
SL - 04	Dueñas Bridge	40,536	2,146	29,298	6,387	2,705
		100.0%	5.3%	72.3%	15.8%	6.7%
SL - 05	Santa María Bridge	15,977	375	14,348	459	795
		100.0%	2.3%	89.8%	2.9%	5.0%
SL - 06	Del Ejercito Bridge	105,494	3,338	78,221	9,875	14,060
		100.0%	3.2%	74.1%	9.4%	13.3%
SL - 07	Santa Rosa Bridge	67,106	1,973	51,170	12,474	1,489
		100.0%	2.9%	76.3%	18.6%	2.2%
SL - 08	Ricardo Palma Bridge	60,584	1,447	45,906	10,487	2,744
		100.0%	2.4%	75.8%	17.3%	4.5%
SL - 09	Huánuco Bridge	62,791	1,667	49,389	7,167	4,568
		100.0%	2.7%	78.7%	11.4%	7.3%
SL - 10	Huáscar Bridge	91,222	2,951	51,804	16,810	19,657
		100.0%	3.2%	56.8%	18.4%	21.5%
SL - 11	Pirámide del Sol Bridge	56,659	2,809	35,510	13,165	5,175
	Chinchaysuyo Bridge	100.0%	5.0%	62.7%	23.2%	9.1%
SL - 12	Las Lomas Bridge	19,847	1,855	15,022	148	2,822
		100.0%	9.3%	75.7%	0.7%	14.2%
SL - 13	Prialé Bridge	36,083	864	20,438	1,603	13,178
		100.0%	2.4%	56.6%	4.4%	36.5%
SL - 14	Huachipa Bridge	39,106	2,345	22,535	7,526	6,700
		100.0%	6.0%	57.6%	19.2%	17.1%
SL - 15	Santa Clara Bridge	794	92	270	122	310
		100.0%	11.6%	34.0%	15.4%	39.0%
	Total	**785,614**	**518,553**	**107,011**	**93,370**	**518,553**
		100.0%	66.0%	13.6%	11.9%	66.0%

Source: Screen Line Survey, 2012



Unit: Vehicles per day
Source: Screen Line Survey, 2012

Figure 2.13 Traffic Volume per Hour on the Rímac River Screen Line



Unit: Vehicles per day
Source: Screen Line Survey, 2012

Figure 2.14 Traffic Volume per Hour on the Southern Panamerican Screen Line

2.5 Passenger Interview Survey

The Passenger interview (PI) survey was carried out to collect information on passengers' willingness to change their transportation mode to mass transit system.

2.5.1 Methodology

Interviews of the users of private and public passenger transport were carried out. Interview items include 1) personal attributes, 2) trip information, 3) opinion on public transport, 4) willingness-to-pay for modern type mass transit system.

The locations of interviews are mainly at the stops on public transportation routes, the stations of Metropolitano (BRT) and Metro Line 1, and private parking lots for car users.

The target sample number was set at 2,000. A pilot survey was done in June 2012 prior to the main interviews.

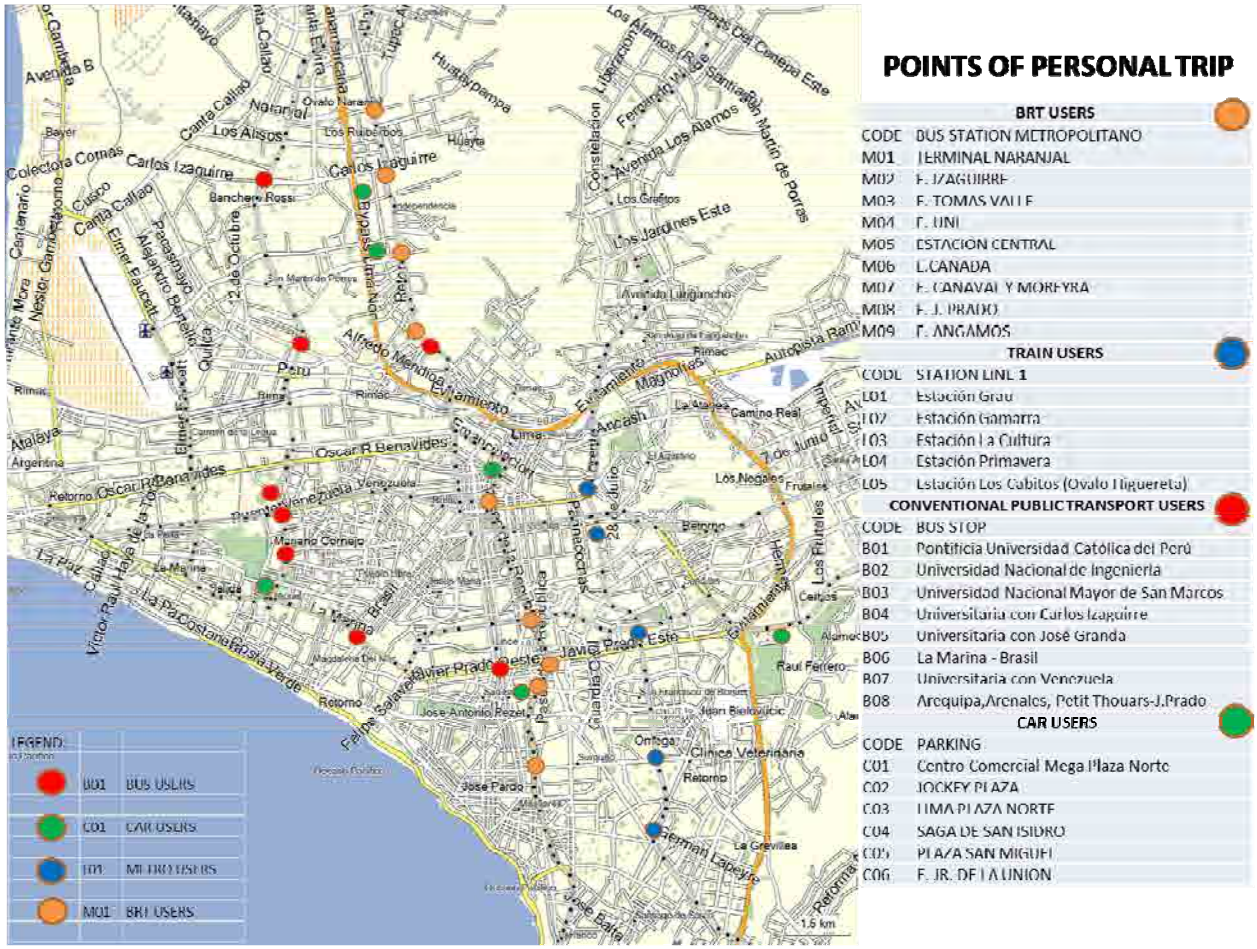
2.5.2 Preparation and Schedule of Survey

The survey data was taken by means of: Stated Preference Survey (SP), Opinion on Public Transport Survey and Willingness-to-Pay Survey. Interviews were carried out according to the schedule shown in Table 2.17 and at locations indicated in Figure 2.15.

Table 2.17 Passenger Interview Schedule (PI)

No	Code	Location/Mode	Week 1	Week 2		
			05/07/2012	10/07/2012	11/07/2012	12/07/2012
			THU	TUE	WED	THU
1	EP1	Bus stops	1			
2	EP2	Parking lots		1		
3	EP3	Metropolitano				1
4	EP4	Metro			1	

Source: JICA Study Team



Source: JICA Study Team

Figure 2.15 Location of Passenger Interviews

2.5.3 Result of the Survey

(1) Car Usage

Among the surveyed public transport users, only 11% of interviewees had cars. Traffic congestion and fuel cost were the main reasons that people did use cars as shown in Table 2.18. As shown in Table 2.19, 86% of the public transportation users take taxi at least once a week.

Table 2.18 Reasons Stated by Users for not using their own Vehicles

Reason	Count	Percentage
1. Fuel price	41	20.0%
2. No parking space	27	13.2%
3. Parking fee	16	7.8%
4. Travel time/ Traffic congestion	71	34.6%
5. Car was not available in the survey day.	34	16.6%
6. Others	16	7.8%
Total	205	100%

Source: Passenger Interview Survey in this study

Table 2.19 Taxi Use Frequency per Month

No. of use per month	No use	1-3	4-6	7-10	11-	Total
Count	343	1,230	528	177	137	2,415
%	14.2	50.9	21.9	7.3	5.7	100.0%

Source: Passenger Interview Survey in this study

(2) Usage of Metropolitano and Metro Line-1

More than half of the bus users (61.3%) were using also Metropolitano, but only one-fifth (21.1%) used Metro Line-1.

(3) Feeder Mode

Metropolitano (BRT) and Metro Line-1 users mainly walked to the stations as shown in Table 2.20.

Table 2.20 Feeder Mode

	Count					Percentage			
	Walk	Car	Para transit	Public mode	Total	Walk	Car	Para transit	Public mode
Metropolitano	904	5	91	722	1,722	52.5	0.3	5.3	41.9
Metro Line-1	673	7	157	609	1,446	46.5	0.5	10.9	42.1
Total	1,577	12	248	1,331	3,168	49.8	0.4	7.8	42.0

Source: Passenger Interview Survey in this study

(4) Previous Mode

Bus and combi accounted for 92.8% of the previous mode of Metropolitano and Metro Line-1 as shown in Table 2.21. Only 5% of passengers used car or taxi previously.

Table 2.21 Previous Mode

	Count					Percentage			
	Car/Taxi	Bus	Combi	Others	Total	Car/Taxi	Bus	Combi	Others
Metropolitano	37	394	155	16	602	6.1	65.4	25.7	2.7
Metro Line-1	14	233	157	6	410	3.4	56.8	38.3	1.5
Total	51	627	312	22	1,012	5.0	62.0	30.8	2.2

Source: Passenger Interview Survey in this study

(5) Evaluation of Mass Transit System

Travel speed of BRT was very well evaluated followed by its frequency, vicinity and comfort as shown in Table 2.22. More than half of the BRT users qualified good or very good its service.

Over 60% of Metro users evaluated its services as good or very good as shown in Table 2.23. Comfort was the worst evaluated but it was still considered acceptable by 80% of users.

Table 2.22 Evaluation of Service of Metropolitano

	Very good	Good	Acceptable	Poor	Very Poor
Fare	17.8	51.1	29.8	1.3	0.0
Speed	18.7	51.6	27.3	2.4	0.0
Frequency	8.2	50.8	35.7	5.1	0.2
Punctuality	12.8	49.2	34.6	3.3	0.1
Safety	15.8	46.1	32.1	6.0	0.0
Boarding/Alighting	5.6	41.1	40.5	12.4	0.3
Comfort in bus	6.6	29.7	35.7	24.5	3.5
Comfort at station	5.9	41.5	37.7	13.4	1.5
Entry/Exit gates	6.9	41.8	40.9	9.5	0.9
Access	4.5	46.5	41.9	6.3	0.8
Feeder Connection	6.7	34.6	45.6	11.5	1.5

Source: Passenger Interview Survey in this study

Table 2.23 Evaluation of Service of Metro Line-1

	Very good	Good	Acceptable	Poor	Very Poor
Fare	30.6	43.8	22.3	2.8	0.6
Speed	37.8	45.2	16.5	0.4	0.1
Frequency	22.3	40.9	32.0	4.4	0.4
Punctuality	31.7	38.2	27.7	2.4	0.1
Safety	27.5	41.1	26.4	4.4	0.6
Comfort in train	17.0	29.7	35.4	16.9	1.0
Comfort at station	15.8	47.0	31.8	4.4	1.0
Access	13.6	44.5	36.9	4.4	0.6

Source: Passenger Interview Survey in this study

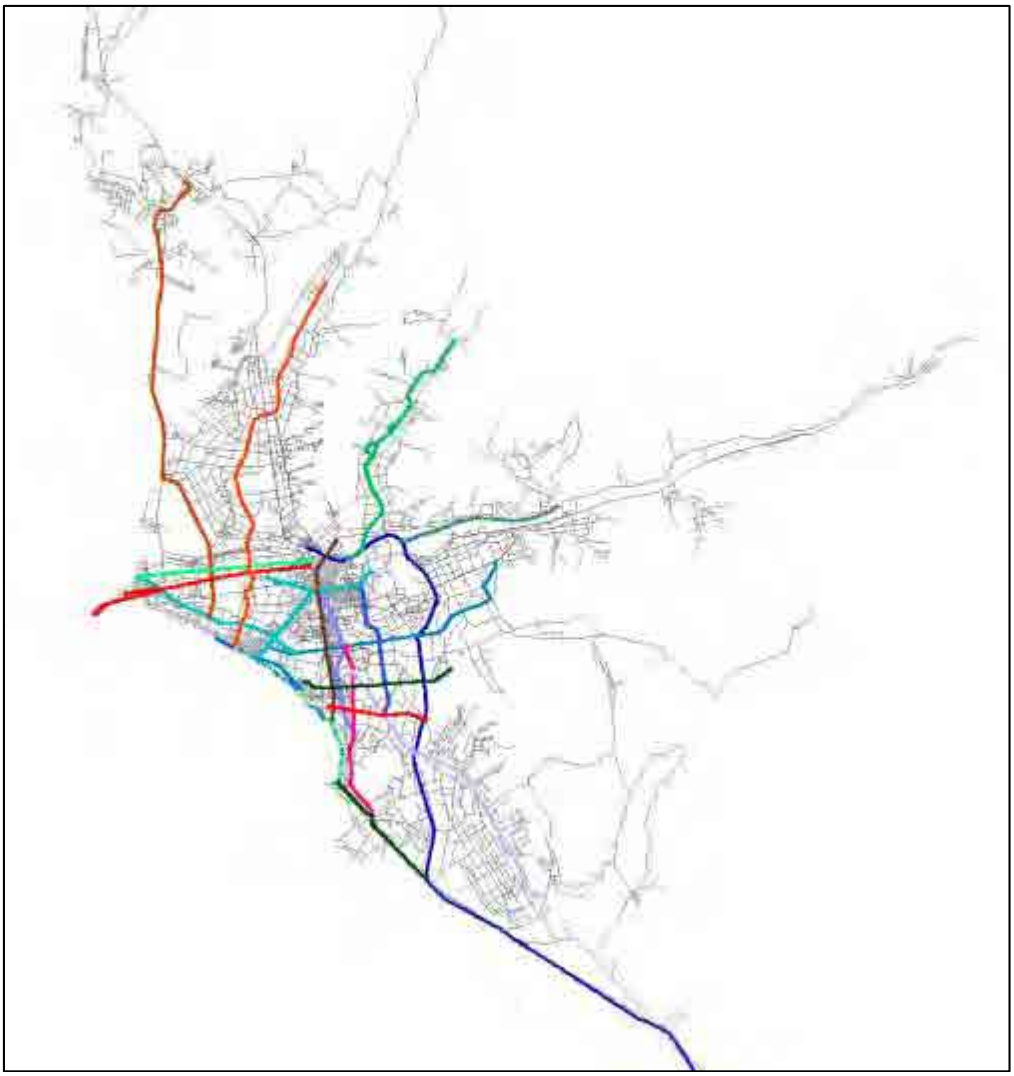
2.6 Travel Speed Survey

2.6.1 Methodology

The objective of the survey is to identify bottlenecks on the road network during peak hours and establish a function of volume-speed relation for each route in combination with the results of the traffic counts.

The survey routes were 22 arterial roads with the total length of approximately 400km as shown in Figure 2.16 and Table 2.24.

The survey was carried out during peak hours and off-peak hours using GPS devices. The peak and off-peak periods for each route are established based on the existing reports and the results of traffic counts carried out prior to the travel speed survey.



Source: JICA Study Team

Figure 2.16 Locations of Travel Speed Survey

Table 2.24 Summary Showing Execution of Speed Survey Schedule

TRAVEL SPEED SURVEY			DATE (DD/MM/YY)
No.	CODE	SECTION	
1	VC1	Carretera Central – Av. Nicolás Ayllón (45 km)	06/06/12
2	VC2	Panamericana Norte - Av. Zarumilla (38.7 km)	24/05/12
3	VC3	Panamericana Sur – Vía Evitamiento (59.9km)	16/05/12
4	VC4	Av. Separadora Industrial –Av. Melgarejo – Javier Prado Este Javier Prado Oeste – Av. Brasil – Av. Ejercito (22.6 km)	15/05/12
5	VC5	Av. Faustino Sánchez Carrión – Av. La Marina – Av. Guardia Chalaca (11.2 km)	15/05/12
6	VC6	Av. Faucett – Av. Néstor Gambetta – Carretera Ventanilla (28.1 km)	22/05/12
7	VC7	Circuito de Playas (12.1km)	29/05/12
8	VC8	Av. Argentina (10.7 km)	29/05/12
9	VC9	Av. Ramiro Prialé (10.6 km)	17/05/12
10	VC10	Av. Aviación (8.6 km)	05/06/12
11	VC11	Vía Expresa paseo dela Republica (9.6 km)	17/05/12
12	VC12	Av. Los Próceres de la Independencia – Av. Wiesse (16.7)	30/05/12
13	VC13	Ca. Las Gaviotas – paseo de la Republica (Pról.) – Av. Escuela Militar – Av. Rep. de Panamá (1km)	05/06/12
14	VC14	Av. Colonial (Oscar r. Benavides) – Av. Almirante Miguel Grau (13.6 km)	31/05/12
15	VC15	Av. Universitaria (25.2 km)	16/05/12
16	VC16	Av. Pachacutec – Av. Los héroes –Av. Santiago de Surco – Av. Tomas Marsano (19.1 km)	30/05/12
17	VC17	Av. Miguel Grau – 9 Diciembre – Arica 87.3 km)	06/06/12
18	VC18	Av. Huaylas (8.2 km)	23/05/12
19	VC19	Av. Brasil (5.2 km)	31/05/12
20	VC20	Prolongación Tacna – Av., Tacna – Av. Garcilaso de la Vega – Av. Arequipa – Av. José Larco (11.4 km)	22/05/12
21	VC21	Av. Angamos Este – Oeste (9.4km)	23/05/12
22	VC22	Av. Benavides (6.3 km)	24/05/12

Source: JICA Study Team

2.6.2 Preparation and Schedule of Survey

Before carrying out the survey, the peak hours and off peak hours of each route were determined based on existing studies and new traffic counts. The survey was carried out from Tuesday to Thursday to collect information on a typical week day. For some routes, it was required to conduct the survey on alternate roads due to some modifications on the routes.

The test vehicle technique was applied for the survey. It is possible to take not only travel time but also the points where delay occurs. This procedure is applicable in urban and suburban roads where the traffic density and regulations generate appreciable speed reduction of vehicles.

A floating vehicle ran along the target route at the approximately average speed of existing cars. The travel time and existing traffic speed were registered on GPS equipment. The stopping duration at certain points were registered considering its eventual importance for normal circulation of vehicles

Each route of the 22 axles has two directions which are classified as incoming traffic (from the suburban areas to the center of the city) and outgoing traffic.

2.6.3 Survey Results

Figure 2.17 shows the traveling speed at morning peak hours for incoming and outgoing traffics. For the incoming direction (entrance), the average travel speed was under 20 km/h on the following sections.

a) La Marina Avenue (Av. Javier Prado – Av. Universitaria)
b) Argentina Avenue (Av. Universitaria – Av. Ugarte)
c) Aviación Avenue (Av. Grau – Av. Javier Prado)
d) República de Panamá Avenue (Av. Javier Prado – Benavides)
e) Tomás Marsano Avenue (Av. República de Panamá – Panamericana Sur)
f) Miguel Grau Avenue (Cementerio – Station Central)
g) Brasil Avenue (Plaza Bolognesi – Av. El Ejército)
h) Arequipa Avenue (Av. 28 de Julio - Av. José Pardo)
i) Nicolás Ayllón Avenue (Ovalo Santa Anita – Separadora Industrial)
j) O.R. Benavides Avenue (Av. Faucett- Av. Alfonso Ugarte)

For the outgoing direction, the average travel speed is under 20 km/h on the following sections.

a) Javier Prado Avenue (Av. Brasil - Paseo de la República)
b) La Marina Avenue (Av. Javier Prado - Av. Universitaria)
c) Miguel Grau Avenue (Av. Aviación - Paseo de la República)
d) Brasil Avenue (Plaza Bolognesi - Circuito de Playas)
e) Tacna Avenue
f) Arequipa Avenue (Av. 28 de Julio – Av. José Pardo)
g) Panamericana Norte (Tomás Valle – Trébol de Caquetá)
h) Aviación (Av. Grau – Av. Primavera)

Arterial roads in Lima have relatively high road capacity. There are several reasons for the low speed sections:

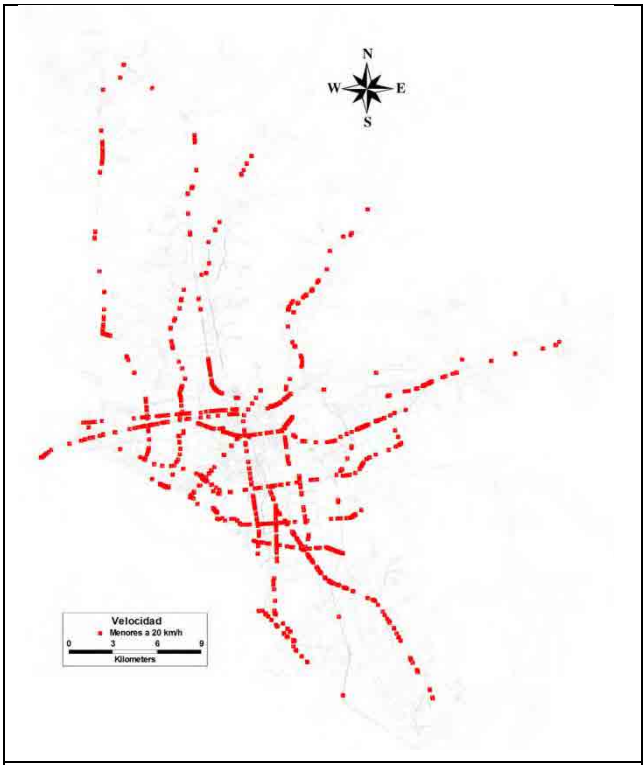
1) Frequent stops of buses cause deceleration of the following vehicles.

2) Deadlocks at intersections are observed because of drivers' behavior in heavy traffic.

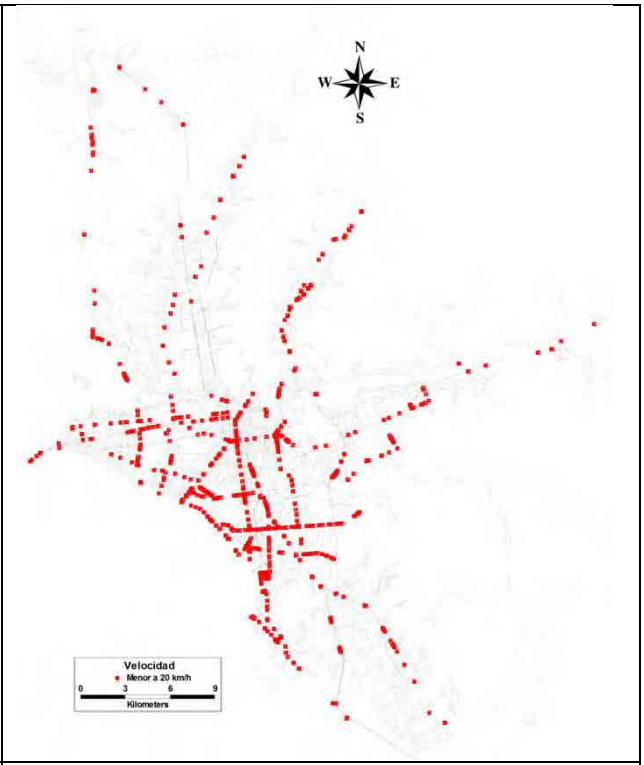
3) Low road capacity of local streets in the central area influences the traffic on arterial roads.

4) Lack of alternative routes crossing Rimac River, Pan Americana Sur, Paseo de Repbulica, and other highways causes queue along these corridors.

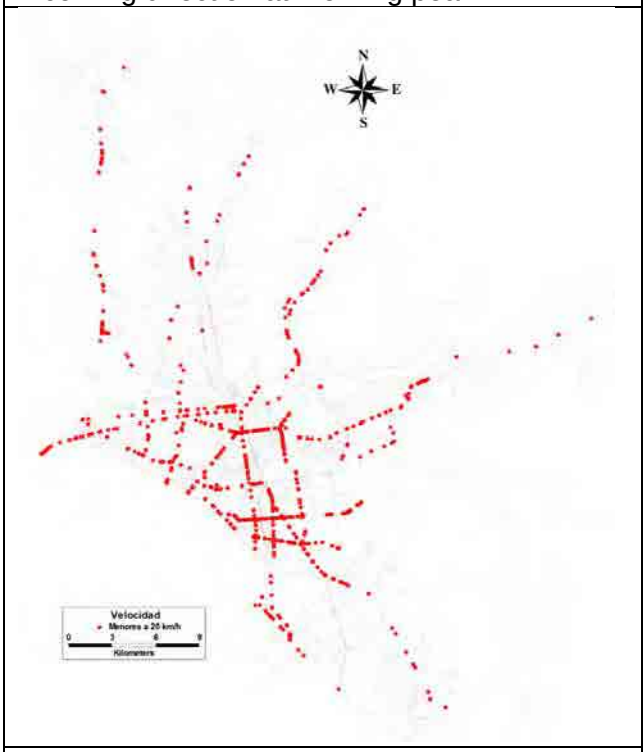
5) Circulation traffic due to one-way street system increases traffic demand.



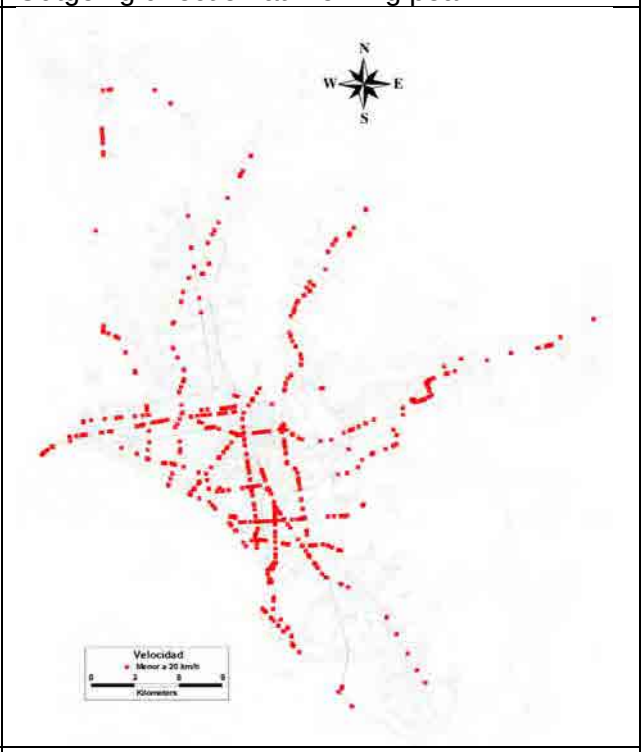
Incoming direction at morning peak



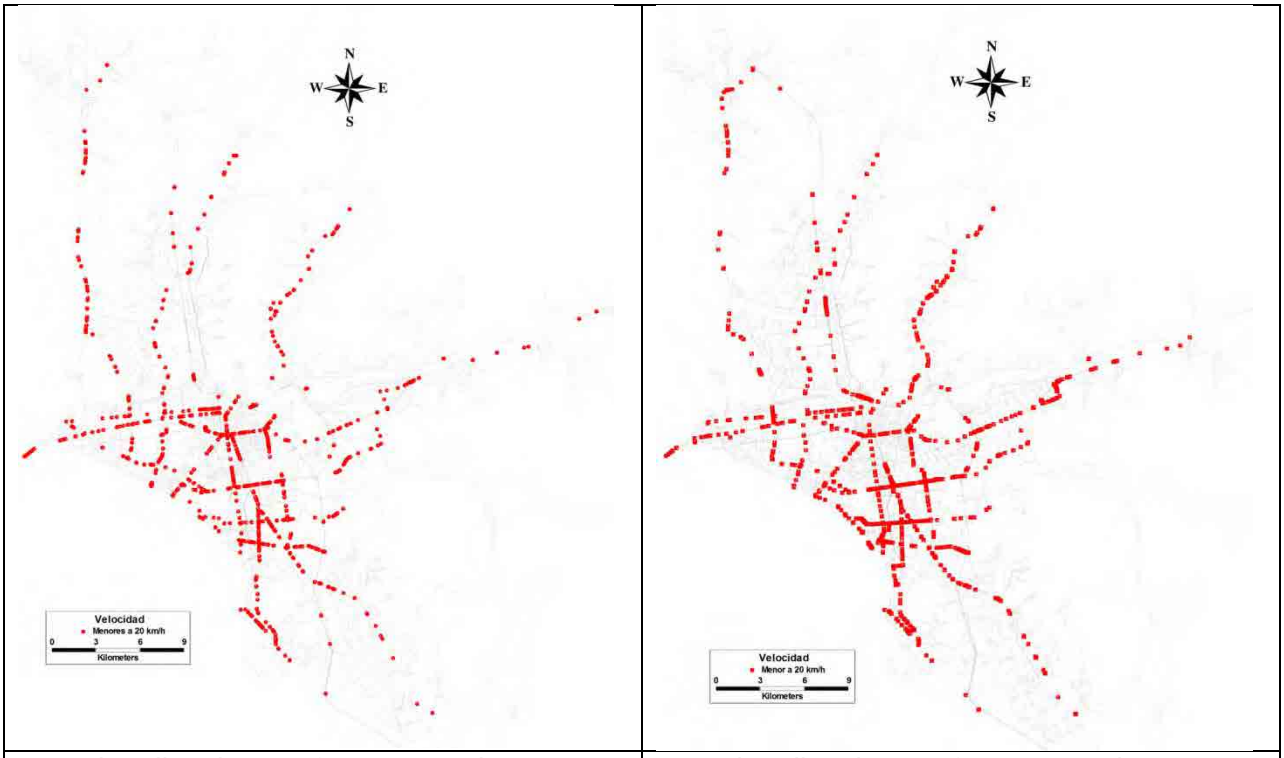
Outgoing direction at morning peak



Incoming direction at off peak



Outgoing direction at off peak



Incoming direction at afternoon peak	Outgoing direction at afternoon peak

Source: JICA Study Team

Figure 2.17 Main Roads with Traveling Speed Less than 20km/h

2.7 Freight Traffic Survey

The Person Trip survey focuses only on individual trips made by the residents in the Study Area.

Therefore, it is necessary to carry out a freight survey to find out movement characteristics of goods in the Study Area.

2.7.1 Methodology

Just as same as the study for PMTU2025, the following surveys were carried out:

a) Traffic Count
b) Interviews on one side of the road
c) Interviews of logistics and transportation companies.

2.7.2 Preparation and Schedule

Vehicles were classified under the following 6 types:

a) Tank truck
b) Collecting truck
c) Light Freight truck
d) 2-axle truck
e) 3-axle truck
f) Trailer

Table 2.25 Surveys done for Freight Transport

Name	Code	Number of Sample
North	CL-01	643
	CL-02	62
Canta	CL-03	248
C.Central	CL-04	249
Sieneguilla	CL-05	27
South	CL-06	426
Airport	EC-01	170
Port	EC-02	1,417
Market	EC-03	440
Pampilla	EC-04	269
Total		2,296

Source: JICA Study Team

2.7.3 Freight Vehicle Volume at each Counting Point

(1) Cordon Line

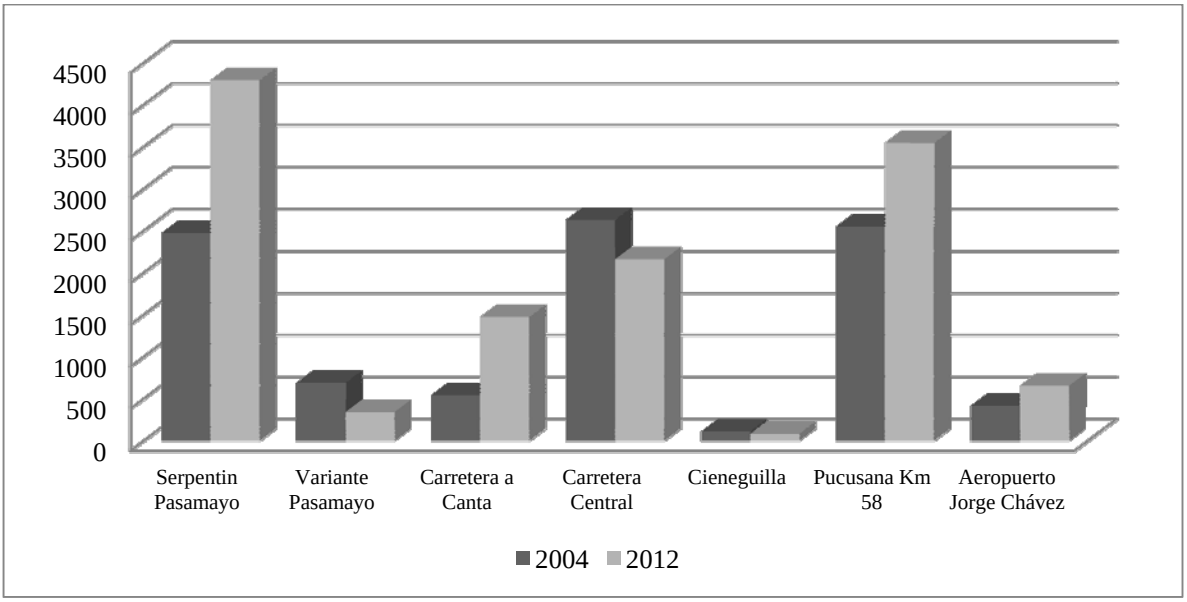
Table 2.26 shows the summary of the number of freight vehicles at each survey location, while Figure 2.18 shows the comparison of the traffic volumes between the survey result in 2004 and 2012.

Table 2.26 Freight Traffic Volume by Survey Location

No. of freight vehicles per day

	CL-01	CL-02	CL-03	CL-04	CL-05	CL-06	CL-07
Incoming	2,076	176	749	1,277	40	1,893	313
Outgoing	2,220	170	729	887	45	1,656	344
Total	4,296	346	1,478	2,164	85	3,549	657

Source: Freight Traffic Survey, 2012



Source: PMTU 2025 and Freight Traffic Survey, 2012

Figure 2.18 Freight Traffic on the Cordon Line

According to the counting results at Stations CL-1 (Lima - Huaral) and CL-6 (Lima - Cañete), the freight vehicle volume at each point has increased in comparison with PMTU-2025, with the following volume counts: 4,296 on Pasamayo Serpentín (Winding Road), 3,549 on Southern Panamerican. The freight traffic volumes at CL-4 (Lima- Huarochirí) were: 2,164 on Central Highway (there has been a decrease here in comparison to PMTU2025). The remaining points

such as CL-2 (Lima – Huaral), CL-3 (Lima -Canta), and CL-5 (Lima - Huarochirí) also showed decrease. Canta showed an increase of 1,478 freight vehicles. The freight traffic volumes on Pasamayo Variante (Alternate Road) and Cineguilla decreased to 346 and 85 vehicles/day, respectively.

On CL-1, trailer type vehicles represented 63.5 % of the total number of vehicles, and light freight vehicles represented 23.3 %. On CL-2, small freight trucks accounted for 88.2 % of the total number of freight vehicles. Not many freight vehicles tended to run on CL-2, except for small trucks. Therefore, most freight vehicles on the Northern area of Lima ran down the old Northern Panamerican Highway, on CL-1.

On CL-4 and CL-6, small freight trucks and 2-axle trucks represented 29% and 28.5%, respectively of the total number of freight vehicles. Trailers represented 51.4 % and 51.9 %, respectively. An increase in the number of this type of units with a greater load capacity was observed.

(2) Freight at the Airport

Table 2.27 shows the freight vehicle count results at the Jorge Chávez Airport, the Callao Port, the wholesale marketplace, and the La Pampilla Oil Refinery Plant.

A total of 657 freight vehicles were counted at the airport. Trailers represented 5 % of the total volumes; however, small trucks represented 48.1 %, and 2-axle trucks represented 43.1 %.

(3) Freight at the Callao Port

As shown in Table 2.27, a total of 6,237 freight vehicles were counted at all of Callao Port's three gates. This figure has significantly increased in comparison with the 2004 figure. Most freight vehicles counted in Callao were trailers, and they represented 85.3 % of the total number of freight vehicles.

(4) Freight at Wholesale Market and Refinery Plant

Interview and freight vehicle count were set up at The Wholesale Marketplace in La Victoria and the La Pampilla Refinery Plant.

1) The Wholesale Marketplace

Freight trucks can enter the Wholesale Marketplace from 14:00 hours to 7:00 hours the day after. A total of 442 freight vehicles were counted in one day. Trailers represented 22.4 %, 3-axle trucks represent 35.5 %, and 2-axle trucks represent 34.8 % of the total number of checked freight vehicles.

2) La Pampilla Oil Refinery Plant

Tank trucks can enter La Pampilla Refinery Plant from 5:00 to 1:00. A total of 659 freight trucks were counted.

Table 2.27 exhibits the locations and counted number of freight vehicles in the Freight Traffic Survey.

Table 2.27 Number of Freight Vehicles at Freight Traffic Survey Locations

Counting point	Location	Tank truck	Light freight truck	2-axle truck	3-axle truck	Trailer	Total
Inbound							
EC1O	Airport	0	133	152	12	16	313
EC2O	Callao port	468	3	30	9	2769	3279
EC3O	Wholesale Marketplace	0	16	76	80	45	217
EC4O	La Pampilla	0	0	125	41	152	318
Outbound							
EC1O	Airport	0	183	131	12	18	344
EC2O	Callao port	254	83	50	18	2553	2958
EC3O	Wholesale Marketplace	0	16	78	77	54	225
EC4O	La Pampilla	0	0	131	50	160	341
Total							
EC1O	Airport	0	316	283	24	34	657
EC2O	Callao port	722	86	80	27	5322	6237
EC3O	Wholesale Marketplace	0	32	154	157	99	442
EC4O	La Pampilla	0	0	256	91	312	659

Source: Freight Traffic Survey, 2012

(5) Freight Company Interview

The freight company interview survey was conducted as a part of the Freight Traffic Survey for five (5) major transportation companies. These companies were selected from a previously prepared list. An interview team made an interview with a staff in charge at each company on a set date. Major topics discussed during the interviews included:

a) The company profile, and
b) Goods being transported

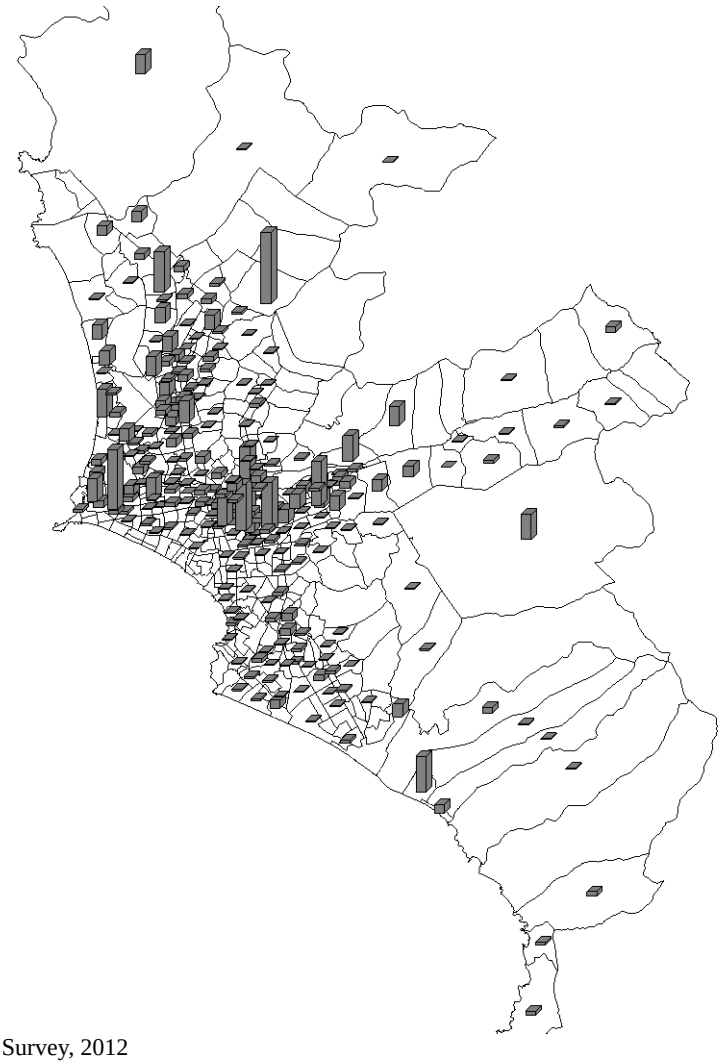
Table 2.28 Profile of Freight Companies

Company	No. of trucks	Truck Size	Transport volume in 2011	Transport Origin
A	50	20 ton	310,876 m^3	Pampilla
B	17	4-8 ton (7) 8-15 ton (10)	63,198 tons + 235,085m^3	Callao
C	40	20 ton	20,000 tons	Puerto
D	97	20 ton	250,000 tons	Almacen
E	45	20 ton	40,000 tons	Almacen

Source: Freight Traffic Survey, 2012

In addition to this survey, information was gathered from the companies at the cordon points, by requesting information with regard to commodities being transported and their weight.

Figure 2.19 shows the distribution of origin and destination of truck movements based on the freight cordon line survey and the freight company interview survey in the study area.



Source: Freight Traffic Survey, 2012

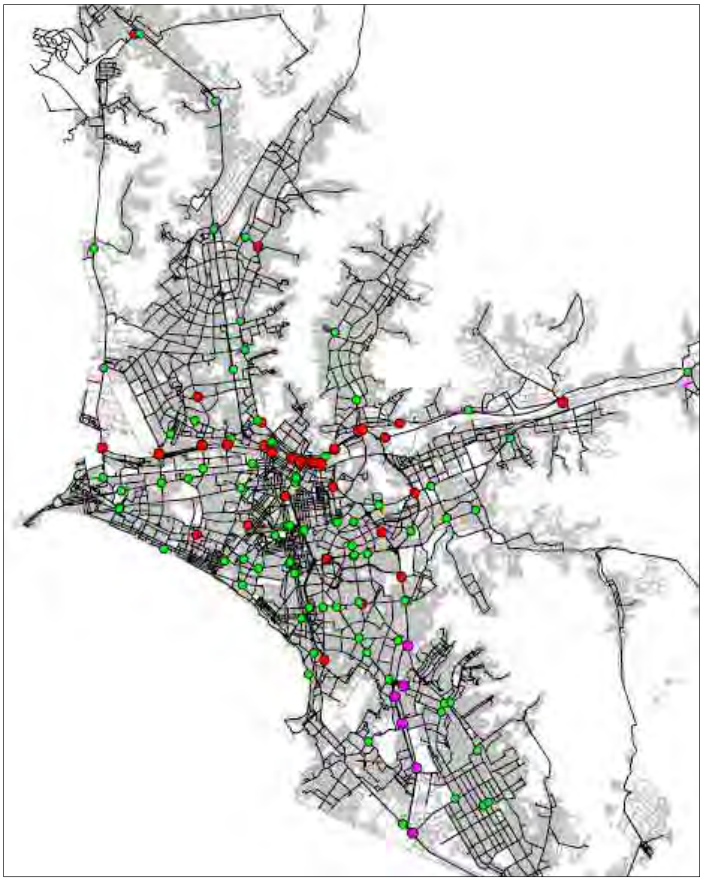
Figure 2.19 Origin and Destination of Trucks in the Study Area

2.8 Traffic Count

Information on traffic volume is used for the calibration of the O-D matrix. In this Study the data was gathered by following ways:

a) Counts on Screen Line and Cordon Line in this Study (May 2012) and
b) Traffic counts on principal roads (from existing studies)

Figure 2.20 shows all the traffic count stations and Table 2.29 summarizes the information from traffic counts.



Source: STCTLC (2009)

Figure 2.20 Traffic Count Stations

Table 2.29 Summary of Traffic Counts

Type of survey	No. of stations of count	Count	
		Traffic counting	Passenger occupancy
Screen line traffic counts	16 stations on bridges along Rimac River	24 hours	14 Hours (7:00 a 21:00)
	8 stations along Panamericana Sur highway	24 hours	14 Hours (7:00 a 21:00)
Cordon line traffic counts	6 stations on principal highways going out Lima	24 hours	
Traffic counts in previous studies	120 stations (Traffic study 2009 – STCTLC)	4 hours (6:00 – 10:00)	
	28 stations (Traffic study 2011 – STCTLC)	12 hours (7:00-11:00; 12:00 -16:00; 17:00 - 21:00)	
	12 stations (Traffic study 2011 – STCTLC)	4 hours (7:00-11:00)	
	52 Stations (Traffic study of Faucett road 2011– AATE)	6 hours (07:00– 10:00; 17:00– 20:00)	
	38 stations (Study of rationalization of Route of Metro Line 1 2011-AATE)	16 hours (06:00-22:00)	
	7 stations (Traffic study of Faucett road 2012– AATE)	6 hours (07:00– 10:00; 17:00– 20:00)	
	28 stations (EMU 2012 – AATE)	16 hours (06:00 – 22:00)	16 hours (06:00 – 22:00)

Source: JICA Study Team

Chapter 3 Person Trip Analysis

3.1 Making OD Matrices

3.1.1 Fitness Analysis

(1) Method

The Person Trip Survey conducted in this Study was a sampling survey with a sampling rate of 0.83%. Although the sampling rate of households was 0.92% as explained in Chapter 2, the sampling rate of the population was 0.83% because there were members who were absent in the interview survey. The JICA Study Team tried to ensure the randomness by the area sampling method. If the sample members were selected randomly, the distribution of gender and age group would fit the population. On the other hand, the population by age group and by gender in 2012 was not available in the Study Area. There was a population projection by age group and that by gender separately. Therefore, the fitness of the samples to the population was assessed from the proportion of gender and that of age group separately.

(2) Gender Proportion

Table 3.1 shows the number of samples by gender and the theoretical numbers calculated from the proportion of the population in 2012. The percentage of the samples is quite similar to that of the population.

Table 3.1 Goodness-of-Fitness (Gender)

Samples		Theoretical Numbers		Chi-Square
Male	Female	Male	Female	
37,144	39,334	37,239	39,239	0.493 < 3.84
48.6%	51.4%	48.7%	51.3%	DF = 1

Note: In the case where the chi-square is greater than 3.84, the two groups are different at 95% confidence.
DF: degree of freedom

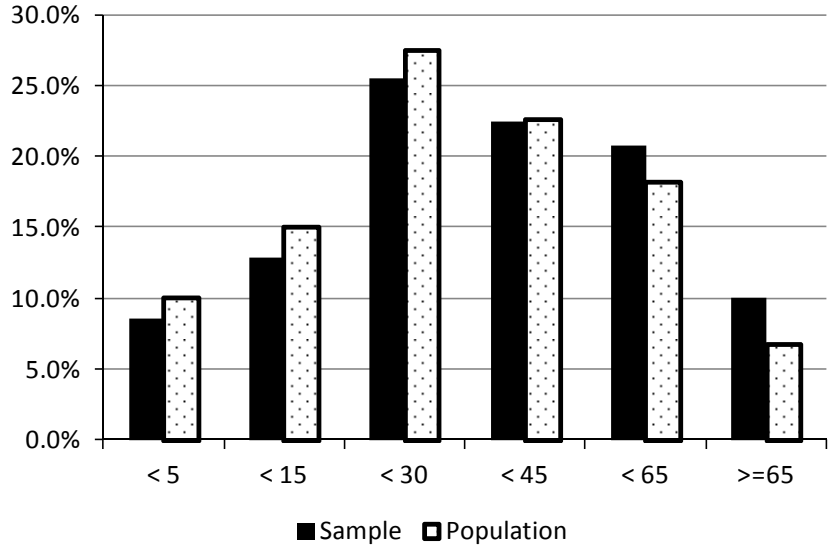
(3) Age Group

Table 3.2 and Figure 3.1 show the distribution of samples by age group and the theoretical numbers calculated from the proportion of the population in 2012. Although the proportion is similar between the two groups, the chi-square test shows that the age distribution is not equal between them.

Table 3.2 Goodness-of-Fitness (Age Group)

Age Group	Samples		Theoretical Numbers		Chi-Square
< 6	6,513	8.5%	7,669	10%	
<15	9,813	12.8%	11,467	15.0%	
< 30	19,510	25.5%	20,985	27.4%	1922 > 11.1
< 45	17,141	22.4%	17,250	22.6%	DF = 5
< 65	15,844	20.7%	13,875	18.1%	
>= 64	7,657	10.0%	5,231	6.8%	

Note: In the case where the chi-square is greater than 3.84, the two groups are different at 95% confidence.
DF: degree of freedom

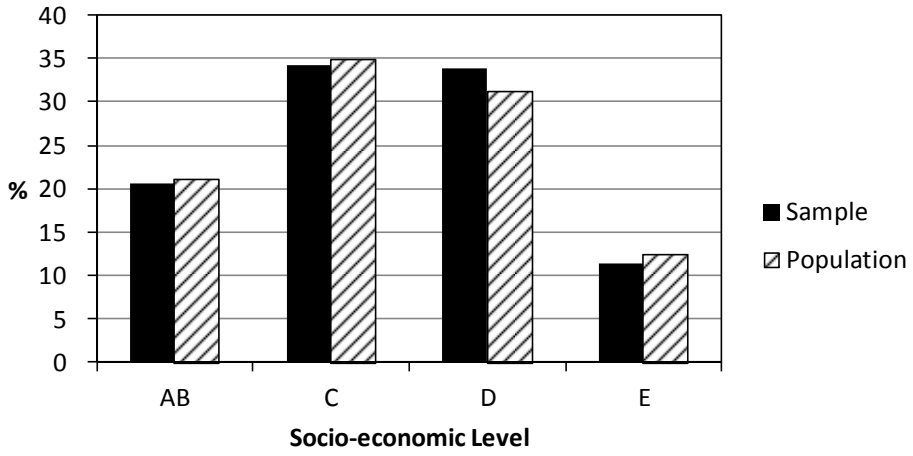


Source: JICA Study Team (Chapter 4 and Person Trip Survey)

Figure 3.1 Proportion of Age Group

(4) Socio-economic Level

Households are categorized into five socio-economic levels (A, B, C, D, and E) as described in Chapter 4 (see Table 4.15), where the population by socio-economic level in 2012 is estimated. Figure 3.2 shows the distribution of members in the Person Trip Survey and that of the estimated population. The chart shows the similar proportions of socio-economic levels. However, the proportion of the level "D" of the samples is higher than that of the estimate while the proportions of other levels are smaller. Since the distribution of the socio-economic level in 2012 is an estimate, it cannot be concluded that the samples do not reflect the real distribution of socio-economic levels.



Source: JICA Study Team (Chapter 4 and Person Trip Survey)

Figure 3.2 Proportion of Samples and Population by Socio-Economic Level

(5) Students

The proportion of the number of students in the samples is almost equal to that of the estimated number in Chapter 4. Primary/secondary school students account for 16.6% and 16.4% in the samples and the estimate, respectively. Superior/occupational school students account for 6.70% and 6.55% in the samples and the estimate, respectively. In the home interview, some interviewees did not give the school name and location, which implies that some children do not go to school. In the samples, primary and secondary school students going to school account for 14.1%. Superior and occupational school students going to school account for 5.57%. These percentages are smaller than those of estimated in Chapter 4.

(6) Fitness to Other Socio-economic Group

The census in 2007 includes a number of categories of population. However, official estimates in the detailed information on the population are not available. Although the JICA Study Team estimated several indicators such as the number of employees, the fitness of the samples for these numbers was not assessed because they were projected numbers and some indicators were estimated from the results of the Person Trip Survey.

3.1.2 Estimation of Expansion Factors

An expansion factor is calculated as the reciprocal of the sampling rate, which is the ratio of the number of samples to the population. Since the samples do not fit the population in terms of age distribution, the expansion factors were calculated by age group by district. Although sampling rates differ by traffic zone, the expansion factor was not calculated by traffic zone because the sample size by traffic zone was very small. Some districts with a small number of samples were integrated, and the same expansion factors were applied. Table 3.3 shows the list of districts that were integrated in calculating the expansion factor.

Table 3.3 List of Integrated Districts for Expansion Factors

No.	Integrated District
1	Bellavista, Carmen de la Legua Reynoso, La Perla, La Punta
2	Lima, Brena
3	Ancon, Santa Rosa
4	Barranco, Miraflores
5	Chaclacayo, Cieneguilla
6	Jesus Maria, Lince
7	Magdalena del Mar, Magdalena del Vieja
8	Pucusana, Punta Hermosa, Punta Negra, San Bartolo, Santa Maria del Mar

Source: JICA Study Team

Table 3.4 shows the estimated expansion factors by district by age group. Although the number of persons should be an integral number, the real number is used for the expansion factors because the difference of the number of persons estimated by the expansion factors with the actual number of persons becomes large if integral numbers are used for the expansion factors.

Table 3.4 Expansion Factors

District	< 6	< 15	< 30	< 45	< 65	>=65
1	218.321	200.379	205.923	218.360	167.964	128.261
2	371.351	318.403	335.483	307.859	231.931	138.039
3	371.351	318.403	335.483	307.859	231.931	138.039
4	371.351	318.403	335.483	307.859	231.931	138.039
5	371.351	318.403	335.483	307.859	231.931	138.039
6	212.029	213.136	261.496	244.775	240.112	150.261
7	148.251	156.818	144.024	130.583	119.951	102.555
8	91.094	106.808	88.963	111.127	81.896	62.854
9	121.678	131.519	113.400	113.767	92.697	81.770
10	163.530	186.596	108.828	101.419	91.585	95.142
11	148.251	156.818	144.024	130.583	119.951	102.555
12	155.326	131.076	133.416	118.314	104.312	84.372
13	163.176	123.440	124.152	121.829	87.982	119.353
14	133.411	140.882	123.455	121.581	116.152	89.886
15	163.176	123.440	124.152	121.829	87.982	119.353
16	152.629	144.900	128.494	122.326	102.300	75.311
17	147.108	130.912	129.149	125.915	109.625	99.769
18	141.875	164.469	134.203	116.832	102.917	72.194
19	214.354	124.985	126.496	130.388	111.729	96.455
20	260.053	171.689	145.176	131.888	112.952	96.168
21	172.674	141.593	139.997	127.725	103.633	72.881
22	214.354	124.985	126.496	130.388	111.729	96.455
23	151.153	156.239	139.629	132.661	107.006	63.648
24	113.775	111.157	112.569	97.478	106.342	79.669
25	78.776	96.537	106.762	85.312	84.008	76.708
26	147.437	229.303	159.042	139.127	123.699	127.424
27	147.437	229.303	159.042	139.127	123.699	127.424
28	163.530	186.596	108.828	101.419	91.585	95.142
29	94.082	144.160	115.690	110.127	92.086	130.500
30	68.340	89.443	59.030	59.243	54.518	44.067
31	129.830	124.839	119.550	106.833	94.709	90.543
32	68.340	89.443	59.030	59.243	54.518	44.067
33	68.340	89.443	59.030	59.243	54.518	44.067
34	164.194	135.787	115.742	103.777	99.386	77.919
35	68.340	89.443	59.030	59.243	54.518	44.067
36	233.226	143.263	177.731	143.243	124.553	76.485
37	67.547	139.297	66.856	63.887	61.817	53.689
38	134.497	128.128	131.009	114.993	104.193	74.795
39	179.785	148.818	125.237	115.257	93.493	78.587
40	161.613	144.340	190.926	121.549	120.885	98.618
41	149.260	144.364	116.043	128.754	107.430	75.246
42	163.652	202.884	134.921	123.528	118.696	97.176
43	176.624	133.620	148.962	117.630	95.269	72.223
44	68.340	89.443	59.030	59.243	54.518	44.067
45	91.094	106.808	88.963	111.127	81.896	62.854
46	210.062	225.459	161.450	150.805	110.857	92.444
47	220.291	178.740	144.877	133.215	104.237	106.156
48	117.816	120.262	115.193	103.197	101.191	72.040
49	116.262	136.334	126.796	119.013	105.410	66.269

Source: JICA Study Team

3.1.3 Making Cordon Line OD

(1) Highway Cordon

Trips by residents in Lima were captured in the Person Trip Survey while those of visitors were not recorded. The Cordon Line Survey was conducted to estimate the number of visitors' trips. Table 3.5 shows the estimate of the number of trips crossing the Cordon Line. CL-5 is excluded because most trips at CL-5 were local trips as mentioned in Chapter 2. The number of visitors' trips was 77,500, accounting for 43% of the total trips.

Table 3.5 Number of Trips (persons) Crossing Cordon Line

CL	Residents		Visitors		Total		
	Car/Taxi	Buses	Car/Taxi	Buses	Car/Taxi	Buses	Total
1	0	44,479	0	42,170	0	86,649	86,649
2	4,126	14,529	1,946	10,803	6,072	25,332	31,404
3	2,742	1,478	1,066	322	3,808	1,800	5,608
4	3,302	5,973	1,325	5,089	4,627	11,062	15,689
6	8,224	18,643	1,954	12,794	10,178	31,437	41,615
Total	18,393	85,102	6,291	71,178	24,685	156,280	180,965

Source: JICA Study Team (Cordon Line Survey)

In the home interview survey, the number of trip samples that crossed the boundary of the Study Area (Cordon Line) was as small as 19 trips by 10 persons. The number of trips crossing the Cordon Line was estimated at 2,200 using the expansion factors (see 1.3).

(2) Airport Cordon

The OD matrix of visitors using the airport was estimated from the Airport Cordon Line Survey. The number of passengers at Jorge Chávez International Airport was 11.79 million in 2011 as shown in Table 3.6. Since transit passengers stay in the airport, the number of passengers from or to the airport is 10.68 million per year. The daily volume was estimated at 29,254 passengers. Since the percentage of visitors was estimated at 45.7% from the Airport Cordon Line Survey, the number of visitors from or to the airport was estimated at 13,359 passengers per day. The number of samples of the survey was 3,540 in total, and the sampling rate was estimated at 12.1%.

Table 3.6 Numbers of Passengers of Jorge Chávez International Airport (2011)

	International	Domestic	Total
(1) Arrival	2,399,695	2,931,026	5,330,721
(2) Departure	2,353,103	2,993,829	5,346,932
(1)+(2)	4,752,798	5,924,855	10,677,653
(3)Transit	1,117,165	-	1,117,165
Total	5,869,963	5,924,855	11,794,818

Source: http://www.lap.com.pe (Lima Airport Partner)

In the home interview survey, there were no trip samples that went to or came from the airport for the flights while trips of other purposes to the airport were collected. This is because the interview was conducted for the household members who can answer about their trips in the day before the interview day. Therefore, the estimated airport OD, including both residents and visitors, was added to the OD of the home interview survey.

3.1.4 Calibration

(1) Calibration by Passenger Boarding of Metro-1

The home interview survey was conducted in June and July, 2012, and trip data of weekdays (Monday – Friday) of the period were collected. The number passenger trips that used Metro-1 was calculated as 56,000 in the Person Trip Survey while the number passengers boarding of Metro-1 was recorded as 75,000 according to AATE. This means that the actual number of the passengers was 29% higher than the estimate. The difference is similar to that of the public transport passengers crossing Rimac River.

(2) Calibration by Screen Line Data

The expansion factor of a trip record was taken from the expansion factor of the person who made the trip. The total number of trips was estimated at 15.9 million by totaling the expansion factors. However, this is smaller than that of the study of PMTU 2025 in which the number of total person trips in 2004 was estimated at 16.5 million. The study of PMTU 2025 adjusted the person trip from the home interview survey by comparing the traffic volume crossing the Rimac River. It is necessary to adjust the number of trips which is estimated by a person trip survey because the questionnaire of trip information is so complicated that people do not necessarily provide interviewers with all trips they made. In addition, the randomness of sampling is not necessarily ensured in the city where the full list of households is not available. The expansion factors of the Study were calibrated from the result of the Screen Line Survey as applied in the study of PMTU 2025.

The number of trips crossing the Rimac River was estimated from the Screen Line Survey and the Person Trip Survey as shown in Table 3.7. The numbers of passengers of Combi, Minibus, and Bus between the two surveys are very similar while the difference of motorcycle and taxi is very large. Since delivery is the major usage of motorcycle in Lima, it is difficult to collect such trips by home interviews in the person trip survey. Note that passengers of some public transport modes such as mototaxi and colectivo transfer to other modes such as bus, Metropolitano, and Metro.

Table 3.7 Comparison of Numbers of Trips Crossing Rimac River

Vehicle Type	Screen Line (S) (1,000)	Person Trip (P) (1,000)	Difference (S)/(P)
Motorcycle	24.5	4.7	5.2
Mototaxi	11.1	9.3	1.2
Car/ Private vehicle	382.8	131.6	2.9
Taxi/ Colectivo	478.5	106.2	5.3
Combi	540,0	405.4	1.3
Minibus/ Bus	1,673.2	1,296.2	1.2
Private modes	407.4	150.2	2.8
Public modes	2,702.8	2,062.8	1.3

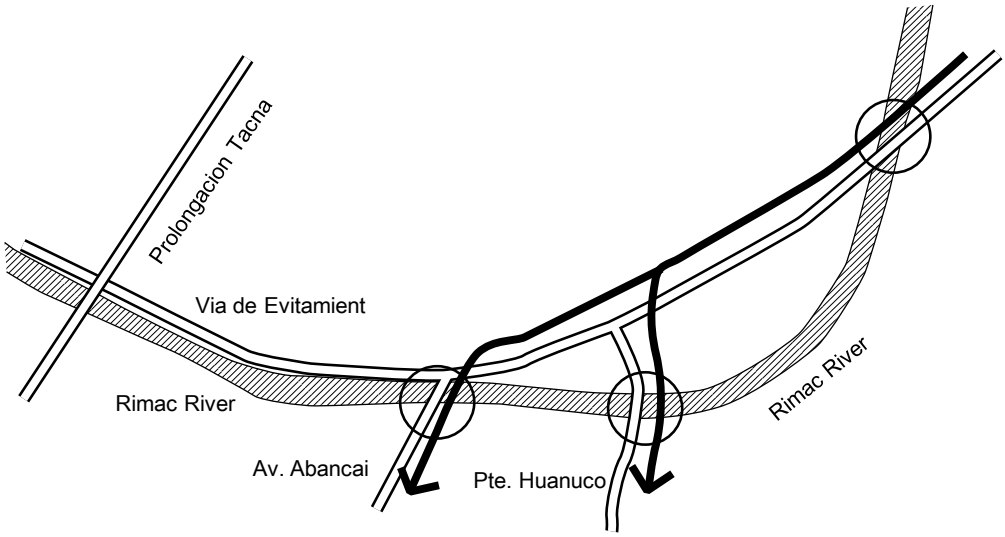
Source: JICA Study Team (Person Trip Survey and Screen Line Survey)

Table 3.7 needs adjustment.

The traffic count along the screen line includes double counting of the same vehicles. For example, some vehicles using Via de Evitamiento, which is used as the bypass route to access the center of the city from the south area to avoid the congestion, cross Rimac River twice as shown in Figure 3.3. Since this kind of traffic is included in the results of the

screen line survey, it is necessary to remove such double counting from Table 3.7. To estimate the percentage of the double counts at each survey point, trail traffic assignments have been carried out.

In addition, cordon line traffic should be added to the estimated trip of the person trip survey because non-residents trips are excluded from the person trip survey.



Source: JICA Study Team

Figure 3.3 Screen Line Crossing

After the traffic assignment simulation, the following adjustment was applied for the expansion factors: 1.0 for mototaxi; 1.91 for taxi and car; and 1.44 for combi, minibus, and bus. In order to compare the survey results to the study in PMTU 2025, the expansion factors are applied to the trip rate calculation as the previous study did.

In the study of PMTU 2025, the adjustment factors are: 1.98 for motorcycle, 0.39 for mototaxi, 2.21 for car, 2.39 for taxi, 1.39 for combi, 1.03 for minibus, and 2.63 for bus. The major trips of mototaxi are found in the east of Rimac River where traffic count on the crossing bridges was not conducted. This might explain the low adjustment factor of mototaxi in PMTU 2025 because the previous study did not consider this.

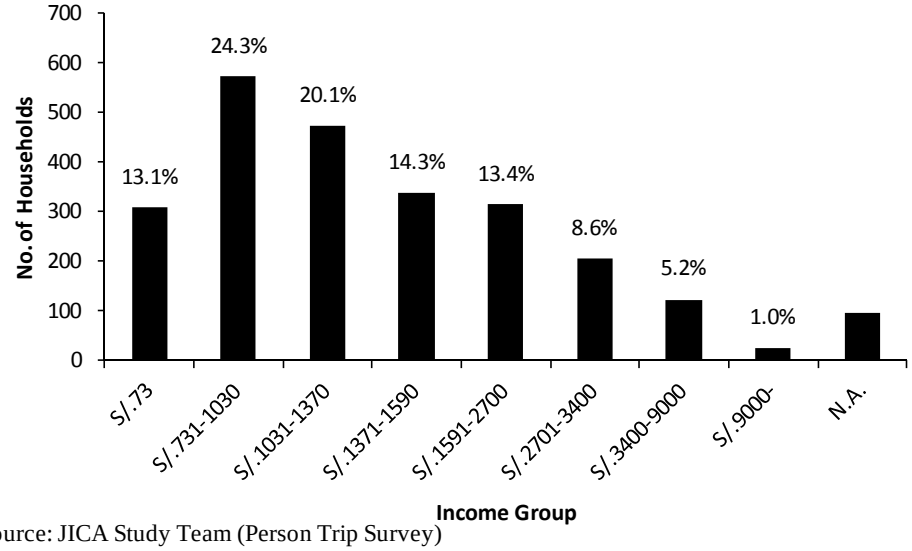
The number of passengers of Metropolitano which cross Rimac River, which was not counted in the Screen Line Survey, was also adjusted by applying the same rate as bus, minibus, and combi. For the passenger traffic of Metro-1, 1.29 was applied. The same rate of 1.29 was applied to walk, bicycle, and motorcycle.

The expansion factors were further calibrated because the difference between the screen line traffic and the result of the person trip survey is small in the morning peak hour. Since the demand forecast of this study focuses on the peak hour traffic, the screen line adjustment does not affect the result so much.

3.2 Trip Characteristics

3.2.1 Socio-economic Characteristics

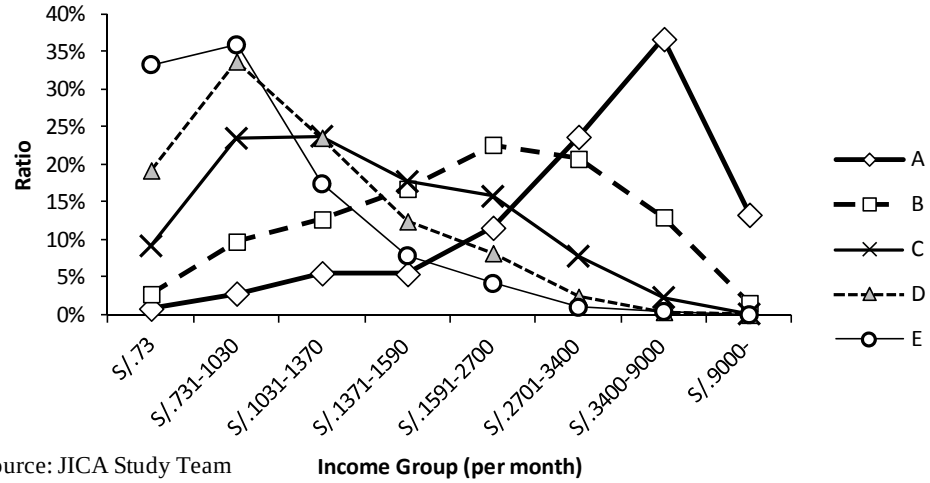
Figure 3.4 shows the number of households and the ratio by income group. "No response" households are excluded from the ratio calculation. The most common income group is S/.731 – 1,030 per month, accounting for 24.3% of the households. The households with the income of less than S/.2700 per month account for 85%.



Source: JICA Study Team (Person Trip Survey)

Figure 3.4 Income Distribution

Figure 3.5 shows the relation between the income group and the socio-economic level (Estrato). The income distributions of Estrato D and E are similar except for the income level of less than S/.730 per month. Estrato C also shows the similar curve. The income distributions of Estrato A and B are quite different from others.



Source: JICA Study Team (Person Trip Survey)

Figure 3.5 Income Group and Estrato

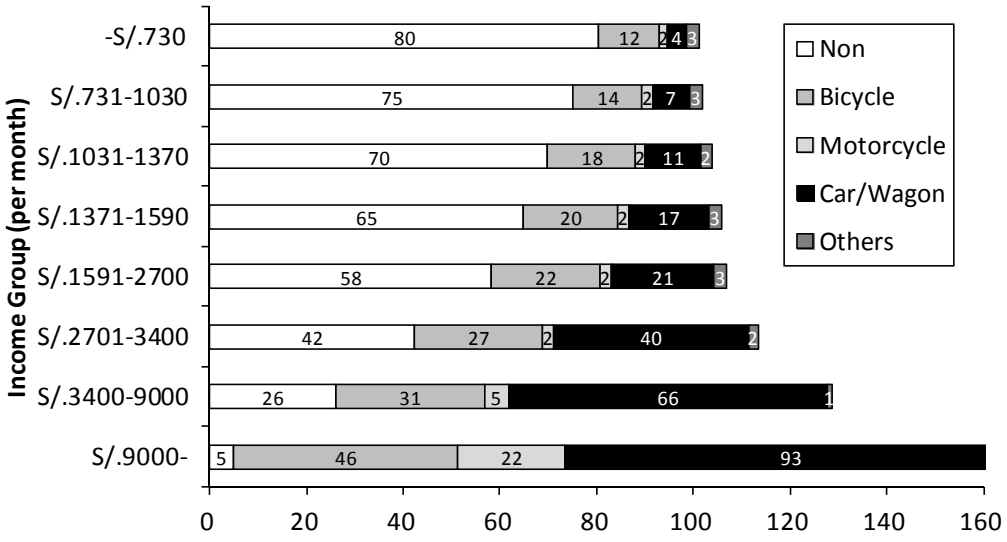
Table 3.8 shows the vehicle ownership in the Study Area. The number of private cars owned by households was estimated at 500,000, and the number of households having one or more cars was estimated at 416,000. The ratio of the car ownership was calculated at 204 vehicles per 1,000 households and 52.9 vehicles per 1,000 persons. The number of motorcycles was as small as 69,000 compared to that of private cars and bicycles.

Table 3.8 Vehicle Ownership

	Bicycle	Motorcycle	Private Car	Combi/ Minibus	Others
No. of vehicles owned by households (1,000)	591	69	500	43	60
No. of households without the vehicle (1,000)	1,993	2,384	2,031	2,409	2,394
No. of households having one or more vehicle (1,000)	455	63	416	38	53
No. of households having one vehicle (1,000)	349	58	348	35	48
No. of households having 2 or more vehicles (1,000)	106	5	68	3	6
Ratio of households having one or more vehicle	19%	3%	17%	2%	2%
No. of vehicles per 1,000 households	242	28	204	18	24

Source: JICA Study Team (Person Trip Survey)

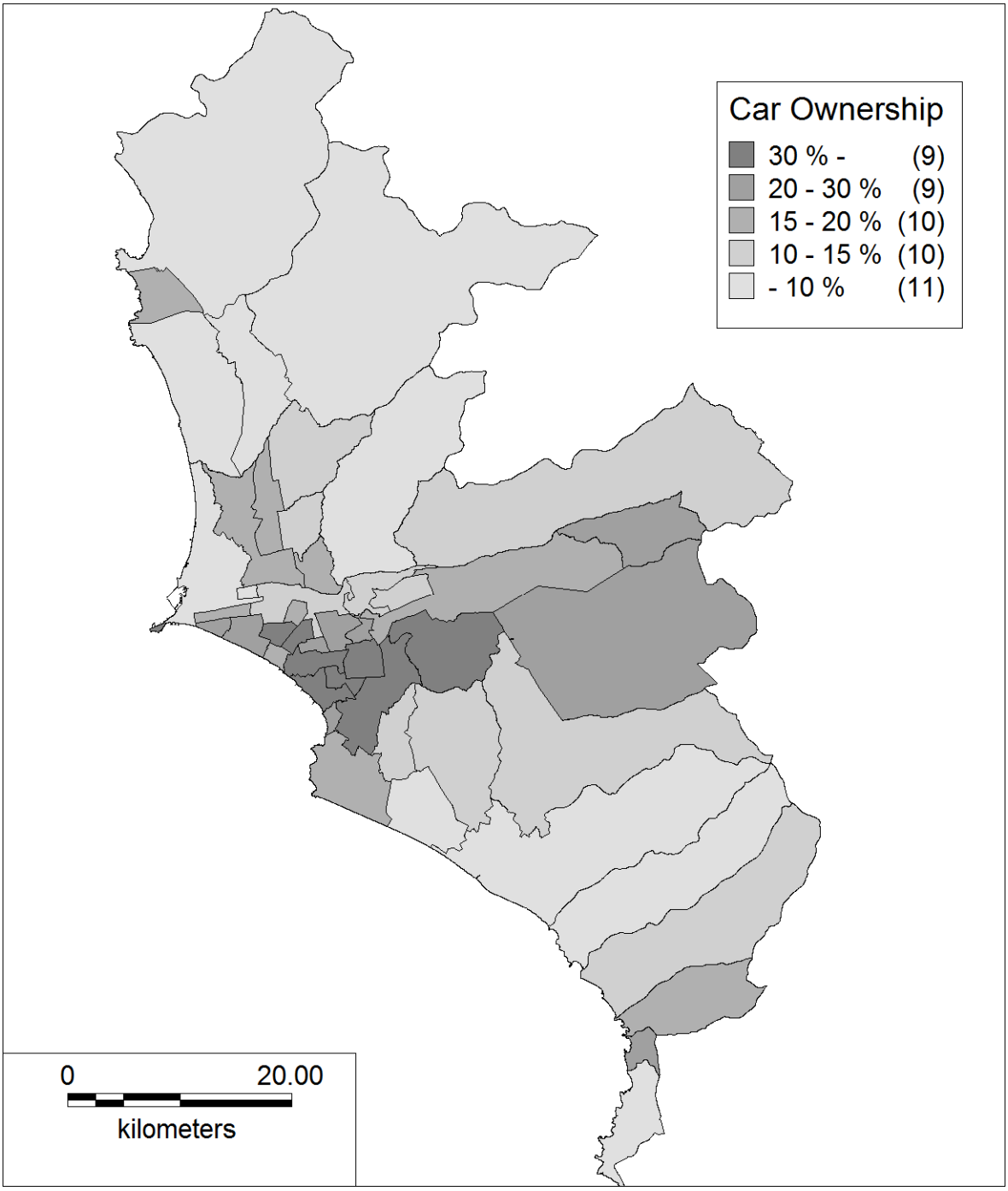
Figure 3.6 illustrates the ratio of vehicle ownership by income group. Since some households own more than two types of vehicles (for example, motorcycle and car), the total of the percentage exceeds 100. The bar chart shows that vehicle ownership is related to the income level. Car ownership of the households with the monthly income of more than S/. 9000 is as high as 93%.



Source: JICA Study Team (Person Trip Survey)

Figure 3.6 Vehicle Ownership by Income Group

Figure 3.7 shows the percentage of households owning cars by district. In the central area, more than 30% of households own one or more cars while the number of households owning cars in the suburban area is less than 10%.

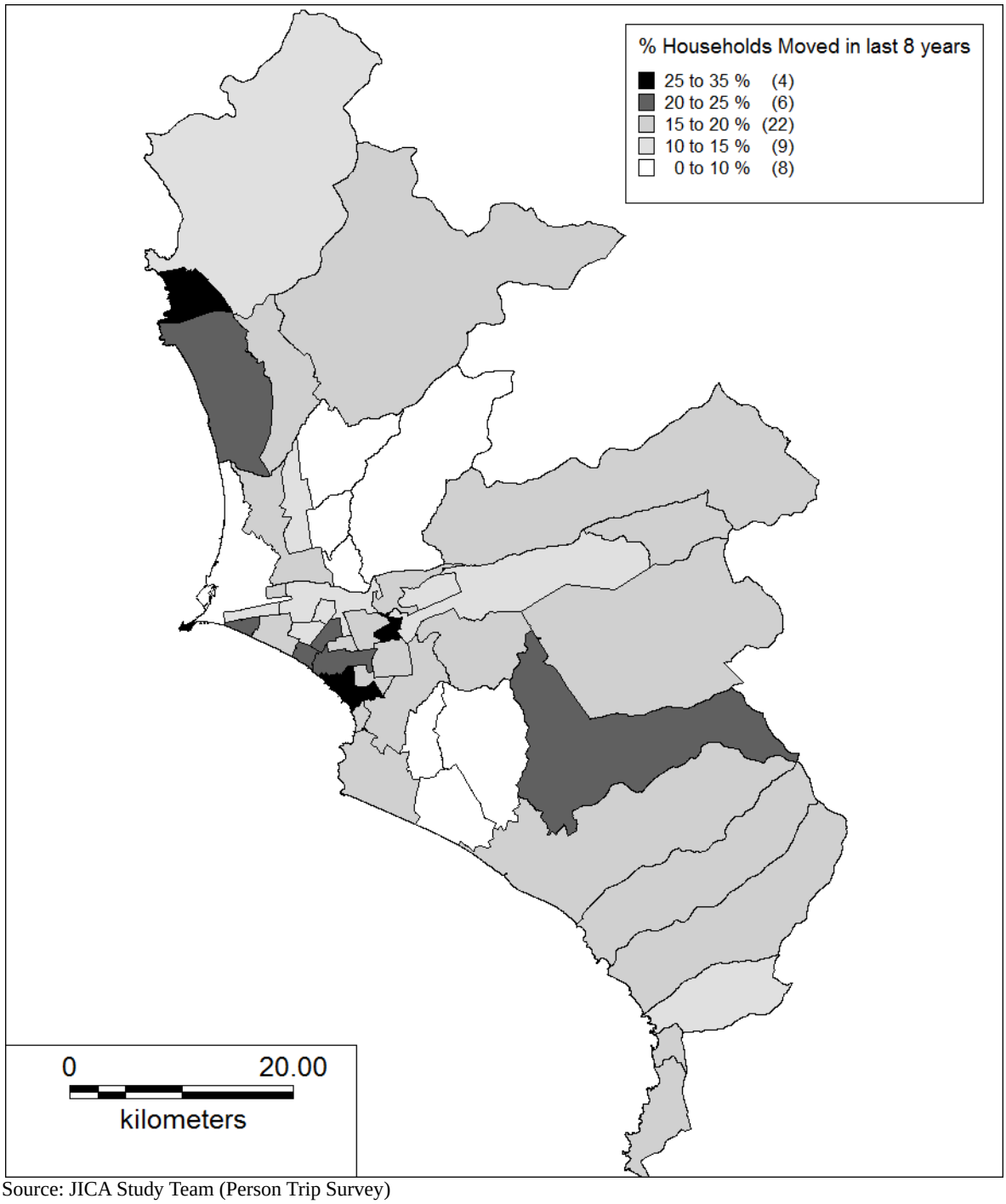


Source: JICA Study Team (Person Trip Survey)

Figure 3.7 Car Ownership (% Households Owning Car)

Figure 3.8 illustrates the ranges of percentages of new residents by district in the last 8 years. This shows that migration in the Study Area has been active after the study of PMTU 2025. In the central area, Miraflores attracts new residents followed by San Isidro, Magdalena del Mar, and Jesus Maria. San Luis also attracts new residents. In the suburban area, Santa

Road and Ventanilla attract new residents. On the other hand, the percentage of new residents is relatively small in San Juan de Lurigancho and Villa Maria del Triunfo. Note that this is the percentage of new residents to the total population. Even if the percentage is low, suburban areas attract new residents.



Source: JICA Study Team (Person Trip Survey)

Figure 3.8 % New Residents in Last 8 Years

3.2.2 Trip Rate

(1) Overall Trip Rate

The number of trips after calibration was estimated at 22.3 million in the Study Area, of which 16.9 million trips are produced by vehicles as shown in Table 3.9. The trip rate of the Study Area is 2.4 trips per day per person while that of the central area and other area are 2.7 and 2.3, respectively.

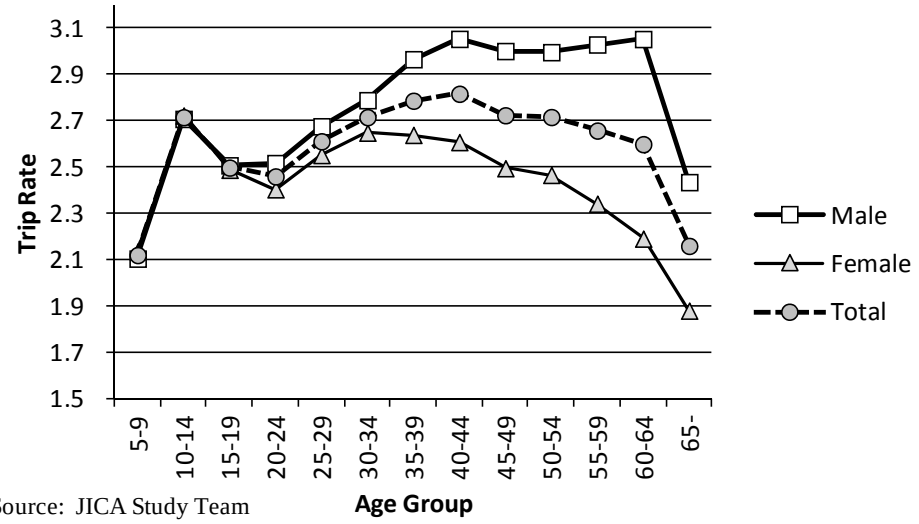
Table 3.9 Number of Trips and Trip Rate of the Study Area

	Central	Other Area	Study Area Total
Population (1,000)	1,873	7,578	9,451
No. of Trips (1,000)	5,012	17,296	22,308
Trip Rate (per day)	2.7	2.3	2.4
No. of Trips excluding Walk Trips	4,091	12,787	16,878
Trip Rate	2.2	1.7	1.8

Source: JICA Study Team

(2) Trip Rate by Age by Gender

Figure 3.9 shows the trip rates by age group and by gender. The trip rate of males from 40 to 64 years of age is high while that of females decreases as they become older. The trip rate of young group (15-29) is low compared to other age groups.

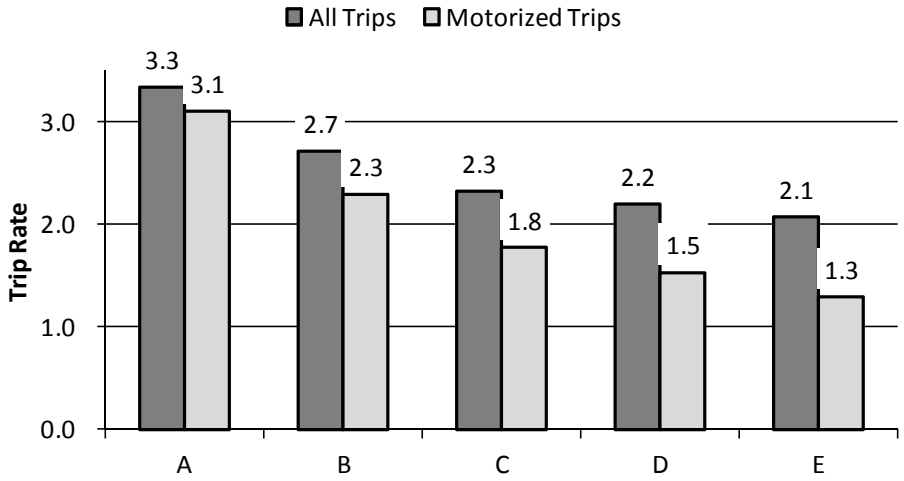


Source: JICA Study Team
(Person Trip Survey)

Figure 3.9 Trip Rate by Age Group (After Calibration)

(3) Trip Rate by Estrato

The traffic demand is related to the income level. The higher the income level, the higher is the traffic demand. Figure 3.10 shows the trip rate by Estrato (socio-economic level). Trip rates of Estrato A and B are quite different from other groups. The difference of motorized trips is larger than that of the total trips because the share of walking trips is larger in the lower income group. This implies that it is necessary to consider the economic growth for the future traffic demand in addition to population increase.

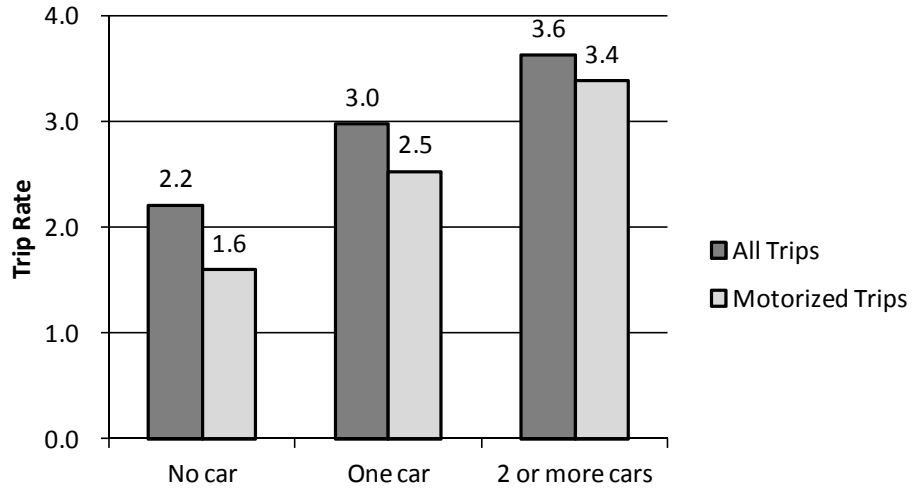


Source: JICA Study Team
(Person Trip Survey)

Figure 3.10 Trip Rate by Estrato (After Calibration)

(4) Trip Rate by Car Ownership

Figure 3.11 shows the trip rate by car ownership. In this chart, "Car ownership status" means that the number of cars owned by a household. The trip rate is low when the household does not own a car while it is high if the household has a car. The members of households having 2 or more cars make more trips than other household members.



Source: JICA Study Team
(Person Trip Survey)

Figure 3.11 Trip Rate by Car Ownership (After Calibration)

3.2.3 Trip Share

(1) Priority Mode

A trip in the Person Trip Surveys consists of more than one mode if the trip involves one or more transfers between transport modes. The trip from an origin to a destination for a certain purpose is called "linked trip" while the movement by a transport mode that is a part of the trip is called "unlinked trip". The transport mode of an unlinked trip is clear while it

is necessary to identify a mode that represents the mode of a linked trip. The representative mode of a linked trip was selected by applying the same method as used in the study of PMTU 2025. In this method, transport modes are prioritized as shown Table 3.10, and the mode of the highest priority is selected as the representative mode of the trip.

Table 3.10 Priority to Identify the Representative Mode

No.	Transport Mode in Person Trip Survey	Priority (1=lowest, 17= highest)
1	Walk	1
2	Bicycle	7
3	Motorcycle	8
4	Mototaxi	9
5	Car	10
6	Taxi	11
7	Colectivo	12
8	Combi	13
9	Minibus	14
10	Bus	15
11	BRT	16
12	Small truck	4
13	Truck	5
14	Trailer	6
15	Train	17
16	Other Private Vehicles	3
17	Others	2

Source: JICA Study Team

(2) Modal Share

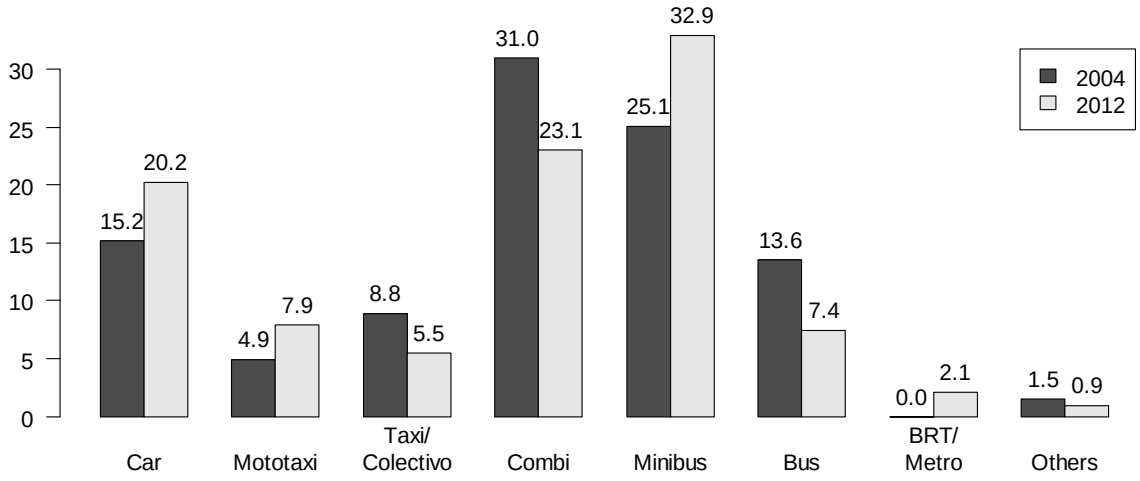
The modal share in the Study Area was calculated based on the primary mode as shown in Table 3.11. The modal share in 2012 is similar to that of 2004. Walk trip accounts for 24%, private mode accounts for 16%, para transit mode accounts for 9%, and public transport mode accounts for 51% of the total modes.

Table 3.11 Modal Share of All Modes

	2012		2004	
Mode	No. of Trips (000)	Modal Share	No. of Trips (000)	Modal Share
Walk	5,416	24.3%	4,208	25.4%
Bicycle	77	0.3%	84	0.5%
Motorcycle	107	0.5%	30	0.2%
Private car	3,401	15.2%	1,856	11.2%
Mototaxi	1,325	5.9%	600	3.6%
Taxi	591	2.6%	902	5.5%
Colectivo	333	1.5%	181	1.1%
Combi	3,880	17.4%	3,791	22.9%
Minibus	5,536	24.8%	3,072	18.6%
Bus	1,248	5.6%	1,661	10.0%
BRT	274	1.2%	0	0.0%
Train	74	0.3%	0	0.0%
Truck&Others	44	0.2%	152	0.9%
Total	22,308	100.0%	16,537	100.0%

Source: JICA Study Team (Person Trip Survey)

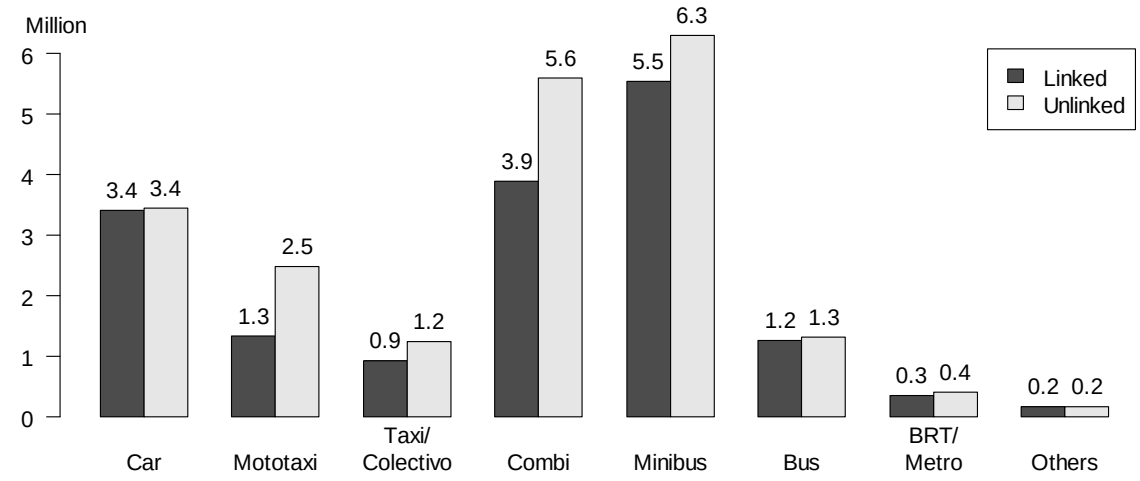
Figure 3.12 shows a comparison of the shares of motorized transport between 2004 and 2012 Person Trip Surveys. Although the impact of the development of Metropolitano and Metro is large, its share in the total transport system is still as small as 3%.



Source: JICA Study Team (Person Trip Survey)

Figure 3.12 Comparison of Modal Share (Motorized Transport)

The above chart shows the modal share based on the primary mode. This means that even if a feeder mode such as mototaxi is used for a trip, it is not counted because such trips are included in the primary mode such as bus and Metropolitano instead of feeder modes. The number of passengers by mode including feeder modes is shown in Figure 3.13 as "unlinked" trips. The bars of "Linked" trips mean the number of trips of each mode when the mode is the primary mode of the trip. As shown in the chart, the use of mototaxi as the primary mode is approximately half of the total usage. A half of mototaxi passengers use the mode as a feeder transport. Combi is also used as feeder transport system. Since a car is rarely used as a feeder transport system, the numbers of passengers of linked trip and unlinked trip are almost the same. Since the transfer from Metropolitano to Metropolitano was observed in the Person Trip Survey, the number of unlinked trips of BRT/Metro is larger than that of linked trips.



Source: JICA Study Team (Person Trip Survey)

Figure 3.13 Number of Passengers of Linked and Unlinked Trips

(3) Trip Purpose

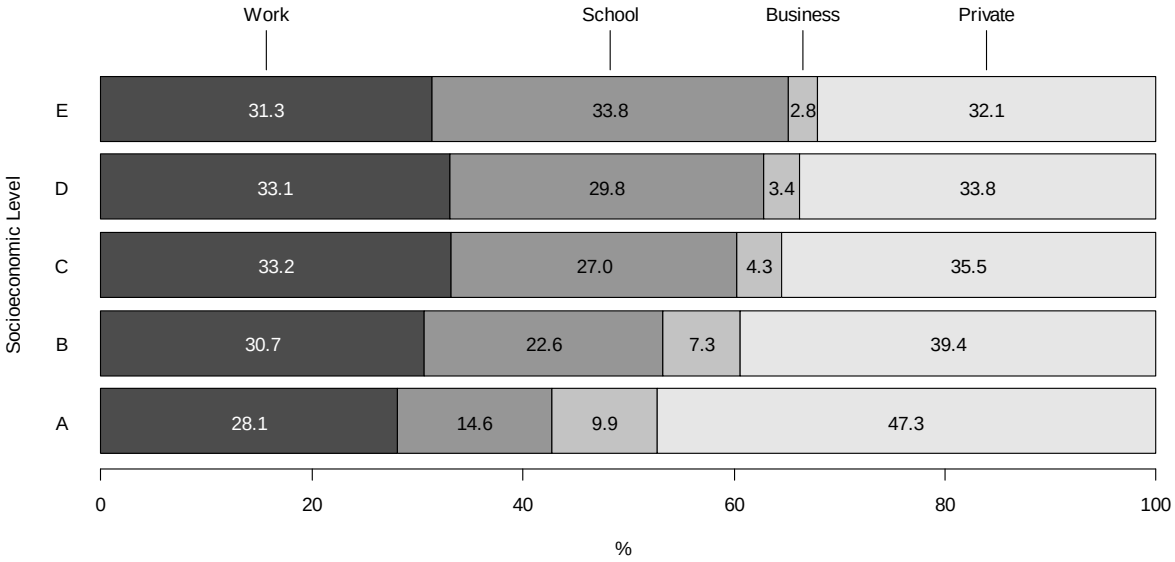
Table 3.12 shows the composition of trips by purpose. Commuter trips ("To Work", "To School", and their returning home trips) are the major trips in the Study Area. "To Work" and "To School" trips account for 16.7% and 14.0% of all mode trips, respectively. The proportions of these trips are slightly larger than those in 2004 (16.2 and 13.9%). Private trips and Business trips account for 19.5% and 2.5%, respectively. These percentages are lower than those in 2004 (3.1%). If walk trips are excluded, the proportion of "To School" trips drops to 11.0%.

Table 3.12 Trip Purpose

Purpose	All Modes			Excluding Walk Trips		
	No. of Trips (1,000)	%	Excluding "To Home"	No. of Trips (1,000)	%	Excluding "To Home"
To Work	3,733	16.7	32.2	3,052	18.1	33.8
To School	3,122	14.0	26.9	1,861	11.0	20.6
Business	557	2.5	4.8	538	3.2	6.0
Private	4,191	19.5	36.1	3,579	21.2	39.6
To Home	10,549	47.3	-	7,849	46.5	-

Source: JICA Study Team (Person Trip Survey)

The composition of the trip purpose varies according to the socio-economic levels as shown in Figure 3.14. As the level becomes higher, the percentages of private and business trips become larger while the percentage of the school trip becomes smaller. This bar chart shows that the difference of trip characteristics among Estrato C, D, and E is small.



Source: JICA Study Team (Person Trip Survey)

Figure 3.14 Trip Purpose by Socio-economic Level (Estrato)

(4) Modal Share and Purpose

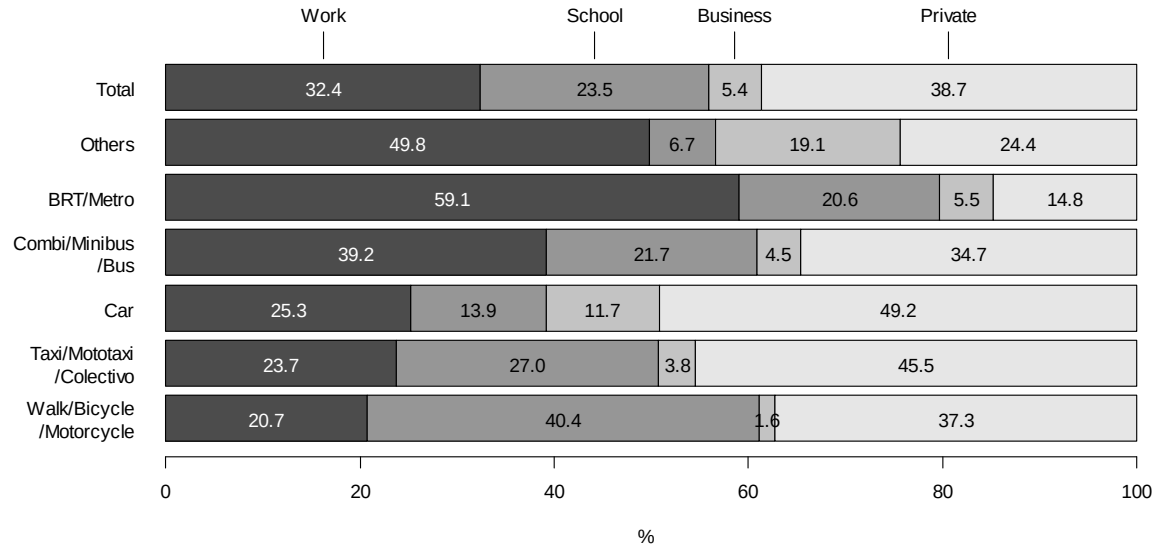
Table 3.13 shows the cross table analysis of the number of trips between the travel mode and the purpose. From this table, the composition of purposes by mode is illustrated in Figure 3.6 while the modal share by purpose is illustrated in Figure 3.7. "To home" trips are excluded from Figure 3.6. As can be seen, Metropolitano and Metro are mainly used for the commuter purpose, accounting for 80% of the trips. The high ratio of commuter trips of

these modes means that reliable, high speed, on-schedule, and reasonable services are very important for the urban transport system. Private purpose trips account for approximately 50% of car trips.

Table 3.13 Number of Trips by Mode by Purpose (1,000)

	To Work	To School	Business	Private	To Home	Total
Walk/Bicycle/Motorcycle	279	545	22	503	1,313	2,661
Taxi/Mototaxi/Colectivo	260	296	42	499	941	2,037
Car	449	246	208	873	1,381	3,157
Combi/Minibus/Bus	1,984	1,097	228	1,757	4,634	9,700
Metropolitano/ Metro	83	29	8	21	122	262
Others	5	1	2	2	6	16

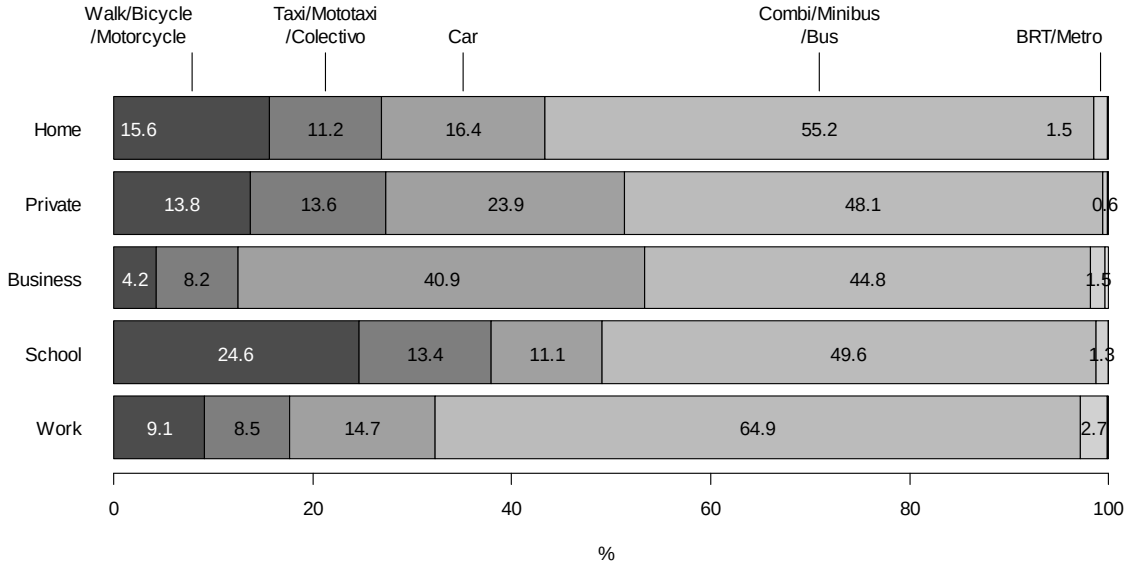
Source: JICA Study Team (Person Trip Survey)



Source: JICA Study Team (Person Trip Survey)

Figure 3.15 Trip Purpose by Travel Mode

Public transport modes (combi, minibus, and buses) are the major modes for all purposes. The ratio of the modes is highest for "To Work" trips, accounting for 65%, followed by "To School" trips with a share of 50%. The ratio of car trips is as high as 41% for business trips, followed by private trips with a share of 24%. Note that the share is calculated based on the primary mode. Para transit modes (taxi, mototaxi, and colectivo) are used for the feeder modes of the public transport modes.



Source: JICA Study Team (Person Trip Survey)

Figure 3.16 Trip Purpose by Travel Mode

3.2.4 Trip Generation and Attraction

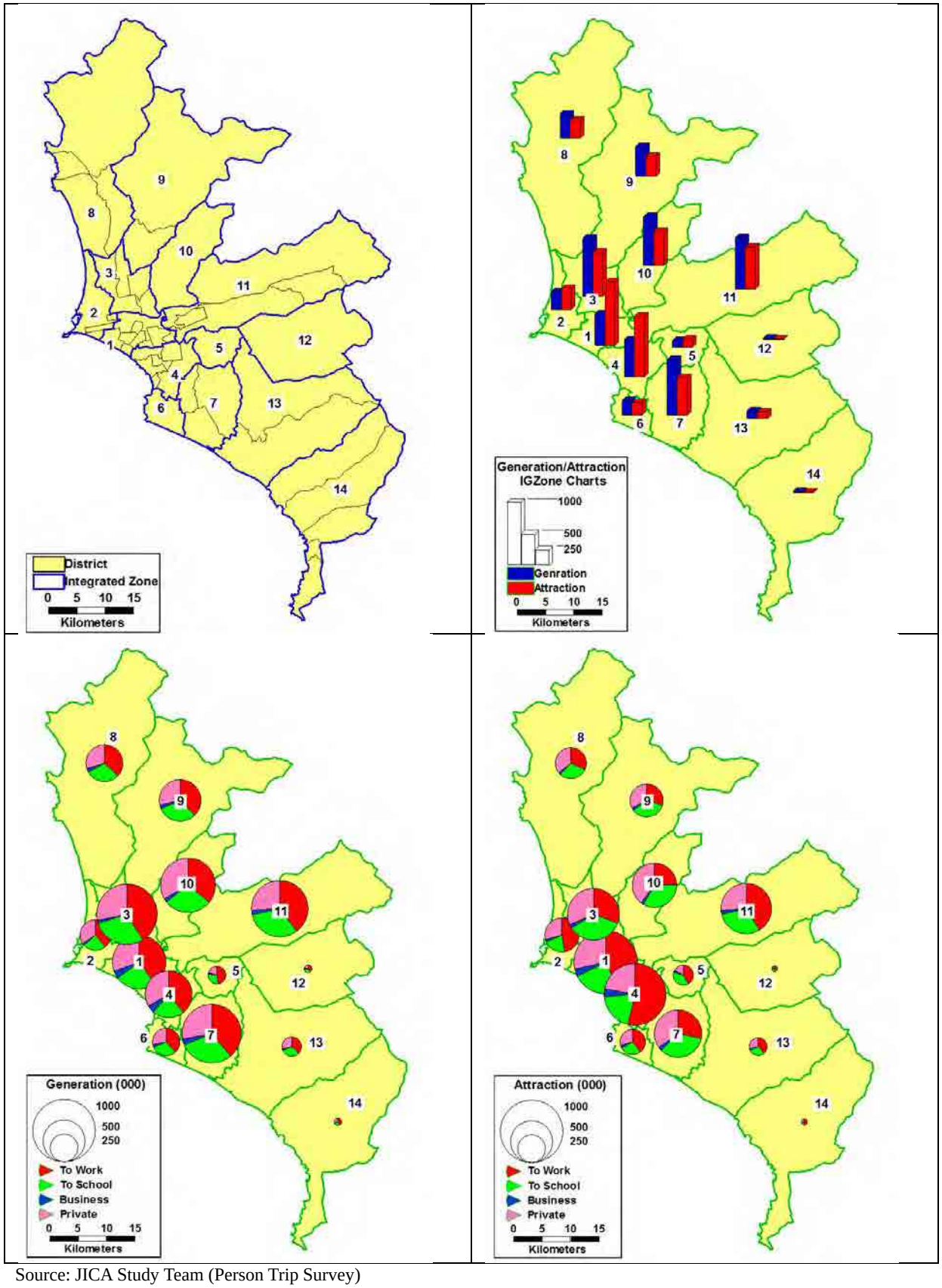
(1) Trip Generation and Attraction by Area

The trip generation is the demand of trips based on the departure place while the trip attraction is that of arrival place. They are calculated based on Traffic Analysis Zone (TAZ), District, Integrated Zone, and the Study Area. The Study of PMTU 2025 used 14 integrated zones to present the results of the analysis instead of using 49 districts. To compare the results with the previous study in 2004, the results of this Study are presented based on the 14 integrated zones. The top-left map in Figure 3.17 illustrates the boundaries of the integrated zones with those of 49 districts.

The top-right map in Figure 3.17 shows the trip generation and attraction in the Study Area. Trip generation and attraction by integrated zone are shown in the top right map. "To home" trips are excluded. Blue and red bars show the trip generation and attraction, respectively. As can be seen, the central areas such as integrated zone 1 and 4 are the major destinations of the daily trips in the Study Area while the trip generation demand is high in suburban areas.

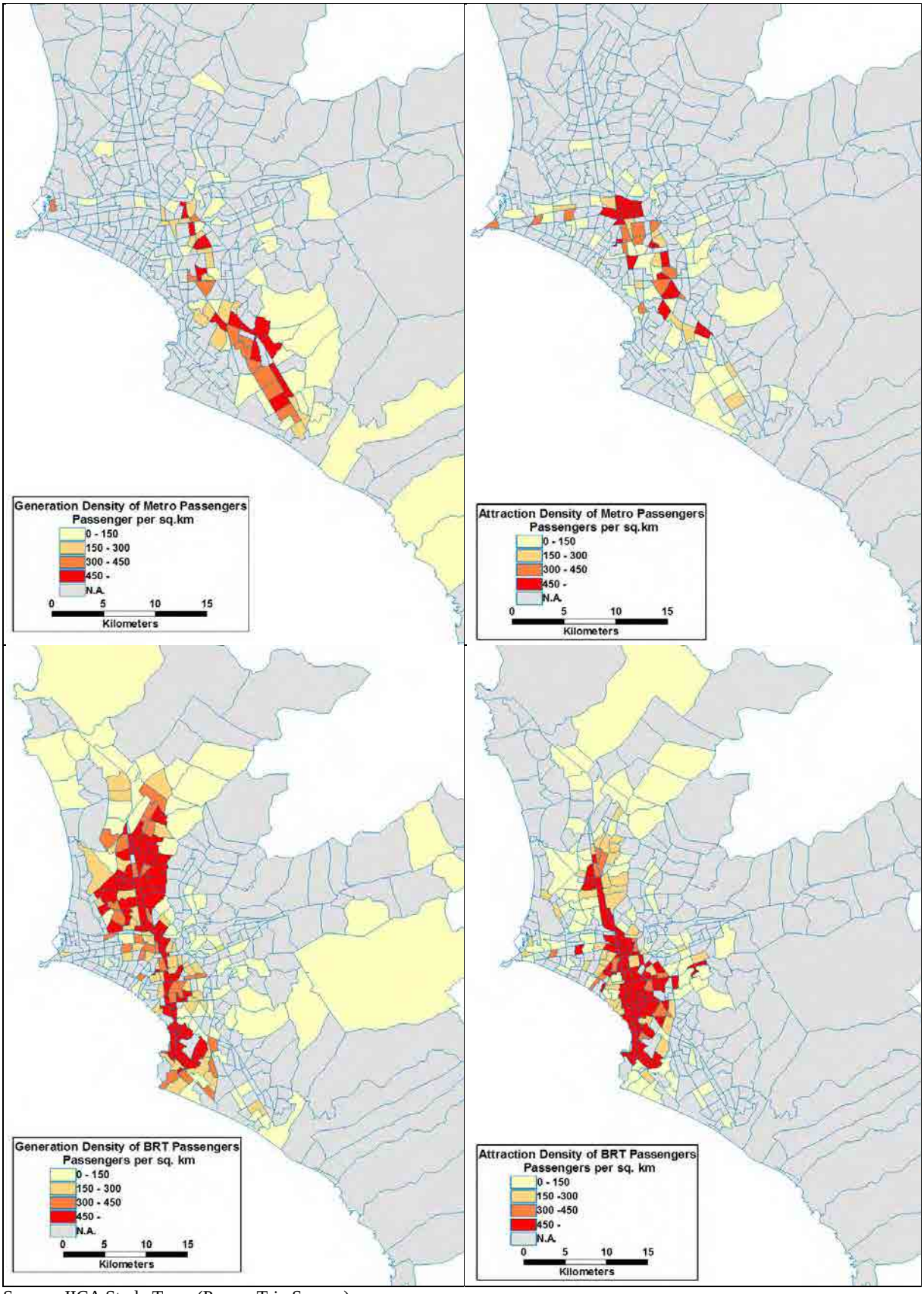
(2) Mass Transit Passengers

The largest difference in the transport system in the Study Area between the year 2004 and 2012 is the existence of mass transit systems such as Metropolitano and Metro Line-1. Figure 3.18 shows the distribution of origins and destinations of mass transit passengers. "To home" trips are excluded. Traffic Analysis Zones (TAZs) are classified by the trip density (the number of trips divided by the area of the zone). Trip origins and destinations are distributed along Metro Line-1 and Metropolitano. As can be seen, trip origins of Metro Line-1 are distributed in the south of the line while trip destinations are concentrated in the center of the city. Metropolitano has a large area of trip origins in the north of the line, and the destinations cover a large area in the center of the city.



Source: JICA Study Team (Person Trip Survey)

Figure 3.17 Trip Generation and Attraction by Integrated Zone

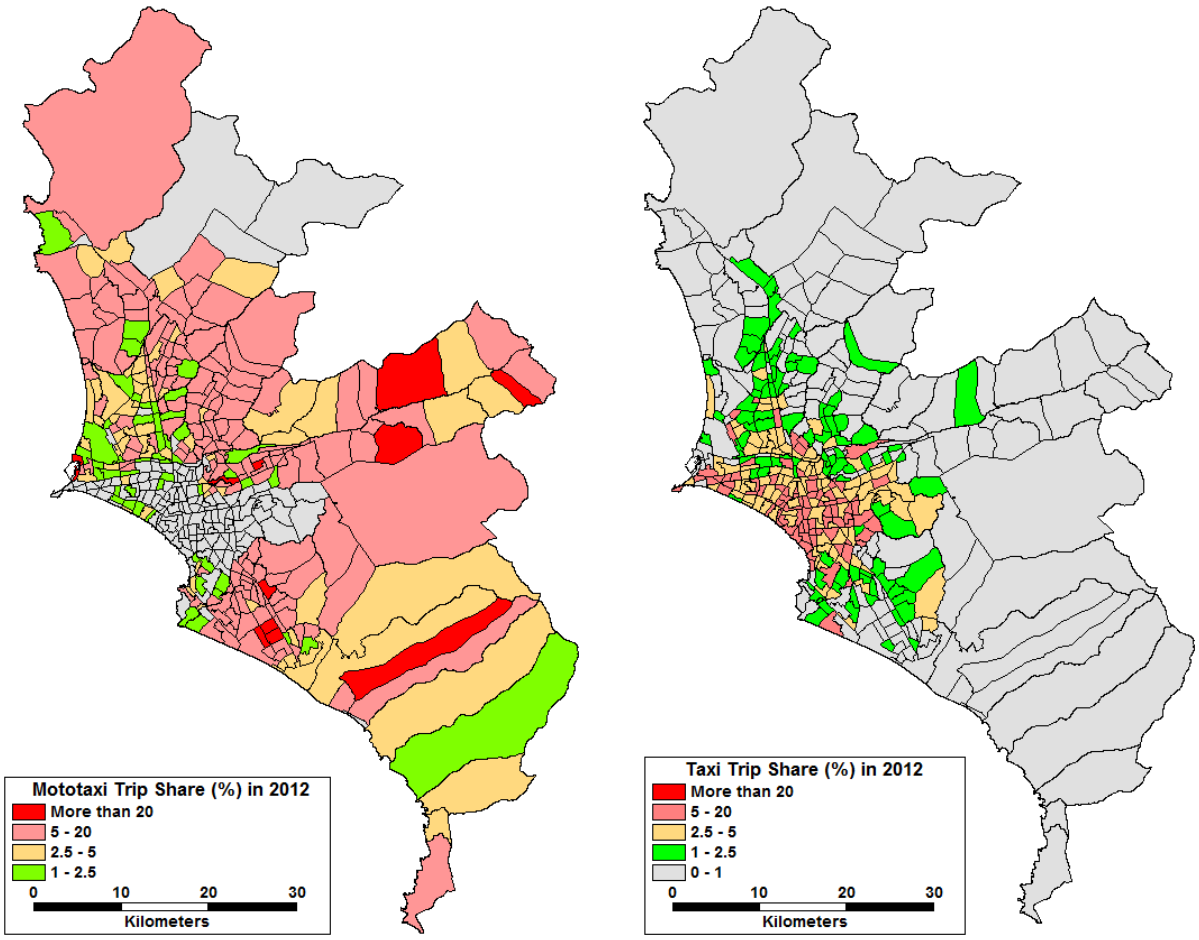


Source: JICA Study Team (Person Trip Survey)

Figure 3.18 Generation and Attraction Density of Mass Transit Passengers

(3) Mototaxi and Taxi

Mototaxi is the major transport mode in the suburban area while taxi is mainly used in the center of the city as shown in Figure 3.19.



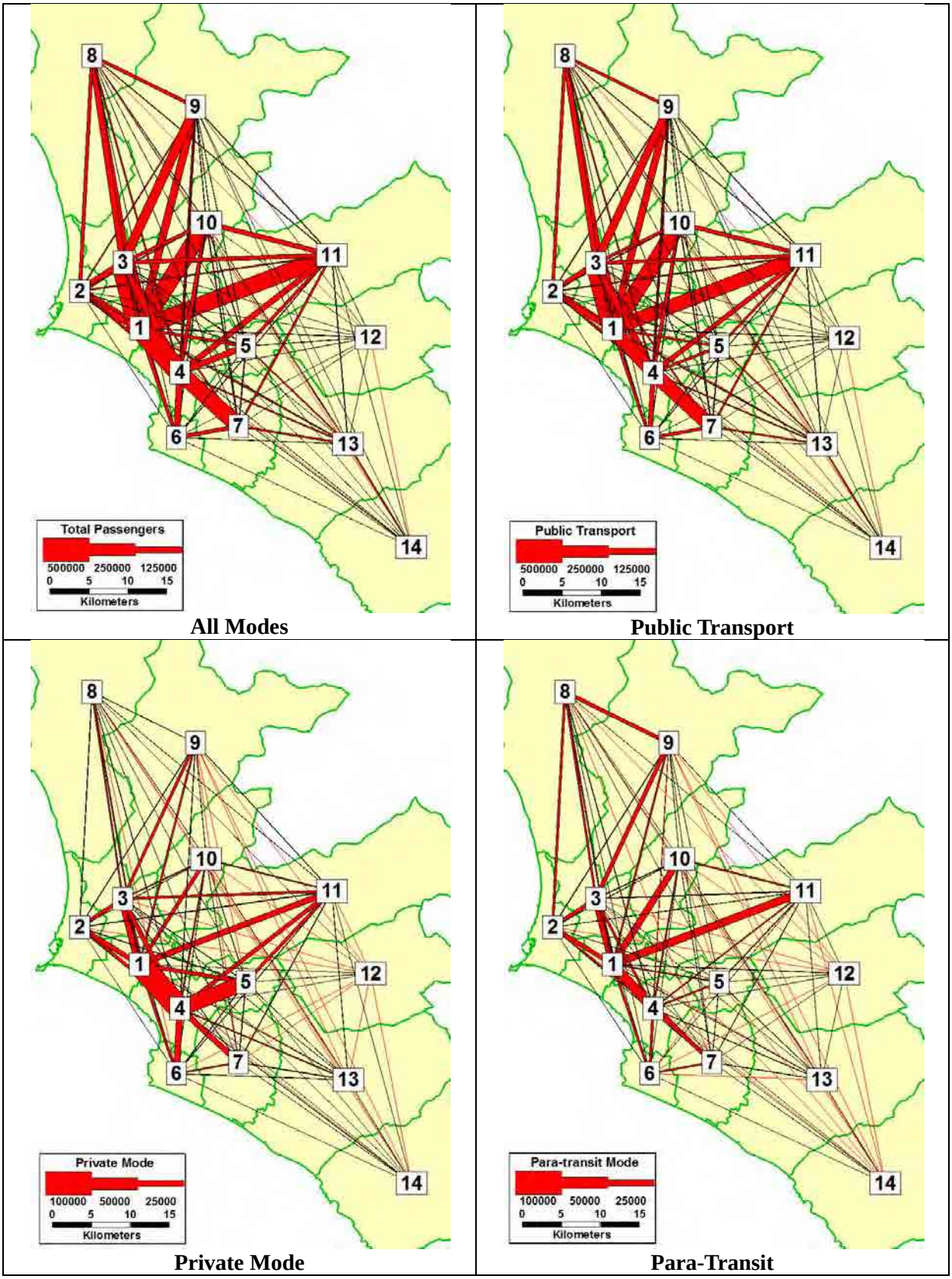
Source: JICA Study Team (Person Trip Survey)

Figure 3.19 Share of Mototaxi and Taxi by Traffic Zone

3.2.5 Trip Distribution

(1) Desired Lines

A desired line diagram is used to visualize an OD matrix by showing the traffic flow among areas with lines whose width represent the traffic volume. Figure 3.20 shows the desired lines among the integrated zones. As can be seen from the figure, traffic demand is concentrated in the integrated zone-1. Since the modal share of public transport is large, the desired line of public transport passengers seems to be almost the same as that of total passengers. The scale of the desired lines of private and para transit modes is enlarged so that the difference of the volume among zones becomes clear. High demand for the private mode is observed in the center of the city such as between zones 1 and 4, and between zones 4 and 5. The distribution pattern of para transit mode is similar to that of public mode.



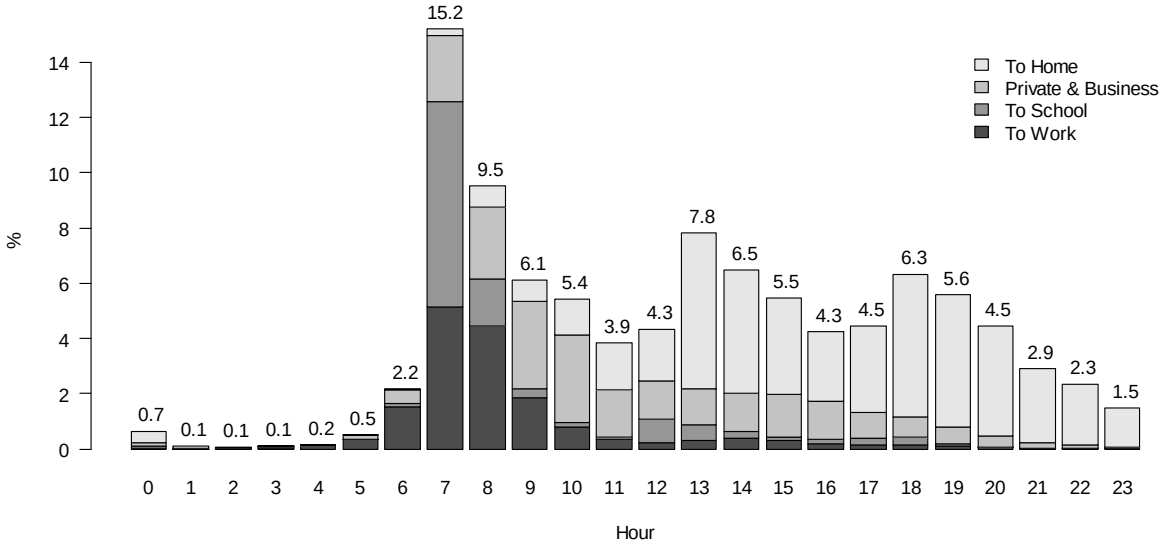
Source: JICA Study Team (Person Trip Survey)

Figure 3.20 Desired Line

3.2.6 Other Trip Characteristics

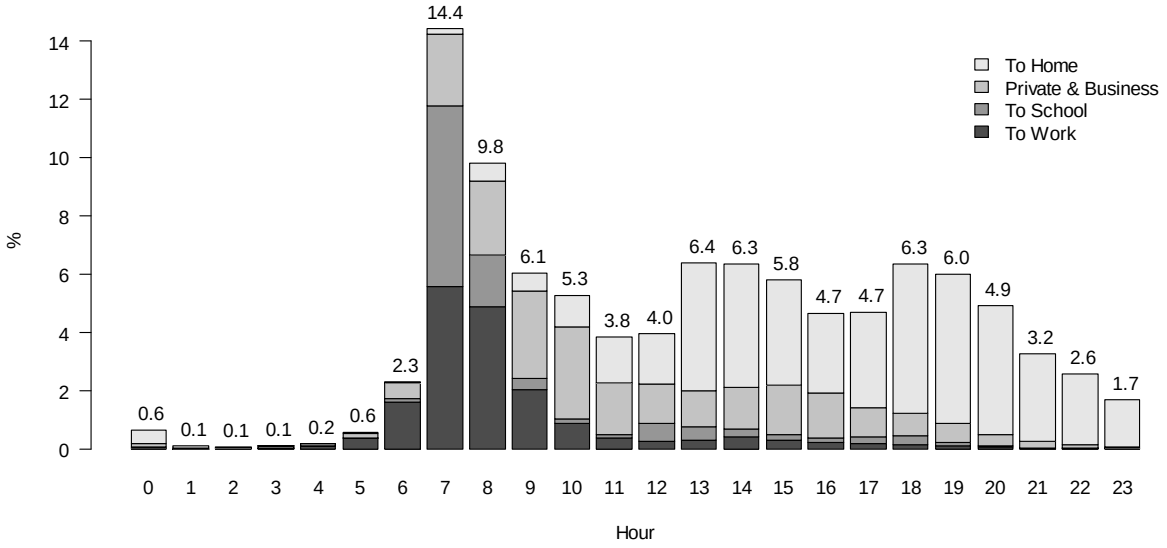
(1) Hourly Distribution

Figure 3.21 shows the distribution of arrival times by trip purpose in the Study Area. The peak hour of arrival trips is 7:00-8:00 a.m. Due to the concentration of school trips and commuter trips, the peak trips at 7:00-8:00 account for 15.2% of the total trips. Most trips of primary school children, whose major transport mode is walking, belong to the peak period. The peak hour of motorized trips is also 7:00-8:00 at the peak rate of 14.4% as shown in Figure 3.22.



Source: JICA Study Team (Person Trip Survey)

Figure 3.21 Distribution of Arrival Time (All Modes)

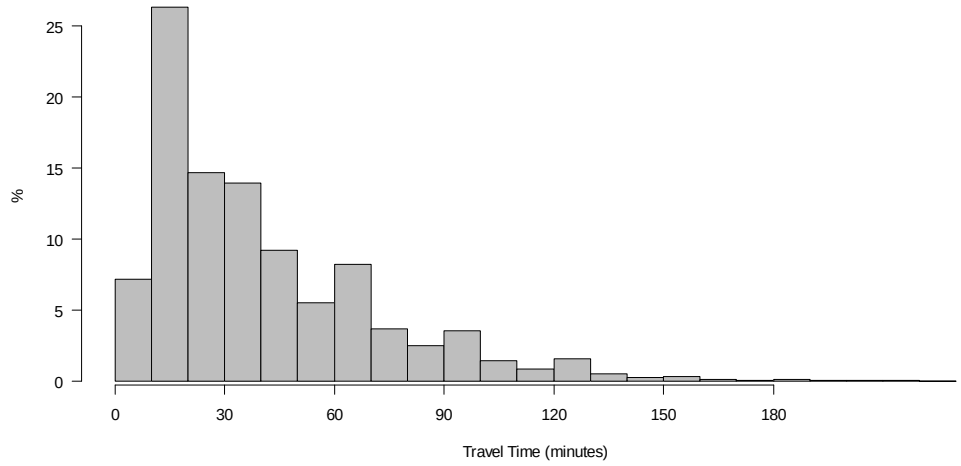


Note: Vertical scale of this char is different from the cart above.
Source: JICA Study Team (Person Trip Survey)

Figure 3.22 Distribution of Arrival Time (Motorized Trips)

(2) Travel Time

Figure 3.23 shows the distribution of travel times in the Study Area. The average travel time is 37 minutes while 48% of the trips have the travel time of less than 30 minutes. This includes walk trips. The average travel time of motorized trips is 41.2 minutes.



Source: JICA Study Team (Person Trip Survey)

Figure 3.23 Distribution of Travel Times (All Modes)

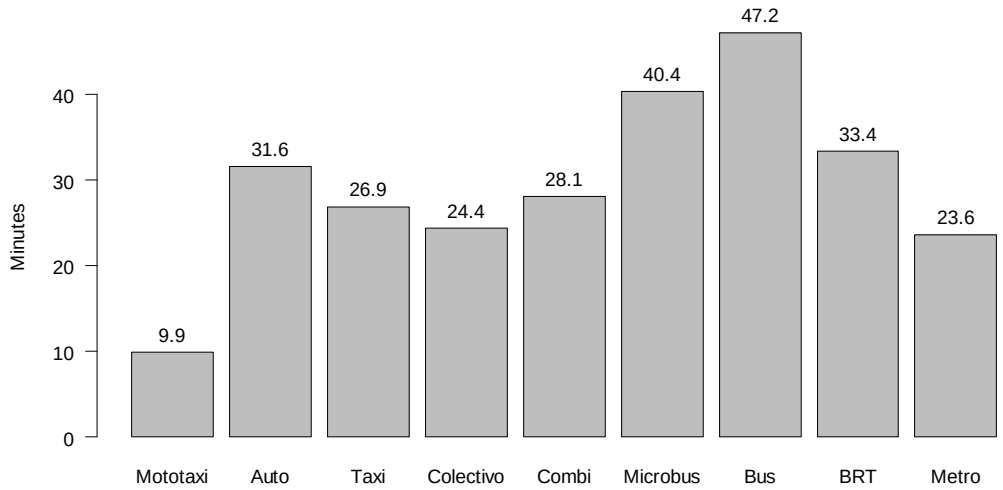
The average travel time by trip purpose is shown in Table 3.14. The time of "To Work" purpose is 44.6 minutes, which is almost the same as that in 2004.

Table 3.14 Average Travel Time by Purpose

	To Work	To School	Business	Private
2012	44.6	29.1	38.9	29.3
2004	43.6	34.5	35.7	31.4

Source: JICA Study Team (Person Trip Survey)

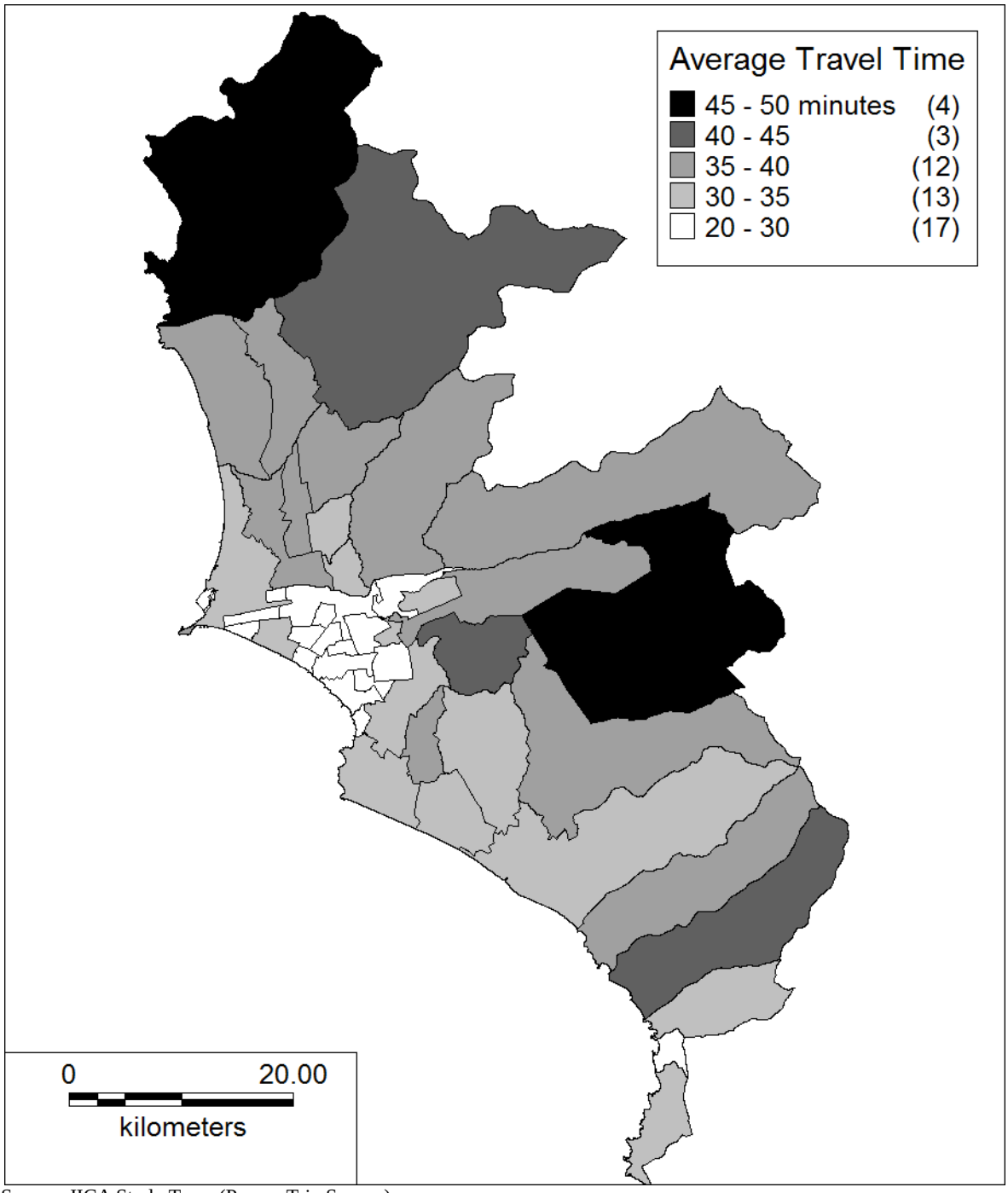
Figure 3.24 shows the average travel time per trip by mode. The average travel time of buses is as long as 47 minutes, followed by minibuses at 40 minutes. The time of mototaxi is as small as 10 minutes because it is used for short distance trips.



Note: BRT = Metropolitano
Source: JICA Study Team (Person Trip Survey)

Figure 3.24 Average Travel Time per Trip

Figure 3.25 shows the average travel time from the residential zone by district. Only home base trips are included in the calculation. This means that the average travel time in this figure is almost the same as the average commuter time. The farther the distance from the central area, the longer is the commuter time. The average travel time in the central area is approximately 20-30 minutes while it is 45-50 minutes from Ancon and Cieneguilla.

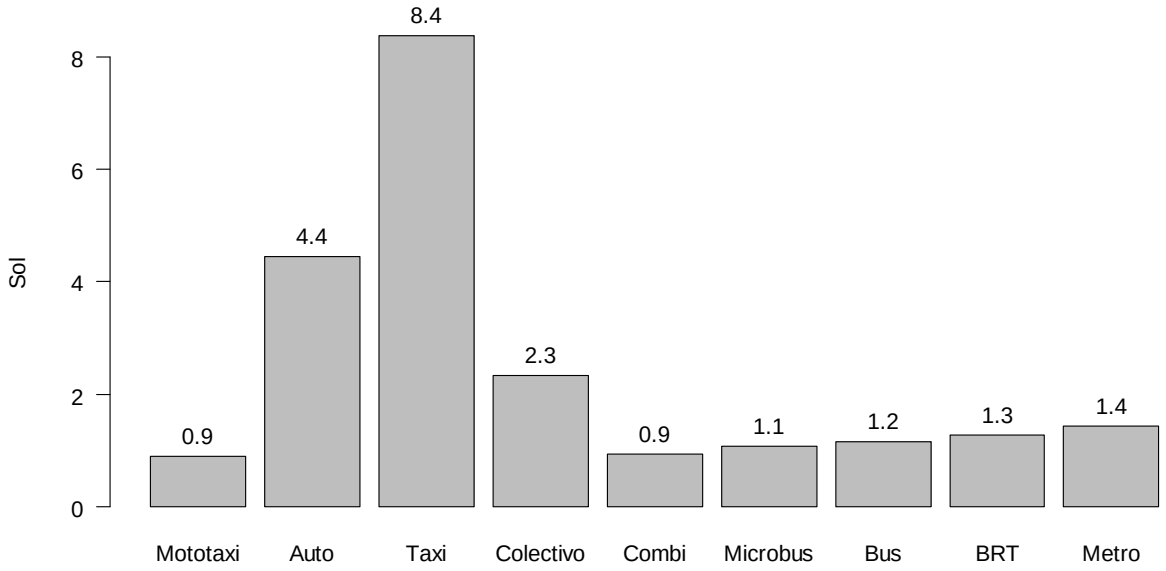


Source: JICA Study Team (Person Trip Survey)

Figure 3.25 Average Travel Time by District

(3) Trip Cost

Figure 3.26 shows the travel cost by trip mode. Taxi is the most expensive mode in Lima. Travel cost of Metro Line 1 is reasonable compared to other modes.

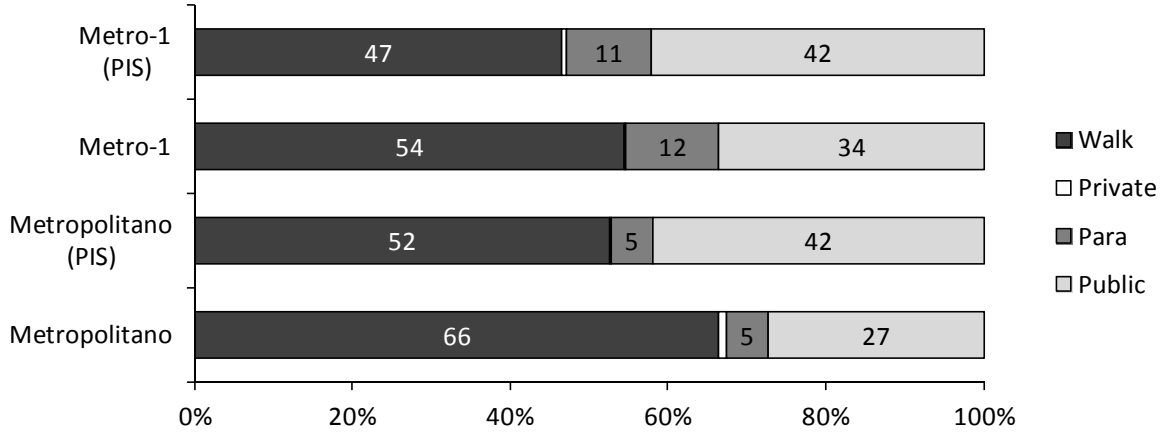


Source: JICA Study Team (Person Trip Survey)

Figure 3.26 Average Travel Cost per Trip

(4) Feeder Transport

The modal share of the feeder transport of Metropolitano and Metro-1 was estimated from the home interview survey using transfer information in the questionnaire. The access modes were also interviewed in the Passenger Interview Survey. The result of the modal share projection is illustrated in Figure 3.27. Although two surveys show different results, it can be said that "Walk" is the major access method, accounting for approximately a half of the access modes. Public transport modes such as bus, minibus, and combi play an important role as the feeder system while the share of para transit system such as mototaxi, taxi and colectivo is as small as 5% and 11-12% for Metropolitano and Line-1, respectively.



Note: PIS= Passenger Interview Survey
Source: JICA Study Team (Person Trip Survey & Passenger Interview Survey)

Figure 3.27 Modal Share of Access to Metropolitano and Metro-1

Chapter 4 Socio-economic Framework

4.1 National GDP and GRDP

4.1.1 National GDP

(1) Historical Trend of the National GDP

The historical data of the National Gross Domestic Product (GDP) and per capita GDP are published by the National Institute for Statistics and Information (INEI: Instituto Nacional de Estadística e Informática) as follows;

1) Product Bruto Interno por Departmentos 1994-2001 (ano base 1994), published by INEI in 2002
2) Product Bruto Interno por Departmentos 2001-2010 (ano base 1994), published by INEI in 2011

Table 4.1 summarizes National GDP and per capita GDP at 1994 constant prices. The average annual growth rate of National GDP from 1995 to 2010 was 4.6% with various ranges of annual growth rate, such as an annual growth rate of -0.7% from 1997 to 1998 and of 9.8% from 2007 to 2008.

Table 4.1 National GDP and Per Capita GDP, 1995-2010

(1994 constant prices)

Year	National GDP		Per Capita GDP	
	(million nuevos soles)	Average annual growth rate (period)	(nuevos soles)	Average annual growth rate (period)
1995	107,064		4,475	
2000	121,057	2.5% (1995-2000)	4,659	0.8% (1995-2000)
2005	148,640	4.2% (2000-2005)	5,345	2.8% (2000-2005)
2010	209,886	7.1% (2005-2010)	7,124	5.9% (2005-2010)

Source: 1) and 2) as described above.

The historical data of National GDP by economic sector is published by INEI as follows;

3) Perú: Informe Económico Trimestral 2009 Enero-Marzo, published by INEI in 2009
4) Perú: Informe Económico Trimestral 2011 Octubre-Diciembre, published by INEI in 2012

Table 4.2 summarizes National GDP by economic sector at 1994 constant prices. From 1995 to 2010, the share of each economic sector was almost the same, but the share of the primary sector is slightly decreasing after reaching a peak in 2002.

Table 4.2 National GDP by Economic Sectors, 1995-2010

(1994 constant prices)

Year	Primary Sector		Secondary Sector		Tertiary Sector		Duties and Taxes	
	(million nuevos soles)	% share	(million nuevos soles)	% share	(million nuevos soles)	% share	(million nuevos soles)	% share
1995	13,615	12.7%	24,942	23.3%	57,644	53.8%	10,863	10.1%
2000	18,041	14.9%	26,625	22.0%	64,705	53.5%	11,686	9.7%
2005	22,853	15.4%	33,257	22.4%	77,851	52.4%	14,679	9.9%
2010	27,434	13.1%	49,800	23.7%	112,383	53.5%	20,269	9.7%

Source: 3) and 4) as described above.

(2) Projection of the National GDP

Different organizations estimated the National GDP and the growth rates at different figures. The Central Reserve Bank of Peru estimated the annual GDP growth rate for 2012 and 2013 at 5.7 % and 6.3 %, respectively, in the latest inflation report of 2012. In the same way, the Ministry of Economy and Finance estimated the annual GDP growth rate for 2012 to 2014 at 6.0 % uniformly in the report of "Multiannual Macroeconomic Framework Revised 2012-2014 (Marco Macroeconomico Multianual Revosado 2012-2014)" published in 2011. As for the future long term, the National Strategic Planning Center (CEPLAN: Centro Nacional de Planeamiento Estratégico) estimated the National GDP in the report of "Economy in the Republic of Peru" as follows:

5) La Economia en el Peru Republica, published by CEPLAN in 2010

The above-mentioned report described National GDP from 2008 to 2021. The Study Team estimated the annual growth rates of National GDP referring to this report for the period from 2012 to 2021, and referring the recent trend for the period from 2022 to 2030. Table 4.3 shows the figures of National GDP estimated from the annual growth rates, and per capita GDP estimated from the National GDP and population projections. The population projection of Peru is referenced from the report "Perú: Estimaciones y Proyecciones de Población, 1950-2050, Boletín de Análisis Demográfico Nº 36" published by INEI in 2009.

Table 4.3 Projection of National GDP and Per Capita GDP, 2012-2030

(1994 constant prices)

Year	National GDP		Per Capita GDP	
	(million nuevos soles)	Average annual growth rate (period)	(nuevos soles)	Average annual growth rate (period)
2012	235,605		7,818	
2015	286,023	6.7% (2012-2015)	9,182	5.5% (2012-2015)
2020	373,861	5.5% (2015-2020)	11,390	4.4% (2015-2020)
2025	461,170	4.3% (2020-2025)	13,401	3.3% (2020-2025)
2030	566,305	4.2% (2025-2030)	15,775	3.3% (2025-2030)

Source: JICA Study Team

There are no official data available regarding the projection of National GDP by economic sector. From the recent trend described in Table 4.2, the Study Team estimated the National GDP by economic sector as shown in Table 4.4. According to the estimate, the percentage share trend in each sector will be stable.

Table 4.4 Projection of National GDP by Economic Sector, 2012-2030

(1994 constant prices)

Year	Primary Sector		Secondary Sector		Tertiary Sector		Duties and Taxes	
	(million nuevos soles)	% share	(million nuevos soles)	% share	(million nuevos soles)	% share	(million nuevos soles)	% share
2012	33,524	14.2%	53,493	22.7%	125,629	53.3%	22,959	9.7%
2015	41,379	14.5%	64,718	22.6%	152,216	53.2%	27,710	9.7%
2020	53,788	14.4%	85,102	22.8%	198,796	53.2%	36,175	9.7%
2025	65,178	14.1%	105,403	22.9%	245,988	53.3%	44,601	9.7%
2030	81,097	14.3%	128,845	22.8%	301,557	53.2%	54,807	9.7%

Source: JICA Study Team

4.1.2 GRDP in the Department of Lima

(1) Historical Trend of the GRDP in the Department of Lima

The historical data of the Gross Regional Domestic Product (GRDP) and the per capita GRDP in the Department of Lima, which includes the Lima and Callao Metropolitan Area, are published by INEI as mentioned in 1) and 2) of section 4.1.1. Table 4.5 and Table 4.6 show GRDP and per capita GRDP in the Department of Lima respectively.

Table 4.5 GRDP in the Department of Lima, 1995-2010

(1994 constant prices)

Year	National GDP (million nuevos soles)	GRDP in Department of Lima (million nuevos soles)	Average annual growth rate (period)	% share in Peru
1995	107,064	49,056		45.8%
2000	121,057	54,695	2.2% (1995-2000)	45.2%
2005	148,640	68,043	4.5% (2000-2005)	45.8%
2010	209,886	100,446	8.1% (2005-2010)	47.9%

Source: 1) and 2) as described in section 4.1.1.

Table 4.6 Per Capita GRDP in the Department of Lima, 1995-2010

(1994 constant prices)

Year	Per Capita GRDP (nuevos soles)	Average Annual Growth Rate (period)
1995	6,367	
2000	6,392	0.1% (1995-2000)
2005	7,284	2.6% (2000-2005)
2010	9,990	6.5% (2005-2010)

Source: 1) and 2) as described in section 4.1.1.

Table 4.7 shows GRDP by economic sector in the Department of Lima. Compared with National GDP by economic sector, the tertiary sector covered a larger portion of GRDP in the Department of Lima and the increasing trend of percentage share of the secondary sector is remarkable.

Table 4.7 GRDP by Economic Sector in the Department of Lima, 1995-2010

(1994 constant prices)

Year	Primary Sector (million nuevos soles)	Primary Sector % share	Secondary Sector (million nuevos soles)	Secondary Sector % share	Tertiary Sector (million nuevos soles)	Tertiary Sector % share	Total (million nuevos soles)	Total % share
1995	1,918	3.9%	10,155	20.7%	36,984	75.4%	49,056	100.0%
2000	2,592	4.7%	10,276	18.8%	41,826	76.5%	54,695	100.0%
2005	3,505	5.2%	17,283	25.4%	47,255	69.4%	68,043	100.0%
2010	4,173	4.2%	26,030	25.9%	70,243	69.9%	100,446	100.0%

Source: 1) and 2) as described in section 4.1.1.

(2) Projection of the GRDP in the Department of Lima

There are no official data available regarding the projection of the GRDP and per capita GRDP in the Department of Lima. Based on the projection of National GDP and the percentage share trend of GRDP in the Department of Lima in Peru, the Study Team estimated the GRDP in the Department of Lima as shown in Table 4.8. Table 4.9 shows the projection of per capita GRDP in the Department of Lima estimated from the GRDP and

population projection for the Department of Lima.

Table 4.8 Projection of GRDP in the Department of Lima, 2012-2030

(1994 constant prices)

Year	National GDP (million nuevos soles)	GRDP in the Department of Lima (million nuevos soles)	Average annual growth rate (period)	% share in Peru
2012	235,605	113,558		48.2%
2015	286,023	139,949	7.2% (2012-2015)	48.9%
2020	373,861	185,998	5.9% (2015-2020)	49.8%
2025	461,170	231,761	4.5% (2020-2025)	50.3%
2030	566,305	287,195	4.4% (2025-2030)	50.7%

Source: JICA Study Team

Table 4.9 Projection of Per Capita GRDP in the Department of Lima, 2012-2030

(1994 constant prices)

Year	Per Capita GRDP (nuevos soles)	Average Annual Growth Rate (period)
2012	10,957	
2015	12,900	5.6% (2012-2015)
2020	15,910	4.3% (2015-2020)
2025	18,486	3.0% (2020-2025)
2030	21,631	3.2% (2025-2030)

Source: JICA Study Team

Similar to the National GDP, there are no official data available regarding the projection of GRDP by economic sector in the Department of Lima. As shown in Table 4.10, the Study Team estimated GRDP by economic sector based on past trends.

Table 4.10 Projection of GRDP by Economic Sector in the Department of Lima, 2012-2030

(1994 constant prices)

Year	Primary Sector (million nuevos soles)	Primary Sector % share	Secondary Sector (million nuevos soles)	Secondary Sector % share	Tertiary Sector (million nuevos soles)	Tertiary Sector % share	Total (million nuevos soles)	Total % share
2012	5,282	4.7%	26,534	23.4%	81,742	72.0%	113,558	100.0%
2015	6,684	4.8%	33,475	23.9%	99,789	71.3%	139,949	100.0%
2020	8,782	4.7%	45,521	24.5%	131,695	70.8%	185,998	100.0%
2025	10,771	4.6%	56,023	24.2%	164,967	71.2%	231,761	100.0%
2030	13,534	4.7%	69,523	24.2%	204,138	71.1%	287,195	100.0%

Source: JICA Study Team

4.2 Land Use Plan

4.2.1 Major Development Plans for the Lima and Callao Metropolitan Area

The first development plan for the Lima and Callao Metropolitan Area was formed by the National Office of Planning and Urban Development (ONPU: Oficina Nacional de Planeamiento y Urbanismo) in 1948. Following this, 2 further plans were prepared by the central government in 1956 and 1967 as shown in Table 4.11. The latest official development plan is the “Metropolitan Development Plan for Lima and Callao 1990-2010 (PLANMET: Plan de Desarrollo Metropolitano de Lima y Callao 1990-2010)” prepared by the Metropolitan Municipality of Lima (MML) in 1989.

Table 4.11 Major Development Plans for the Lima and Callao Metropolitan Area

Year	Development Plan	Formulated By
1948	"Pilot Plan of Lima" ("Plan Piloto de Lima")	National Office of Planning and Urbanism (ONPU), Ministry of Development and Public Works
1956	"Regulating Plan of Lima"	National Office of Planning and Urbanism (ONPU), Ministry of Development and Public Works
1967	"Metropolitan Development Plan, Lima and Callao 1967-1980" ("PLANDEMET: Plan de Desarrollo Metropolitano Lima Callao, Esquema Director 1967-1980")	National Office of Planning and Urbanism (ONPU), Ministry of Development and Public Works
1989	"Metropolitan Development Plan for Lima and Callao 1990-2010" ("PLANMET: Plan de Desarrollo Metropolitano de Lima y Callao 1990-2010")	Metropolitan Municipality of Lima (MML)
1995-	"Urban Development Plan for the Province of Callao 1995-2010"	Metropolitan Institute of Planning (IMP) and the Province of Callao
on going	"Metropolitan Territorial Plan and Urban Development Plan for Lima 2006-2021" ("PLAM de Lima: Plan Metropolitano de Acondicionamiento Territorial y Desarrollo Urbano de Lima 2006-2021")	Metropolitan Institute of Planning (IMP), Metropolitan Municipality of Lima (MML)

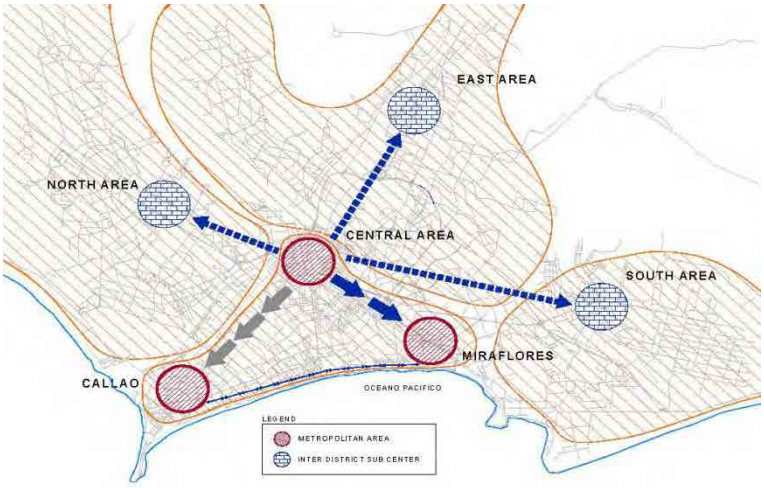
Source: PMTU-2025 and edited by JICA Study Team.

According to the study of PMTU-2025, the Metropolitan Institute of Planning (IMP: Instituto Metropolitano de Planificación) was preparing the "Urban Development Plan for the Province of Callao 1995-2010", although it has not been finalized yet. In addition, according to an interview with IMP, the "Metropolitan Territorial Plan and Urban Development Plan for Lima 2006-2021 (PLAM de Lima)" is still underway, but its progress is not sufficient due to lack of funds.

4.2.2 Current Land Use Plan

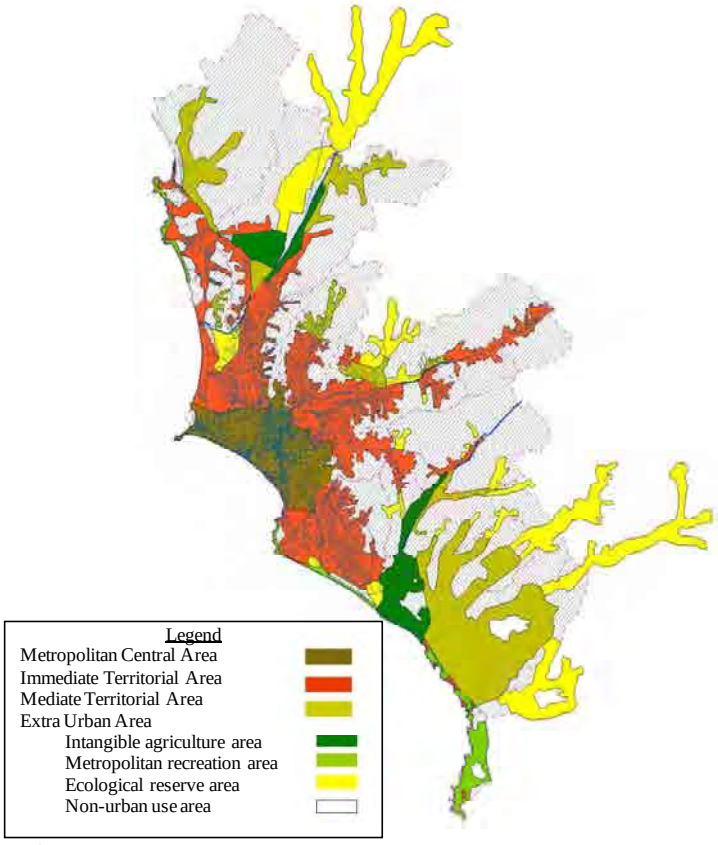
(1) Metropolitan Development Plan for Lima and Callao 1990-2010 (PLANMET)

As mentioned in the above section, the latest official development plan for the Lima and Callao Metropolitan Area is the "Metropolitan Development Plan for Lima and Callao 1990-2010" (hereafter, PLANMET) formulated by MML in 1989. The PLANMET promotes the concept of "4 major urban centers" with the existing metropolitan center and 3 new sub-centers (see Figure 4.1), and "Territorial Unites of Metropolitan Planning" with 4 categorizations of the area according to the target level of urbanization (see Figure 4.2).



Source: PMTU-2025

Figure 4.1 Concept of 4 Major Urban Centers of PLANMET



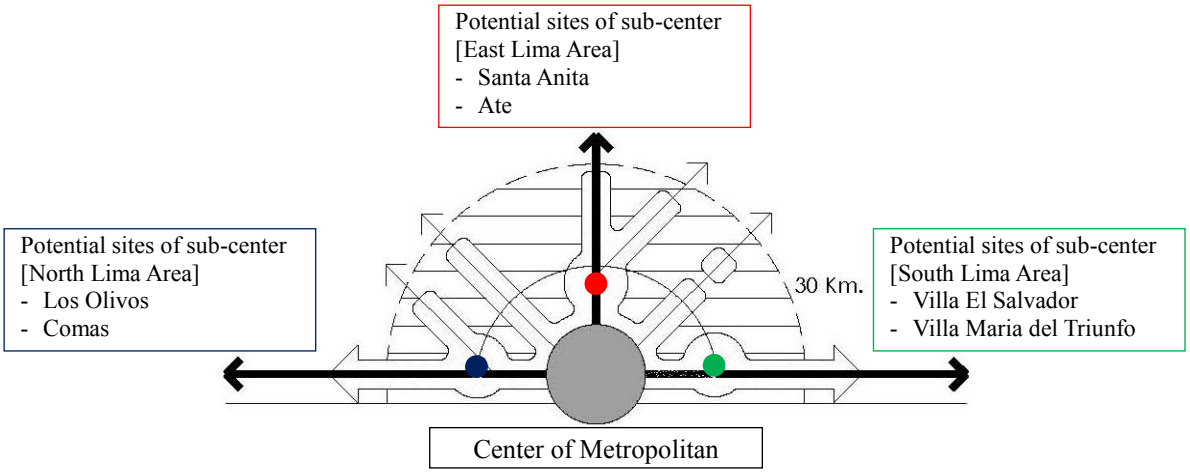
Source: PMTU-2025

Figure 4.2 Territorial Units of Metropolitan Planning of PLANMET

(2) Land Use Plan of PMTU in 2025

Agreeing with the points in PMTU-2025, the latest development plan of PLANMET needs to be updated to take into account the current situation and future projections. The PMTU-2025 is the urban transportation master plan for the Lima and Callao Metropolitan Area, and for the purposes of estimating future projections and demand forecasts, a future land use plan has been prepared for the target year of 2025. This land use plan basically

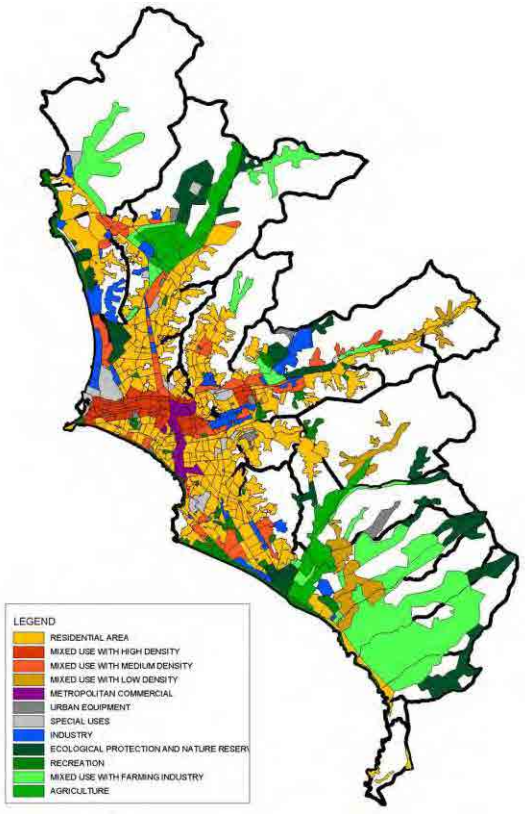
follows the concepts of PLANMET. The "4 major urban centers" in PLANMET are detailed as a "Poly-centric decentralized development pattern" with potential sites of new sub-centers for the target year of 2025 as described in Figure 4.3.



Source: PMTU-2025 and edited by JICA Study Team.

Figure 4.3 Poly-centric Decentralized Development Pattern of PMTU-2025

Figure 4.4 shows the land use plan for 2025 from PMTU-2025. The Study Team followed the concepts of its metropolitan structure and adopted the land use plan for future projections.



Source: PMTU-2025

Figure 4.4 Land Use Plan for PMTU in 2025

4.3 Population

The future population of the Lima and Callao Metropolitan Area with 427 traffic zones in 2012 (present year), 2020 (middle year) and 2030 (target year) was estimated. The latest national population and household census (Censos Nacionales 2007: XI de Población y VI de Vivienda) was implemented in 2007. Several population projections for Peru and for the department level were officially conducted as described in the following section (1) Reference Data. However, the population projection at the province level covering the Lima and Callao Metropolitan Area was not conducted for the future long term. The Study Team conducted the population projection for the Lima and Callao Metropolitan Area, referring to previous studies as control totals.

4.3.1 Methodology

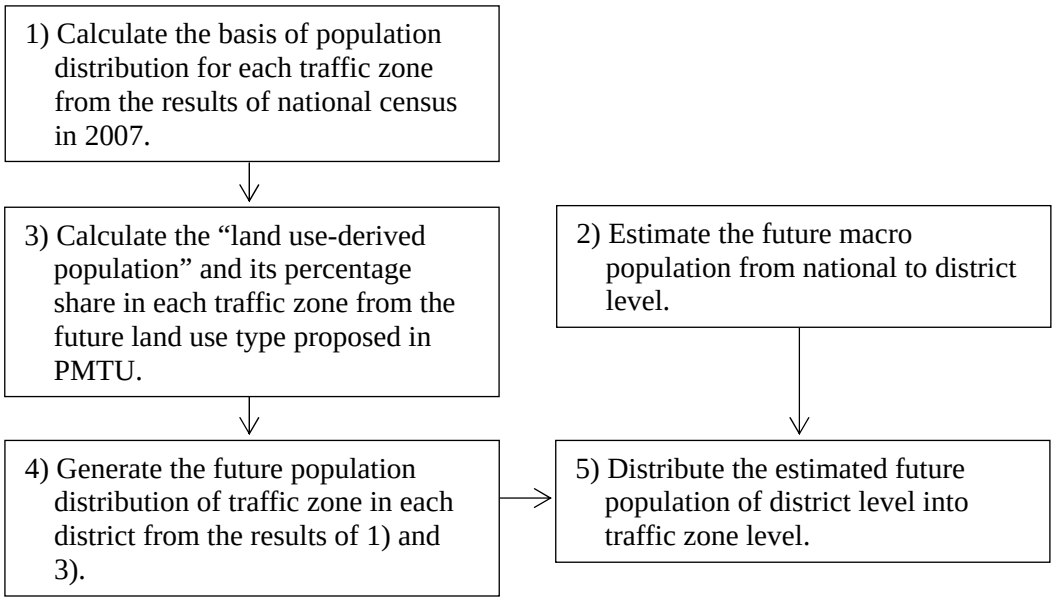
(1) Reference Data

The following studies and national census are referred to in the projection of future population.

1) Perú: Estimaciones y Proyecciones de Población, 1950-2050, Boletín de Análisis Demográfico Nº 36, published by INEI in 2009
2) Perú: Estimaciones y Proyecciones de Población por Departamento, Sexo y Grupos Quinquenales de Edad 1995-2025, Boletín de Análisis Demográfico Nº 37, published by INEI in 2009
3) Perú: Estimaciones y Proyecciones de Población por Sexo, Según Departamento, Provincia y Distrito, 2000-2015, Boletín Especial Nº 18, published by INEI in 2009
4) Perú: Estimaciones y Proyecciones de Población Total y Edades Quinquenales, según Departamento, Provincia y Distrito, 2005-2015, Boletín Especial Nº 21, published by INEI in 2010
5) Censos Nacionales 2007: XI de Población y VI de Vivienda Perfil Sociodemográfico de la Provincia de Lima, published by INEI in 2008
6) Censos Nacionales 2007: XI de Población y VI de Vivienda Perfil Sociodemográfico de la Provincia Constitucional del Callao, published by INEI in 2008

(2) Future Population Projection Process

Essentially, the future population projection process was done in accordance with the PMTU-2025. Meanwhile, control totals were set to a more detailed level as the district. Figure 4.5 shows the flowchart and description of the projection process.



Source: JICA Study Team

Figure 4.5 Flowchart of Future Population Projection Process

1) From the results of the national census in 2007, the population at block level in the Lima and Callao Metropolitan Area (approximately 80,000 blocks) was aggregated into 427 traffic zones. The population distribution of traffic zones in 2007 was generated in this stage, and this distribution becomes the basis of future population distributions.

2) Future populations at the following levels were estimated referring to trends and previous studies as control totals.

   - National level
   - Department of Lima level
   - Province of Lima and Province of Callao level
   - 43 districts in Province of Lima and 6 districts in Province of Callao level

3) Based on the future land use types proposed in PMTU-2025, "land use-derived population" was calculated by multiplying the area of each traffic zone and the average population density by each land use type.

4) From the results of stage 1) and 3), population distributions in each traffic zone were generated, and the future percentage share of each traffic zone in each district was assumed from a basic population distribution and "land use-derived population" distribution.

5) Finally, the estimated future populations of the 49 districts were distributed into the 427 traffic zones by multiplying the future percentage share of each traffic zone.

4.3.2 Results of Future Population Projection

Table 4.12 summarizes the recent and future populations from the national level to provincial level. The percentage share of population of the Lima and Callao Metropolitan Area has gradually increased from 30% to 34% in Peru.

Table 4.12 Summary of Recent and Future Population

Year	Peru	Lima and Callao Metropolitan Area		Lima Province	Callao Province
	Population	Population	% share in Peru	Population	Population
2000	25,983,588	7,757,300	29.9%	6,968,339	788,961
2005	27,810,540	8,489,668	30.5%	7,622,791	866,877
2012	30,135,875	9,450,585	31.4%	8,481,415	969,170
2020	32,824,358	10,690,877	32.6%	9,609,386	1,081,491
2030	35,898,422	12,175,250	33.9%	10,963,461	1,211,789

Source: 1), 2), 3) and JICA Study Team

Table 4.14 shows the results of future population projections and population densities in the Lima and Callao Metropolitan Area combining 427 traffic zones into 49 districts. Figure 4.6 shows the population density by traffic zone. Consequently, as mentioned in the urban structure of PMTU-2025 in section 4.2, the Central Lima Area shows a population decrease trend while the neighboring areas of North, South and East Lima Area show population growth.

4.3.3 Future Population by Age Group

The future population by age group was estimated referring to the percentage share of each age group in the Department of Lima and the Province of Callao as described in "Perú: Estimaciones y Proyecciones de Población por Departamento, Sexo y Grupos Quinquenales de Edad 1995-2025, Boletín de Análisis Demográfico Nº 37" published by INEI in 2009. Table 4.13 summarizes the future population of 5 age groups in the Lima and Callao Metropolitan Area. The percentage share of age group "0-14", "15-29" and "30-44" is in decreasing trend, while the percentage share of age group "45-64" and "65 over" is slightly increased.

Table 4.13 Summary of Future Population by Age Group

Year	Age Group				
	0-14 years old	15-29 years old	30-44 years old	45-64 years old	65 years old and over
2012	2,353,533	2,583,146	2,138,440	1,724,692	650,774
2020	2,644,203	2,958,136	2,398,119	1,981,050	709,370
2030	2,907,501	3,226,520	2,735,185	2,388,409	917,635

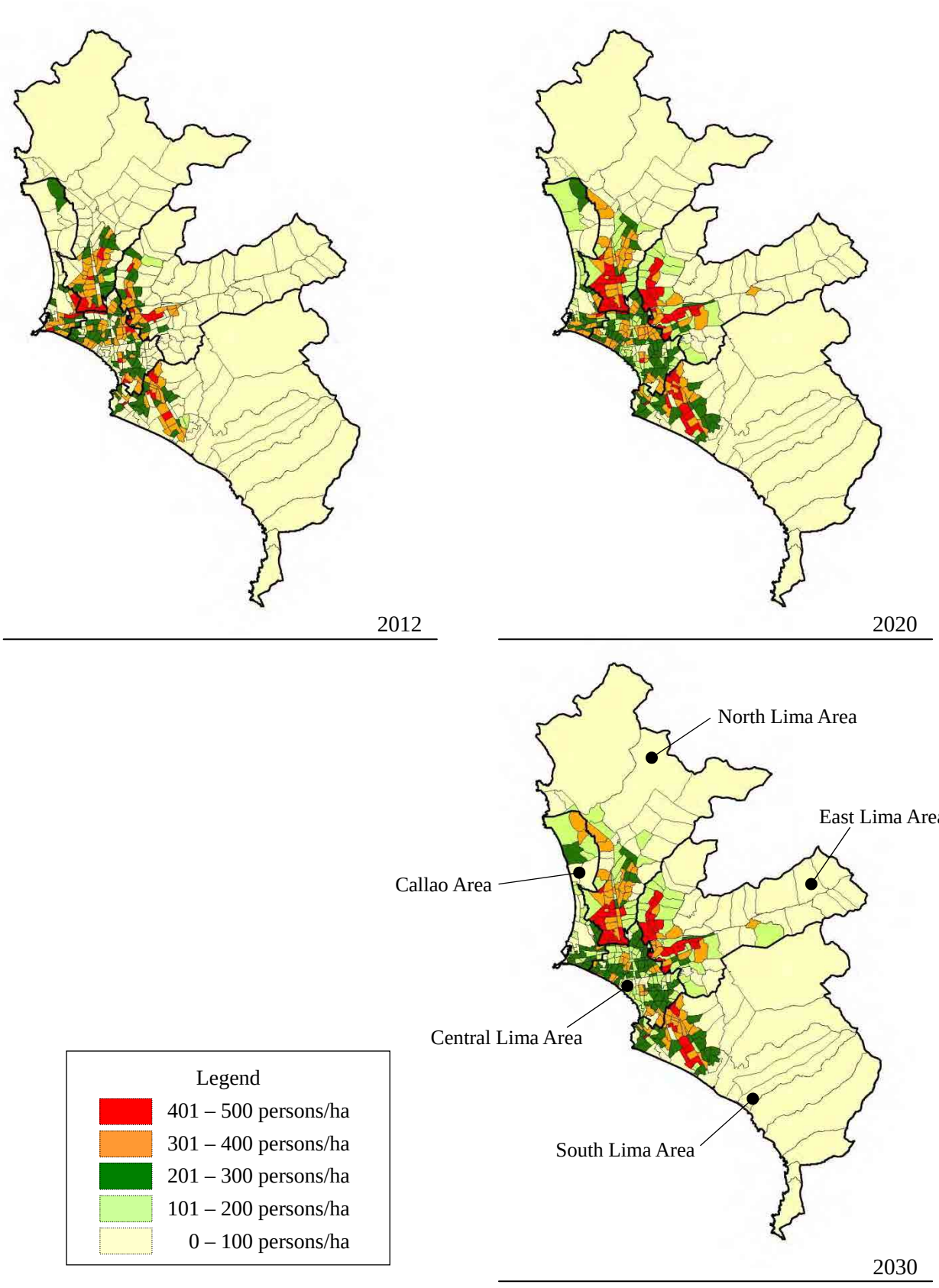
Source: JICA Study Team

The results of future population projection for 2012-2030 are shown in Table 4.16, and the population density by traffic zone is illustrated in Figure 4.6.

Table 4.14 Future Population Projection, 2012-2030

Area	District Name	Area (ha)	2012		2020		2030	
			Population	Population Density	Population	Population Density	Population	Population Density
Sub Total [Lima Area]		267,040	8,481,415	31.8	9,609,386	36.0	10,963,461	41.1
Central Lima Area	Lima	2,198	286,849	130.5	250,769	114.1	204,312	93.0
	Barranco	333	31,959	96.0	27,037	81.2	20,677	62.1
	Breña	322	79,456	246.8	71,214	221.2	60,605	188.2
	Jesús Maria	457	71,364	156.2	71,964	157.5	72,714	159.1
	La Victoria	874	182,552	208.9	156,044	178.5	121,838	139.4
	Lince	303	52,961	174.8	46,379	153.1	37,894	125.1
	Magdalena del Mar	361	54,386	150.7	55,111	152.7	56,016	155.2
	Magdalena Vieja	438	77,038	175.9	75,281	171.9	73,025	166.7
	Miraflores	962	84,473	87.8	79,092	82.2	72,168	75.0
	Rimac	1,187	171,921	144.8	155,885	131.3	135,257	113.9
	San Borja	996	111,568	112.0	112,970	113.4	114,595	115.1
	San Isidro	1,110	56,570	51.0	51,124	46.1	44,117	39.7
	San Luis	349	57,368	164.4	58,593	167.9	60,066	172.1
	San Miguel	1,072	135,086	126.0	137,470	128.2	140,124	130.7
	Santiago de Surco	3,475	326,928	94.1	375,355	108.0	434,720	125.1
	Surquillo	346	92,328	266.8	90,386	261.2	87,852	253.9
Total [Central Lima Area]		14,783	1,872,807	126.7	1,814,674	122.8	1,735,983	117.4
North Lima Area	Ancón	29,864	39,769	1.3	49,178	1.6	60,555	2.0
	Carabayllo	34,688	267,961	7.7	353,520	10.2	455,939	13.1
	Comas	4,875	517,881	106.2	544,326	111.7	576,884	118.3
	Independencia	1,456	216,503	148.7	220,608	151.5	225,398	154.8
	Los Olivos	1,825	355,101	194.6	401,239	219.9	457,906	250.9
	Puente Piedra	7,118	305,537	42.9	423,069	59.4	562,386	79.0
	San Martín de Porres	3,691	659,613	178.7	772,050	209.2	909,235	246.3
	Santa Rosa	2,150	15,399	7.2	23,344	10.9	32,537	15.1
Total [North Lima Area]		85,667	2,377,764	27.8	2,787,336	32.5	3,280,840	38.3
South Lima Area	Chorrillos	3,894	314,835	80.9	346,955	89.1	386,483	99.3
	Cieneguilla	24,033	38,328	1.6	58,998	2.5	82,870	3.4
	Lurin	18,026	76,874	4.3	98,024	5.4	123,497	6.9
	Pachacamac	16,023	102,691	6.4	165,546	10.3	237,453	14.8
	Pucusana	3,739	14,403	3.9	20,786	5.6	28,273	7.6
	Punta Hermosa	11,950	6,935	0.6	8,681	0.7	10,791	0.9
	Punta Negra	13,050	6,878	0.5	9,478	0.7	12,560	1.0
	San Bartolo	4,501	7,008	1.6	8,792	2.0	10,946	2.4
	San Juan de Miraflores	2,398	393,493	164.1	426,560	177.9	467,313	194.9
	Santa Maria del Mar	981	1,220	1.2	2,108	2.1	3,107	3.2
	Villa El Salvador	3,546	436,289	123.0	509,576	143.7	599,201	169.0
	Villa Maria del Triunfo	7,057	426,462	60.4	488,430	69.2	564,414	80.0
Total [South Lima Area]		109,198	1,825,416	16.7	2,143,934	19.6	2,526,907	23.1
East Lima Area	Ate	7,772	573,948	73.8	720,347	92.7	897,166	115.4
	Chaclacayo	3,950	43,180	10.9	44,417	11.2	45,897	11.6
	El Agustino	1,254	189,924	151.5	196,726	156.9	205,050	163.5
	La Molina	6,575	157,638	24.0	194,308	29.6	238,757	36.3
	Lurigancho	23,647	201,248	8.5	247,707	10.5	304,039	12.9
	San Juan de Lurigancho	13,125	1,025,929	78.2	1,206,300	91.9	1,426,300	108.7
	Santa Anita	1,069	213,561	199.8	253,639	237.3	302,521	283.0
Total [East Lima Area]		57,392	2,405,428	41.9	2,863,442	49.9	3,419,731	59.6
Callao Area	Callao	4,565	417,622	91.5	394,834	86.5	339,742	74.4
	Bellavista	456	74,287	162.9	68,485	150.2	57,308	125.7
	Carmen de La Legua-Reynoso	212	42,065	198.4	39,944	188.4	35,092	165.5
	La Perla	275	60,886	221.4	55,966	203.5	46,625	169.5
	La Punta	75	3,793	50.6	2,655	35.4	1,396	18.6
	Ventanilla	7,352	370,517	50.4	519,606	70.7	731,626	99.5
Total [Callao Area]		12,935	969,170	74.9	1,081,491	83.6	1,211,789	93.7
Grand Total [Lima and Callao Metropolitan Area]		279,975	9,450,585	33.8	10,690,877	38.2	12,175,250	43.5

Source: JICA Study Team



Source: JICA Study Team

Figure 4.6 Population Density by Traffic Zone

4.4 Population by Socio-economic Level

INEI published the following report on socio-economic levels and corresponding income levels from the results of the national census in 2007.

1) Pianos Estratificados de Lima Metropolitana a Nivel de Manzana Segun Ingreso Per Capita del Hogar, published by INEI in 2009

Table 4.15 shows the aggregated results of each socio-economic level in 2007.

Table 4.15 Distribution of Socio-economic Level in the Study Area, 2007 (by INEI)

Socio-economic Level	Population	% Share	Per Capita Income Per Household (in nuevos soles)
A and B	2,033,234	24.0%	1,700.00 and over (A) 900.01-1,700.00 (B)
C	3,111,127	36.7%	550.01-900.00
D	1,768,649	20.9%	380.01-550.00
E	1,569,608	18.5%	380.00 and under
Total	8,482,619	100.0%	

Remarks: A: High, B: Medium high, C: Medium, D: Medium low, E: Low
Source: JICA Study Team

At the same time, the Peruvian Association of Market Investigation Companies (APEIM: Asociación Peruana de Empresas de Investigación de Mercados) conducted a survey of socio-economic levels (NSE: Niveles Socioeconomicos) in the Lima and Callao Metropolitan Area and results were published in the documents listed in 2) - 6) below.

2) Niveles Socioeconomicos 2007-2008, published by APEIM in 2007
3) Niveles Socioeconomicos 2009, published by APEIM in 2008
4) Niveles Socioeconomicos 2010 Lima Metropolitana, published by APEIM in 2010
5) Niveles Socioeconomicos 2011 Total Peru Urbano y Lima Metropolitana, published by APEIM in 2011
6) Niveles Socioeconomicos 2012 Total Peru Urbano y Lima Metropolitana, published by APEIM in 2012

Table 4.16 shows the summary of the percentage share change of socio-economic levels in the Lima and Callao Metropolitan Area.

Table 4.16 Distribution of Socio-economic Levels in the Study Area, 2004-2012 (by APEIM)

Year	% Share of Socio-economic Level			
	A and B	C	D	E
2004	18.0%	31.7%	32.3%	18.0%
2007/2008	21.0%	28.7%	33.9%	16.4%
2009	22.0%	31.8%	30.1%	16.1%
2010	22.9%	33.1%	30.2%	13.8%
2011/2012	21.2%	34.9%	31.3%	12.6%

Source: 2), 3), 4), 5) and 6) as mentioned above.

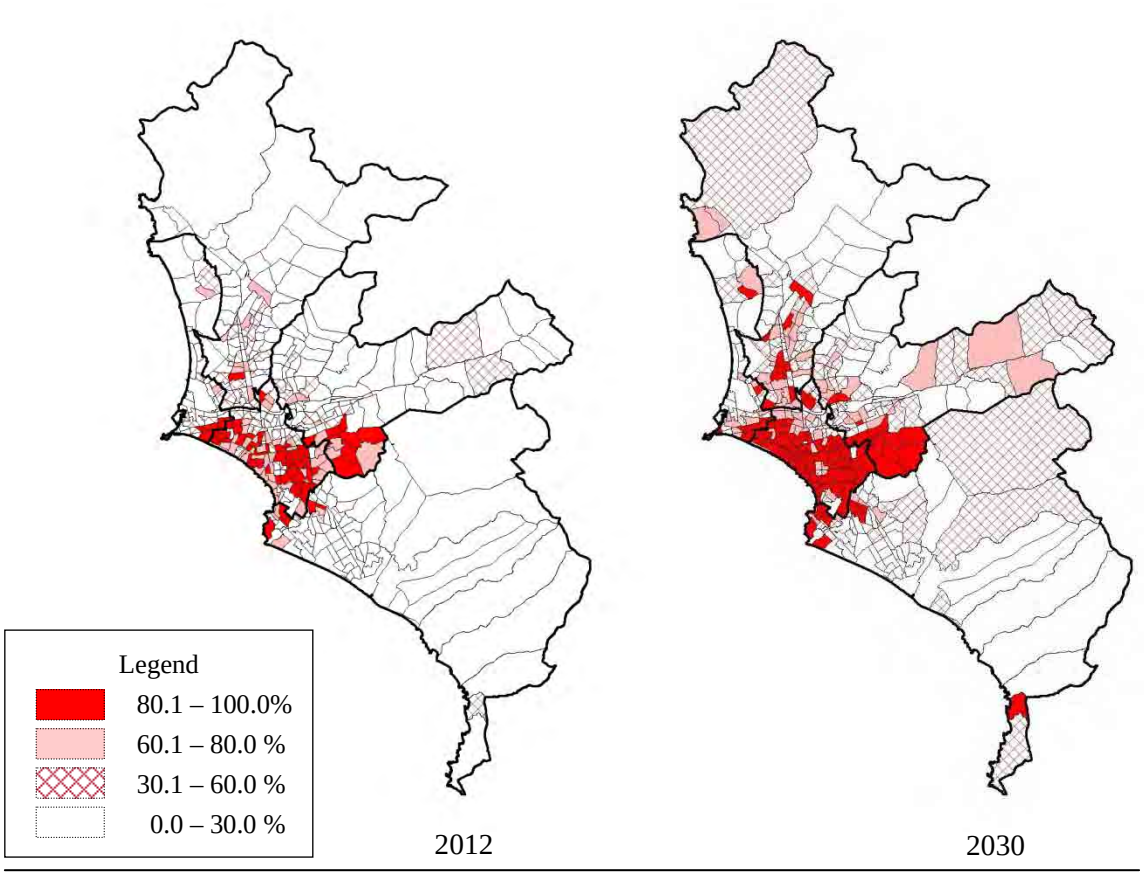
Based on data published by INEI and APEIM, and following the future development scenario of PMTU-2025, the Study Team estimated the future population distribution by socio-economic level as shown in Table 4.17. Figure 4.7 to Figure 4.10 show the population distribution at each socio-economic level. According to the estimation,

socio-economic levels A and B will significantly concentrate in the Central Lima Area, and the socio-economic levels C to E will spread from the central area to surrounding areas.

Table 4.17 Future Population by Socio-economic Level in the Study Area, 2012-2030

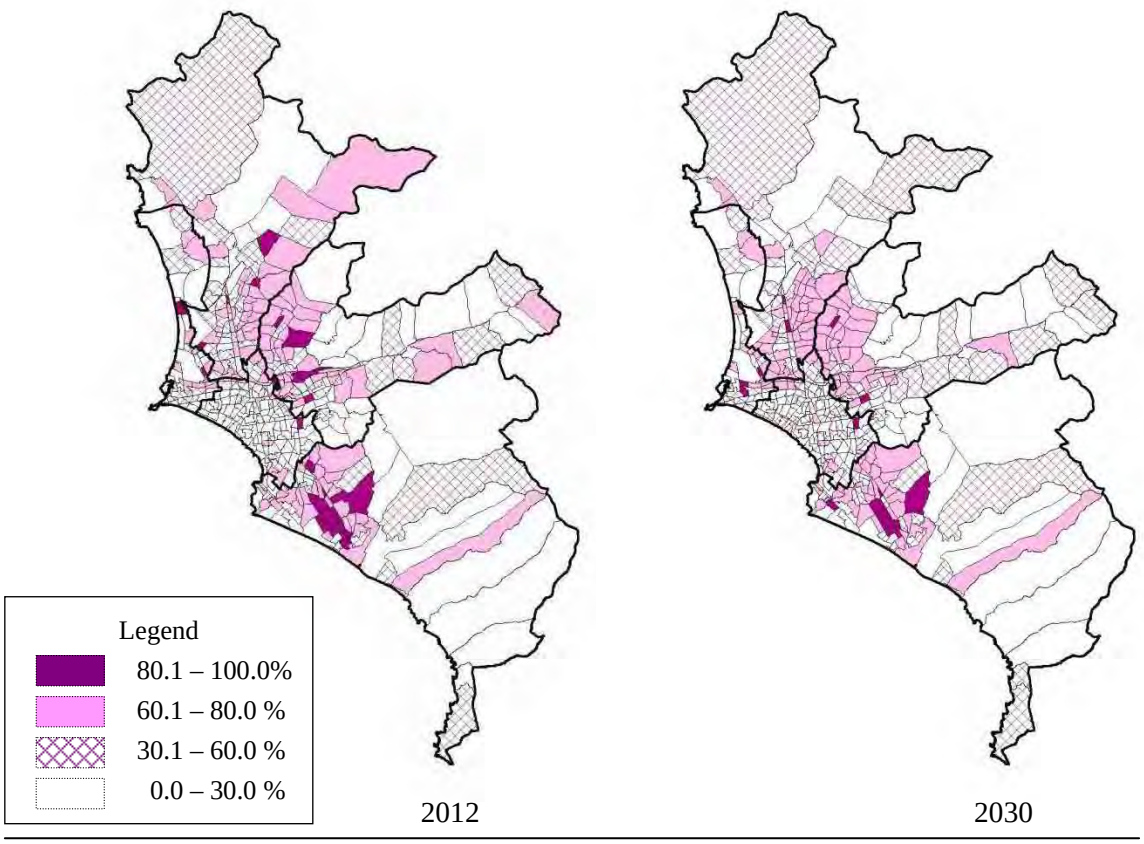
Year	Population by Socio-economic Level (% share)				
	A and B	C	D	E	Total
2012	2,006,351 (21.2%)	3,298,800 (34.9%)	2,957,358 (31.3%)	1,188,076 (12.6%)	9,450,585 (100.0%)
2020	3,152,225 (29.5%)	3,682,967 (34.4%)	2,737,926 (25.6%)	1,117,759 (10.5%)	10,690,877 (100.0%)
2030	4,217,054 (34.6%)	4,154,220 (34.1%)	2,687,412 (22.1%)	1,116,565 (9.2%)	12,175,250 (100.0%)

Source: JICA Study Team



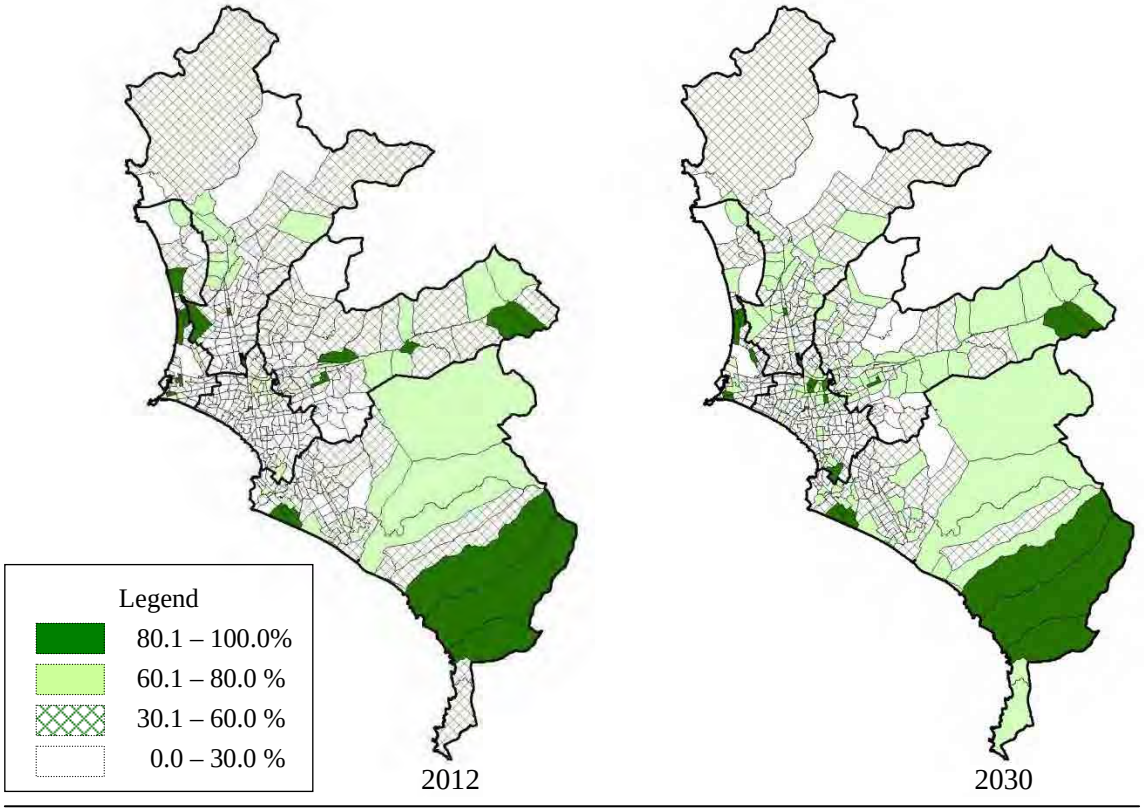
Source: JICA Study Team

Figure 4.7 Population Distribution of Socio-economic Level A and B by Traffic Zone



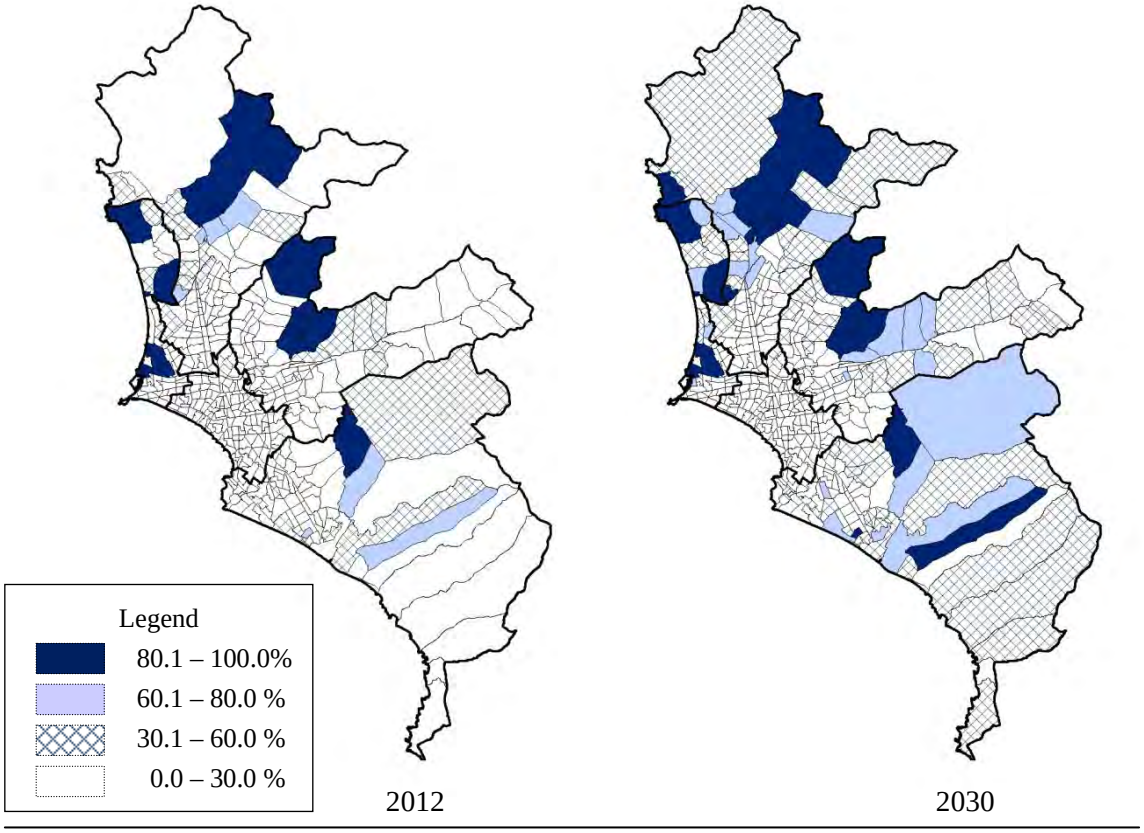
Source: JICA Study Team

Figure 4.8 Population Distribution of Socio-economic Level C by Traffic Zone



Source: JICA Study Team

Figure 4.9 Population Distribution of Socio-economic Level D by Traffic Zone



Source: JICA Study Team

Figure 4.10 Population Distribution of Socio-economic Level E by Traffic Zone

4.5 Number of Workers

For the projection of the working population, the Study Team classified several job categories into 3 industrial categories. Table 4.18 shows the classification of jobs from the 13 categories defined in the national census in 2007.

Table 4.18 Classification of Job Categories

Classification		Including Job Categories
1	Primary Industry	1) Agriculture 2) Fishery / Mining
2	Secondary Industry	3) Manufacture 4) Construction
3	Tertiary Industry	5) Trading 6) Transport / Communication 7) Electricity / Gas / Water 8) Hotel / Restaurant 9) Finance 10) Estate / Rental service 11) Education 12) Other service 13) Unclassified service

Source: JICA Study Team

4.5.1 Number of Workers at Resident Place

The latest national census in 2007 (mentioned in 1) and 2) below) includes the resident-based number of workers by job category in the Lima and Callao Metropolitan Area. The historical working population (Poblacion Economicamente Activa (PEA) Ocupados) in the Lima and Callao Metropolitan Area was published in the study mentioned in 3) below. Future projections of the number of resident-based workers were conducted based on the results of the national census in 2007, and corresponded to the historical trend of the working population by job category.

1) Censos Nacionales 2007: XI de Población y VI de Vivienda Perfil Sociodemográfico de la Provincia de Lima, published by INEI in 2008
2) Censos Nacionales 2007: XI de Población y VI de Vivienda Perfil Sociodemográfico de la Provincia Constitucional del Callao, published by INEI in 2008
3) Perú: Evolucion de los Indicadores de Empleo e Ingresos por Departamentos, 2001-2010, published by INEI in 2011

4.5.2 Number of Workers at Working Place

Official data on working place-based number of workers is not available for the Lima and Callao Metropolitan Area. The national economic census was conducted in 2008 and published by INEI in 2010 as “Perú: IV Censo Nacional Economico”. From the results of the national census in 2007, the number of resident-based workers was 3,634,416 persons in 2007. On the other hand, the number of working place-based workers was 1,509,423 persons in the results of the national economic census in 2008. However the national economic census did not include data on agriculture, public administration and defense organizations, etc., so the differences in the working population seem excessive. Therefore, as with PMTU-2025, the Study Team assumed that the total number of resident-based workers and working place-based workers should be the same, but distributions of traffic zones are different. Future projections of working place-based working populations were conducted based on the future resident-based working populations estimated in section 4.5.1 and the future distribution of workers by traffic zone in PMTU-2025. Table 4.19 summarizes the future number of workers by industrial category, and Table 4.20 shows the summary of future number of workers by district level.

Table 4.19 Future Number of Workers by Industrial Category

Year	Primary Industry	Secondary Industry	Tertiary Industry	Total
2012	42,261	1,137,967	3,298,095	4,478,324
2020	33,666	1,292,977	3,686,811	5,013,454
2030	32,893	1,505,890	4,292,035	5,830,818

Source: JICA Study Team

Table 4.20 Future Number of Workers by District Level

Area	District Name	2012		2020		2030	
		at Resident Place	at Working Place	at Resident Place	at Working Place	at Resident Place	at Working Place
Sub Total [Lima Area]		4,031,028	4,015,547	4,516,202	4,424,161	5,259,013	5,146,460
Central Lima Area	Lima	146,050	561,634	146,220	455,295	150,625	529,842
	Barranco	16,972	23,693	16,864	27,384	17,201	31,882
	Breña	41,011	58,247	41,540	66,272	43,425	77,100
	Jesús Maria	35,158	79,037	37,239	88,471	41,083	102,910
	La Victoria	97,743	232,076	97,660	263,169	100,243	306,323
	Lince	28,699	81,333	28,863	53,690	29,922	62,467
	Magdalena del Mar	27,108	25,348	28,804	29,141	31,878	33,914
	Magdalena Vieja	38,677	38,064	40,482	43,912	44,048	51,062
	Miraflores	45,917	218,416	47,326	164,560	50,608	191,480
	Rimac	85,349	92,917	86,661	92,034	90,838	107,044
	San Borja	56,570	76,570	60,070	83,100	66,434	96,660
	San Isidro	30,624	146,813	31,179	171,332	32,858	199,233
	San Luis	29,240	45,695	31,234	47,030	34,731	54,737
	San Miguel	68,064	77,448	72,489	87,058	80,337	101,304
	Santiago de Surco	159,078	139,979	179,268	162,822	210,400	189,511
	Surquillo	47,358	62,294	49,661	68,672	54,119	79,930
Total [Central Lima Area]		953,619	1,959,564	995,559	1,903,942	1,078,750	2,215,400
North Lima Area	Ancón	16,749	9,974	19,673	13,197	23,927	15,134
	Carabayllo	114,174	50,189	139,139	79,348	174,220	92,012
	Comas	245,395	152,738	265,404	197,461	298,747	229,746
	Independencia	103,231	80,172	110,141	79,395	122,152	92,421
	Los Olivos	172,156	140,663	192,766	141,519	224,639	164,718
	Puente Piedra	127,831	94,134	160,794	71,642	205,908	83,281
	San Martín de Porres	307,052	145,502	350,094	165,846	414,788	192,968
	Santa Rosa	6,118	817	8,202	1,171	10,937	1,350
Total [North Lima Area]		1,092,706	674,189	1,246,213	749,579	1,475,318	871,629
South Lima Area	Chorrillos	152,528	127,111	168,650	119,555	194,203	138,953
	Cieneguilla	14,182	1,775	19,435	5,243	26,303	6,069
	Lurin	33,600	48,622	39,890	96,635	49,049	111,974
	Pachacamac	40,953	9,758	56,758	17,341	77,173	20,057
	Pucusana	5,606	2,303	7,161	2,326	9,318	2,550
	Punta Hermosa	3,244	1,854	3,831	3,135	4,677	3,626
	Punta Negra	2,876	1,464	3,608	1,744	4,615	2,014
	San Bartolo	3,051	1,609	3,610	1,912	4,423	2,207
	San Juan de Miraflores	191,515	126,230	210,266	136,022	240,334	158,339
	Santa Maria del Mar	505	0	739	48	1,032	56
	Villa El Salvador	205,456	113,492	234,039	189,950	276,918	221,149
	Villa Maria del Triunfo	200,236	104,752	225,844	98,536	264,843	114,664
Total [South Lima Area]		853,754	538,970	973,830	672,449	1,152,887	781,659
East Lima Area	Ate	262,056	231,731	310,137	193,264	379,275	224,874
	Chaclacayo	20,636	16,565	22,087	16,439	24,596	19,131
	El Agustino	93,213	50,071	100,276	54,520	112,228	63,478
	La Molina	76,263	46,655	89,194	75,333	108,175	87,488
	Lurigancho	89,159	128,601	104,142	386,389	126,177	449,439
	San Juan de Lurigancho	486,141	287,749	555,904	276,612	659,895	322,023
	Santa Anita	103,481	81,454	118,858	95,635	141,713	111,339
Total [East Lima Area]		1,130,949	842,824	1,300,599	1,098,192	1,552,058	1,277,771
Callao Area	Callao	205,742	259,650	211,863	238,783	219,027	276,445
	Bellavista	35,831	37,261	36,507	42,097	37,476	48,995
	Carmen de La Legua-Reynoso	20,893	24,475	21,648	18,648	22,654	21,713
	La Perla	30,112	18,266	30,679	19,677	31,485	22,895
	La Punta	1,980	3,664	1,841	4,875	1,758	5,643
	Ventanilla	152,738	119,462	194,715	265,212	259,405	308,667
Total [Callao Area]		447,296	462,777	497,252	589,293	571,805	684,358
Grand Total [Lima and Callao Metropolitan Area]		4,478,324	4,478,324	5,013,454	5,013,454	5,830,818	5,830,818

Source: JICA Study Team

4.6 Number of Students

For the projection of student populations, the Study Team categorized several levels of school into 3 groups similar to those in PMTU-2025. Table 4.21 shows categories of students.

Table 4.21 Categories of Students

Category		Including Levels of School in Peru	Age Group
1	Primary / Secondary School Student	-Educación Primaria -Educación Secundaria -Educación Básica Alternativa -Educación Especial	6-11 years old 12-16 years old
2	Superior School Student (including university and graduate school)	-Superior Universitaria -pre grado -post grado -Superior Pedagógica -Superior Tecnológica -Superior Artística	17 year old and over (mainly 17-24 years old)
3	Occupational School Student	CETPRO (Centro de Educacion Tecnico Productiva)	

Source: JICA Study Team

4.6.1 Number of Students at Residential Places

The latest national census in 2007 (mentioned in 1) and 2) below) includes the resident-based number of students in the Lima and Callao Metropolitan Area. The "Education Indicators by Department (Indicadores de Educacion por Departamentos), 2001-2010" mentioned in 3) below indicated that the percentage of school attendance in each category is almost at the same level over the most recent 10 years.

1) Censos Nacionales 2007: XI de Población y VI de Vivienda Perfil Sociodemográfico de la Provincia de Lima, published by INEI in 2008
2) Censos Nacionales 2007: XI de Población y VI de Vivienda Perfil Sociodemográfico de la Provincia Constitucional del Callao, published by INEI in 2008
3) Perú: Indicadores de Educacion por Departamentos, 2001-2010, published by INEI in 2011

Future projections of the number of resident-based students were conducted based on the results of the national census in 2007 and corresponding to the growth rates of the relevant age groups in the 3 categories. Table 4.22 summarizes the future number of resident-based students.

Table 4.22 Future Number of Students at Residential Places

Year	Primary / Secondary School Student	Superior School Student	Occupational School Student	Total
2012	1,550,395	551,426	67,137	2,168,958
2020	1,716,645	607,003	75,461	2,399,108
2030	1,886,629	656,943	83,209	2,626,781

Source: JICA Study Team

4.6.2 Number of Students at School Locations

The Ministry of Education publishes the web-based GIS database regarding the number of students in school locations (mentioned in 4) below). This database is prepared based on the results of the educational census (Censo Escolar), and the latest census was implemented in 2011. The number of students at school locations in the Lima and Callao Metropolitan Area in 2011 was aggregated from this database and divided into 427 traffic zones with the 3 categories mentioned above. As for university and graduate schools, the number of students was published by INEI in the national university census (Censo Nacional Universitario 2010) as mentioned in 5) below.

4) Estadistica de la Calidad Educativa (ESCALE) based on the results of educational census (Censo Escolar), operated by Ministry of Education
   web site: http://escale.minedu.gob.pe/web/inicio/padron-de-iiee
5) Perú: II Censo Nacional Universitario 2010, Sistema de Consulta de Base de Datos, operated by INEI
   web site: http://desa.inei.gob.pe/cenaun/redatam/?id=ResultadosCensales

Based on the latest number of students, future projections were conducted corresponding to the growth rates of the relevant age groups in the 3 categories. Table 4.23 summarizes the future number of students at school locations, and Table 4.24 shows the number of students at residential places and at school locations by district level.

Table 4.23 Future Number of Students at School Locations

Year	Primary / Secondary School Student	Superior School Student	Occupational School Student	Total
2012	1,698,956	525,457	94,981	2,319,394
2020	1,844,860	511,651	95,083	2,451,594
2030	1,989,674	485,189	92,875	2,567,738

Source: JICA Study Team

Table 4.24 Future Number of Students

Area	District Name	2012		2020		2030	
		at Residential Places	at School Locations	at Residential Places	at School Locations	at Residential Places	at School Locations
Sub Total [Lima Area]		1,947,232	2,121,317	2,131,835	2,221,359	2,332,210	2,326,587
Central Lima Area	Lima	57,722	209,469	48,052	175,838	36,901	135,374
	Barranco	5,945	15,539	4,755	12,345	3,395	8,797
	Breña	15,838	32,692	13,494	27,842	10,790	22,261
	Jesús Maria	12,724	28,901	12,120	27,560	11,393	25,924
	La Victoria	36,179	36,762	29,498	29,891	21,777	22,040
	Lince	9,558	17,661	7,911	14,629	6,021	11,139
	Magdalena del Mar	10,114	12,889	9,710	12,336	9,220	11,701
	Magdalena Vieja	14,769	78,577	13,674	73,645	12,385	67,089
	Miraflores	13,315	40,677	11,642	35,639	9,735	29,846
	Rimac	36,297	43,061	31,421	37,301	25,798	30,630
	San Borja	21,363	16,835	20,457	16,000	19,331	15,054
	San Isidro	9,338	71,584	7,895	61,344	6,258	48,958
	San Luis	11,872	12,936	11,556	12,528	11,180	12,094
	San Miguel	27,490	50,083	26,565	48,531	25,390	46,432
	Santiago de Surco	70,833	81,336	77,388	89,066	84,223	96,990
	Surquillo	17,667	11,253	16,408	10,392	14,956	9,453
Total [Central Lima Area]		371,024	760,254	342,544	684,887	308,755	593,783
North Lima Area	Ancón	10,271	9,351	13,244	11,089	16,447	13,066
	Carabayllo	67,352	49,796	85,336	62,896	105,051	77,472
	Comas	118,971	104,153	119,661	104,353	120,437	105,025
	Independencia	48,303	34,593	47,089	33,648	45,687	32,643
	Los Olivos	84,074	88,074	90,997	95,003	98,637	102,847
	Puente Piedra	80,202	59,729	106,916	79,355	136,005	100,930
	San Martín de Porres	154,627	111,918	173,227	124,917	193,635	139,554
	Santa Rosa	4,054	1,282	5,898	1,858	7,835	2,472
Total [North Lima Area]		567,855	458,896	642,368	513,118	723,734	574,008
South Lima Area	Chorrillos	72,704	66,086	76,711	69,506	81,160	73,499
	Cieneguilla	9,504	4,151	14,064	6,112	18,846	8,182
	Lurin	18,913	17,516	23,178	21,423	27,902	25,791
	Pachacamac	26,572	19,978	41,165	30,879	56,467	42,378
	Pucusana	3,459	2,275	4,786	3,141	6,215	4,082
	Punta Hermosa	1,508	472	1,806	563	2,132	664
	Punta Negra	1,529	1,029	2,013	1,350	2,534	1,700
	San Bartolo	1,975	1,369	2,394	1,648	2,855	1,961
	San Juan de Miraflores	91,410	78,455	94,963	81,236	98,972	84,610
	Santa Maria del Mar	293	130	484	214	677	300
	Villa El Salvador	106,710	82,771	119,654	92,601	134,270	103,913
	Villa Maria del Triunfo	99,596	82,531	109,310	90,279	120,243	99,321
Total [South Lima Area]		434,171	356,761	490,529	398,952	552,274	446,400
East Lima Area	Ate	141,002	112,494	169,972	135,082	202,010	160,410
	Chaclacayo	9,781	11,316	9,616	11,069	9,414	10,832
	El Agustino	43,395	27,534	43,111	27,232	42,799	27,009
	La Molina	36,927	58,337	43,426	68,686	50,310	79,610
	Lurigancho	50,540	54,982	59,767	65,118	70,016	76,287
	San Juan de Lurigancho	245,029	190,027	276,501	213,605	311,685	240,530
	Santa Anita	47,508	90,717	54,003	103,610	61,214	117,718
Total [East Lima Area]		574,183	545,406	656,395	624,401	747,448	712,396
Callao Area	Callao	89,279	75,571	89,600	75,881	73,606	61,981
	Bellavista	14,795	35,890	14,616	35,467	11,608	28,298
	Carmen de La Legua-Reynoso	8,773	8,280	8,861	8,363	7,423	6,960
	La Perla	11,771	8,850	11,625	8,746	9,176	6,849
	La Punta	650	647	495	494	245	240
	Ventanilla	96,458	68,839	142,075	101,284	192,513	136,823
Total [Callao Area]		221,726	198,077	267,272	230,235	294,570	241,151
Grand Total [Lima and Callao Metropolitan Area]		2,168,958	2,319,394	2,399,108	2,451,594	2,626,781	2,567,738

Source: JICA Study Team

4.7 Number of Vehicles

From the results of Person Trip Survey conducted by the JICA Study Team, the number of vehicles in the Lima and Callao Metropolitan Area was estimated. Based on the premise that the number of vehicles owned by household should be different by household income level, the estimate was conducted by the process as described in Section 4.7.1.

The 8 levels of household income ranges set in the Person Trip Survey corresponded to the socio-economic levels described in Section 4.4. Additionally, to cover the lack of survey samples, those household income levels were integrated in 2 levels as shown in Table 4.25.

Table 4.25 Household Income Level and Socio-economic Level

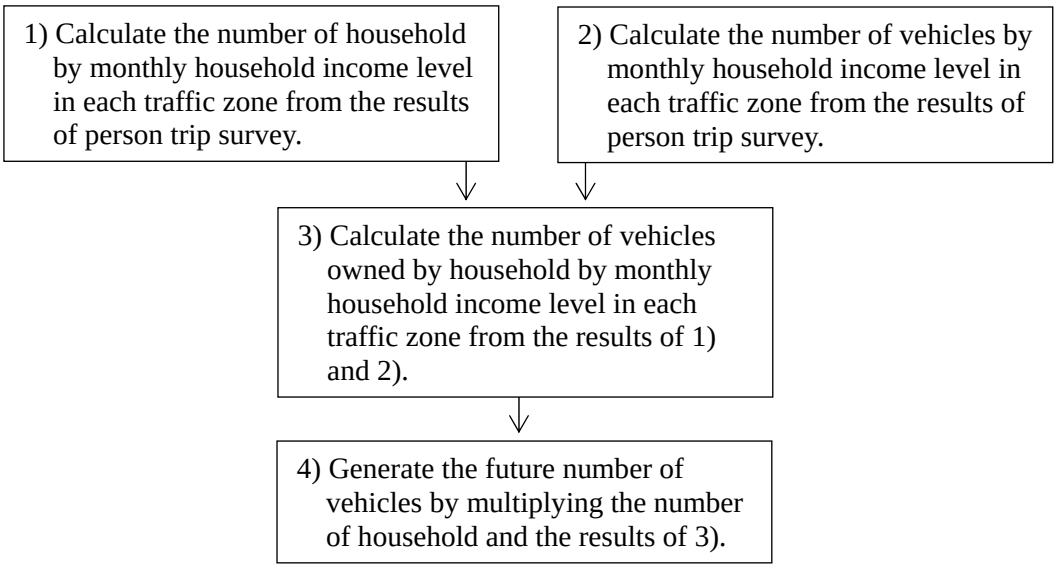
Monthly Household Income (in person trip survey)	Socio-economic Level
8	A, B
7	
6	C
5	D
4	E
3	
2	
1	

Monthly Household Income (in person trip survey)	Socio-economic Level
8, 7, 6	A, B, C
5, 4, 3, 2, 1	D, E

Source: JICA Study Team

4.7.1 Projection Process for Number of Vehicles

Figure 4.7.1 shows the flowchart and description of the projection process.



Source: JICA Study Team

Figure 4.11 Flowchart for Projection Process of Number of Vehicles

1) From the results of Person Trip Survey, the number of households in 2 levels of the above-mentioned monthly household income level was aggregated into 427 traffic

zones.

2) From the results of Person Trip Survey, the number of vehicles by monthly household income level (2 levels) was aggregated into 427 traffic zones.

3) From the results of stages 1) and 2), the number of vehicles owned by household by monthly household income level (2 levels) was calculated.

4) Finally, by multiplying the estimated future number of households by monthly household income level (2 levels) and the results of 3) above, the number of vehicles in the Lima and Callao Metropolitan Area was estimated. For some traffic zones, in the case that the number of vehicles owned by households cannot be calculated owing to the lack of survey samples, the estimated number of neighboring traffic zone was adopted.

4.7.2 Future Number of Vehicles

Table 4.26 shows results of projection of future number of vehicles in the Lima and Callao Metropolitan Area.

Table 4.26 Future Number of Vehicles in the Lima and Callao Metropolitan Area

Area	District Name	Number of Vehicles		
		2012	2020	2030
Sub Total [Lima Area]		672,365	835,045	972,744
Central Lima Area	Lima	9,400	8,665	7,176
	Barranco	3,655	3,777	2,993
	Breña	7,934	9,082	8,811
	Jesús Maria	10,746	11,411	11,981
	La Victoria	12,840	12,922	10,230
	Lince	9,138	8,890	7,580
	Magdalena del Mar	2,708	3,791	4,121
	Magdalena Vieja	14,420	15,162	15,121
	Miraflores	29,442	33,041	32,088
	Rimac	10,793	10,870	10,034
	San Borja	30,467	32,950	33,787
	San Isidro	21,722	21,524	19,052
	San Luis	6,463	7,025	7,515
	San Miguel	11,848	12,626	13,254
	Santiago de Surco	66,914	86,685	102,126
	Surquillo	16,827	19,834	20,763
Total [Central Lima Area]		265,317	298,254	306,632
North Lima Area	Ancón	240	235	199
	Carabayllo	10,851	15,500	19,552
	Comas	27,769	29,753	32,144
	Independencia	13,120	12,089	12,858
	Los Olivos	26,890	33,958	40,200
	Puente Piedra	8,369	11,649	15,623
	San Martín de Porres	48,365	61,097	73,962
	Santa Rosa	1,052	1,997	2,943
Total [North Lima Area]		136,657	166,278	197,481
South Lima Area	Chorrillos	22,948	25,397	29,191
	Cieneguilla	1,469	2,172	2,893
	Lurin	3,082	5,779	8,479
	Pachacamac	3,604	7,515	11,632
	Pucusana	659	1,506	2,697
	Punta Hermosa	2	5	10
	Punta Negra	187	257	340
	San Bartolo	364	470	607
	San Juan de Miraflores	22,906	27,070	31,087
	Santa Maria del Mar	162	338	544
	Villa El Salvador	30,851	43,001	53,571
	Villa Maria del Triunfo	21,535	29,748	36,128
Total [South Lima Area]		107,770	143,257	177,178
East Lima Area	Ate	41,909	60,412	80,643
	Chaclacayo	6,944	13,893	16,886
	El Agustino	8,391	12,758	14,125
	La Molina	30,793	45,596	56,818
	Lurigancho	11,939	19,738	29,170
	San Juan de Lurigancho	48,419	55,013	68,486
	Santa Anita	14,226	19,846	25,324
Total [East Lima Area]		162,622	227,255	291,453
Callao Area	Callao	10,517	8,899	7,549
	Bellavista	5,924	6,391	5,486
	Carmen de La	2,798	2,450	2,241
	La Perla	5,733	5,311	4,430
	La Punta	267	167	84
	Ventanilla	8,418	11,542	18,149
Total [Callao Area]		33,656	34,760	37,940
Grand Total [Lima and Callao Metropolitan Area]		706,021	869,805	1,010,684

Source: JICA Study Team

Chapter 5 Demand Forecast

5.1 Introduction

This chapter describes the methodology and the results of the modeling of the transport system in the Study Area.

The main data source of the study was the Person Trip Survey in this Study. The matrices estimated in the Person Trip Survey were calibrated for the demand forecast modeling.

After the calibration of the matrices, the trip generation model, which estimates the trip production and attraction by traffic zone, was developed by analyzing relations between the number of trips and socio-economic data.

The next step was to develop the trip distribution model using the impedance matrices from network model. A gravity model was calibrated for the trip distribution model.

The sequence was the modal split model. A binary Logit model was utilized in this step.

Finally, the trip matrices by mode were assigned to the network model.

The future supply scenarios were also defined and, consequently impedance matrices for 2020 and 2030 estimated from the network model. These impedance matrices allowed the application of the distribution model and the modal split model for each target year. The results of this process were the private and public matrices estimated for the target years that permitted the simulation and analysis of the future network.

The process shortly described above is better detailed in the following chapters:

1) Zoning system;
2) Network modeling;
3) Calibration of the matrices;
4) Transport Models
   a) Trip Generation Model;
   b) Trip Distribution Model;
   c) Modal Split Model;
   d) Validation of the Model.
5) Supply Scenarios;
6) Future Matrices;
7) Simulation of Alternatives
8) Final Results

5.2 Zoning System

The same zoning system, consisting of 427 traffic zones, as adopted in the study of PMTU-2025 was also used for this Study. Lima has 401 zones and 26 are located in Callao.

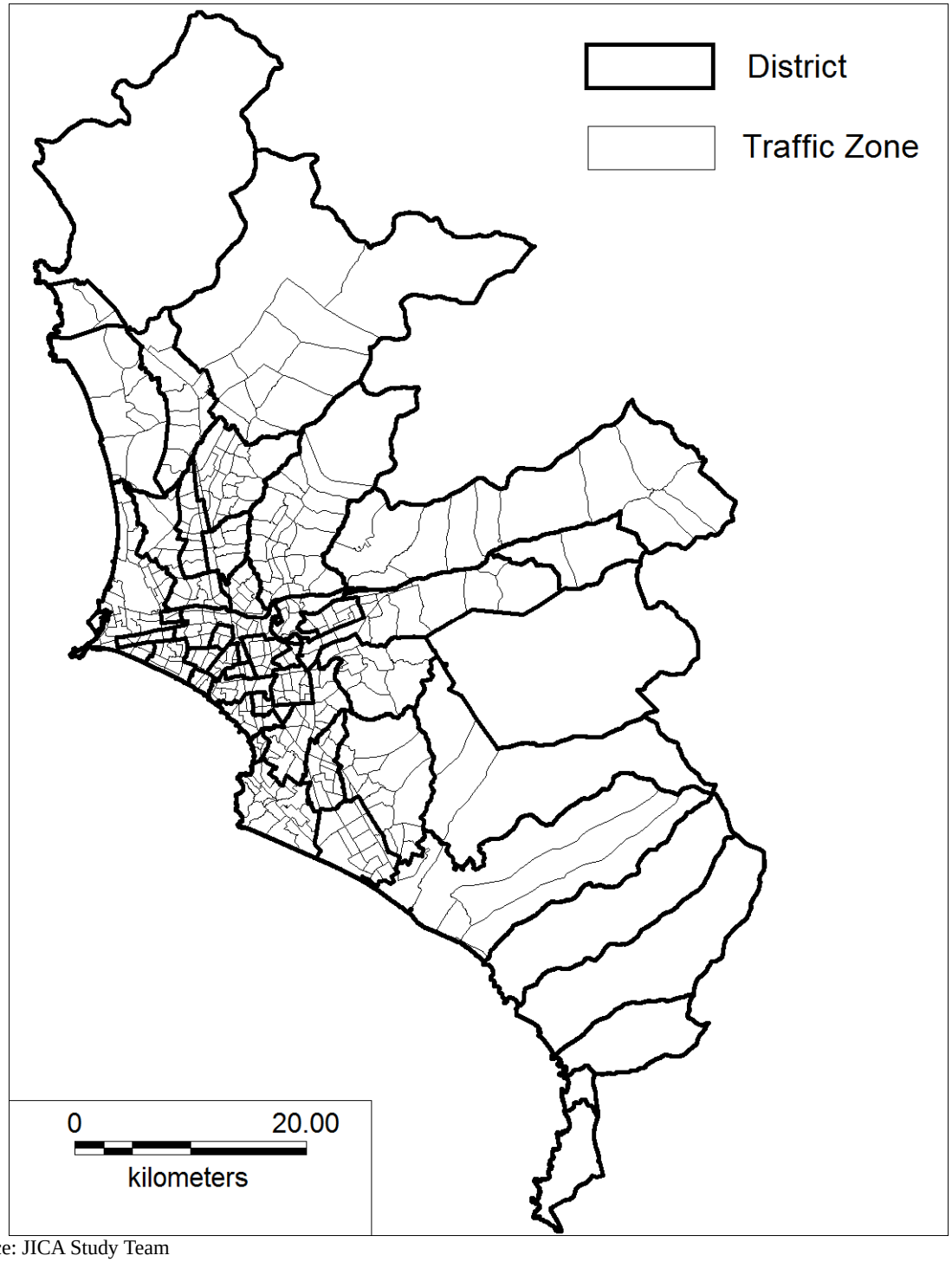
An upper level of aggregations was also defined considering the 49 districts of the Study Area. Table 5.1 shows the number of traffic zones by district, and Figure 5.1 illustrates the zones.

Table 5.1 Number of Traffic Zones by District

DISTRICT	ZONES
ANCON	1
ATE VITARTE	17
BARRANCO	5
BELLAVISTA	5
BRENA	3
CALLAO	26
CARABAYLLO	11
CARMEN DE LA LEGUA REYNOSO	2
CHACLACAYO	2
CHORRILLOS	19
CIENEGUILLA	1
COMAS	22
EL AGUSTINO	8
INDEPENDENCIA	7
JESUS MARIA	7
LA MOLINA	10
LA PERLA	3
LA PUNTA	1
LA VICTORIA	12
LIMA	22
LINCE	3
LOS OLIVOS	13
LURIGANCHO	12
LURIN	7
MAGDALENA DEL MAR	3

DISTRICT	ZONES
MIRAFLORES	8
PACHACAMAC	3
PUCUSANA	1
PUEBLO LIBRE	5
PUENTE PIEDRA	10
PUNTA HERMOSA	1
PUNTA NEGRA	1
RIMAC	9
SAN BARTOLO	1
SAN BORJA	11
SAN ISIDRO	9
SAN JUAN DE LURIGANCHO	26
SAN JUAN DE MIRAFLORES	14
SAN LUIS	3
SAN MARTIN DE PORRES	15
SAN MIGUEL	10
SANTA ANITA	8
SANTA MARIA DEL MAR	1
SANTA ROSA	3
SANTIAGO DE SURCO	22
SURQUILLO	5
VENTANILLA	9
VILLA EL SALVADOR	15
VILLA MARIA DEL TRIUNFO	15
Total	**427**

Source: JICA Study Team



Source: JICA Study Team

Figure 5.1 Traffic Zones and Districts of the Study Area

5.3 Network Modeling

The network model consists of public and private networks. The network model was built in TransCad software which has been used for the recent transport studies in the Study Area.

5.3.1 Private Mode

The private network is represented by the main road network associated with operational

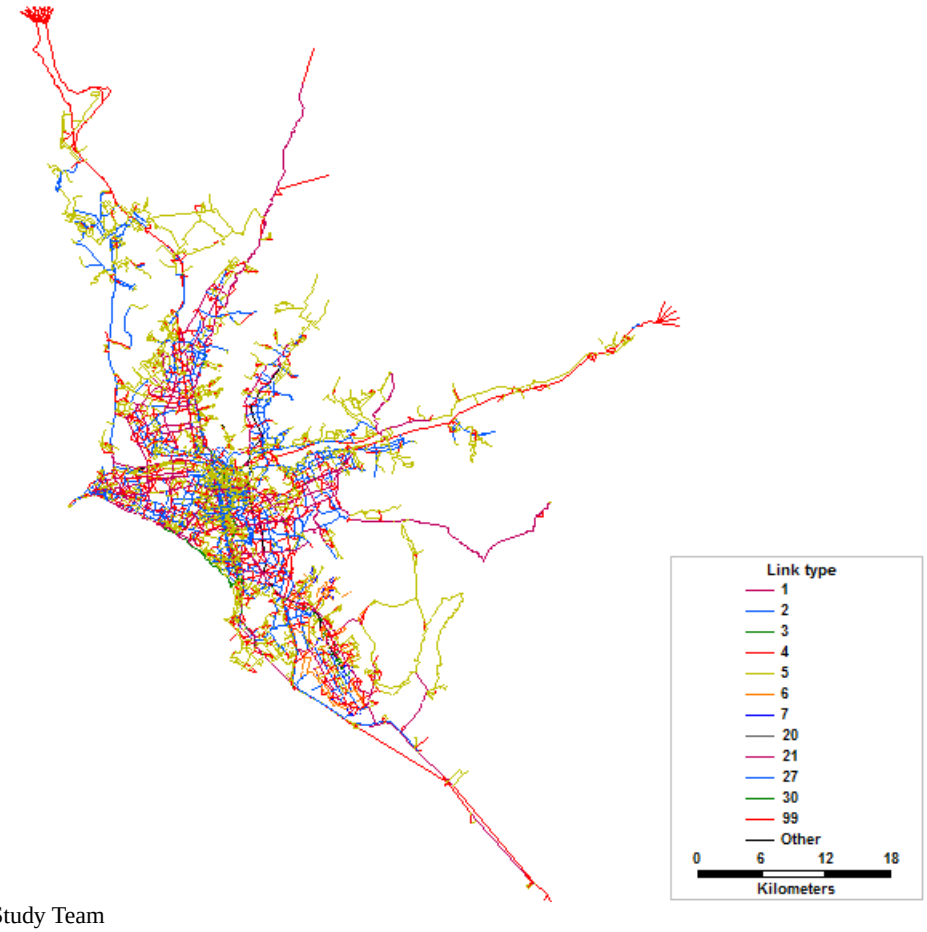
attributes such as road class, capacity, distance, free flow speed, and toll location. Table 5.2 shows the value of attributes adopted in the model.

Table 5.2 Parameters for the Network Model

Type	Road Class	Capacity/lane	Speed (km/h)
1	Arterial	1,200	45-60
2	Collector	960	30
3	Express	1,400	80
4	Highway	1,400	80
5	Local Type 1	840	25
6	Local Type 2	700	20
7	Local Type 3	600	10
20	Metropolitan (BRT)	37,400	30
21	Railway	24,000	40
30	Pedestrian	1,200	4
99	Connector	9,999	4

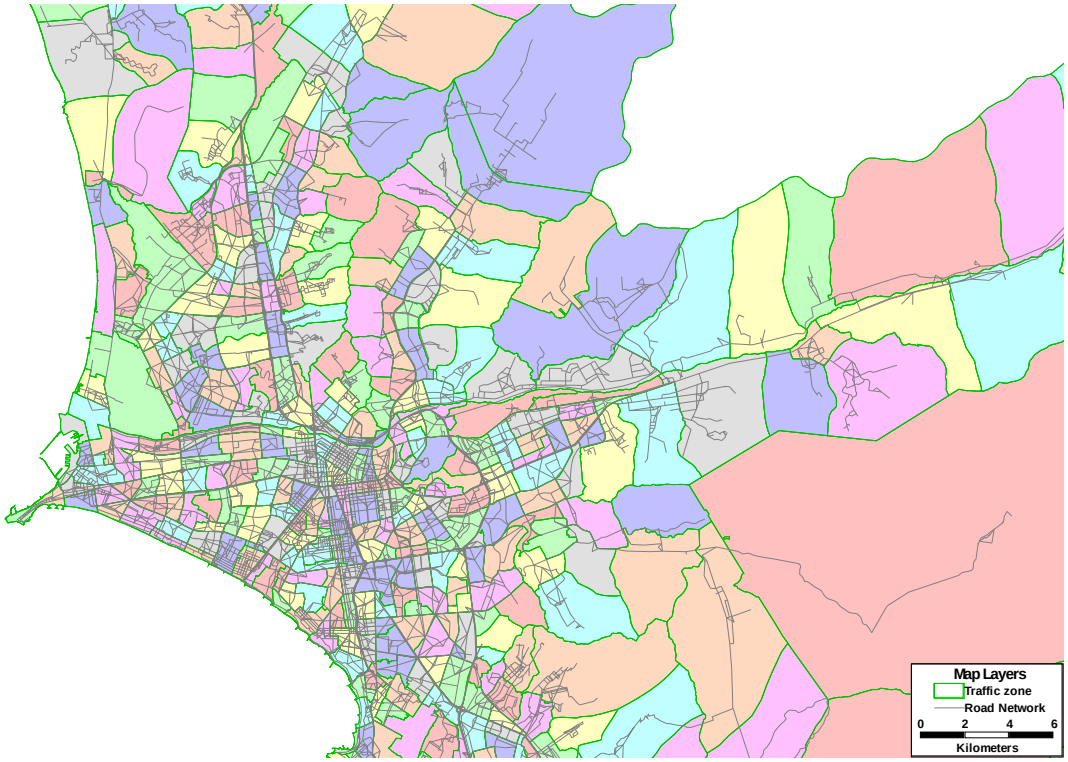
Source: JICA Study Team

Figure 5.2 illustrates the private network model and Figure 5.3 illustrates the network in the central area with the zoning system.



Source: JICA Study Team

Figure 5.2 Private Network Model



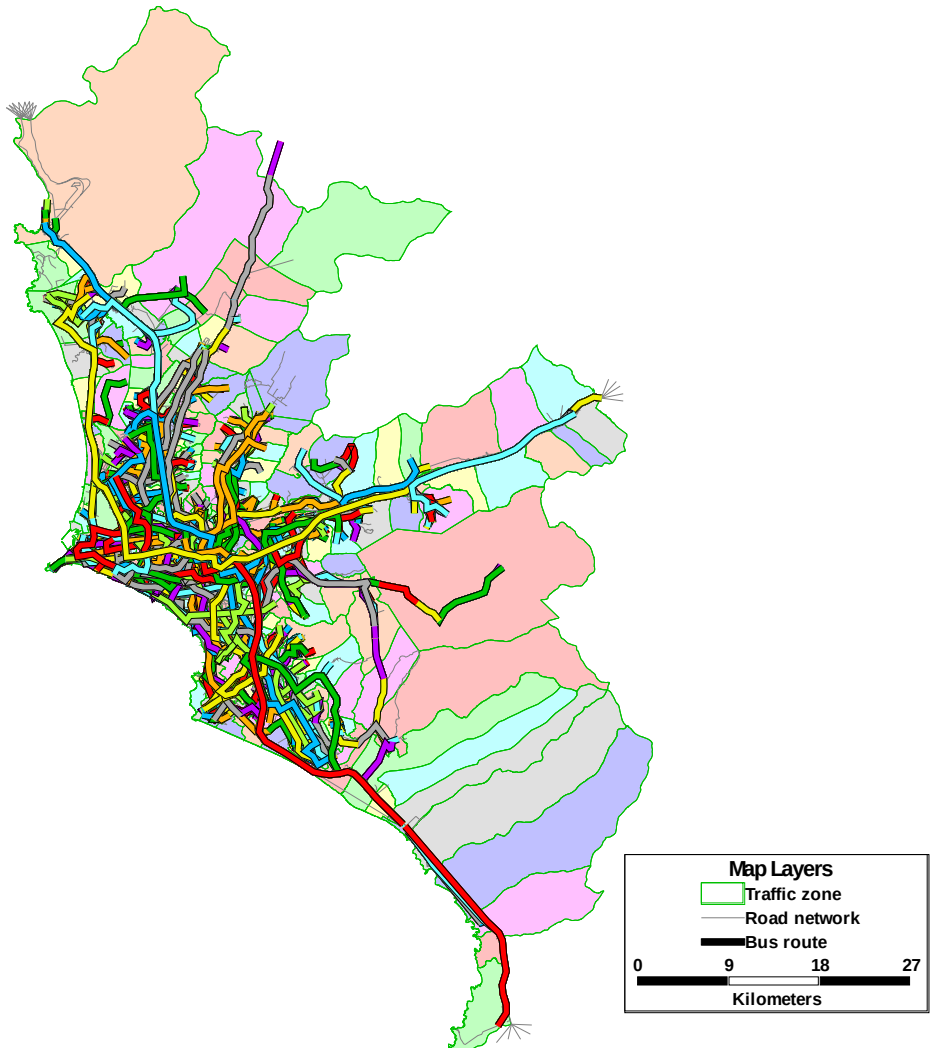
Source: JICA Study Team

Figure 5.3 Private Network and Zoning System

5.3.2 Transit Mode

The transit mode network is more complex than private mode network due to bus routes and other public lines as BRT and railway lines as shown in Figure 5.4.

There are 590 routes in the transit network. Each line has attributes such as headway, type of vehicle, capacity and fare.



Source: JICA Study Team

Figure 5.4 Bus Route Network in the Study Area

5.4 Calibration of the matrices

The Person Trip Survey produces raw private and public matrices that need to be adjusted by comparing the traffic assignment and traffic count data. This process also called matrix calibration.

The adjustment was done for the morning peak hour by using an automated algorithm given by TransCad and additional manual adjustment.

Figure 5.5 and Figure 5.6 show the comparison between the traffic count data and simulated data for private and public mode, respectively. R^2 was calculated at 0.95 for private mode and 0.89 for public mode. The results are reasonable for the demand forecast in the Study.