Transportation Council of Lima and Callao,
Ministry of Transportation and Communications
The Republic of Peru

Feasibility Study on Urban Transportation in the Lima and Callao Metropolitan Area in the Republic of Peru

Final Report

March 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

YACHIYO ENGINEERING CO.,LTD
CHODAI CO.,LTD

Exchange Rates: May 2006

US$ 1.00 = Soles S/. 3.25

US$ 1.00 = ¥ 116.35

Preface

In response to a request from the Government of the Republic of Peru, the Government of Japan decided to conduct Feasibility Study on Urban Transportation in the Lima and Callao Metropolitan Area in the Republic of Peru and entrusted the study to Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Koichi TSUZUKI of Yachiyo Engineering Co., Ltd., to Peru, Two times between May 2006 and December 2006. In addition, JICA set up an advisory committee headed by Dr. Hisao UCHIYAMA, Tokyo University of Science between April 2006 and December 2006, which examined the Study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Peru and conducted a field survey in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to officials concerned of the Government of the Republic of Peru for their close cooperation extended to the team.

March 2007

Kazuhisa MATSUOKA
Vice President
Japan International Cooperation Agency

Letter of Transmittal

March 2007

Mr. Kazuhisa MATSUOKA
Vice President
Japan International Cooperation Agency

Dear Sir:

It is a great honor for me to submit herewith the final reports of Feasibility Study on Urban Transportation in the Lima and Callao Metropolitan Area in the Republic of Peru.

A study team, which consists of Yachiyo Engineering Co., Ltd. and Chodai Co., Ltd, conducted field surveys, data analysis and planning works of the feasibility study in Peru based on the terms of references instructed by the Japan International Cooperation Agency (JICA) from April 2006 to March 2007.

The study team held thorough discussions and investigations with officials concerned of the Government of Peru, accordingly, various traffic surveys, present conditions analysis, Environmental Study, preparation of implementation project, and project evaluation. The results were compiled in the final report, main and summary volumes.

On behalf of the team, I wish to express my heartfelt appreciation to the officials concerned of the Government of Peru for their warm friendship and cooperation extended to us during our stay in Peru.

I also wish to express my sincere appreciation to JICA, Consejo de Transporte de Lima y Callao, Ministry of Transportations and Communications, the Embassy of Japan in Peru, and other government authorities concerned for their valuable advice and cooperation given to us in the course of the Study.

Yours Faithfully,

Koichi TSUZUKI
Team Leader,
Feasibility Study on Urban Transportation in the Lima and Callao Metropolitan Area in the Republic of Peru

EXECUTIVE SUMMARY

SUMMARY OF EAST-WEST TRUNK BUS FEASIBILITY STUDY

The Feasibility Study on Urban Transportation in the Lima and Callao Metropolitan Area in the Republic of Peru (the Study) was commenced on May 2006, and Draft Final Report of the Study was submitted to the Peruvian Counterpart on December 2006. The Study was conducted by the closely cooperation with members of Steering Committee, Technical Committee and Peruvian Counterparts. The results of the Study are summarized in Table S-1.

Table S-1 Summary of the Study

Study Field	Items	Results of the Study
General	Objectives	1) To formulate Feasibility Study of East-West Trunk Bus System. 2) To develop Improvement Plan of Traffic Management. 3) To transfer Technology to Peruvian Counterpart
	Study Area	1) On Av. Venezuela, Av. Arica, Av. Ayllon, and Carretera Central for F/S 2) Critical Areas for Traffic Management Plan
	Target Year	In year 2010
	Execution Organization	1) Government of Peru 2) Government of Japan
Socioeconomic Conditions in Metropolitan Area	Population	1) About 8.0 million in 2004 2) About 11.0 million in 2025
	Other Indicators	Various socioeconomic indicators were adopted based on the M/P conducted in 2005.
Traffic Conditions in Metropolitan Area	Modal Share	Passenger car=24%,Taxi=33%,Combi=18%, Microbus=11%,Bus=5%,Truck=6%,M/C=3%
	Total Travel Demand	1) No. of Trips=16.538 million/day 2) Trip rate=2.1 times/day 3) No. of Trips Excluding Walk Trips=12.246 million/day
	Bus Route	1) Av. bus routes length=60km to70km long 2) Bus routes were concentrated at trunk roads
	Travel Time	Ave. bus travel time =60 minutes
Traffic and Bus Conditions on Project Road	Field Survey	Traffic count survey, bus passenger survey, facilities survey were conducted in the Study. The results of surveys were submitted to Peruvian Counterpart by CD-ROM
	Traffic Volume	The maximum traffic volume (about 65,000 vehicles per day) was observed at the central areas.
	Modal Share	Passenger car and taxi=17%,Combi=55%, Microbus=28%depend on the road segment.
	Bus operation speed	1) Central areas=10km/h to 20km/h 2) Suburban areas=20km/h to 30km/h
	Bus Fare	Average bus fare was observed at S/ 1.0 to S/1.9.
	No. of Bus Route	1) About 100 routes to 150 routes in 2004. 2) About 22 routes in 2007.
Traffic Projection	Demand Forecast	Based on the results of the Master Plan conducted in 2005, the future traffic and transport projection was estimated. The future socioeconomic framework of the Study was also adopted by the results of the Master Plan.
Recommendation Of East-West Trunk Bus (Component-I)	Location of Trunk Busway	East-West trunk busway is planned on Av. Venezuela, Av. Arica. Av. Grau, Av. Ayllon, and Carretera Central. However, trunk busway of Av. Grau already was constructed in 2006.
	Location of Bus Terminals	Following two bus terminals are planned. 1) One terminal is planned at Santa Anita in Lima city. 2) One terminal is planned at end of Av. Venezuela in Callao

		city
	Location of Bus Stop	The bus stop of trunk busway was planned at major intersection, based on the interval about 800m to 1,000m distance.
	Trunk bus Operation Route	Following 3 bus routes are recommended. 1) Line-1=Santa Anita----Central bus station 2) Line-2=Callao----Central bus station 3) Line-3=Callao----Santa Anita(Via Central bus station)
	Feeder Bus Operation Route	Following feeder bus routes are recommended. 1) 3 feeder bus routes= Santa Anita---Santa Clara 2) 3 feeder bus routes=Santa Anita---Huaycan 3) 5 feeder bus routes=Callao terminal----inside city
	Conventional Bus Re-routing	1) There are 73 conventional bus routes on project road. 2) 22 conventional bus routes are eliminated
	Passenger Volume on Trunk Bus	1) 13,685 persons/hr./dir in 2010 2) 16,755 persons/ hr./dir in 2025
	Trunk Passenger volume in 2010	1) Line-1=4,000 to 6,000 persons/hr./dir. 2) Line-2=1,700 to 3,800 persons/hr./dir. 3) Line-3=5,000 to 6,000 persons/hr./dir.
	Passenger Volume in Bus Terminal	Callao Bus Terminal 1) Trunk bus=5,330 persons/hr./both dir. 2) Feeder bus=1,652 persons/hr./both dir. Santa Anita Bus terminal 1) Trunk bus=14,394 persons/hr./both dir. 2) Feeder bus=10,149 persons/hr./both dir.
	Trunk Bus Operation Frequency	1) Line-1=1.7 to 2.5 minutes 2) Line-2=3.0 to 4.6 minutes 3) Line-3=1.7 to 2.3 minutes
	Feeder Bus Operation Frequency	1) Callao Area=5.0 to 12.0 minutes on each 5 route 2) Santa Clara Area=1.0 to 8.0 minutes on each 3 route 3) Huaycan Area=2.5 to 3.5 minutes on each 3 route
	Trunk Bus Fleet Required	1) Line-1=about 30 Articulated Bus 2) Line-2=about 16 Articulated Bus 3) Line-3=about 50 Articulated Bus 4) Total 100 Articulated Bus Fleets required 5) Bus doors are settled at left side of bus fleet 6) Bus floor height is 90 cm
	Feeder Bus Fleet Required	1) Callao Area= 40 Single Bus 2) Santa Clara Area=130 Single Bus 3) Huaycan Area=130 Single Bus 4) Total 300 Single Bus Fleets required 5) Bus doors are settled at left side of bus fleet
	Bus Operation System	1) Trunk bus from/to Trunk bus= integrated 2) Trunk bus from/to Feeder bus=integrated 3) Trunk bus from/to Conventional bus= not integrated 4) Feeder bus from/to Conventional bus= not integrated
	Bus Fare System	1) Constant bus fare rate system is recommended 2) Trunk bus only=S./1.5 per person 3) Trunk bus and feeder bus=S./ 1.5 per person 4) Feeder bus only=S./1.5 per person
	Bus Fleet Required	1) Trunk bus= Articulated Bus with 4 doors, (CNG),(capacity is 160 to 170 persons) 2) Feeder bus=Single Bus with 2 doors, (CNG), (capacity 30 to 40 persons)
	Trunk Busway Facility	1) 2-lane bus exclusive road (width of bus exclusive lane= 8.0m) is recommended 2) Typical cross sections of trunk busway including other

		traffic lanes are adopted at 52.0m(Type-A), 42.0m(Type-B), 36.0m(Type-C), 32.0m(Type-D), and 25.0m(Type-E) in accordance with right of way width of existing roads. 3) Bus exclusive lane is separated from other vehicle lanes by divider. 4) Bus exclusive lane is planned at center lane of existing Av. Venezuela, Av. Arica, Av. Ayllon, and Carretera Central.. 5) Generally, bus exclusive lane is planned without additional land acquisition. 6) However, some road segments on Av. Venezuela are required additional land acquisition.
	Intersection Facility	1) At-grade intersection type is planned at each intersection. 2) Bus stops of trunk bus are planned at the major intersections 3) Bus exclusive traffic signals are settled at intersection 4) Turn left traffic from trunk busway is prohibited.
	Bus Stop Facility	1) Size of bus platform: L=50m, W=3.5m, H=90cm 2) Bus stop are planned at after crossing intersection 3) Platform is planned at left side of bus lane 4) Pedestrian signal required at each bus stop
	Environmental Aspects	1) There is no remarkable negative environmental impact. 2) CO2 vehicle emission can be decreased 3) Noise level along road sides can be decreased 4) Additional land acquisition on some road segments of Av. Venezuela are required 5) Environmental monitoring during construction stage should be conducted.
	Project Cost	1) Project Cost of Construction of Road Facilities a) Construction Cost =US$ 28,945 million b) Land acquisition Cost =US$9,301million c) Engineering Cost =US$3,825million d) Administration Coat =US$3,825million e) Contingency =US$5,737million f) IGV =US$9,810million g) Total =US$61,442million 2) Bus Fleets Procurement Cost =US$52.0million 3) Operation and Maintenance Cost (OM Cost) for Trunk bus operation = US$ 16,996million
	Economic Evaluation	As the results of economic analysis, following matters are evaluated. 1) EIRR=15.4% 2) NPV=US$35,302million 3) B/C=1.26 As the EIRR (15.4%) is exceeded the discounted ratio (11%), the East-West trunk bus project is economically feasible.
	Financial Analysis	As the financial analysis, following maters are evaluated. 1) Financial Internal Ratio of Return (FIRR) in Case-A and Case-B are calculated at 9.5% and 7.9%. 2) FIRR in Case-C and Case-D are calculated at 18.2% to 15.7%. 3) FIRR in Case-E, Case-F and Case-G are calculated at 16.9%, 14.3%, and 23.9%. Considering above mentioned conditions, the FIRR of the Case-C to Case-G are exceed the interest of commercial bank (about 15%). Therefore, these 5 cases are financially feasible.

	Execution Organization	1) Protransport is recommended for the execution of East-West trunk bus system under controlled by municipalities. 2) Protransporte has responsible for construction of busway and related facilities, and also control and management of East-West trunk bus system. 3) A newly private bus company (Consortium) has responsible for procurement of bus fleets, and operation and maintenance of East-West trunk bus system under controlled by Protransporte. 4) Municipalities have responsible for control and management of all bus transport in metropolitan area, and also Protransporte and a newly private bus company.
	Social Impact	1) When the East-West trunk bus system is operated, about 1,000 employees who working the conventional bus are lost the jobs. A newly private company (consortium) should be employed the 1,000 parsons priority under controlled condition of concession. 2) When the East-West trunk bus system is operated, about 400 newly bus fleets are introduced. In this case, the environmental aspects such as air- pollution and spectacle of town are improved. 3) When the East-West trunk bus system is operated, the infrastructures and related facilities, and existing bus operation system are improved. In this case, the socioeconomic activities can be also increased. 4) During the construction stage of the busway, newly jobs can be created.
Recommendation of Traffic Management Plan (Component-II)	Road Safety Education Plan	1) The target group for the plan is divided to 2 groups; a) children group, and b) public entities operators. 2) National Council of Road Safety (CNSV) should be enhanced by effective function and staffing. 3) The training program for children; specific road safety lessons in the national curriculum can be included in the school timetable. 4) Teacher's guideline for road safety education by target age group is introduced, to give teachers correct information to be able to teach road safety effectively. 5) Safe driving managers should be staffed in each public transport entity, in order to manage the vehicle operation and safety driving. 6) A safe driving manager's guideline for the road safety education of public transport operators is introduced.
	Road Accident Monitoring Plan	1) The target group for the road accident monitoring plan will be divided to 2 groups; a) road planners and engineers, and b) traffic police. 2) The road accident monitoring plan should be formulated, consisting of 5 functions: a) investigation and database system, b) analysis system on hazardous locations and confirmation of problems, c) system for planning of measures, d) implementation of countermeasures system, c) follow-up system. 3) As the pilot study, remedial measures for 12 black spots in the area managed by 6 police stations are proposed.
	Intersection Improvement Plan	1) The target route for the intersection improvement plan is Av. Aviacion and Av. Tomas Marsano in total length of

		11.7km 2) The major causes of traffic congestion are: a) unsuitable traffic signal control systems, b) blocking of intersection due to heavy left-turn vehicles, c) conflict of buses near bus stops, and d) merging and diverging from/to side roads. 3) The intersection subject will be identified, 16 intersections by revise of signal phase and split, 7 intersections by improvement of traffic signal phase and split system at signalized intersection, taking into account exclusive left-turn phase, and 7 intersection will be newly signalized. 4) 4 sub areas for synchronized control system on Av. Aviacion, and two (2) sub areas on the Av. Tomas Marsano will be formulated. 5) A traffic channelization measure for the intersections will be prepared in order to achieve the smooth flow of traffic.
	Traffic Demand Management Plan	1) The best one of TDM measures is selected, as license-plate numbering system, and recommendable other TDM measures will be area licensing system (ALS) and auto-restricted zone in CBD. 2) The area of Av. Angamos-Arequipa-Javier Prado-Brasil-Av. Alfonso Ugarte-Aviacion (31km^2) is preferable to introduce for the area licensing system. 3) The ALS is controlled by toll collection of the manual method. 4) The operation time is defined as 12 hours 7:00-19:00. 5) The toll charge is recommendable in the range of S./1.0-S./2.0. 6) The control facilities is classified into 3 types; a) 2-3 tollbooths on 40 each road, b) 1 tollbooth on each 59 road, and c) 94 one way regulations on narrow streets. 7) It is preferable that this project should be managed by Lima Municipality.
	On-street Parking Improvement Plan	1) Two target areas were selected: a) Av. Angamos Este (Cdras. 6-17) , and b) Av. Saenz Peña 2) Two kinds of prohibition measures will be recommended; one is the prohibition of on-street parking on the principal road during 6:00-21:00 and the other is to charge all vehicles on the minor streets. 3) It is recommended here to adopt parking ticket system which is economic and does not use any machine or instrument. 4) One (1) hour ticket should be introduced. The rate of parking charge is recommendable to be between S/.1.0 and S/.1.5 per hour. 5) Implementation organization will be same as the current organization: Surquillo and San Borja District Municipality and Callao City Municipality. 6) The local facility for the on-street parking charge system is composed of parking spaces and guide signs.
	Action Plan for Road Accident Monitoring Plan	1) The action plan for road accident monitoring plan was identified. The practical action plans proposed: a) sustainable institutional organization, b) a guideline for road accident monitoring system, and c) implementation of seminar. 2) A sustainable organization system with clear the mechanisms and functions of relevant agencies was

		proposed. 3) The guideline was prepared; the guideline consists of 5 chapters, which are equipped with practical examples of traffic accident. 4) The seminar was conducted by using text material (a guideline for road accident monitoring plan), the target audience for the seminar is divided into 2 groups; a) road planners /engineers, and b) traffic police.
	Project Cost	1) Project cost for the traffic management plan: a. Road safety education plan: US$2.71 million b. Road accident monitoring plan: US$1.56 million c. Intersection improvement plan: US$4.73 million d. Traffic demand management plan: US$2.40 million e. On-street parking improvement plan: US$0.05 million 2) Maintenance/operation cost for the traffic management plan: a. Intersection improvement plan: US$0.2 million b. Traffic demand management plan: US$2.13 million c. On-street parking improvement plan: US$0.38 million
Development strategy of Taxi	Suggestion and Technical Analysis for taxi transport	1) Station taxi system is suggested. Taxi passenger goes to a trunk bus stop with taxi and gets on the trunk bus to go to a destination instead the direct arrival with taxi. 2) As a result of the analysis, current taxi trip will decrease approx. 10% by vehicle-km base, and individual taxi trip decrease 20%. 10% of current taxi trip will exchange into the trunk bus use trip.
	Development strategy	1) Taxi will be functioned as a sub-mode of railway and the trunk bus in the future public transportation hierarchy. 2) Taxi registration system is introduced and all taxis are operated as authorized taxis.
Development strategy of Colectivos	Suggestion and Technical Analysis for colectivo transport	1) Elimination of 7 routes overlapped 20% or more parts of total with the trunk bus route are suggested 2) Future demand of colectivo will rise. Even in the eliminated case, total passenger demand and operated frequency also rises at 1.65 and 1.68 times. That means the importance of collectivo will be higher.
	Development strategy of Colectivo	1) Current Colectivo routes remain to support the trunk bus system. However, with the progress of installation of trunk bus and railway, the colectivo operation route overlapped with a trunk bus will be eliminated. 2) In case the elimination, Transport Company which operates colectivo currently is given a right to join a consortium of trunk bus operation with high priority.
Development strategy of Mototaxi	Suggestion and Technical Analysis for Mototaxi transport	1) The improvements of terminals and roads facilities for mototaxi are suggested. 2) The operation volumes in a coarse bus network rise at 1.5 times for mototaxi and decrease at 0.9 times for a bus compared with a fine network. 3) For the purpose of the resident's satisfaction, a minimum bus network service needs to prepare the covered population ratio of 70% or more. 4) It is necessary to coexist with buses and mototaxi under the bus network service with a covered population ratio of 70% or more.
	Development Strategy	1) The mototaxi continuously function as a support of bus systems in those areas because of difficulty to install new bus route.

		2) The operation area has to be limited to the certain area because of the performance of speed and the engine power.
Cargo Transport Strategy	Suggestion of current cargo road network and urgent countermeasures	1) Effect of improvement of the cargo road network can not be observed in 2010. It is thought that the necessity of the new road added to the cargo road network is low. 2) Considering hourly fluctuation on 2010 traffic flow, effect of the time period of the cargo traffic control can be observed on the Pan Americana Norte and Pan Americana Sur. 3) It is suggested that time period control of the cargo traffic should be introduced as the urgent countermeasure on 2010. Target roads are i)Pan Americana Norte (restriction) ii)Pan Americana Sur (restriction) and iii)Elmer Faucett, Canta Callao (introduction as the network on evening)
	Development Strategy	1) To develop the further cargo transport strategy, it is necessary to formulate the Cargo Transport Master Plan. 2) It is desirable to implement the appropriate study including freight transport survey and the strategy plan, and sector plans.
Recommendation		1) The East-West trunk bus project is feasible based on the technical aspect, economical and financial aspects, and environmental aspects. The project should be completed in the year 2010 in accordance with the implementation schedule recommended in the Study. 2) The Lima and Callao municipalities should procure the project cost for construction of the East-West trunk busway facilities as soon as possible. 3) The traffic management improvement plans recommended in the Study are contributed to mitigate the traffic congestion of Lima and Callao metropolitan area. The plans and projects recommended in the Study should be executed within 5 years. 4) To ensure smooth and prompt execution of the East-West trunk bus project and the traffic management improvement plans recommended in the Study, a Final Design of the East-West trunk bus project and traffic management plans should be executed as soon as possible. 5) To ensure smooth and prompt execution of the East-West trunk bus project and the traffic management improvement plans and projects recommended in the Study, the budget and staffs of the execution organization structures should be reinforced.

Feasibility Study on Urban Transportation in the Lima and Callao Metropolitan Area in the Republic of Peru

Final Report

Table of Contents

1. INTRODUCTION 1-1

1.1. Objectives of the Study 1-1
1.2. Study Area 1-1
1.3. Target Year 1-2
1.4. Study Implementation Plan 1-2
1.4.1. Outline of Study and Schedule 1-2
1.4.2. Stage-1 of the Study (Work in Peru) 1-2
1.4.3. Stage-2 of the Study (Work in Peru) 1-2
1.4.4. Stage-3 of the Study (Work in Japan) 1-3
1.5. Organization 1-3

2. CURRENT CONDITIONS OF THE LIMA AND CALLAO METROPOLITAN AREA 2-1

2.1. General 2-1
2.2. Socio-economic Conditions in Lima and Callao Metropolitan Area 2-1
2.2.1. Population and Projection 2-1
2.2.2. GRDP Index of Department of Lima and Callao 2-2
2.2.3. Basic Policy for Future Land Development Structure 2-5
2.3. Environmental and Traffic Conditions of THE Lima and Callao Metropolitan Area 2-7
2.3.1. Natural Conditions 2-7
2.3.2. Road Traffic Conditions 2-7
2.3.3. Public Transport 2-10
2.4. Person Trip Characteristics of THE Lima and Callao Metropolitan Area 2-14
2.4.1. Socio Economic Characteristics 2-14
2.4.2. Travel Demand Characteristics 2-15

3. PRESENT BUS TRANSIT CHARACTERISTICS ON THE EAST-WEST CORRIDOR 3-1

3.1. Outline of Supplement Traffic Survey 3-1
3.2. Traffic and Transportation Conditions 3-1
3.3. Bus Operation Route Characteristics 3-6
3.4. Bus Passenger Travel Characteristics 3-6
3.4.1. Passenger Volume on the East West Corridor 3-6
3.4.2. Passenger Trip Characteristics 3-10

3.5. Bus Operation Characteristics....3-13
3.6. Bus Passenger trip characteristic and Opinion....3-16
3.7. Bus Company Characteristics Survey....3-16
3.8. On-Going Related Projects....3-16

4. CURRENT TRANSPORT AND TRAFFIC ISSUES AND PLANNING CONSIDERATIONS.... 4-1
4.1 Current Issues and Measures in the Study....4-1
4.2 Hierarchy of Transport Mode in the Study Area....4-2
4.3 Basic Planning Considerations and Planning Objective....4-4
4.3.1 Basic Planning Consideration....4-4
4.3.2 Planning Objective of the Study....4-4

5. FUTURE TRAFFIC AND TRANSPORTATION DEMAND FORECAST 5-1
5.1. General....5-1
5.2. Socio-Economic Framework....5-1
5.3. Travel Demand in the Study Area....5-2
5.4. Travel Demand in the Peak Hour on the East-West Corridor....5-4

6. TRUNK BUS SYSTEM PLAN 6-1
6.1. Proposed Trunk Bus System....6-1
6.1.1. Outline of the Proposed Trunk Bus System....6-1
6.1.2. Planning Policy and Strategy....6-1
6.2. Trunk Bus Line and Feeder Bus Line Plans....6-6
6.2.1. Proposed Trunk Bus Line System....6-6
6.2.2. Trunk Bus Line....6-6
6.2.3. Conventional Bus Lines....6-8
6.2.4. Feeder Bus Lines....6-12
6.2.5. Feeder Bus Network Analysis....6-19
6.3. Technical Analysis of the Trunk Bus System....6-22
6.3.1. Demand Analysis of the Trunk Bus System....6-22
6.4. Bus Fare Rate System Plan....6-33
6.4.1. Proposed Fare System....6-33
6.4.2. Sensitivity Analysis....6-33
6.5. Trunk Bus Operation Plan....6-37
6.5.1. Planning....6-37
6.5.2. Procurement Plan of Trunk Bus and Feeder Bus....6-38
6.5.3. Vehicular Requirement of Trunk Bus System....6-38
6.5.4. Fare System....6-40
6.5.5. Traffic Signal System....6-41
6.6. Expected Benefit of Trunk Bus System....6-45
6.6.1. Benefit to Bus Passengers....6-45
6.6.2. Benefit to the Public at Large....6-47
6.6.3. Traffic Flow Conditions on Av. Venezuela (Risk Analysis)....6-51
6.6.4. Social Impacts by the Trunk Bus System (Risk Analysis)....6-57

6.7. Influence of Other Mass Transit Projects (Risk Analysis) 6-60
6.7.1. Network Cases 6-60
6.7.2. Passenger Demand on Other Mass Transit Project 6-60
6.7.3. Total Passenger Volumes Transferred to/from COSAC 6-61
6.7.4. Maximum Line Passengers on Other Mass Transit Projects 6-61
6.8. East-West Trunk Bus Operation Organization Structure 6-66
6.8.1. Current (Conventional) Bus Operation Organization Structure 6-66
6.8.2. Outline of Proposed Trunk Bus Operation System on East West Trunk Busway 6-67
6.8.3. Alternative Operation Organization Structure 6-67
6.8.4. Suggested Trunk Bus Operation Organization Structure 6-70
6.9. Operation and Maintenance (OM) Cost Estimate 6-75
6.9.1. Conditions of Cost Estimate 6-75
6.9.2. Number of Employees Required and Personnel Costs 6-76
6.9.3. Facilities and Equipment Costs 6-79
6.9.4. Bus Fleet Operation Costs 6-79
6.9.5. Annual Operation and Maintenance (OM) Costs 6-80
6.9.6. Bus Fleet Procurement Costs 6-81

7. PRELIMINARY ENGINEERING FOR TRUNK BUSWAY 7-1
7.1. Existing Project Road Conditions 7-1
7.1.1. Existing Road Facility Conditions 7-2
7.1.2. Underground Soil Conditions 7-7
7.1.3. Underground Facility Conditions 7-12
7.1.4. Past Related Plans and Studies 7-12
7.2. Trunk Busway Facilities Development Criteria 7-14
7.2.1. Function and Characteristics of Trunk Busway 7-14
7.2.2. Typical Cross Section of Trunk Busway 7-15
7.2.3. Guideline of Bus Stop and Bus Terminal Development 7-20
7.3. Preliminary Design for Trunk Busway 7-32
7.3.1. Conditions of Preliminary Design 7-32
7.3.2. Field Survey Conducted 7-32
7.3.3. Alignment Design of Exclusive Trunk busway 7-36
7.3.4. Cross Section Design 7-36
7.3.5. Intersection Design 7-39
7.3.6. Pavement Design 7-41
7.4. Construction Quantity Estimate 7-46
7.4.1. Conditions of Construction Quantity Estimate 7-46
7.4.2. Construction Quantity Estimate 7-46
7.5. Project Cost Estimate 7-49
7.5.1. Unit Construction Cost Analysis 7-49
7.5.2. Project Cost Estimate 7-55

8. ENVIROMENTAL STUDY 8-1

8.1. Introduction 8-1
8.1.1. Objectives 8-1
8.1.2. Outline 8-1
8.1.3. Engineering Options 8-1
8.2. Brief Summary of Baseline Environment 8-3
8.2.1. Bio-Physical Environment 8-3
8.2.2. Socio-Cultural Environment 8-4
8.3. Environmental Scoping and Screening 8-6
8.3.1. Introduction 8-6
8.3.2. Initial Environmental Examination 8-6
8.3.3. Summary of IEE 8-12
8.4. Environmental Impact Assessment 8-14
8.4.1. Scoping for EIA Study 8-14
8.4.2. ToR for EIA Study 8-14
8.4.3. Impact Assessment 8-14
8.4.4. ToR of EIA-related Field Survey 8-18
8.5. Environmental Field Study 8-20
8.5.1. Roadside Air Quality Survey 8-20
8.5.2. Roadside Noise Survey 8-26
8.5.3. Roadside Vibration Survey 8-29
8.5.4. Cultural Environment Survey 8-32
8.5.5. Visual Resources Environment Study 8-34
8.5.6. Health Damage Survey 8-37
8.6. Expropriation Estimation Study 8-41
8.6.1. Introduction 8-41
8.6.2. Area of Land Acquisition Required 8-41
8.7. Impacts Mitigation 8-46
8.7.1. Introduction 8-46
8.7.2. Implementation 8-46
8.8. Environmental Impact Prediction Study 8-49
8.8.1. Noise Impact Prediction 8-49
8.8.2. Vibration Impact Prediction 8-51
8.8.3. Vehicular Emission Study 8-53
8.9. Environmental Management 8-55
8.9.1. Introduction 8-55
8.9.2. Scopes and Objectives 8-55
8.9.3. Methodology 8-55
8.9.4. Environmental Management Plan (EMP) 8-55
8.10. Environmental Monitoring 8-59
8.10.1. Introduction 8-59
8.10.2. Objectives 8-59
8.10.3. Scope of the Monitoring Plan 8-59
8.10.4. Methodology 8-59
8.10.5. Environmental Monitoring 8-59
8.10.6. Monitoring Requirements 8-60
8.10.7. Implementation and operation of monitoring program 8-60

8.10.8. Manpower and Budgeting 8-61
8.11. Recommendation 8-61
8.12. Stakeholder Meetings Conducted 8-62
8.12.1. Introduction 8-62
8.12.2. Summary of Stakeholder Meetings 8-63

9. ECONOMIC AND FINANCIAL STUDIES 9-1
9.1. General Methodology 9-1
9.1.1. Economic and Financial Evaluations 9-1
9.1.2. General Conditions for Analysis 9-1
9.2. Economic Analysis 9-3
9.2.1. General 9-3
9.2.2. Economic Feasibility Study of COSAC Project 9-4
9.2.3. Basic Calculation of Factors for Economic Evaluation 9-5
9.2.4. Economic Evaluation 9-11
9.3. Financial evaluation 9-18
9.3.1. General 9-18
9.3.2. Major Assumptions 9-18
9.3.3. Revenue and Operating Cost 9-19
9.3.4. Cash Flow and Accumulated Balance 9-20
9.3.5. Financial Procurement 9-31

10. IMPLEMENTATION PLAN OF THE EAST-WEST TRUNK BUS SYSTEM . 10-1
10.1. Necessity of the Project 10-1
10.2. Description of Proposed Project 10-3
10.2.1. Objectives of the Project 10-3
10.2.2. Project Environment 10-3
10.2.3. Outline of the Project 10-4
10.3. Project Costs 10-6
10.3.1. Project Costs 10-6
10.4. Project Benefits 10-8
10.4.1. Technical Evaluation and Effectiveness 10-8
10.4.2. Environmental Evaluation and Social Impacts 10-8
10.4.3. Economic and Financial Evaluation 10-9
10.5. Implementation of Organization Structure 10-10
10.6. Implementation Schedule 10-15
10.6.1. Work Items to be Executed for Realization of East-West Trunk Bus System 10-15
10.6.2. Implementation Schedule 10-16

11. INTRODUCTION OF A TRAFFIC MANAGEMENT STRATEGY 11-1
11.1. Road Safety Education Plan 11-1
11.1.1. Objectives 11-1
11.1.2. Strategy for Road Safety Education Plan 11-1
11.1.3. Plan for Organization of Coordination and Management of Road

Safety 11-2
11.1.4. Review of 5-year Programs for Road Safety 11-5
11.1.5. Plan for Road Safety Education and Campaign Programs 11-6
11.1.6. Implementation Plan 11-24
11.1.7. Cost Estimation 11-28
11.2. Road Accident Monitoring Plan 11-29
11.2.1. Objectives 11-29
11.2.2. Strategy for Road Accident Monitoring Plan 11-29
11.2.3. Plan for Organization of Coordination and Management of Road Accident Monitoring 11-29
11.2.4. Plan for Investigation and Database System 11-30
11.2.5. Plan for Analysis System of Hazardous Locations and Confirmation of Problems 11-36
11.2.6. Plan for Planning Measures System 11-41
11.2.7. Plan for Implementation of Measures System 11-44
11.2.8. Plan for Follow-Up System 11-44
11.2.9. Pilot Study of Road Accident Monitoring System in Critical Area 11-45
11.2.10. Implementation Plan 11-59
11.2.11. Cost estimation 11-62
11.3. Intersection Improvement Plan 11-63
11.3.1. Objectives 11-63
11.3.2. Selection Of Critical Area For Study 11-63
11.3.3. Current Traffic Conditions On Study Route 11-64
11.3.4. Traffic Signal Control System 11-69
11.3.5. Improvement of Intersections 11-77
11.3.6. Administrative Organization 11-82
11.3.7. Implementation plan 11-82
11.3.8. Cost estimation 11-83
11.4. Traffic Demand Management Plan (TDM Plan) 11-84
11.4.1. Objectives 11-84
11.4.2. Selection of Critical Area for Study 11-84
11.4.3. Identified TDM Measures 11-84
11.4.4. Plan of Area Licensing System 11-94
11.4.5. Implementation Plan 11-105
11.4.6. Cost Estimation 11-107
11.5. On-street Parking Improvement plan 11-108
11.5.1. Objectives 11-108
11.5.2. Selection of Target Locations for Study 11-108
11.5.3. Current On-Street Parking Situation 11-108
11.5.4. Plan Description of Improvement Plan 11-112
11.5.5. Implementation Plan 11-117
11.5.6. Cost Estimates 11-118

12. ACTION PLAN FOR ROAD ACCIDENT MONITORING PLAN 12-1
12.1. General 12-1
12.2. Plan Description 12-1

12.2.1. Preparation of Institutional organization for Road Accident Measures..12-1
12.2.2. Preparation of Guideline for Road Accident Monitoring System 12-3
12.2.3. Implementation of Seminar for Road Accident Monitoring System 12-5

13. PARA-TRANSIT STUDY 13-1
13.1. General 13-1
13.2. Taxi Study 13-1
13.2.1. Current Conditions 13-1
13.2.2. Technical Analysis of Taxi 13-6
13.2.3. Development Strategy 13-9
13.3. Colectivo Study 13-11
13.3.1. Current Conditions 13-11
13.3.2. Technical Analysis of Colectivo 13-18
13.3.3. Development Strategy of Colectivo 13-24
13.3.4. Colectivo Passenger Demand on the 2004 Present Conventional Bus Network System 13-26
13.4. Mototaxi Study 13-27
13.4.1. Trip Characteristics in the Districts of Huaycan and Santa Clara 13-27
13.4.2. Mototaxi Characteristics in Huaycan and Santa Clara 13-31
13.4.3. Technical Analysis for Modal Share of Mototaxi and Bus 13-33
13.4.4. Development Strategy of Mototaxi 13-48

14. CARGO TRANSPORTATION STUDY..... 14-1
14.1. Current Conditions 14-1
14.1.1. Current Regulations 14-1
14.1.2. Freight Volumes and Items for Each Direction 14-2
14.1.3. Load Weight of Cargo Vehicle 14-5
14.1.4. Hourly Fluctuation of Large Truck Volume 14-6
14.1.5. Heavier Large Truck Volumes on the Road Network 14-7
14.1.6. Ratio of Large Truck Volume to Total Traffic Volume 14-8
14.1.7. Effect of Traffic Congestion by Large Truck 14-9
14.1.8. Summary of the Present Cargo Transport in Lima and Callao 14-11
14.2. Technical Analysis for Urgent Countermeasures 14-12
14.2.1. Analysis Policy 14-12
14.2.2. Freight Transport Network Analysis 14-13
14.2.3. Time Zone Control Analysis 14-16
14.2.4. Suggestion on Urgent Countermeasures 14-20
14.3. Freight Transport Study 14-22
14.3.1. Necessity of Freight Transport Master Plan 14-22
14.3.2. Suggestion of Necessary Surveys for the Master Plan 14-22

15. CONCLUSION AND RECOMMENDATIONS 15-1

LIST OF FIGURES

Figure 1.5-1 Study Organization Chart 1-3

Figure 2.3-1 Estimated Traffic Volume on Major Road Networks in 2004 2-8
Figure 2.3-2 Counted Traffic Volume on Major Roads 2-9
Figure 2.3-3 Modal Share of Screen-line Survey (Pan Americana Sur) 2-9
Figure 2.3-4 Modal Share of Screen-line Survey (Rimac River) 2-10
Figure 2.3-5 Total Bus Passenger and Omnibus Passenger Volume in 2004 2-11
Figure 2.3-6 Number of Bus Routes on Major Roads 2-12
Figure 2.3-7 Bus Route Length 2-13
Figure 2.3-8 Bus Travel Time 2-13

Figure 3.2-1 Traffic Volume Count Survey Locations 3-1
Figure 3.2-2 Traffic Volume on the Feasibility Study Road (Converted to 24 hours) 3-2
Figure 3.2-3 Comparison of Traffic Volume of 2004 and 2006 3-2
Figure 3.2-4 Traffic Volume by Vehicle Type in the Morning Peak Hour (8:00-9:00) 3-4
Figure 3.2-5 Bus Volume in the Morning Peak Hour (8:00-9:00) 3-5
Figure 3.2-6 Ratio of Bus Fleet Type in the Morning Peak Hour (8:00-9:00) 3-5
Figure 3.3-1 Number of Present Bus Lines on the East-West Trunk Bus Corridor 3-6
Figure 3.4-1 Bus Passenger Volumes in the Morning Peak Hour (All Buses) 3-6
Figure 3.4-2 Total Bus Passenger Volumes in the Morning Peak Hour by Bus Fleet Types 3-7
Figure 3.4-3 10 Surveyed Bus Line Configuration 3-8
Figure 3.4-4 Characteristics of Boarding and Alighting on the Route EM-38 (Huaycan-Lima-Callao) 3-9
Figure 3.4-5 Characteristics of Boarding and Alighting on the Route OM-75 (Chosica-Lima-Callao) 3-9
Figure 3.4-6 Characteristics of Boarding and Alighting on the Route EO-29 (Callao-Lima Centro-Chosica) 3-10
Figure 3.4-7 Trip Desire Lines of the Passenger in the Morning Peak Hour on the 10 Surveyed Route 3-10
Figure 3.4-8 Trip Desire Lines of Passengers in the Morning Peak Hour based on the surveyed route (Origin or Destination is Callao, Santa Clara, Huaycan and Chosica) 3-11
Figure 3.4-9 Location of Segment Code 3-11
Figure 3.4-10 Major Passenger Flows between Bus Stops (Route OM-75 to East) 3-12
Figure 3.4-11 Major Passenger Flows between Bus Stops (Route EM-38 to West) 3-12
Figure 3.5-1 Bus Operation Speed on Line OM-75 3-13
Figure 3.5-2 Bus Operation Speed Characteristics in the Morning Peak Hour (To East) 3-14
Figure 3.5-3 Bus Operation Speed Characteristics in the Morning Peak Hour (To West) 3-14
Figure 3.5-4 Distribution of Bus Tariff on the East -West Corridor 3-14
Figure 3.5-5 Passenger Impression of the Bus Fare 3-15
Figure 3.5-6 Passenger Impression by Actual Payment Amount 3-15
Figure 3.5-7 Fare Opinions in Each Area 3-15

Figure 4.2-1 Hierarchy of Transport Mode in the Study Area 4-3
Figure 4.2-2 Concept of Hierarchy of Transport Mode in the Study Area 4-3

Figure 5.3-1 Trip Generation and Attraction in 2010 (All Purposes exclusive of To home) 5-3
Figure 5.3-2 Daily Trip Desire Line by Public Modes in 2004 and 2010 5-4

Figure 5.4-1 Zoning in Huaycan and Santa Clara 5-5
Figure 5.4-2 Trip Generation and Attraction in 2010 along the East- West Corridor 5-5
Figure 5.4-3 Desire Lines in Zone Block Nos. 7, 8, and 9 in Inbound Direction 5-6
Figure 5.4-4 Desire Lines in Zone Block Nos. 7, 8, and 9 in Outbound Direction 5-7
Figure 5.4-5 Desire Lines in Zone Block Nos. 1 and 6 (Callao) in Inbound Direction 5-7
Figure 5.4-6 Desire Lines in Zone Block Nos. 1 and 6 (Callao) in Outbound Direction 5-8
Figure 5.4-7 Desire Lines in Zone Block No. 10 (Santa Clara) in Inbound Direction 5-8
Figure 5.4-8 Desire Lines in Zone Block No. 10 (Santa Clara) in Outbound Direction 5-9
Figure 5.4-9 Desire Lines in Zone Block No. 11 (Huaycan) in Inbound Direction 5-9
Figure 5.4-10 Desire Lines in Zone Block No. 11 (Huaycan) in Outbound Direction 5-10

Figure 6.2-1 Conventional Bus System 6-6
Figure 6.2-2 Trunk Bus Line System (Shuttle Service) 6-6
Figure 6.2-3 Trunk Bus Line Configuration 6-7
Figure 6.2-4 Number of Conventional Bus Lines on the East-West Trunk Bus Line/one-way 6-8
Figure 6.2-5 Conventional Bus Lines overlapping and not overlapped with the Trunk Bus Line 6-8
Figure 6.2-6 Distribution of Accumulated Number of Bus Lines against Overlapped Distance Ratio 6-9
Figure 6.2-7 Typical Bus Lines Eliminated by Overlapping with the East-West Trunk Bus Line 6-10
Figure 6.2-8 Typical Bus Lines Eliminated by Overlapping with the East-West Trunk Bus Line 6-10
Figure 6.2-9 22 Conventional Bus Lines (Overlapped Ratio of 20% or More of the Total Line Distance) 6-10
Figure 6.2-10 Major Facilities in Huaycan 6-15
Figure 6.2-11 Major Facilities in Santa Clara 6-15
Figure 6.2-12 Feeder Bus Line Network Case-1 6-16
Figure 6.2-13 Feeder Bus Line Network Case-2 6-16
Figure 6.2-14 Feeder Bus Operation Case-1 6-17
Figure 6.2-15 Feeder Bus Operation Case-2 6-17
Figure 6.2-16 Covered Area by the Feeder Bus Line Network Case-1 6-18
Figure 6.2-17 Procedure of Feeder Bus Line Analysis 6-19
Figure 6.3-1 Line Passenger Demand/hour/dir and Minimum Operating Headway in 2010 and 2025 on the EW-Trunk Busway 6-23
Figure 6.3-2 Hourly Fluctuation of Bus Passengers and Fleets on Carretera Central in 2006 .. 6-24
Figure 6.3-3 Trunk Bus Passenger Flows in the Morning Peak Hour per Dual Directions 6-24
Figure 6.3-4 Feeder Bus Passenger Flows per Dual Directions in Callao 6-24
Figure 6.3-5 Feeder Bus Passenger Flows per Dual Directions in Santa Clara and Huaycan .. 6-25
Figure 6.3-6 Trunk Bus Volumes in the Morning Peak Hour/Dual Directions 6-25
Figure 6.3-7 Feeder Bus Volumes in the Morning Peak Hour/Dual Directions in Callao 6-26
Figure 6.3-8 Feeder Bus Volumes in the Morning Peak Hour/Dual Directions in Santa Clara and Huaycan 6-26
Figure 6.3-9 Bus Passengers by Bus Transferred Modes 6-27
Figure 6.3-10 Trunk Bus Passengers on Board 6-28
Figure 6.3-11 Trunk Bus Passengers on Board 6-28
Figure 6.3-12 Trunk Bus Passengers on Board 6-29
Figure 6.3-13 Bus Stop Locations 6-30
Figure 6.3-14 Boarding and Alighting Passengers at Bus Stops, and Passengers on Board (Line Nos. C300121 and C300122) 6-30
Figure 6.3-15 Boarding and Alighting Passengers at Bus Stops, and Passengers on Board (Line No. C300101) 6-31
Figure 6.3-16 Boarding and Alighting Passengers at Bus Stops, and Passengers on Board

(Line No. C300111) 6-31
Figure 6.4-1 Bus Fare Rate per GRDP/capita in South American Countries 6-33
Figure 6.4-2 Procedures of Sensitivity Analysis 6-34
Figure 6.4-3 Relationship between Total Proceeds, Passengers and Paid Rate/passenger 6-35
Figure 6.4-4 Relationship between Operated Buses and Proceeds/bus 6-35
Figure 6.4-5 Passengers by Transferred Modes 6-36
Figure 6.5-1 Standard Cross-Section Views of Four-Door Articulated Bus 6-39
Figure 6.5-2 Proposed Bus Priority Traffic Signal System 6-43
Figure 6.6-1 Area Assumed that the EW Trunk Bus System Directly Effects 6-45
Figure 6.6-2 Distribution of Travel Time by With and Without Projects 6-46
Figure 6.6-3 Distribution of Travel Times and Its Accumulated Percentage in Travel Distance 20km or Less 6-46
Figure 6.6-4 Distribution of Travel Times and Its Accumulated Percentage in Travel Distance 20km or More 6-46
Figure 6.6-5 Distribution of Waiting Time at Bus Stop by With and Without Projects 6-47
Figure 6.6-6 Traffic Volumes by Type of Vehicles on East-West Corridor in Without and With Cases 6-48
Figure 6.6-7 Total Traffic Volumes on East-West Corridor in Without and With Cases 6-48
Figure 6.6-8 Composition Ratio of Traffic Accidents by Type of Vehicles in 2003 6-50
Figure 6.6-9 Procedure of Analysis 6-51
Figure 6.6-10 Study Location 6-52
Figure 6.6-11 Location of Each Segment related to Table 6.6-3 6-53
Figure 6.6-12 Simulation Results in Present, 2010 Without and 2010 With Cases 6-55
Figure 6.6-13 Simulation Results in 2010 Completed, Provisional and Provisional + No Conventional Bus Operation 6-55
Figure 6.6-14 Average Speed and Delay Time by the Examination Cases 6-56
Figure 6.7-1 Total Passenger Volumes by Project 6-61
Figure 6.7-2 Maximum Line passenger Volumes by Project 6-62
Figure 6.7-3 Trunk Bus and Railway Passenger Flows per Hour per Dual Directions in Impact Case-1 6-63
Figure 6.7-4 Trunk Bus and Railway Passenger Flows per Hour per Dual Directions in Impact Case-2 6-64
Figure 6.7-5 Trunk Bus and Railway Passenger Flows per Hour per Dual Directions in Impact Case-3 6-65
Figure 6.8-1 Conventional Bus Operation Organization Structure 6-66
Figure 6.8-2 Operation Organization Structure of Alternative-A 6-68
Figure 6.8-3 Operation Organization Structure of Alternative-B 6-69
Figure 6.8-4 Organization of the Overall Bus Operation System 6-71
Figure 6.8-5 Organization of Trunk Bus System 6-72
Figure 6.9-1 Suggested organization of Cooperative Bus Company 6-76

Figure 7.1-1 Location of the Trunk Busway to be Studied (Av. Venezuela Side) 7-1
Figure 7.1-2 Location of the Trunk Busway to be Studied (Carre. Central Side) 7-1
Figure 7.1-3 Typical Cross Section of Existing Av. Venezuela and Av. Arica 7-3
Figure 7.1-4 Typical Cross Section of Existing Av. Ayllon and Carretera Central 7-5
Figure 7.1-5 Thickness of Existing Cement Concrete Pavement Layers 7-5
Figure 7.1-6 Thickness of Existing Asphalt Concrete Pavement Layers 7-5
Figure 7.2-1 Typical Cross Section 52m (Type-A) 7-18
Figure 7.2-2 Typical Cross Section 42m (Type-B) 7-18
Figure 7.2-3 Typical Cross Section 36m (Type-C) 7-19
Figure 7.2-4 Typical Cross Section 32m (Type-D) 7-19
Figure 7.2-5 Typical Cross Section 25m (Type-E) 7-20
Figure 7.2-6 Location of Bus Stops on Trunk Busway 7-21

Figure 7.2-7 Bus Stop and Central Bus Station 7-22
Figure 7.2-8 General Layout of Central Bus Station 7-26
Figure 7.2-9 Connection System between COSAC and East-West Project 7-26
Figure 7.2-10 Location of Candidate Trunk Busway Terminal 7-29
Figure 7.2-11 Initial Drawing of Trunk Bus Terminal 7-31
Figure 7.3-1 Typical Location of Water Supply and Sewage Pipe in Av. Venezuela 7-34
Figure 7.3-2 Typical Location of Water Supply and Sewage Pipe in Av. Arica 7-34
Figure 7.3-3 Typical Location of Water Supply and Sewage Pipe in Av. Ayllon 7-35
Figure 7.3-4 Typical Location of Water Supply and Sewage Pipe in Carretera Central 7-35
Figure 7.3-5 Location of No. of Cross Section Design Conducted 7-37

Figure 8.3-1 Maranga Ruins Complex (part 1): San-Marcos University Side 8-8
Figure 8.3-2 Maranga Ruins Complex (part 2) 8-8
Figure 8.3-3 Vehicle lane discontinuity due to the illegal settlement of factory (Av. Venezuela) 8-9
Figure 8.3-4 Vehicle lane discontinuity due to the illegal settlement of factory (Av. Venezuela) 8-9
Figure 8.3-5 Mountain side of Cerro El Pino (view from Av. C-Central) 8-12
Figure 8.3-6 “Tacora” Market 8-12
Figure 8.5-1 Wind Flow Pattern (Velocity and Direction, Aug/10/06), Av. Venezuela 1139 8-21
Figure 8.5-2 Wind Flow Pattern (Velocity and Direction, Aug/02/06), Av. Nicolas Ayllón 3010 .. 8-21
Figure 8.5-3 Wind Flow Pattern (Velocity and Direction, Aug/11/06), Carretera Central Essalud Hospital 8-22
Figure 8.5-4 Roadside A/Q Survey (PM 10 and PM2.5, Av. Venezuela 1139, August/11/06) 8-23
Figure 8.5-5 Roadside A/Q Survey (PM 10 and PM2.5, Av. Nicolas Ayllón Cdra. 18, August/03/06) 8-24
Figure 8.5-6 Roadside A/Q Survey Results (CO, Av. Venezuela Navy Hospital, Aug/09/06) 8-24
Figure 8.5-7 Roadside A/Q Survey Results (CO, Av. Arica 1239, Aug/07/06) 8-24
Figure 8.5-8 Roadside A/Q Survey Results (NO2 and SO2, Av. Venezuela 1139, Aug/11/06) .. 8-25
Figure 8.5-9 Roadside A/Q Survey Results (NO2 and SO2, Av. Venezuela Navy Hospital, Aug/09/06) 8-25
Figure 8.5-10 Roadside A/Q Survey Results (NO2 and SO2, Av. Arica 1239, Aug/07/06) 8-25
Figure 8.5-11 Roadside A/Q Survey Results (NO2 and SO2, Carretera Central, Cdra. 22, Aug/01/06) 8-26
Figure 8.5-12 Noise Measurement Results (Av. Arica 1239, Aug/07/06) 8-28
Figure 8.5-13 Noise Measurement Results (Carretera Central Cdra. 22, Aug/01/06) 8-28
Figure 8.5-14 Roadside Noise Level (dBA)Ld, Ln and Ldn of Av. Venezuela and Carretera Central, 2006 8-29
Figure 8.5-15 Vibration Measurement Results (Av. Venezuela 1139, August 11, 2006) 8-31
Figure 8.5-16 Vibration Measurement Results (Av. Arica 1239, August 07, 2006) 8-31
Figure 8.5-17 Vibration Measurement Results (Carretera Central Cdra. 22, August 01, 2006) 8-32
Figure 8.5-18 Daytime/Nighttime averaged VAL 8-32
Figure 8.6-1 Location Site of Land Acquisition Required on Av. Venezuela (1) 8-43
Figure 8.6-2 Location Site of Land Acquisition Required on Av. Venezuela (2) 8-44
Figure 8.6-3 Location Site of Land Acquisition Required on Av. Venezuela (3) 8-45
Figure 8.8-1 Predicted Roadside Leq Values (W=52 m) 8-50
Figure 8.8-2 Predicted Roadside Leq Values (W=42 m) 8-50
Figure 8.8-3 Predicted Roadside Leq Values (W=36 m) 8-51
Figure 8.8-4 Predicted Roadside Leq Values (W=25 m) 8-51
Figure 8.8-5 Predicted Roadside L10 Values (Av. Venezuela) 8-53
Figure 8.8-6 Predicted Roadside L10 Values (Carretera Central) 8-53
Figure 8.8-7 CO2 Vehicular Emission Loading and Environmental Benefit 8-54

Figure 8.12-1 General Impression of 1st Stakeholder Meeting 8-64
Figure 8.12-2 Does the proposed project cause any impacts? 8-64
Figure 8.12-3 Positive/negative influence of the proposed project..... 8-64
Figure 8.12-4 Do you support the proposed project? 8-64
Figure 8.12-5 General impression of 2nd stakeholder meeting..... 8-66
Figure 8.12-6 Does the proposed project cause any impacts? 8-66
Figure 8.12-7 Positive/negative influence of the proposed project..... 8-67
Figure 8.12-8 Do you support the proposed project? 8-67
Figure 8.12-9 Which environmental aspect concerns you most? (multiple answers) 8-67

Figure 9.2-1 Workflow of Economic Evaluation 9-3
Figure 9.2-2 Unemployment Rate in Lima 9-7
Figure 9.2-3 Procedure of Estimation of Economic Benefit..... 9-10
Figure 9.2-4 Social Discount Rates and Net Present Values, Base Case (A)..... 9-17
Figure 9.3-1 Framework of Financial Evaluation of Trunk Bus-way System 9-18

Figure 10.2-1 Typical Cross Section of Exclusive Trunk Busway..... 10-4
Figure 10.5-1 Organization of Trunk Bus Operation..... 10-10
Figure 10.5-2 Relation between Organization and Activities..... 10-12
Figure 10.6-1 Implementation Schedule..... 10-17

Figure 11.1-1 Current Organization for Road Safety 11-2
Figure 11.1-2 Organization and Activities of CNSV 11-3
Figure 11.1-3 Ideal Proposal of Funding Sources for CNSV 11-3
Figure 11.1-4 Proposed Sustainable Funding Mechanism for CNSV and NGOs/Private Sectors 11-4
Figure 11.1-5 Training Schedule for Development of Human Resources 11-4
Figure 11.1-6 Management and Coordination for 5-Year programs 11-5
Figure 11.1-7 General Program and Implementation Schedule for 5-Year Strategic Plan 11-5
Figure 11.1-8 Outline of Teacher Training by Local Workshops 11-10
Figure 11.1-9 Outline of Safe Driving Manager Training by Local Workshops 11-20
Figure 11.1-10 Implementation Schedule for Road Safety Education Plan.....11-27
Figure 11.2-1 Ideal Coordination and Management of Road Accident Monitoring 11-30
Figure 11.2-2 Examples of Computer Software Package Analysis 11-35
Figure 11.2-3 Extraction of Hazardous Locations (Black Spots) 11-36
Figure 11.2-4 Percentage of Accidents by Distance form Intersection 11-36
Figure 11.2-5 Interpretation of Accident Records 11-37
Figure 11.2-6 Example of Outline of Accident and Sketch of Scene 11-37
Figure 11.2-7 Collection and Summarizing of Relevant Materials.....11-38
Figure 11.2-8 A Sample of a Collision Diagram 11-40
Figure 11.2-9 Four Basic Strategies for Accident Reduction at Hazardous Locations 11-40
Figure 11.2-10 A Sample of Presumption of Accident Causes at a Black Spot 11-41
Figure 11.2-11 Fundamental items for Minimization of Accidents.....11-42
Figure 11.2-12 A Sample of Presumed Countermeasures at Black Spot 11-43
Figure 11.2-13 Target Area Managed 6 Police Stations in LMA 11-45
Figure 11.2-14 Annual Traffic Accidents and Accident Density by Police Station 11-45
Figure 11.2-15 Location of Traffic Accidents by Traffic Police 11-46
Figure 11.2-16 Extraction of Black Spots in Six Traffic Police Stations 11-47
Figure 11.2-17 Detailed Location of Black Spots by Police Station 11-48
Figure 11.2-18 Target Black Spots with High Number of Accidents for the Improvement Plan .11-48
Figure 11.2-19 Target Black Spots Involving Fatalities for Improvement Plan.....11-49
Figure 11.2-20 A Sample of Analysis of Accident Record in 12 Black Spots 11-49
Figure 11.2-21 A Sample of Field Investigation in 12 Black Spots.....11-51

Figure 11.2-22 Intersection Av. Los Heroes-Av. San Juan....11-57
Figure 11.2-23 (1) Improvement Plan for Av. Los Héroes-Av. San Juan....11-58
Figure 11.2-24 Intersection Av. Próceres de la Independecia-Av. Tusilagos....11-58
Figure 11.2-25 Implementation Schedule for Road Accident Monitoring Plan....11-61

Figure 11.3-1 Identified Route for Intersection Improvement plan....11-63
Figure 11.3-2(1) Travel Time and Distance Diagram....11-65
Figure 11.3-2(2) Travel Time and Distance Diagram....11-66
Figure 11.3-2(3) Travel Time and Distance Diagram....11-68
Figure 11.3-3 Major Issues of Traffic Congestion at Key Bottlenecks....11-68
Figure 11.3-4 Identified Intersection for Improvement of Signal Control....11-70
Figure 11.3-5 A Sample of Improvement Plan for Signal Phase and Signal Split at Av.Aviacion-Av. Angamos Intersection....11-73
Figure 11.3-6 Identified Intersection for Improvement of Signal Control....11-74
Figure 11.3-7 Standard Installation Plan for Detector and Cabinet....11-75
Figure 11.3-8 Standard Installation Plan for Local Controllers Located Near Intersections....11-75
Figure 11.3-9 Standard Installation Plan of Signal Lights for Vehicles and Pedestrians....11-76
Figure 11.3-10 (1) Standard Layout for Pavement Marking Where Lane Operation to be Altered....11-80
Figure 11.3-10 (2) Standard Layout for Additional, Exclusive, Left-turn Lane....11-80
Figure 11.3-10 (3) Standard Layout for Improvement of Bus Stop Location....11-80
Figure 11.3-11 A Sample of Plan for Intersection Improvement....11-81
Figure 11.3-12 Administrative Organization for Traffic Signal Control Plan....11-82
Figure 11.3-13 Implementation Schedule for Intersection Improvement Project....11-82
Figure 11.4-1 Trips for Control....11-84
Figure 11.4-2 Traffic Calming....11-85
Figure 11.4-3 Area Licensing....11-85
Figure 11.4-4 Auto-Restricted Zone....11-85
Figure 11.4-5 HOV Priority....11-86
Figure 11.4-6 Ridesharing....11-86
Figure 11.4-7 Auto-Restricted Zone....11-87
Figure 11.4-8 Alternatives TDM Area....11-95
Figure 11.4-9 Area of Chronic Traffic Congestion....11-96
Figure 11.4-10 Distribution of Zonal Car Attraction Trips....11-96
Figure 11.4-11 Distribution of Attraction Trip Shares of Middle- and High Income Users....11-97
Figure 11.4-12 (1) Knowledge of TDM Measures....11-99
Figure 11.4-12 (2) Rights/Wrongs about Charge....11-99
Figure 11.4-12 (3) Opinions Measures to Restriction....11-100
Figure 11.4-12 (4) Charge Cost....11-100
Figure 11.4-13 Control Area....11-100
Figure 11.4-14 Camera-Surveillance System Figure 11.4 15 Electronic Road Pricing System....11-100
Figure 11.4-16 Proposed Locations for Installation of Control Facilities....11-102
Figure 11.4-17 Typical Standard Control Facilities....11-103
Figure 11.4-18 Proposed Administrative Organization for ALS....11-103
Figure 11.4-19 Change of Modal Split in Passenger inside the Area....11-104
Figure 11.4-20 Relationship between Car Volumes and Revenue in Pricing Area....11-105
Figure 11.4-21 Implementation Schedule for Traffic Demand Management Project (ALS)....11-107
Figure 11.5-1 Target Locations for On-Street Parking Improvement Plan....11-108
Figure 11.5-2 Parking Occupancy of Av. Angamos Este and Surrounding area....11-109
Figure 11.5-3 Parking Occupancy of Av. Saenz Peña and Surrounding area....11-109
Figure 11.5-4 Accumulated Curves of Parking Duration on Av. Angamos Este....11-110
Figure 11.5-5 Accumulated Curves of Parking Duration on Jr. Inca/Av. Saenz Peña....11-110

Figure 11.5-6 Hourly Fluctuation of Parked Vehicles on Jr. Inca 11-111
Figure 11.5-7 Hourly Fluctuation of Parked Vehicles on Av. Saenz Peña 11-111
Figure 11.5-8 Concept of Parking Control System 11-112
Figure 11.5-9 Planning Location of Parking Control System in Av. Angamos Este Area 11-113
Figure 11.5-10 Planning Location of Parking Control System in Av. Saenz Peña Area 11-113
Figure 11.5-11 Parking Ticket Machine in Japan 11-113
Figure 11.5-12 Outline of Control Method of Parking Ticket System 11-114
Figure 11.5-13 A Sample Design of Parking Ticket 11-114
Figure 11.5-14 Procedure for Regulation of Parking Violation 11-115
Figure 11.5-15 Organization of Parking Ticket System in the Parking System of Av.Angamos Este 11-116
Figure 11.5-16 Organization of Parking Ticket System on Av. Saenz Penaame one as the current organization, whw 11-116
Figure 11.5-17 Standard Design of Unit Parking Area and Guide Sign 11-116
Figure 11.5-18 Implementation Schedule for On-street Parking Improvement Plan 11-118

Figure 12.2-1 Mechanism and Function of Road Safety 12-1
Figure 12.2-2 Major Role of Relevant Agencies for Road Accidents 12-2
Figure 12.2-3 Periodic Work Procedure for Road Accident Monitoring System 12-3
Figure 12.2-4 A Sample of Spanish Text 12-6
Figure 12.2-5 A Sample of One Slide of Presentation 12-7
Figure 12.2-6 Scenes from Seminar Implementation 12-7

Figure 13.2-1 Age Distribution of Taxis in Lima 13-2
Figure 13.2-2 Distribution of Total and Taxi Travel Times 13-3
Figure 13.2-3 Distribution of Taxi Travel Time by Independent Use and Transfer from/to Others 13-3
Figure 13.2-4 Distribution of Taxi Fare Rate 13-4
Figure 13.2-5 Most Active Taxi Operation Areas 13-5
Figure 13.2-6 Illustration of Station Taxi System 13-6
Figure 13.2-7 Procedure of Technical Analysis of Taxi 13-7
Figure 13.2-8 Illustration of Taxi and Its Alternative Travel Routes 13-7
Figure 13.2-9 Relationship between Taxi and Trunk Bus & Other Mode Travel Times 13-8
Figure 13.2-10 Taxi Vehicle-Km by With and Without Cases 13-8
Figure 13.2-11 Present Transportation Hierarchy 13-9
Figure 13.2-12 Future Transportation Hierarchy 13-9
Figure 13.3-1 34 Studied Colectivo Routes 13-12
Figure 13.3-2 Hourly distribution of Total Colectivo Volumes 13-12
Figure 13.3-3 Route Distribution of Colectivo Volumes on Each Route 13-13
Figure 13.3-4 Composition Ratio of Trip Purposes of Colectivo Users 13-13
Figure 13.3-5 Composition Ratio of Frequency of Colectivo Use 13-14
Figure 13.3-6 Occupation and Income Level of Colectivo Users 13-14
Figure 13.3-7 Distribution of Travel Time of Colectivo Users 13-15
Figure 13.3-8 Relationship between Traffic Volume and Colectivo Composition Ratio on Roads 13-15
Figure 13.3-9 Accumulated Percentage of Colectivo Ratio on Each Road 13-16
Figure 13.3-10 Relationship between the Ratio of Colectivo and its Passengers 13-17
Figure 13.3-11 Procedure of Technical Analysis of Colectivo 13-19
Figure 13.3-12 34 Major Colectivo Lines 13-19
Figure 13.3-13 Elimination of Colectivo Lines with 20% Overlapped (7 Lines) 13-20
Figure 13.3-14 Colectivo Operation Line AC-22 pass on the East-West Trunk Bus Line 13-20
Figure 13.3-15 Reduction of Relative Speed on Road between Colectivo and Conventional

Bus 13-21
Figure 13.3-16 Relationship of Hourly Operated Frequency of Colectivo Lines between 2004 and 2010 “Without” Cases 13-22
Figure 13.3-17 Colectivo Passengers and Line Distance by the 2004, 2010 Without and With Cases 13-23
Figure 13.3-18 Total Colectivo and Bus Passengers by the 2004, 2010Without and With Cases 13-23
Figure 13.3-19 Summary of Demand Analysis 13-24
Figure 13.3-20 Future Development Strategy of Colectivo 13-25
Figure 13.3-21 Relationship of Hourly Operated Frequency between 2004 and 2010 Without on the 2004 Bus Lines 13-26
Figure 13.4-1 Distribution of Residents by Estratos C-D and E 13-27
Figure 13.4-2 Walking Time from House to the Center of Huaycan 13-28
Figure 13.4-3 Total Travel Time by Estrato C-D and E 13-28
Figure 13.4-4 Accumulated Percentage of Travel Time from House to Bus Stop 13-29
Figure 13.4-5 Travel Modes from House to Bus Stop 13-29
Figure 13.4-6 Travel Modes to Destination 13-30
Figure 13.4-7 Travel Time of Mototaxi from House to Bus Stop 13-31
Figure 13.4-8 Mototaxi Fare Rate from House to Bus Stop 13-31
Figure 13.4-9 Mototaxi Travel Time to Destination 13-32
Figure 13.4-10 Mototaxi Fare Rate from House to Destination 13-32
Figure 13.4-11 Study Flow Chart 13-34
Figure 13.4-12 Diversion Models of Internal-External Trips 13-35
Figure 13.4-13 Walking Distance from House (Zone Centroid) to Bus Stop 13-36
Figure 13.4-14 Mototaxi Passenger Ratio from House to Bus Stop in the Base Case 13-36
Figure 13.4-15 Mototaxi Passenger Volumes from House to Bus Stop in the Base Case 13-37
Figure 13.4-16 Zoning System and Bus Line Network in Huaycan 13-37
Figure 13.4-17 Mototaxi Passenger Volumes from House to Destination (Huaycan) in the Base Case 13-39
Figure 13.4-18 Total Mototaxi Passenger Volumes in Base Case 13-39
Figure 13.4-19 Passenger Volume Count Data in Huaycan 13-40
Figure 13.4-20 Comparison between Counting Data and Estimation 13-40
Figure 13.4-21 Alternative Cases of Feeder Bus Network 13-41
Figure 13.4-22 Service Area within 500m from Bus Lines in Case-1 13-42
Figure 13.4-23 Covered Population and Walking Distance by Alternative Cases 13-42
Figure 13.4-24 Mototaxi Passenger Ratio from House to Bus Stop by Alternative Cases 13-43
Figure 13.4-25 Total Mototaxi Passenger Volumes by Alternative Cases 13-44
Figure 13.4-26 Modal Share of Passengers by Alternative Cases 13-45
Figure 13.4-27 Increase and Decrease Ratios of Total Vehicle Numbers to Case-5 13-45
Figure 13.4-28 Distribution of Walking Time by Walking People 13-46
Figure 13.4-29 Distribution of Travel Time (converted into Walking Time) by Mototaxi Passengers 13-46
Figure 13.4-30 Ratio of Walking Time of 20 minutes or more to Total and Covered Population Ratio 13-47

Figure 14.1-1 Trunk Roads where Large Truck Vehicles are permitted to Pass through 14-2
Figure 14.1-2 Composition Ratio of Cargo Transportation (From North, East, South) 14-4
Figure 14.1-3 Item Composition of Cargo (The main Origin/Destination point of Cargo in Lima and Callao) 14-4
Figure 14.1-4 Directional Ratio of Actual Load Weight to the Loading Capacity from the Cordon Line Survey 14-5
Figure 14.1-5 Ratio of Actual Load Weight to the Capacity at Main Facilities 14-5
Figure 14.1-6 Hourly Fluctuation of Cargo Truck Volumes on the Cordon Line

(6:00-24hours) 14-6
Figure 14.1-7 Hourly Fluctuation of Truck Volume in the Airport, the Port of Callao and the Oil Refinery (6:00-24 hours) 14-7
Figure 14.1-8 Hourly Fluctuation of Truck Volume in the Market (6:00-24 hours)..... 14-7
Figure 14.1-9 Number of Heavier Large Truck Volumes)..... 14-8
Figure 14.1-10 Relationship between All Traffic Volumes and Large Truck Volumes in 2004 ... 14-8
Figure 14.1-11 Road Locations of Heavier Large Truck Ratio..... 14-9
Figure 14.1-12 Relationship between Traffic Volume and Ratio of Large Truck to the Total..... 14-9
Figure 14.1-13 Volume and Capacity Ratio on the Selected Roads in the Morning Peak Hour 14-10
Figure 14.2-1 Analysis Procedure of Urgent Countermeasure in Freight Network System 14-12
Figure 14.2-2 Trunk Roads Examined as New Freight Vehicle Road in 2010 14-13
Figure 14.2-3 Volume-Capacity Ratio on Main Freight Roads in 2010 by Without, With Case-1 and With Case-2 14-15
Figure 14.2-4 Analyzed point for time fluctuation of the freight corridor 14-16
Figure 14.2-5 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Gambetta in 2010 14-17
Figure 14.2-6 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Panamericana Norte in 2010 14-17
Figure 14.2-7 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Carretera Central in 2010..... 14-18
Figure 14.2-8 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Panamericana Sur in 2010..... 14-18
Figure 14.2-9 Estimated Hourly Fluctuation of Traffic Volume (PCU) on Av. Circunvalación in 2010 14-19
Figure 14.2-10 Suggestion for Time Zone Regulation..... 14-21

LIST OF TABLES

Table 2.2-1 Population Trend in Peru and Metropolitan Area of Lima and Callao, 1940-2004 2-1
Table 2.2-2 Annual Population Rate in Peru and Metropolitan Area of Lima and Callao, 1940-2004 2-2
Table 2.2-3 Distribution of the Future Population, 2004, 2010 and 2025 2-2
Table 2.2-4 GRDP of the Department of Lima and Callao by Economic Sectors, 1970-1995(at 1979 prices) 2-3
Table 2.2-5 Share of the GRDP of the Department of Lima and Callao in the National Products, 1970-1990 2-3
Table 2.2-6 Annual Growth Rate of the GRDP by Economic Sector in the Department of Lima and Callao, 2001-2004 2-4
Table 2.2-7 Estimated GRDP by Economic Sector in the Department of Lima and Callao, 2001-2004 at 1994 constant prices) 2-4
Table 2.2-8 Projection of the GRDP in the Departments of Lima and Callao, 2004-2025 2-4
Table 2.2-9 Projection of the GRDP by Economic Sector in the Departments of Lima and Callao, 2004-2025 2-4
Table 2.4-1Distribution of Households by Estrato 2-14
Table 2.4-2 Population and Households 2-14
Table 2.4-3 Overall Travel Demand 2-15
Table 2.4-4 Number of Trips by Trip Purpose 2-15
Table 2.4-5 Vehicle Ownership 2-16
Table 2.4-6 Number of Vehicles Owned 2-16
Table 2.4-7 Non-motorized Trip Rate 2-17
Table 2.4-8 Travel Time and Travel Distance 2-17

Table 3.2-1 Traffic Volume on Counted Points (converted into 24 hour volume) 3-3

Table 4.1-1 Relationship between Current Issues and Measures in the Study 4-1

Table 5.2-1 Summary of Socioeconomic Indexes and Travel Demand 5-1
Table 5.3-1 Trip Generation and Attraction by Integrated Zones in 2010 (Exclusive of “to home” purpose) 5-2
Table 5.3-2 Modal Share of Person Trips (persons/day) in 2010 and 2025 5-3

Table 6.1-1 Service Frequency and Transport Capacity of Trunk Bus Line 6-3
Table 6.2-1 Relationship between Overlapped Ratio and Number of Lines 6-9
Table 6.2-2 Eliminated 22 Conventional Bus Lines/oneway 6-11
Table 6.2-3 Number of Bus Companies and Bus Fleets in Metropolitan Lima and Callao 6-11
Table 6.2-4 Employment Factors for Driver and Conductor 6-11
Table 6.2-5 Workers for Management and Maintenance 6-12
Table 6.2-6 Employees Influenced by Eliminated Bus Lines in 2010 6-12
Table 6.2-7 Number of Feeder Bus Lines 6-15
Table 6.2-8 Covered Area and Population in the Feeder Bus Network Case-1 6-18
Table 6.2-9 Covered Area and Population in the Feeder Bus Network Case-2 6-18
Table 6.2-10 Total Number of Hourly Bus Passengers in Feeder Case-1 and Case-2 6-19
Table 6.2-11 Number of Passengers by Bus Transferred Modes in Feeder Case-1 and Case-2 6-20
Table 6.2-12 Average Line Operation Conditions in Feeder Case-1 6-20
Table 6.2-13 Average Line Operation Conditions in Feeder Case-2 6-20
Table 6.2-14 Ratio of Average Line Operation Conditions in Feeder Case-2 to Case-1 6-21

Table 6.2-15 Summary of Line Operation Indices 6-21
Table 6.3-1 Total Number of Hourly Bus Passengers in the Trunk Bus System 6-22
Table 6.3-2 Maximum Line Passengers on the EW-Trunk Busway 6-23
Table 6.3-3 Number of Passengers by transferred Modes in the EW-Trunk Bus System 6-27
Table 6.3-4 Trunk and Feeder Bus Passengers, and Service Frequency in Both Bus Terminals 6-32
Table 6.3-5 Total Revenue from Bus Operation 6-32
Table 6.4-1 Total Number of Hourly Bus Passengers and Proceeds by Fare Rate Cases 6-35
Table 6.4-2 Passengers by Bus Transferred Modes and Total Proceeds 6-36
Table 6.5-1 Bus Service Frequency and Fleet Requirement for Trunk and Feeder Buses 6-37
Table 6.6-1 Average Travel Speed and Volume-Capacity Ratio on Roads in With and Without Cases 6-49
Table 6.6-2 Traffic Volumes in 2010 on the EW Corridor 6-50
Table 6.6-3 Examination Cases 6-52
Table 6.6-4 Number of Lanes by Examination Cases 6-53
Table 6.6-5 Average Delay Time and Average Speed by the Cases 6-56
Table 6.7-1 Network Project Cases 6-60
Table 6.7-2 Total Number of Hourly Bus/Railway Passengers by Project 6-61
Table 6.7-3 Total Passenger Volumes Transferred to/from COSAC 6-61
Table 6.7-4 Maximum Line Passenger Volumes by Project 6-62
Table 6.9-1 Number of Employees Required 6-77
Table 6.9-2 Personnel Costs for Cooperative Bus Company 6-78
Table 6.9-3 Facilities and Equipment Costs 6-79
Table 6.9-4 Bus Fleet Operation Costs 6-80
Table 6.9-5 Annual Operation and Maintenance (OM) Costs 6-80
Table 6.9-6 Bus Procurement Cost 6-81

Table 7.1-1 Types of Intersection on the Project Roads 7-6
Table 7.2-1 Geometric Design Standards 7-15
Table 7.2-2 Minimum Curvature and Maximum Gradient on Project Roads 7-16
Table 7.2-3 Capacity of Lane and Trunk Bus Volume Projected 7-17
Table 7.2-4 Differentiation of Bus Stop Conditions 7-23
Table 7.2-5 Operation Conditions of East-West Trunk Bus Project in Central Bus Station 7-27
Table 7.3-1 Results of Cross Section Design 7-38
Table 7.3-2 Conditions and situation of Intersection Improvement Projects 7-39
Table 7.3-3 Equivalent Corridors (ESAL) for arterial roads 7-42
Table 7.3-4 Pavement Structure Thickness for Arterial Roads (cm.) 7-44
Table 7.4-1 Conditions of Construction Quantities Estimate 7-47
Table 7.4-2 List of Construction Quantities for Trunk Busway Construction 7-48
Table 7.5-1 List of Mayor Construction Material Market Price 7-49
Table 7.5-2 List of Unit Construction Cost Analysis 7-51
Table 7.5-3 Unit cost of Major construction Working Items 7-53
Table 7.5-4 Total Construction Cost for Trunk Busway 7-55
Table 7.5-5 Construction Cost on Av. Venezuela and Av. Arica 7-56
Table 7.5-6 Construction Cost on Av. Ayllon and Carretera Central 7-57
Table 7.5-7 Construction Cost for Improvement of Bus Stops on Av. Grau 7-58
Table 7.5-8 Land Acquisition Cost for Trunk Busway Construction 7-59
Table 7.5-9 Compensation Cost for Trunk Busway Construction 7-59
Table 7.5-10 Land Acquisition Cost For Trunk Bus Terminal 7-59
Table 7.5-11 List of Project Cost 7-60
Table 7.5-12 Foreign Currency and Local Currency 7-60
Table 7.5-13 List of Bus Fleet Purchase Cost 7-61

Table 8.1-1 Typical Cross Sections of proposed Busway Project 8-2
Table 8.3-1 Initial Environmental Examination (Av. Venezuela) 8-7
Table 8.3-2 Initial Environmental Examination (Av. Ayllón and Carretera Central) 8-11
Table 8.3-3 Summary of Potential Negative Impacts 8-13
Table 8.3-4 Breakdown of Each Potential Impact 8-13
Table 8.4-1 Field Environmental Survey (Bio-Physical) 8-18
Table 8.4-2 Field Environmental Survey (Socio-Cultural) 8-19
Table 8.5-1 Instruments Used for Air Quality Measurements 8-20
Table 8.5-2 Measurement Point Location (Air Quality) 8-20
Table 8.5-3 Noise Measurement 8-26
Table 8.5-4 Measurement Point Location (Noise) 8-26
Table 8.5-5 Roadside Noise Survey Results 8-27
Table 8.5-6 Noise Zone Classifications 8-28
Table 8.5-7 Vibration Measurement 8-29
Table 8.5-8 Measurement Point Location (Vibration) 8-30
Table 8.5-9 Roadside Vibration Survey Results 8-31
Table 8.5-10 Vibration –related Environmental Standard, L10 (dB) 8-31
Table 8.5-11 Summary of Nearby Archeological Sites (Close to Av. Venezuela) 8-33
Table 8.5-12 Summary of Nearby Archeological Sites (Close to Carretera Central) 8-33
Table 8.5-13 Summary of Nearby Historical Sites (Close to Av. Venezuela) 8-33
Table 8.5-14 Summary of Nearby Historical Sites (Close to Carretera Central) 8-34
Table 8.5-15 Study Section of Visual Resources Study 8-34
Table 8.5-16 Identified Visual Resources (Av. Venezuela) 8-35
Table 8.5-17 Identified Visual Resources (Av. Carretera Central) 8-36
Table 8.5-18 Selected Potentially Sensitive Visual Resources 8-37
Table 8.5-19 Study Design of Health Damage Survey 8-37
Table 8.5-20 Health Survey Results (Police Officers: multiple answers) 8-38
Table 8.5-21 Health Survey Results (Street Vendors: multiple answers) 8-39
Table 8.5-22 Health Survey Results (Office Workers: multiple answers) 8-39
Table 8.6-1 Possible Expropriation Required 8-42
Table 8.7-1 Summary of Mitigation Measures 8-46
Table 8.8-1 Numerical Conditions 8-49
Table 8.8-2 Simulation Results (Av. Venezuela) 8-50
Table 8.8-3 Simulation Results (Carretera Central) 8-50
Table 8.8-4 Numerical Conditions 8-52
Table 8.8-5 Simulation Results (Av. Venezuela) 8-52
Table 8.8-6 Simulation Results (Carretera Central) 8-52
Table 8.10-1 Monitoring Activities and Indicators 8-60
Table 8.12-1Schedule of Stakeholder Meetings 8-62
Table 8.12-2 Homepage for Stakeholder Meetings 8-62
Table 8.12-3 Outline of 1st Stakeholder Meeting 8-63
Table 8.12-4 Categorization of Questions 8-63
Table 8.12-5 Outline of 2nd Stakeholder Meeting 8-65
Table 8.12-6 Categorization of Questions 8-65
Table 8.12-7 Outline of 3rd Stakeholder Meeting 8-68
Table 8.12-8 Categorization of Questions 8-68

Table 9.1-1 Economic vs. Financial Evaluations 9-1
Table 9.2-1 Unit Vehicle Operating Cost (Public), 2006 9-6
Table 9.2-2 Unit Vehicle Operating Cost 9-6
Table 9.2-3 Social Time Value of Transport Users by Mode (SNIP Annex 09) 9-6
Table 9.2-4 Travel Time Cost 9-7
Table 9.2-5 Economic Cost and Financial Cost of Project 9-8

Table 9.2-6 Investment Schedule of Infrastructure 9-8
Table 9.2-7 Total Estimated Traffic Volume 9-9
Table 9.2-8 Comparison of Estimated Traffic Volume 9-9
Table 9.2-9 Economic Benefit of Trunk Bus-way System 9-10
Table 9.2-10 Economic Cash Flow of Trunk Bus-way Infrastructure Project 9-12
Table 9.2-11 Economic Evaluation Indices in Alternative Case 9-13
Table 9.2-12 Cash Flow of Case (B) 9-14
Table 9.2-13 Cash Flow of Case (C) 9-15
Table 9.2-14 Cash Flow of Case (D) 9-16
Table 9.2-15 Variation of Cost and Benefit in Base Case 9-17
Table 9.3-1 Financial Cash Flow of Base Case (Case-A) 9-23
Table 9.3-2 Financial Cash Flow of Case-B 9-24
Table 9.3-3 Financial Cash Flow of Case-C 9-25
Table 9.3-4 Financial Cash Flow of Case-D 9-26
Table 9.3-5 Financial Cash Flow of Case-E 9-27
Table 9.3-6 Financial Cash Flow of Case-F 9-28
Table 9.3-7 Financial Cash Flow of Case-G 9-29
Table 9.3-8 Results of Financial Analysis on Each Case 9-30

Table 10.2-1 Outline of Recommendation of the Project 10-4
Table 10.3-1 Summary of Project Cost 10-6
Table 10.3-2 OM Cost for Trunk Bus Operation 10-6
Table 10.3-3 Annual Bus Fleet Purchase Cost 10-7
Table 10.4-1 Changing Traffic Conditions in 2010 10-8
Table 10.4-2 Effectiveness for Bus Passengers 10-8
Table 10.4-3 Effectiveness of CO2 Reduction 10-8
Table 10.4-4 Results of Economic and Financial Analysis 10-9

Table 11.1-1 Qualitative Assessment of Present Education Textbooks 11-7
Table 11.1-2 Major Issues of Current Education Textbooks 11-7
Table 11.1-3 Structure of Guidelines for Road Safety Education by Target Age Group 11-8
Table 11.1-4 Teacher's Guideline for Road Safety Education by Target Age Group (Infants) 11-12
Table 11.1-5 Teacher's Guideline for Road Safety Education by Target Age Group (Schoolchildren) 11-14
Table 11.1-6 Teacher's Guideline for Road Safety Education by Target Age Group (Junior High School Students) 11-17
Table 11.1-7 Structure of Guideline for Road Safety Education of Public Transport Operators 11-20
Table 11.1-8 Safe Driving Manager's Guideline for Road Safety Education of Public Transport Operators 11-22
Table 11.1-9 Summary of Campaign Programs by Target Audience 11-24
Table 11.1-10 Project Cost for Traffic Safety Education Programs 11-28
Table 11.2-1 Coded Items by Category 11-31
Table 11.2-2 Proposed Traffic Accident-Recording Sheet 11-32
Table 11.2-3 Key Points of Field Observation 11-39
Table 11.2-4 Presumed Countermeasures by Types of Accident 11-43
Table 11.2-5 Main Factor for Comparative Evaluation between Before-And-After Studies 11-44
Table 11.2-6 Target Accident Data for Extraction of Black Spot 11-46
Table 11.2-7 Victim's Condition by Injury and Casualty at Black Spots 11-47
Table 11.2-8 Major Characteristics of Traffic Accidents in 12 Black Spots 11-50
Table 11.2-9 Major Problems and Issues in 12 Black Spots 11-52
Table 11.2-10 Proposed Remedial Measures for 12 Black Spots 11-56
Table 11.2-11 Project Cost for Road Accident Monitoring Project 11-63

Table 11.3-1(1) Sections with Low Average Speed and Causes of Delay Time 11-65
Table 11.3-1(2) Sections with Low Average Speed and Causes of Delay Time 11-66
Table 11.3-1(3) Sections with Low Average Speed and Causes of Delay Time 11-67
Table 11.3-2 Service Level at Major Intersections on the Study Route 11-69
Table 11.3-3 Identified Intersection for Improvement of Signal Control 11-71
Table 11.3-4 Summary of Improvement Plan for Signal Phase and Signal Split 11-71
Table 11.3-5 Improvement Measures by Major Issues 11-78
Table 11.3-6 Improvement Measures by Intersection 11-79
Table 11.3-7 Standard Installation Plan for Detector and Cabinet 11-83
Table 11.3-8 Standard Installation Plan for Local Controllers Located near Intersectitons 11-83
Table 11.4-1 Summary of Characteristics for Typical TDM Measures 11-89
Table 11.4-2 Qualitative Benefit of Different Travel Impacts 11-92
Table 11.4-3 Indicators for Evaluation by Criteria 11-93
Table 11.4-4 Selection of Target TDM Measure for Study Area 11-94
Table 11.4-5 Characteristics of Existing Attraction Trips by Alternatives 11-97
Table 11.4-6 Assessment of Effective TDM Area for Area Licensing System 11-98
Table 11.4-7 Summary of Interview Result 11-99
Table 11.4-8 Number of Proposed Locations for Installation of Control Facilities 11-102
Table 11.4-9 Revenue from Toll Fee 11-105
Table 11.4-10 Project Cost for Traffic Demand Management Project (ALS) 11-107
Table 11.4-11 Operation Cost for Traffic Management Project 11-107

Table 11.5-1 On-street Parking Duration by Sections on the Target Areas 11-110
Table 11.5-2 Rough Estimation of Total Annual Revenue in target area 11-117
Table 11.5-3 Project Cost for On-Street parking Improvement Project 11-118
Table 11.5-4 Operation Cost for On-Street parking Improvement Project 11-118

Table 12.2-1 Table of Contents for Guideline 12-4
Table 12.2-2 Seminar Schedule 12-5

Table 13.2-1 Number of Registered Taxis in Lima and Callao 13-1
Table 13.2-2 Taxi Transfer from/to Other Modes 13-2
Table 13.2-3 Average Travel Time of Modes Used Before Taking a Taxi 13-2
Table 13.2-4 Taxi Trips Transferred to Trunk Bus System 13-8
Table 13.3-1 Roads with Higher Composition Ratio of Colectivo Volume by Direction 13-17
Table 13.3-2 Colectivo Passengers and Frequency by the 2004, 2010 Without and With Cases 13-22
Table 13.3-3 Total Colectivo and Bus Passengers by the 2004, 2010 Without and With Cases 13-23
Table 13.3-4 Colectivo Passengers and Frequency on the 2004 Conventional Bus Lines 13-26
Table 13.4-1 Travel Modes in Internal – Internal Trips 13-30
Table 13.4-2 Ratio of Bus Use after the Use of Mototaxis from the House 13-30
Table 13.4-3 Coefficient of Utility Function 13-38
Table 13.4-4 Average Walking Distance by the Alternative Cases 13-46

Table 14.1-1 Freight Traffic Control Items in Lima and Callao Metropolitan Area 14-2
Table 14.1-2 Average Load Weight per Truck of Inbound/Outbound on the Cordon Line Survey 14-5
Table 14.1-3 Average Load Weight per Truck Carried into/out of the Main Facilities (ton/veh) 14-6
Table 14.1-4 Roads with Heavier Large Truck Volumes 14-8
Table 14.1-5 Roads with Heavier Large Truck Ratio 14-9
Table 14.1-6 Volume and Capacity Ratio on the Selected Roads in the Morning Peak Hour .. 14-10

Table 14.2-1 Alternative Cases for Freight Transport Network 14-13
Table 14.2-2 Peak Hour Volume-Capacity Ratio by Alternative Cases in 2004 and 2010 14-14
Table 14.2-3 Large Truck Composition Ratio and Volume-Capacity Ratio in the Peak Hours. 14-18
Table 14.2-4 Possibility of the Time Zone Control (Prohibition to enter) on Large Truck Road Network 14-19
Table 14.2-5 The comparison between present control and suggested control 14-20

List of Abbreviations

¥	Yen
AASHTO	American Association of State Highway and Transportation Officials
AATE	Autonomous Authority of the Special Project of Electric Mass Transport System for Lima and Callao
ALS	Area Licensing System
Av.	Avenue
AVL	Automated Vehicle Location System
B/C	Benefit Cost Ratio
BRT	Bus Rapid Transit
BSP	Bus Signal Priority
CBD	Central Business District
CBR	California Bearing Ratio
CNG	Compressed Natural Gas
CNSV	National Road Safety Council
COFIDE	Financial Corporation of Development
CONAM	National Environmental Council
COSAC	High Capacity Segregated Corridor
COSAC I	High Capacity Segregated Corridor Phase I
CTLC	Transport Council of Lima and Callao
DR	Discount Rate
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EIA-sd	Semi-detailed Study of Environmental Impact
EMAPE	Municipal Toll Administration Company
EMP	Environmental Monitoring Plan
ERP	Electronic Road Pricing
EW	East-West
FHWA	Federal Highway Administration (USA)
FIRR	Financial Internal Rate of Return
F/S	Feasibility Study
GGDU	General Agency of Urban Development (Callao)
GGTU	General Agency of Urban Transport (Callao)
GRDP	Gross Regional Domestic Product
GTU	Urban Transport Agency (Lima)
HC	Hydrogen Monoxide
HCM	Highway Capacity Manual (USA)
HOV	High Occupancy Vehicle

IBRD/WB	International Bank for Reconstruction and Development /World Bank
IDB	Inter-American Development Bank
IEE	Initial Environmental Examination
IGN	National Institute of Geographics
IMP	Metropolitan Planning Institute
INC	National Institute of Culture
INEI	National Institute for Statistics and Information
INVERMET	Metropolitan Investment Fund
IRR	Internal Rate of Return
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LED	Light Emitting Diode
M/P	Master Plan for Lima and Callao Metropolitan Area Urban Transportation in the Republic of Peru
MEF	Ministry of Economy and Finance
MML	Metropolitan Municipality of Lima
MPC	Province Municipality of Callao
MTC	Ministry of Transportation and Communications
NCSV	National Council of Road Safety
NGO	Non-Governmental Organization
NOx	Nitrogen Oxides
NPV	Net Present Value
OD	Origin Destination
OM	Operation and Maintenance
PCU	Passenger Car Unit
PQ	Pre Qualification
PG/R	Progress Report
PM	Particulate Matter
ROW	Right of Way
PVC	Polyvinyl Chloride
PROTRANSPORTE	Investments Plan Elaboration Project for Lima's Metropolitan Transport
PT	Person Trip
PTPS	Public Transport Priority System
PTUL	Lima Urban Transport Program
REO	Resident Engineer’s Organization
S/.	Soles
SEDAPAL	Drinking Water and Sewerage Service of Lima
SWR	Shadow Wage Rate

SNIP	National System for Public Investment
TDM	Traffic Demand Management
TOR	Terms of Reference
TTC	Travel Time Cost
US$	American Dollar
USTDA	Feasibility Study on Urban Railway Project in Lima
VAL	Vibration Acceralation Level
VOC	Vehicle Operation Cost

CHAPTER 1
Introduction

1. INTRODUCTION

In response to the request from the Government of the Republic of Peru (hereinafter, "the Government of Peru"), the Government of Japan engaged in a project, "Feasibility Study of Urban Transportation in the Lima and Callao Metropolitan Area" in the Republic of Peru (hereinafter "the Study") in accordance with the relevant laws and regulations in force in Japan.

The Japan International Cooperation Agency (hereinafter, "JICA"), the official agency responsible of the implementation of technical cooperation programs undertaken by the Government of Japan, conducted the Study in close cooperation with the Peruvian authorities concerned.

A Preparatory Study Mission was dispatched in July 2005, and after discussions with officials of the Government of Peru, the Scope of Work of the Study was agreed to by both sides, along with the contents. These are "(1) a Feasibility Study of the East-West Trunk Bus System" and "(2) Traffic Management." The Agreement was signed on July 1st, 2005. Subsequently, in order to conduct a more successful Study of the traffic management involved, a second Preparatory Study Mission was dispatched in October 2005, and the Scope of Work of the contents of the traffic management portion of the Study was agreed upon, and an agreement was signed on October 18th, 2005.

JICA organized a Study Team to conduct the Study. The Team worked in close cooperation with the Peruvian counterpart team in accordance with the agreed upon Scope of Work and the contents of the Inception Report.

1.1. OBJECTIVES OF THE STUDY

The objectives of the Study are summarized below.

1) To formulate a Feasibility Study of the East-West Trunk Bus System (Component-1) that is recommended as a high-priority project in the Lima and Callao Metropolitan Area Urban Transportation Master Plan.

2) To develop Improvement Plans of Traffic Management (Component-2) as a quick and economical countermeasure for traffic congestion. This work has three parts (1) Introduction of a Traffic Management Strategy; (2) a Traffic Control Plan of Taxis, Colectivos and Mototaxis; and (3) Guidelines of Cargo Transportation Control.

3) To transfer technology to Peruvian counterpart personnel in the course of conducting the Feasibility Study.

1.2. STUDY AREA

The Study area generally covers the Lima and Callao Metropolitan Area, where the JICA Master Plan Study was conducted in 2005. The study area of Component-1, the busway infrastructure and special operation measures, covers the main east-west traffic corridor, including Av. Venezuela and Carretera Central. Details of busway locations on the Study roads were discussed with the Peruvian counterpart personnel.

As of Component-2, the study area depends on the plans mentioned above. The improvement plans of critical areas where traffic conditions are difficult were studied and improved by implementing traffic management plans. The critical areas were discussed with the Peruvian counterpart personnel.

1.3. TARGET YEAR

The year 2010 is defined as the target year of the Study. The demand analysis was conducted until the year 2025.

1.4. STUDY IMPLEMENTATION PLAN

1.4.1. OUTLINE OF STUDY AND SCHEDULE

The major activities under the Study are classified into the following three (3) stages. The major study items of each stage are described below.

1.4.2. STAGE-1 OF THE STUDY (WORK IN PERU)

Stage-1 was carried out in Peru from May to August 2006. The major study items are listed below.

(1) Preparatory Study

Review of the data carried out under the Master Plan: study socioeconomic conditions, traffic surveys, public transportation and the environmental conditions.

(2) Supplemental traffic and transportation surveys

(3) Road inventory survey

(4) Component-1: East-West Trunk Bus System Study

a) To study the trunk bus line
b) To study rerouting and integration of conventional bus lines
c) To study a feeder bus operating system
d) To study a bus fare rate system
e) To study a trunk bus operating system

(5) Component-2: Traffic Management Study

a) To study five (5) traffic management plans
b) To develop improvement plans of the study area as part of each traffic management plan
c) To review existing conditions of taxis, Colectivos and Mototaxis
d) To analyze cargo transportation
e) To study a road network system of cargo transportation

1.4.3. STAGE-2 OF THE STUDY (WORK IN PERU)

Stage-2 was conducted in Peru from September to December 2006. The major study items are listed below.

(1) Component-1: East-West Trunk Bus System Study

a) To study effectiveness of the system
b) To conduct preliminary engineering design of trunk busway
c) To conduct an Environmental Impact Study
d) To study organization of the trunk bus system
e) To study the implementation program and fund procurement plan
f) To study the economic and financial evaluation

(2) Component-2: Traffic Management Study

a) To study a Traffic Management Action Plan
b) To study an improvement plan and a strategy of taxis, Colectivos and Mototaxis
c) To suggest an integral study method of the cargo transportation system

1.4.4. STAGE-3 OF THE STUDY (WORK IN JAPAN)

Work on Stage-3 of the Study was conducted done in Japan from January to March 2007. The major work items included the preparation of a Final Report to be written after receiving comments on the Draft Final Report from the Peruvian side.

1.5. ORGANIZATION

The parties concerned with the implementation of the Study are the Technical Secretariat of the Transport Council of Lima and Callao (ST/CTLC in Spanish) as the counterpart agency to the team, JICA, the Steering Committee organized by the Government of Peru, the Advisory Committee organized by JICA, Peruvian Counterparts, and the Study team. The Study organization chart is shown in Figure 1.5-1.

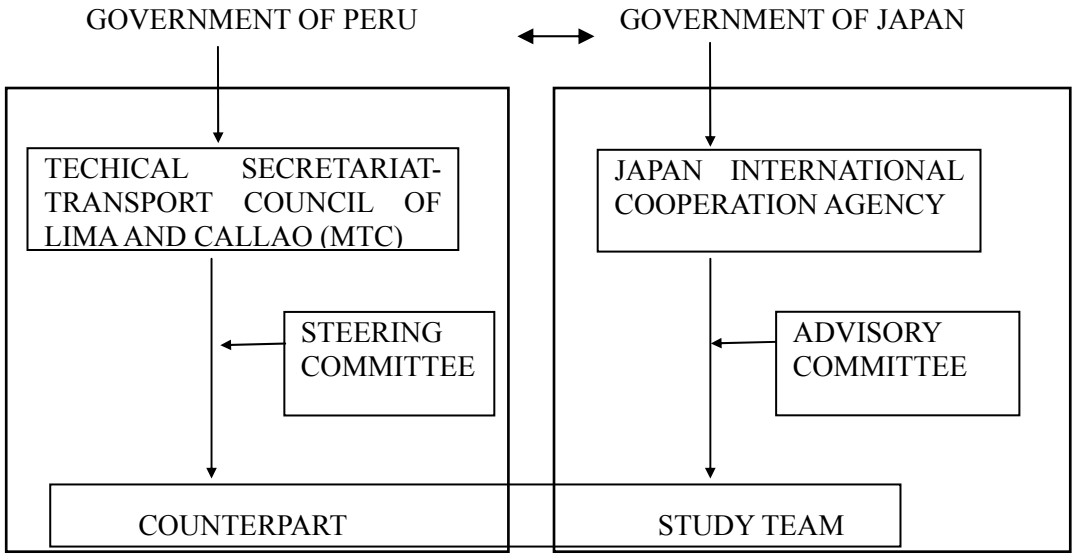


Figure 1.5-1 Study Organization Chart

(1) Members of Steering Committee

1) Dr. Mario Arbulú Miranda (May - September 2006)	Secretaría Técnica del Consejo De Transporte de Lima y Callao (ST/ CTLC).
Dr. Roberto Vélez Salinas (From October on)	Secretaría Técnica del Consejo De Transporte de Lima y Callao (ST/CTLC).
<u>Representative</u> Eco. Blanca Guerrero Rodríguez	Secretaría Técnica del Consejo De Transporte De Lima y Callao (ST/CTLC). Expert in Public Transport Management
2) Arq. Alberto Sánchez Aizcorbe Carranza (May-September 2006)	Autoridad Autónoma del Proyecto Especial Sistema Eléctrico de Transporte Masivo de Lima y Callao-AATE. Executive President, President Steering Committee
Víctor Pacahuala Velásquez (From September 2006 on)	Autoridad Autónoma del Proyecto Especial Sistema Eléctrico de Transporte Masivo de Lima y Callao-AATE. Executive Presidente
<u>Representative</u> Eng. Javier Cornejo Arana	Autoridad Autónoma del Proyecto Especial

	Sistema Eléctrico de Transporte Masivo de Lima y Callao-AATE.
3) Dr. Jose Luis Villarán	Instituto Metropolitano de Planificación (IMP), Executive Director
Representative Eng. Guillermo Tamayo	Instituto Metropolitano de Planificación (IMP), Road and Transportation Director
4) Lic. Jaime Romero Bonilla (From October 2006 on)	Gerencia de Transporte Urbano (GTU), Urban Transport Manager Steering Committee President
Representative Eng. Fanny Eto	Gerencia de Transporte Urbano (GTU), GTU Advisor
5) Eco. Juan Alberto Aching Ashuy	Protransporte, President Executive Director
Representative Eng. Walter Paredes Rojas	Protransporte, Planning Manager
6) Dr. Jorge Villareal Ruiz	Gerencia General de Transporte Urbano (GGTU), Urban Transport General Manager
Representative Eng. Manuel Coz Miraval	Gerencia General de Transporte Urbano (GGTU), Studies and Projects Area Chief
7) Arch.. Fernando Gordillo Tordoya	Gerencia General de Desarrollo Urbano (GGDU), General manager Urban Development
Representative Eng. Susana Maldonado Villanueva	Gerencia General de Desarrollo Urbano (GGDU), GGDU Expert
8) Eng. Hernán Aréstegui Matutti	Ministerio de Economía y Finanzas (MEF), Advisor – General Direction for the Multi-annual Programming for the Public Sector
Representative Eng. Milton Soto	Ministerio de Economía y Finanzas (MEF), Consultant– General Direction for the Multi-annual Programming for the Public Sector
9) Eco. Henry Zaira Rojas	Ministerio de Transportes y Comunicaciones Secretaría de Transporte - Advisor
Representative Eco. Orlando Olcese Bocanegra	Ministerio de Transporte y Comunicaciones Secretaría de Transporte - Advisor

(2) Counterpart Members

1) Eco. Blanca Guerrero Rodríguez	Secretaría Técnica del Consejo de Transporte de Lima y Callao (ST/ CTLC)
2) Eng. John Romero Conde	Secretaría Técnica del Consejo de Transporte de Lima y Callao (ST/CTLC)
3) Eng. Jose Chanamé Zapata	Secretaría Técnica del Consejo de

	Transporte de Lima y Callao (ST/CTLC)
4) Eng. Marcos Santos Piminchumo	Secretaría Técnica del Consejo de Transporte de Lima y Callao (ST/CTLC)
5) Eco. Roberto Alarcón Lazarte	Secretaría Técnica del Consejo de Transporte de Lima y Callao (ST/CTLC)

(3) Members of JICA Advisory Committee

1) Prof. Dr. Hisao UCHIYAMA	Leader/Professor, the Tokyo University of Science

(4) Members of JICA Tokyo Head Quarters

1) Mr. Hideo MIYAMOTO	Group Director, GroupⅢ（Transport and ICT）, Social Development Department
2) Mr. Chikahiro MASUDA	Team Director, Transportation TeamⅡ, GroupⅢ, Social Development Department
3) Mr. Nobuhiro KAWATANI	Transportation Team II, Group III Social Development Department

(5) Members of JICA Peru Office

1) Mr. Takao OMOTE	Resident Representative
2) Mr. Shoji OZAWA	Deputy Resident Representative
3) Ms. Ruth Elena Fernández	Project Coordinator

(6) Members of JICA Study Team

1) Mr. Koichi TSUZUKI:	Team Leader/Urban Transport Planner
2) Mr. Kenichi SEKINE:	Public Transportation Planner
3) Mr. Kimio KANEKO:	Traffic Management Planner
4) Mr. Hisayuki YAMAGUCHI:	Traffic Demand Analyst/ System Engineer
5) Mr. Yoshiaki NISHIKATSU:	Transportation Facility Planner
6) Mr. Osamu OHTSU:	Economist
7) Dr. Takanori HAYASHIDA:	Environment Analyst
8) Mr. Takeshi KAGAJO:	Traffic Engineer

CHAPTER 2
Current Conditions of the Lima and Callao Metropolitan Area

2. CURRENT CONDITIONS OF THE LIMA AND CALLAO METROPOLITAN AREA

2.1. GENERAL

JICA executed the Lima and Callao metropolitan area urban transport master plan study from January, 2004 to March, 2005. A person trip (PT) survey was conducted with about 35,000 families of the Lima and Callao metropolitan area region, cordon-line survey, screen line survey, traffic counting survey, various public transport surveys, and initial environmental examination, etc. were executed in this study. The collection and the analysis of a lot of related material was also done. The comprehensive urban transport master plan in 2025 (M/P study) was created based on these results of information.

In this section, based on the report of the M/P study, the society, economic indicators, nature conditions, social environmental situations, traffic characteristics, and traffic situations, etc. in the Lima and Callao metropolitan area region become basic analysis material adopted and used for the F/S.

2.2. SOCIO-ECONOMIC CONDITIONS IN LIMA AND CALLAO METROPOLITAN AREA

2.2.1. POPULATION AND PROJECTION

(1) Population

There is no census population data available after 1993. As shown in Table 2.2-1, the current population was estimated by the INEI (Peru: Population Projections by Departments, Provinces and Districts). According to INEI data, the present population of 2004 is 27,547,000 habitants in the country and 8,043,000 habitants in the metropolitan area of Lima and Callao.

Table 2.2-2 shows that the average annual population growth rate is 2.0 % between 1993 and 2004 in the Lima and Callao metropolitan area, while the national average is 1.8 % during the same period. Although the population growth rate in the Lima and Callao metropolitan area has dropped since the 1980s, the percentage share in the country increased from 28.4 % in 1993 to 29.2 % in 2004. The metropolitan area of Lima and Callao represents nearly 30 % of the country's total population.

Table 2.2-1 Population Trend in Peru and Metropolitan Area of Lima and Callao, 1940-2004

Year	Peru	The Metropolitan Area of Lima and Callao	
	Population (1,000)	Population (1,000)	% Share in Peru
1940	7,023	662	9.4%
1961	10,420	1,902	18.2%
1972	14,122	3,418	24.2%
1981	17,762	4,836	27.3%
1993	22,639	6,434	28.4%
2004	27,547	8,043	29.2%

Source: (1) INEI, Statistical Year Book, 2002;
(2) INEI, Peru: Population Projections by Departments, Provinces and Districts, 2002.

Table 2.2-2 Annual Population Rate in Peru and Metropolitan Area of Lima and Callao, 1940-2004

Year	Peru	Metropolitan Area of Lima-Callao
1940-1961	1.9%	5.2%
1961-1972	2.8%	5.5%
1972-1981	2.6%	3.9%
1981-1993	2.0%	2.4%
1993-2004	1.8%	2.0%

Source: (1) INEI, Statistical Year Book, 2002;
(2) INEI, Peru: Population Projections by Departments, Provinces and Districts, 2002.

(2) Future Population Projection

The future population by traffic zone in the M/P study was allocated in considerations of the future land use pattern and population density by land use category in 2025. The total population will increase by nearly 3.0 million habitants between 2004 and 2025. Table 2.2-3 summarizes the results of future population distribution in the areas of Central, North, South and East Lima and Callao. East Lima will increase by about 835,000 habitants from 2004 to 2025, followed by North Lima with about 453,000 habitants and South Lima with about 721,465 habitants. Although the central area shows a population decrease in the recent year, it is estimated to increase the population by a vertical densification of the residential area and a transformation of the land use from industrial use to residential use, particularly in the area along the Lima and Callao axis.

Table 2.2-3 Distribution of the Future Population, 2004, 2010 and 2025

(Unit: persons)

Area	Year			Increase	
	2004	2010	2025	2004-2010	2010-2025
Central Lima	2,239,144	2,420,873	2,895,250	181,729	474,377
North Lima	1,728,968	1,881,640	2,182,784	152,672	301,144
South Lima	1,428,428	1,620,090	2,149,883	191,662	529,793
East Lima	1,763,395	2,008,245	2,598,992	244,850	590,747
Callao	883,129	955,333	1,166,589	72,204	211,256
Total	8,043,064	8,886,181	10,993,498	843,117	2,107,317

Source: The Urban Transport Master Plan for Lima and Callao Metropolitan Area

2.2.2. GRDP INDEX OF DEPARTMENT OF LIMA AND CALLAO

(1) Existing GRDP Index

The data of Gross Regional Domestic Products (GRDP) is only available for the Departments of Lima and Callao, which includes the Metropolitan Area of Lima and Callao. According to the GRDP at 1974 constant price, the Department of Lima and Callao generated 1,150 million soles in 1970 and 1,658 million soles in 1980. Then, the GRDP dropped to 1,371 million soles in 1990. The average annual growth rates were 3.7 % in the 1970s, and it dropped to a negative growth of 1.9 % in the 1980s. If these figures are compared to the national average, it can be said that the severe recession of 1985 caused a greater negative effect to the economies of the Department of Lima and the Constitutional Province of Callao.

According to the GRDP by economic sector shown in Table 2.2-4, the tertiary sector produced 825 million soles in 1990, which occupied 60.2 % of the total regional products, followed by the secondary sector with 35.3 % (484 million soles). The primary sector produced only 4.5 % (62 million soles) of the regional products. In the percentage share of the GRDP of the Department of Lima and Callao in the national products between 1970 and 1990, the Department of Lima and Callao occupied a significant portion of the national products: i.e., 45.7 % in 1970, 45.5 % in 1980 and 42.0 % in 1990. These figures encapsulate the exceptional importance of the economic activities in the metropolitan area of Lima and Callao as shown in Table 2.2-5.

Table 2.2-4 GRDP of the Department of Lima and Callao by Economic Sectors, 1970-1995(at 1979 prices)

Year	Primary Sector		Secondary Sector		Tertiary Sector		Total	
	Million Soles	%	Million Soles	%	Million Soles	%	Million Soles	%
1970	61	5.3	450	39.2	639	55.6	1,150	100.0
1980	57	3.4	586	35.3	1,015	61.2	1,658	100.0
1990	62	4.5	484	35.3	825	60.2	1,371	100.0

Source: INEI, Almanac of Lima and Callao, 2001

Table 2.2-5 Share of the GRDP of the Department of Lima and Callao in the National Products, 1970-1990

Year	Peru	Lima-Callao Departments	
	Million Soles	Million Soles	Share in National GDP (%)
1970	2,518	1,150	45.7%
1980	3,646	1,658	45.5%
1990	3,264	1,371	42.0%

Source: INEI, Almanac of Lima and Callao, 2001

The recent GRDP data of the Department of Lima and Callao are not available, but the Ministry of Economy and Finance (MEF) recently estimated the economic growth rate by sector since 2001. The annual growth rate of the GRDP was estimated at 4.0 % between 2001 and 2002, 3.9 % between 2002 and 2003, and 3.2 percent between 2003 and 2004. The secondary sector was estimated to be the highest growth rate with 6.1 % between 2001 and 2002, 5.0 % between 2002 and 2003, and 4.7 % between 2003 and 2004 as shown in Table 2.2-6.

Based on these growth rates by economic sector, the real GRDP at 1994 constant price, between 2001 and 2004, were estimated. The real GRDP of the Department of Lima and Callao increased from 54,580 million soles in 2001 to 60,830 million soles in 2004. According to economic sector, the tertiary sector generated 57.6 % of the regional products in 2004, followed by the secondary sector with 38.0 % and the primary sector with 4.4 % as shown in Table 2.2-7. The recent GRDP figure shows that the secondary sector is a driving force of the economic growth in the Department of Lima and in the Province of Callao.

Table 2.2-6 Annual Growth Rate of the GRDP by Economic Sector in the Department of Lima and Callao, 2001-2004

Year	Primary Sector	Secondary Sector	Tertiary Sector	Total
2001-2002	4.1 %	6.1 %	2.8 %	4.0 %
2002-2003	3.6 %	5.0 %	3.1 %	3.9 %
2003-2004	3.1 %	4.7 %	2.2 %	3.2 %

Source: Grupo Maximixe, Study for the Elaboration of Macroeconomic Projections, 2000, prepared for the Ministry of Economy and Finance.

Table 2.2-7 Estimated GRDP by Economic Sector in the Department of Lima and Callao, 2001-2004 at 1994 constant prices)

Year	Primary Sector		Secondary Sector		Tertiary Sector		Total	
	Million Soles	%	Million Soles	%	Million Soles	%	Million Soles	%
2001	2,394	4.4	19,811	36.3	32,355	59.3	54,560	100.0
2002	2,491	4.4	21,015	37.0	33,246	58.6	56,752	100.0
2003	2,581	4.4	22,073	37.4	34,286	58.2	58,940	100.0
2004	2,661	4.4	23,118	38.0	35,050	57.6	60,830	100.0

Source: The Urban Transport Master Plan for Lima and Callao Metropolitan Area

(2) Projection of GRDP

The GRDP in the Departments of Lima and Callao was estimated based on the past trend of the percentage share of the regional product in the national economy and the growth rate of the GRDP prepared by the study report for the Ministry of Economy and Finance (MEF). Table 2.2-8 shows the estimated values of the GRDP in the Departments of Lima and Callao during the period between 2004 and 2025. According to the projection, the GRDP in the Departments of Lima and Callao will increase from 60,830 million Soles in 2004 to 76,202 million Soles in 2010 and to 148,053 million Soles in 2025. The percentage share of the Departments of Lima and Callao in the national GDP will slightly decrease from 44.3 % in 2004 to 44.0 % in 2010 and to 43.5 % in 2025.

There is no data available on the current GRDP by economic sector. The Study team estimated the GRDP by economic sector, based on the past data prepared by the INEI, the projected growth rates by economic sector during the period between 2001 and 2020. Based on this data, the study team estimated the GRDP by economic sector during the period between 2004 and 2025 (Table 2.2-9).

Table 2.2-8 Projection of the GRDP in the Departments of Lima and Callao, 2004-2025

Year	National GDP*	GRDP in the Departments of Lima and Callao		
	Million Soles	Million Soles	Growth Rate** (%)	Share in Peru (%)
2004	137,167	60,830	----	44.3
2005	142,363	62,977	3.53	44.2
2010	173,167	76,202	3.89	44.0
2015	214,141	93,599	4.20	43.7
2020	268,811	116,802	4.53	43.5
2025	341,947	148,053	4.86	43.3

Table 2.2-9 Projection of the GRDP by Economic Sector in the Departments of Lima and Callao, 2004-2025

(1994 price)

Year	Primary Sector		Secondary Sector		Tertiary Sector		Total	
	Million Soles	Share (%)	Million Soles	Share (%)	Million Soles	Share (%)	Million Soles	Share (%)
2004	2,661	4.4	23,118	38.0	35,050	57.6	60,830	100.0
2005	2,736	4.3	23,927	38.0	36,313	57.7	62,977	100.0
2010	3,234	4.2	28,915	37.9	44,053	57.8	76,202	100.0
2015	3,987	4.3	35,969	38.4	53,844	57.3	93,599	100.0
2020	5,031	4.3	45,491	38.9	66,280	56.7	116,802	100.0
2025	6,460	4.4	58,195	39.3	83,397	56.3	148,053	100.0

Source: The Urban Transport Master Plan for Lima and Callao Metropolitan Area

2.2.3. BASIC POLICY FOR FUTURE LAND DEVELOPMENT STRUCTURE

According to the Final Report of "The Master Plan for Lima and Callao Metropolitan Area Urban Transport in The Republic of Peru", the following basic policy for future land development structure was described.

(1) To consolidate the Metropolitan Services in the Central Area

The Historical Center of Lima, including the districts of Lima and Rimac, will strengthen its functions as political, administrative and institutional center on a metropolitan and national level. Applying a special regime defined by a Municipal Regulation from the Province of Lima (Regulation 201), the historical monuments and buildings in the area should be restored as cultural and tourism attractions. The traffic regulations should be strengthened to avoid over congestion of the traffic in the central area.

1) The Lima–Miraflores Axis, will consolidate the business and commercial activities at a metropolitan level.
2) The Lima and Callao Axis, the current industrial zones along Av. Argentina, Colonial and Venezuela, will be transformed to high-density housing areas.
3) The Coastal Axis, will consolidate the metropolitan recreational use as well as medium-density residential areas. The recreational area along the coast will be a tourism attraction.
4) The San Isidro-La Molina Axis, will consolidate the mixed use of commercial and business activities with vertical densification of residential areas.

(2) To Promote Decentralization of Urban Services in Sub-Centers

The development of the sub-centers will encourage a decentralization of urban activities that are currently concentrated in the central area of Lima. The sub-centers will promote commercial and business activities at district and inter-district level, and their surrounding areas are occupied by medium and high-density residential areas.

1) The sub-centers will be located in the districts of Comas and/or Los Olivos in the north, Santa Anita and/or Ate in the east, and Villa El Salvador and/or Villa Maria Del Triunfo in the south.
2) In addition to the three sub-centers, it is recommended that new commercial and service centers should be developed at district level in terms of the future population growth in the outskirts of the Lima and Callao Metropolitan Area.

(3) To Consolidate the Existing Industrial Areas

The industries will be located in the strategic areas along the Av.Panamericana Norte, the Carretera Central and the Av.Panamericana Sur, outside of the central area. In addition, there are specific locations of industrial parks in Villa El Salvador, Zárate in San Juan Lurigancho, Cajamarquilla in Lurigancho, and Ventanilla and Gambetta in Callao.

(4) To Develop Urban Service Equipments at District Level

The basic urban service equipments should be developed according to the population increase at district level, which includes primary and secondary schools, hospitals, parks and other service facilities.

(5) To Upgrade the Living Standards of Informal Housing

A large number of informal housing occupies the outskirts of the Metropolitan area. The most critical issue in the informal housing is the lack of basic infrastructure and deterioration of their living environment. It is recommended that the informal housing should be combined with some productive activities, that is, the mixed use of industrial or agricultural activity. The potential sites of informal housing with the mixed use are: Carabayllo, Ventanilla and Ancon in the north, Punta Hermosa, Punta Negra and San Bartolo in the south, and Caballero and Huachipa in the east.

(6) To Preserve Agricultural Land

Many agricultural lands in the Rimac river basin have been lost and transformed into residential areas over the last few decades. With strong measures of land management, the agricultural lands in the Chillon and Lurin river basins should be preserved. For this purpose, the upper stream areas of the rivers should be protected as ecological and natural reserves.

2.3. ENVIRONMENTAL AND TRAFFIC CONDITIONS OF THE LIMA AND CALLAO METROPOLITAN AREA

2.3.1. NATURAL CONDITIONS

(1) Climate

The coastal zone from northern Chile to Peru is a dry zone. This is because the south-eastern Pacific high pressure zone stays in this area all year round by the influence of the Humboldt Current, which is a cold ocean current that does not produce a lot of evaporation, though it is in a tropical area. The Lima and Callao metropolitan area is located in this dry zone, with desert climate and only 13mm of annual precipitation. The annual average temperature is about 20 degrees C, with an annual range of about 9 degrees measured from 15.1 degrees C in winter to 22.2 degrees C in summer. Though this area is in the desert, the daily range of temperature is as small as 7 degrees C because of the influence of the ocean.

(2) Topography

There are alluvial plains along the Chillón River in the north and the Lurin River in the south. There is an alluvial fan developed in the Rimac River Basin. The main part of the city of Lima is located on the fan-shaped plain of the Rimac River Basin, which develops in its north and south finger-shaped valley in the palm-hand fan. In these valleys there are a lot of advanced urbanizations, crowded with scanty houses, reaching halfway up the mountains. In these surrounding mountains are Mt. San Cristobal (409m height from sea level), Mt. San Jeronimo (755m), Mt. San Francisco (629m), Mt. Puruchuco(666m), and others. The coast in the center of this area is an elevated coast, which height is about 100m in the Costa Verde Seashore of the Miraflores District.

2.3.2. ROAD TRAFFIC CONDITIONS

(1) Traffic Volume on Trunk Road

Based on the OD table of 2004, the traffic demand was estimated in the M/P stage. The estimated traffic volume in 2004 on the major trunk roads and the traffic congestion rate of the major trunk roads are shown in Figure 2.3-1. Av. Panamericana Norte, Av. Tupac Amaru, Av. Javier Prado, and Centro are exceeding with a traffic congestion of 1.0.

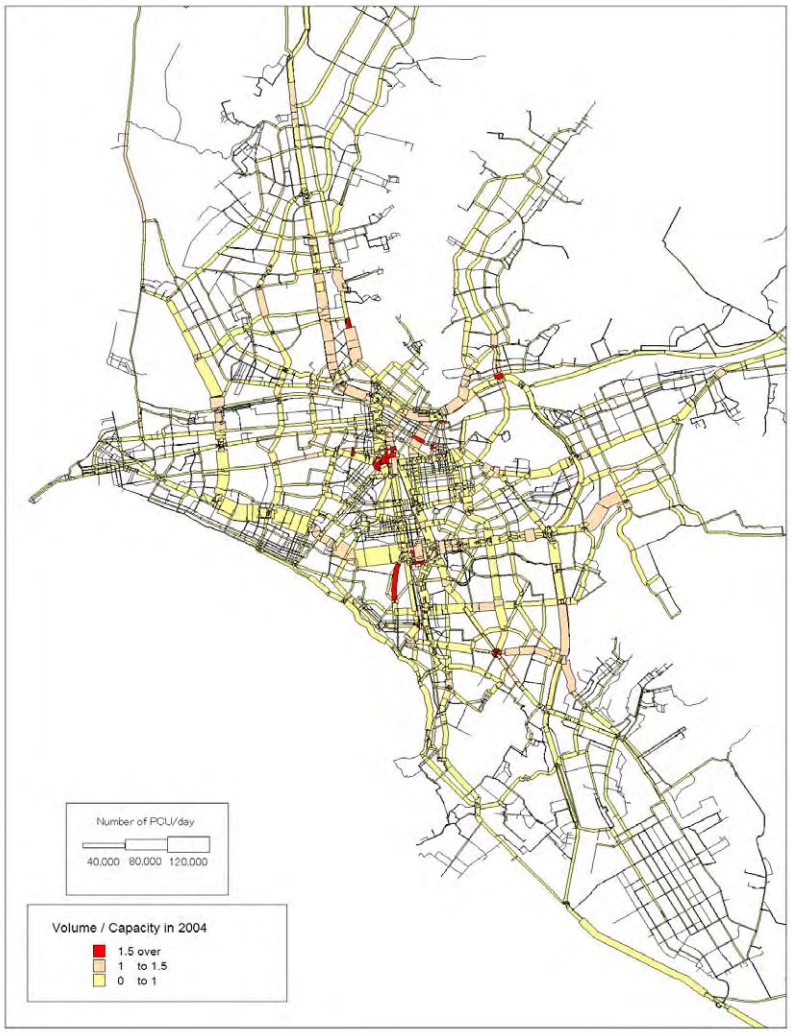


Figure 2.3-1 Estimated Traffic Volume on Major Road Networks in 2004

On the other hand, an actual counted traffic survey was conducted on the major trunk roads during peak hours in about 100 survey points by the JICA Study Team in 2005 during the M/P study stage. The results of this counted traffic survey are shown in Figure 2.3-2. The radial trunk roads and the center of Lima were observed as heavy congested areas.

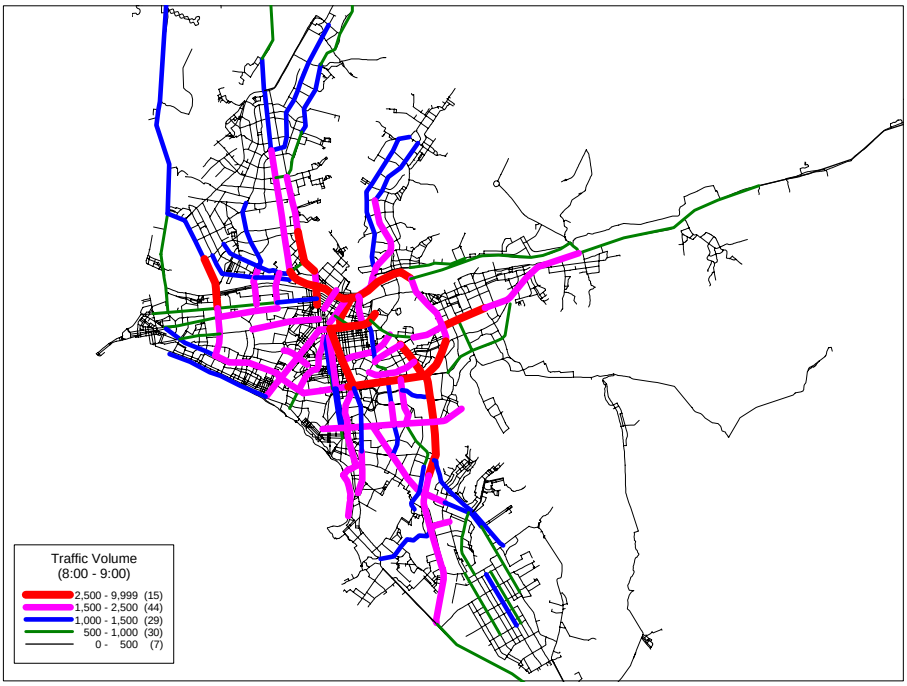


Figure 2.3-2 Counted Traffic Volume on Major Roads

(2) Modal Share of Screen Line Section

According to the results of the Screen-line Survey that was conducted by the JICA Study Team in 2005 during the realization of the Master Plan of Urban Transport in Lima and Callao Metropolitan Area, the modal share of the trunk roads of this area was observed and 24% of the total was occupied by private cars, about 30% of the total was occupied by taxis, about 35% of the total was occupied by buses, and approximately 6% was occupied by trucks as shown in Figure 2.3-3 and Figure 2.3-4 .

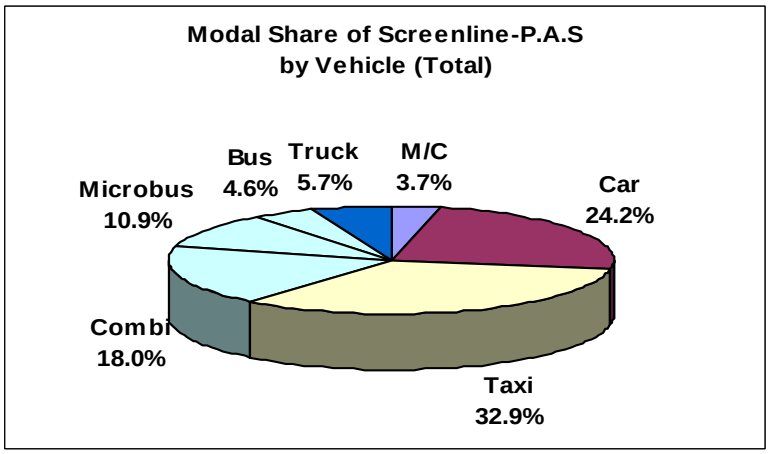


Figure 2.3-3 Modal Share of Screen-line Survey (Pan Americana Sur)

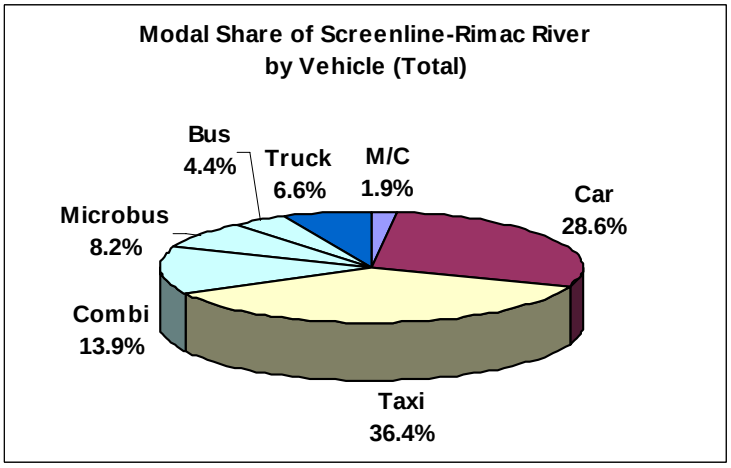


Figure 2.3-4 Modal Share of Screen-line Survey (Rimac River)

(3) Travel Speed on Major Roads

According to the results of the travel speed survey conducted in 2004 during the M/P stage, the average travel speed was down below 20km/h on the following sections for the inbound direction.

1) Av. La Marina (Av. Javier Prado – Av. Universitaria)

2) Av. Argentina (Av. Universitaria – Av. Ugarte)

3) Av. Aviación (Av. Grau – Av. México)

4) Av. República de Panamá (Av. Javier Prado – Paseo de la República)

5) Av. Tomas Marsano (Av. República de Panamá – Av. Aviación)

6) Av. Miguel Grau (Cementario – Braille: vía completa)

7) Av. Brasil (Plaza Bolognesi – Av. La Marina)

8) Av. Arequipa (Av. Grau - Av. Javier Prado)

The average travel speed was down below 20km/h on the following sections for the outbound direction.

1) Av. Javier Prado (Av. Brasil - Paseo de la República)

2) Av. La Marina (Av. Javier Prado - Av. Universitaria)

3) Av. Miguel Grau (Av.Aviación - Paseo de la República)

4) Av. Brasil (Plaza Bolognesi - Circuito de Playas)

5) Av. Tacna

6) Av. Arequipa (Av. Javier Prado – Av. Angamos Este)

2.3.3. PUBLIC TRANSPORT

(1) Bus Passenger Volume

Figure 2.3-5 shows the number of passengers on the trunk roads in Lima and Callao metropolitan area in 2004.The highest bus passengers were recorded on Av. Tupac Amaru at 38,000/hour/direction. Av. Panamericana Norte and Av. Zarumilla carred the highest bus passenger volumes. Its figures range from 24,000 to 26,000 passengers/hour/direction. These roads are located in the northern part of the metropolitan area where bus passenger

demands are relatively higher. Bus fleets mixed with Omnibus, Microbus and Camioneta transport those passengers. In 2004, bus passenger ratios by bus fleet were 31% for Camioneta, 42% for Microbus and 27% for Omnibus. However, the bus passengers in Bogotá, Colombia and Belem, Brazil recorded approximately 35,000 passengers/hour/ direction with only Omnibus (ordinary bus). Therefore, the passenger volumes on the major roads are close to transport capacity under the present public transport system on the mixed type of bus fleets.

On the other hand, the passengers in San Isidro, Miraflores, San Borja, Surquillo, etc., were somewhat low. Those areas are higher in ratio of passenger car volume in comparison to the rest of the modes.

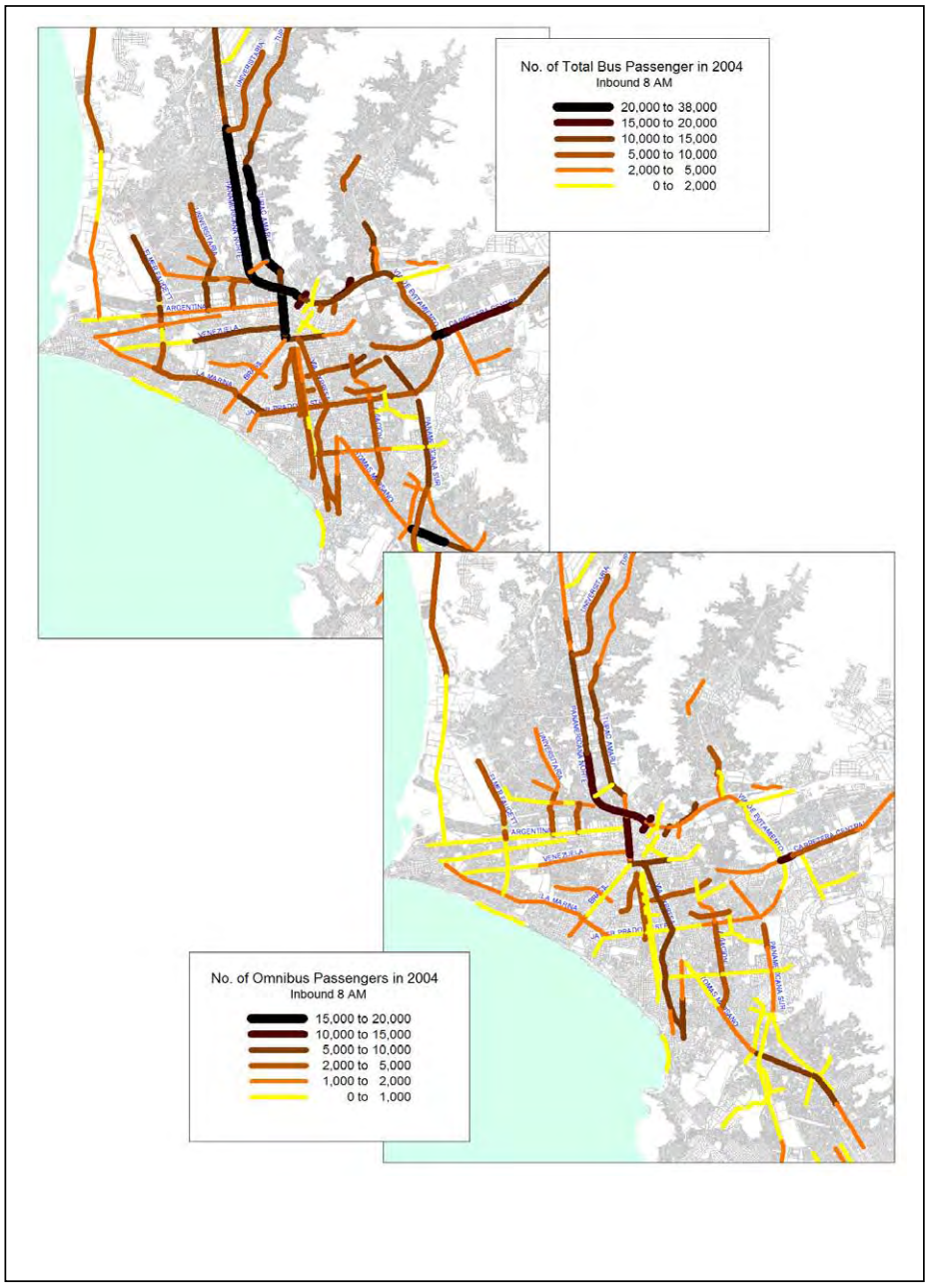


Figure 2.3-5 Total Bus Passenger and Omnibus Passenger Volume in 2004

(2) Bus Routes

Figure 2.3-6 shows the number of bus routes superimposed on roads in which the value of bus routes takes 1 for a single route, while a roundtrip route counts as 2. As it can be seen, the route configuration forms to radiate in all directions from the Center area. The corridors with a heavy number of bus routes were from the north and east directions of Lima, and from Callao to the Center.

The roads with 100 or more bus routes are shown below.

North direction: Av. Tupac Amaru (Arterial road)

North-East direction: Av. Proceres de la Independencia (Arterial road)

North-West direction: Av. Nestor Gambetta (Expressway road in the future)

East-West direction: Av. Venezuela- Av. Grau – Av. N. Ayllon (Arterial road)

Av. De la Marina- Av. Javier Prado Este (Expressway road in the future)

South direction: Av. Aviación – Av. Santiago de Surco (Arterial road)

The bus routes were concentrated on the arterial roads in Lima and Callao. Among them, about 150 routes, equivalent to 25% of the total routes, pass through Av. Ugarte in the Center.

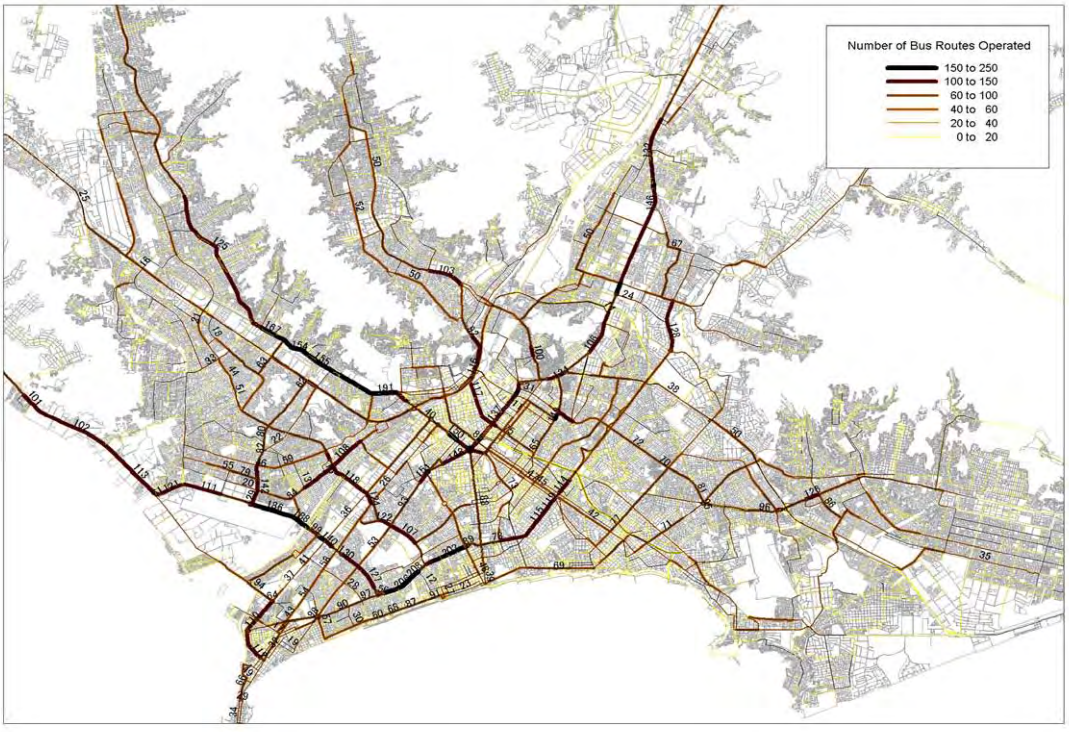


Figure 2.3-6 Number of Bus Routes on Major Roads

(3) Bus Operation Distance

Figure 2.3-7 shows the distribution of the route service distance authorized by the DMTU (in 2004). This route distance shows the total distance and in the case of a roundtrip route it takes a roundtrip route distance. As it can be seen, the average distance was approximately 64.3km long in the roundtrip route. This means approximately 30-40km long in the single route, whose distance is equivalent to the distance between the south and the north of Lima. The ratio of routes to exceed 100km long in the roundtrip route to the total number was approximately 7% and the maximum route distance was 163km long.

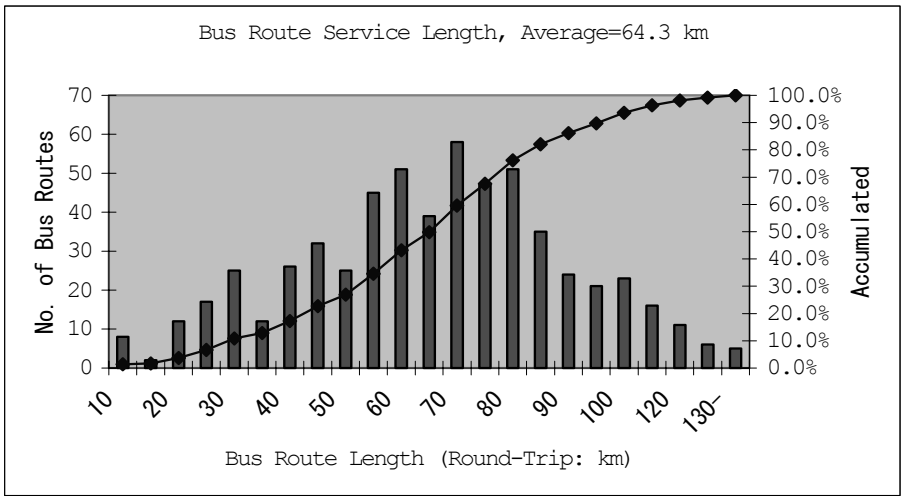


Figure 2.3-7 Bus Route Length

(4) Bus Passenger Travel Time

Passenger travel time was surveyed in the bus passenger interview survey in 2004, in which travel times from house to destination and from house to near bus stop in the morning peak hour were interviewed in the whole study area. Figure 2.3-8 shows the distribution of travel time from house to destination. As it can be seen, approximately 45% of the total had a travel time of more than 60 minutes and the ratio of travel time to exceed 90 minutes was approximately 20% of the total. As it can be seen, half of the bus passengers were forced to travel for an hour or more.

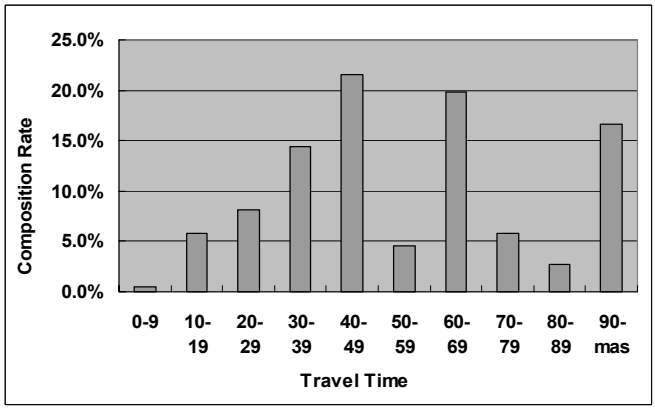


Figure 2.3-8 Bus Travel Time

2.4. PERSON TRIP CHARACTERISTICS OF THE LIMA AND CALLAO METROPOLITAN AREA

2.4.1. SOCIO ECONOMIC CHARACTERISTICS

(1) Population of Estrato

The socio-economic level of the household is one of the important factors, not only for the analysis of existing situations but also for building models of future traffic demand forecast. The concept of ESTRATO prevails in this country. However, there is hardly a defined and established methodology for the analysis. Therefore, the Study Team applied the proposal of the survey company conducting the Person Trip survey.

The result of the "Cluster" analysis is shown in Table 2.4-1. The ratio of the A-class household, the highest level, indicates 3.6% while Estrato E, the lowest, indicates 16.8%.

Table 2.4-1Distribution of Households by Estrato

ESTRATO	Households		Population	
	No.	Rate (%)	No.	Rate (%)
A	63.7	3.6	305.5	3.8
B	283.3	15.8	1,330.3	16.5
C	439.2	24.5	1,871.6	23.3
D	706.4	39.4	3,306.9	41.1
E	301.6	16.8	1,228.8	15.3
Total	1,794.3	100.0	8,043.1	100.0

(2) Population Characteristics

The total population in the Study area was estimated at 8,043 thousand habitants, while there are 7,160 thousand habitants in the province of Lima and 883 thousand habitants in the province of Callao respectively. The total number of households can also estimated at 1,794 thousand based on the average number of members in the households obtained by the Person Trip survey.

The population structure is illustrated in Table 2.4-2. The highest age group is from 20 to 24 years old, representing 10% of the whole population. The ratio of the working age group ranging from 15 to 60 years old indicates 66% and the ratio of old people over 60 years old is 10%.

Table 2.4-2 Population and Households

Area	Population (000)	Population 6 yrs old and above		No. of Households (000)	Average Household Member
		Male (000)	Female (000)		
Lima	7,160	3,200	3,376	1,608	4.5
Callao	883	386	411	186	4.7
Study Area Total	8,043	3,586	3,788	1,794	4.5
Ratio (%)		48.6	51.4		

2.4.2. TRAVEL DEMAND CHARACTERISTICS

(1) Overall Travel Demand

According to the result of the Person Trip survey conducted by the Study Team in 2004, the total transport demand in the Study area was estimated at 16.5 million trips per day, of which 12.2 million trips are produced by vehicles. Trip rates can be also calculated at 2.1 (including walk trips) and 1.5 (excluding walk trips) as shown in Table 2.4-3.

Table 2.4-3 Overall Travel Demand

Items	Central	Other Area	Study Area Total
Population (1,000)	2,064	5,979	8,043
No. of Trips (1,000)	4,700	11,838	16,538
Trip Rate	2.3	2.0	2.1
No. of Trips Excluding Walk Trips	3,688	8,558	12,246
Trip Rate	1.8	1.4	1.5

(2) Trip Purpose and Modal Share

Table 2.4-4 shows the composition of travel purposes. “To work” trips and “To school” trips, being estimated that they produce the congestion in the morning peak, accounting for 31% and 26%, respectively.

The modal share of public transport was 52% when “walk” trips were included, it is about 70% when “walk” trips were excluded. The share of both private mode and paratransit mode was about 10% of the total trips. The Combi was the most often-used mode in the public transport mode; its share was estimated to be 45%.

Table 2.4-4 Number of Trips by Trip Purpose

Trip Purpose	All Mode Trips			Excluding Walk Trips		
	(1,000)	Ratio (%)	Ratio excl. ”To home” (%)	(1,000)	Ratio (%)	Ratio excl. “To Home” (%)
To work	2,677	16.2	30.5	2,413	19.6	36.7
To school	2,300	13.9	26.2	1,519	12.3	23.1
Business	511	3.1	5.8	433	3.5	6.6
Business	383	2.3	4.4	348	2.8	5.3
Back to office	128	0.8	1.5	86	0.7	1.3
Private	3,294	19.9	37.5	2,206	17.9	33.6
Shopping	1,248	7.5	14.2	677	5.5	10.3
Restaurant	151	0.9	1.7	93	0.8	1.4
Entertainment	164	1.0	1.9	109	0.9	1.7
Pick-up/send off	311	1.9	3.5	185	1.5	2.8
Others	1,420	8.6	16.2	1,142	9.3	17.4
To home	7,756	46.9	-	5,758	46.7	-
Total	*16,538*	*100.0*	*100.0*	*12,330*	*100.0*	*100.0*

(3) Vehicle Ownership

As a result of the Person Trip survey, which was conducted in 2004, the vehicle ownership can be estimated in Table 2.4-5 . The ownership of private cars was indicated at 18.6% in the Study area. The higher ratio can be seen in the Central Area with more than 30%, while there was a ratio of 14% in the rest of areas. The ownership of both bicycle and motorcycle was 25.4% and 25.1%, respectively.

As shown in Table 2.4-6, the total number of private cars owned in the Study area was 421 thousand vehicles, which is equivalent to 52.3 vehicles per 1,000 people.

Table 2.4-5 Vehicle Ownership

Type	Home	Central Area		Others		Study Area Total	
		No. of H/H (1,000)	Rate (%)	No. of H/H (1,000)	Rate (%)	No. of H/H (1,000)	Rate (%)
Bicycle	Not owning	378	74.5	960	74.6	1,338	74.5
	1 owning	92	18.1	237	18.4	328	18.3
	2 or more	38	7.5	90	7.0	128	7.1
	Total	*508*	*100.0*	*1,287*	*100.0*	*1,794*	*100.0*
Motorcycle	Not owning	380	74.8	964	74.9	1,344	74.9
	1 owning	29	5.8	72	5.6	102	5.7
	2 or more	99	19.5	250	19.4	349	19.4
	Total	*508*	*100.0*	*1,287*	*100.0*	*1,794*	*100.0*
Car	Not owning	354	69.8	1,106	85.9	1,460	81.4
	1 car owning	118	23.2	152	11.8	269	15.0
	2 cars or more	36	7.0	29	2.3	65	3.6
	Total	*508*	*100.0*	*1,287*	*100.0*	*1,794*	*100.0*

Table 2.4-6 Number of Vehicles Owned

Type of Vehicle	No. of Vehicles (1,000)		
	Central Area	Others	Study Area Total
Bicycle	177	445	622
Motorcycle	7	20	27
Car	193	194	386
Combi	5	14	19
Microbus	1	8	9
Bus	0	1	1
Truck	1	4	5
Trailer	0	0	1
Others	2	20	22
Total	*386*	*706*	*1092*

(4) Non-Motorized Travel Demand Characteristics

According to Table 2.4-7, the ratio of walk trips to the total number of trips produced by the residents in the Study area was about 25%, and that of bicycle trips was about 0.5%. The trip rate of both by walk and by bicycle trips was as small as 0.5 and 0.01, respectively. Non-motorized trips, like walking and by bicycle, were sometimes not considered important because they were small and don't affect the load of traffic. However, the analysis of non-motorized trips was indispensable for planning a pedestrian and bicycle network.

Table 2.4-7 Non-motorized Trip Rate

	No. of Trips (1,000)	Ratio (%)	Trip Rate
Total Trip	16,538	100.0	2.1
Walk Trip	4,208	25.4	0.5
Bicycle Trip	84	0.5	0.01

Regarding the trip purposes, a walk trip was mainly done for "to school" or "shopping" trips while a bicycle trip was for "to work" or "other private" trips as shown in Table 2.4-8. Walk trips had the same travel time and the same travel distance regardless of the trip purpose. On the other hand, bicycle trips had different travel time and travel distance with the trip purpose.

Table 2.4-8 Travel Time and Travel Distance

Purpose	Walk		Bicycle	
	Time (minutes)	Distance (km)	Time (minutes)	Distance (km)
To work	12.1	0.7	18.4	2.3
To school	11.6	0.5	14.5	1.5
Business	12.1	0.6	14.6	2.2
Private	11.6	0.5	14.2	1.6

COMPONENT I

FEASIBILITY STUDY ON EAST-WEST TRUNK BUSWAY

CHAPTER 3
Present Bus Transit Characteristics on the East-West Corridor

3. PRESENT BUS TRANSIT CHARACTERISTICS ON THE EAST-WEST CORRIDOR

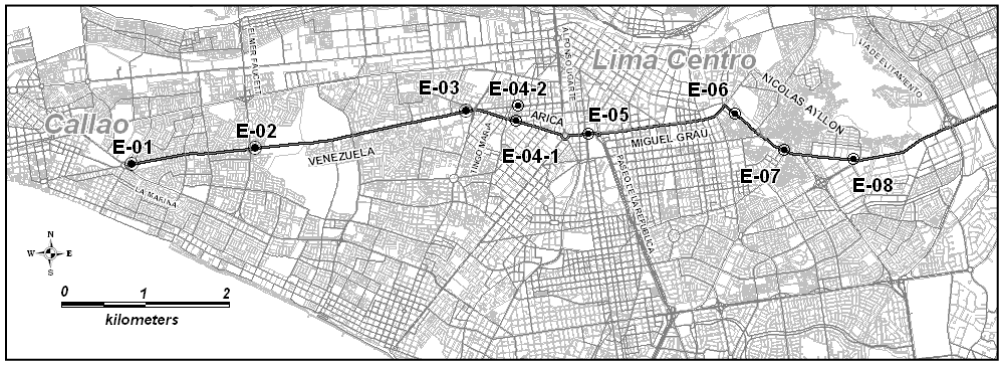
3.1. OUTLINE OF SUPPLEMENT TRAFFIC SURVEY

In the Master Plan Study, various types of transportation surveys were carried out and the survey data was compiled as a database in the computer. In this Feasibility Study, supplementary traffic surveys to supply particular traffic data of the target projects and areas were carried out. Various types of transportation surveys were conducted in this feasibility Study, as described below. The survey data is used for the trunk bus system plan and paratransit system plan. The analyses of the survey are shown in the following sections.

- Traffic Volume Count Survey
- Bus Operation Speed Survey
- Bus Passenger Volume Survey
- Bus Passenger Interview Survey
- Bus Facility Inventory Survey
- Bus Company Interview Survey
- Taxi, Colectivo, and Mototaxi Condition Survey
- Poor People Interview Survey

3.2. TRAFFIC AND TRANSPORTATION CONDITIONS

The traffic volume count survey was carried out to clarify the traffic and transportation conditions in the East-West corridor. Figure 3.2-1 shows the survey location where seven (7) locations coincide with that in 2004 counted in the Master Plan Study. The remaining locations are newly added in the 2006 survey.



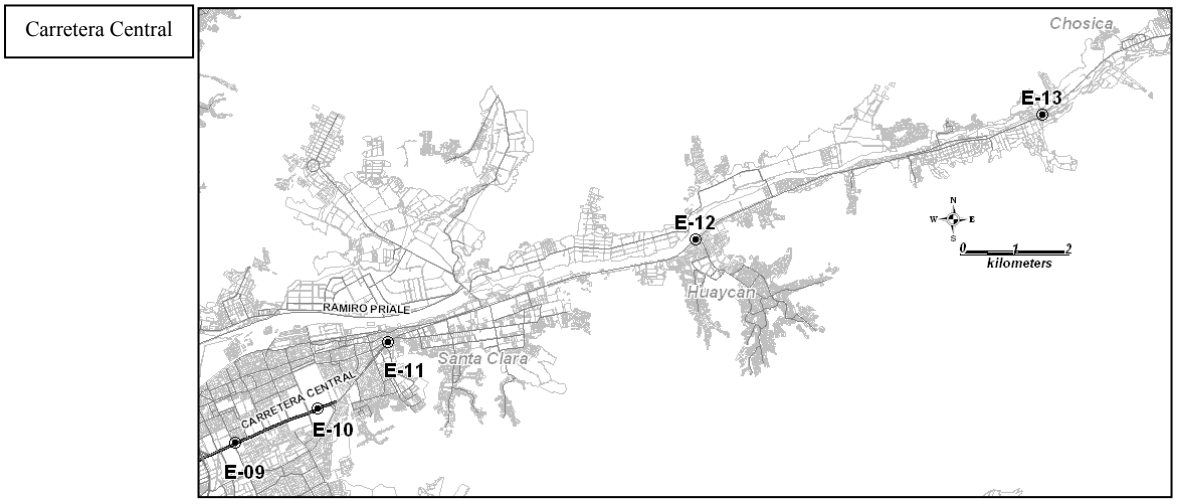


Figure 3.2-1 Traffic Volume Count Survey Locations

(1) Traffic volume

Figure 3.2-2 shows the daily traffic volume in the inbound and outbound directions. Traffic volume is the largest in Central Lima (E4, E5) and near the Vía de Evitamiento (E9). Those figures are approximately 35,000 vehicles for each direction per day. E11 (Santa Clara on Carretera Central) records a larger traffic volume of 25,000 per day in the westerly direction.

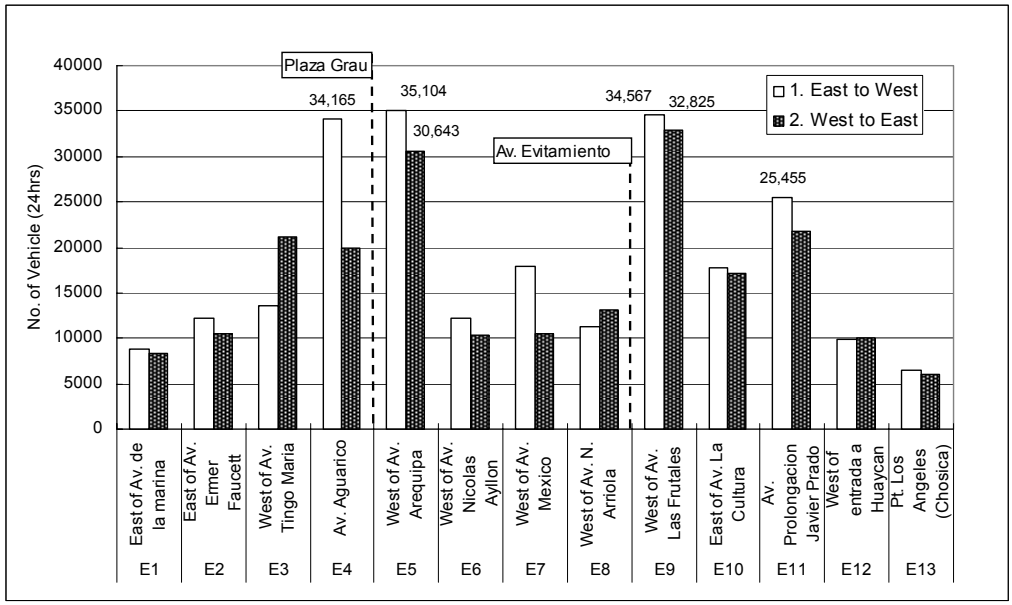


Figure 3.2-2 Traffic Volume on the Feasibility Study Road (Converted to 24 hours)

(2) Comparison to the Counting Data in 2004

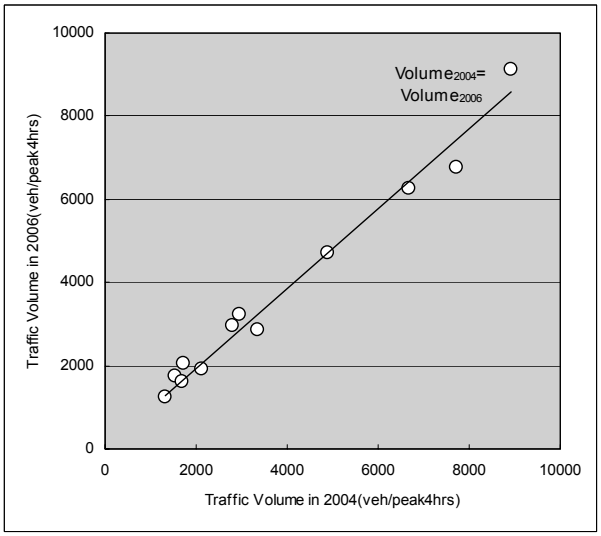


Figure 3.2-3 Comparison of Traffic Volume of 2004 and 2006

Table 3.2-1 shows traffic volume counting data converted into 24 hour volume. Figure 3.2-3 is the comparison between both the count survey results in 2004 and in 2006. Although there is a little difference in volume in both the surveys, a significant difference is not observed.

1. East to West

		Bicycle	Motorcycle	Moto-taxi	Car	Taxi	Informal Taxi	Colectivo	Combi	Microbus	Bus	Other bus	Small Truck	Truck	Trailer	Others	Total
E1	East of Av. de la marina	150	139	7	2,357	1,589	1,603	16	2,002	282	224	4	191	92	70	91	8,817
E2	East of Av. Ermer Faucett	78	217	52	4,113	938	2,685	12	2,173	1,030	596	6	212	96	42	10	12,258
E3	West of Av. Tingo Maria	238	464	24	3,850	2,735	1,616	24	1,601	1,748	329	9	524	236	45	85	13,527
E4(1)	(Av. Arica) East of Av. Aguarico	0	14	15	5,243	4,455	146	0	2,285	4,109	140	12	378	143	112	0	17,052
E4(2)	Aguarico	189	338	349	4,563	4,148	3,585	0	2,074	583	982	3	232	64	0	4	17,114
E5	West of Av. Arequipa	31	126	0	14,741	10,552	3,207	22	30	4,376	1,622	62	231	78	0	26	35,104
E6	West of Av. Nicolas Ayllon	99	86	283	1,307	2,211	2,411	2	475	3,975	517	36	309	198	24	228	12,160
E7	West of Av. Mexico	4	42	88	2,259	2,646	4,958	34	1,141	5,009	829	51	298	423	51	145	17,977
E8	West of Av. N. Arriola	31	100	367	2,566	3,022	430	0	27	3,381	415	134	376	331	96	70	11,344
E9	West of Av. Las Frutales	53	270	63	8,435	7,378	221	0	8,398	4,860	1,313	198	962	1,192	1,227	0	34,567
E10	East of Av. La Cultura	39	211	213	3,230	2,275	205	167	5,798	3,330	420	105	523	846	391	69	17,821
E11	Av. Prolongacion Javier Prado	20	201	282	5,226	1,034	5,135	291	5,434	4,739	1,119	106	409	1,016	439	5	25,456
E12	West of entrada a Huaycan	6	81	73	2,586	740	325	494	2,087	2,033	21	76	446	450	404	45	9,867
E13	Pt. Los Angeles (Chosica)	19	52	26	2,718	282	337	97	0	1,792	0	112	136	427	463	0	6,459

2. West to East

		Bicycle	Motorcycle	Moto-taxi	Car	Taxi	Informal Taxi	Colectivo	Combi	Microbus	Bus	Other bus	Small Truck	Truck	Trailer	Others	Total
E1	East of Av. de la marina	112	138	2	1,783	1,637	1,735	15	2,129	255	267	2	113	60	46	60	8,354
E2	East of Av. Ermer Faucett	135	242	74	3,264	738	2,201	6	1,959	1,200	556	5	91	54	25	3	10,553
E3	West of Av. Tingo Maria	175	595	14	5,804	4,907	2,326	12	1,938	3,974	417	17	436	231	90	165	21,099
E4(1)	(Av. Arica) East of Av. Aguarico	0	10	12	5,040	6,218	380	7	3,372	4,319	128	6	208	90	56	0	19,847
E4(2)	Aguarico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E5	West of Av. Arequipa	102	148	0	11,181	5,448	7,403	0	97	4,105	1,342	328	316	135	0	38	30,643
E6	West of Av. Nicolas Ayllon	49	70	196	1,224	1,115	2,482	0	518	3,671	296	2	292	193	36	201	10,344
E7	West of Av. Mexico	135	242	74	3,264	738	2,201	6	1,959	1,200	556	5	91	54	25	3	10,553
E8	West of Av. N. Arriola	32	88	373	2,787	2,043	1,840	0	35	3,656	722	175	553	637	118	103	13,161
E9	West of Av. Las Frutales	22	355	92	7,447	7,364	478	284	8,027	3,986	612	230	937	1,848	1,141	1	32,825
E10	East of Av. La Cultura	7	202	156	2,395	1,361	1,612	49	6,043	2,566	567	190	508	995	470	52	17,173
E11	Av. Prolongacion Javier Prado	567	254	460	4,093	928	2,597	43	5,482	4,213	640	182	760	927	655	24	21,826
E12	West of entrada a Huaycan	19	72	145	1,921	1,042	304	19	2,245	2,194	58	165	703	662	412	0	9,962
E13	Pt. Los Angeles (Chosica)	17	24	20	2,202	624	65	4	0	1,830	0	153	113	593	446	0	6,091

Table 3.2-1 Traffic Volume on Counted Points (converted into 24 hour volume)

(3) Traffic Volume by Type of Vehicles in the Morning Peak Hour

Figure 3.2-4 shows the number of the vehicles by five types of vehicle between 8:00 a.m. and 9:00 a.m., which are composed of passenger cars, taxis, Colectivos, buses and trucks. As can be seen, the trunk bus corridor is divided into two traffic characteristics as shown below:

1) Segment from Intersection of Av. Tingo Maria to Central Lima on Av. Arica. (E4-E5)

The passenger cars and taxis together account for 70 to 80 % of total traffic, especially, the passenger car and taxi of 800-1,000 veh/h pass through the location E5.

2) Segment from Intersection of Vía de Evitamiento to Santa Clara on Carretera Central (E9-E11)

Bus fleets are predominant in volume. Approximately 40% to 60% of traffic flows are the buses at E9, E10 and E11. Approximately 800 to 1,200 fleets pass in the westerly direction and 600 to 900 buses in the easterly direction at each point.

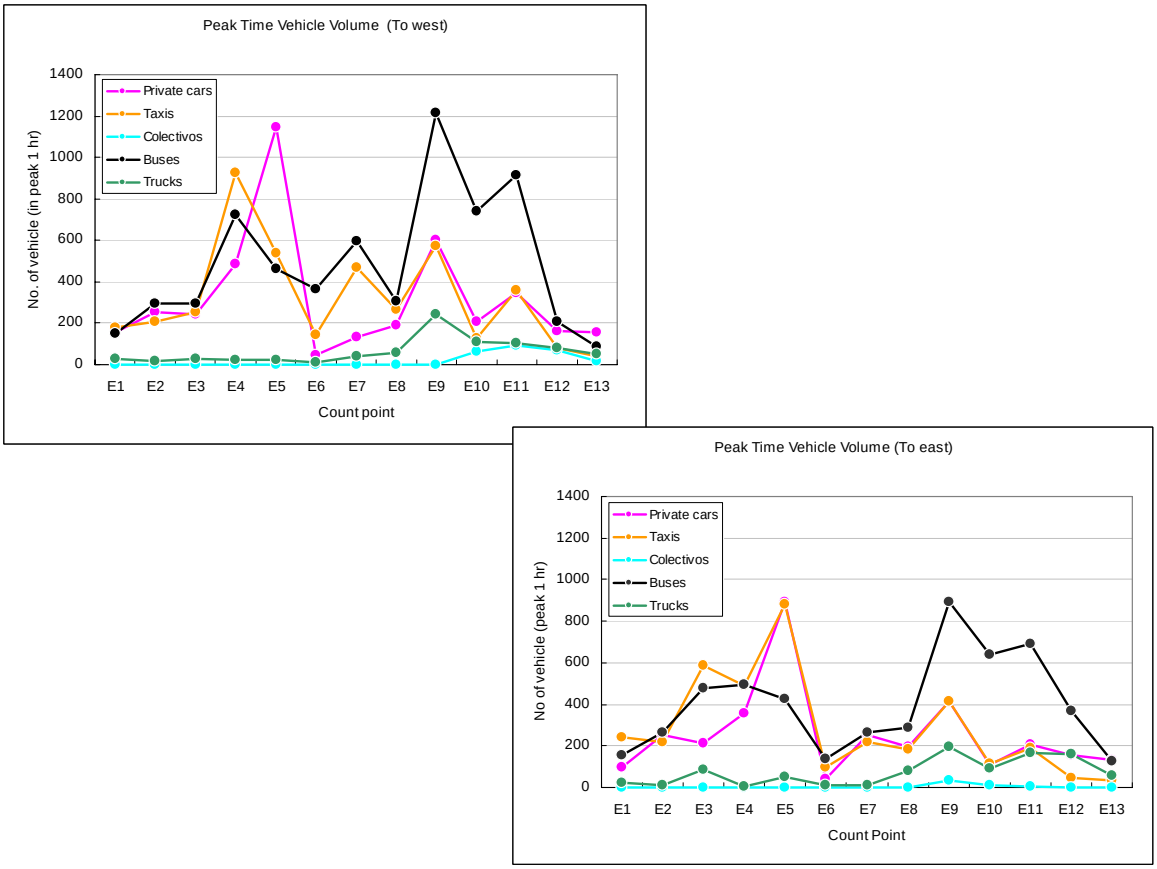


Figure 3.2-4 Traffic Volume by Vehicle Type in the Morning Peak Hour (8:00-9:00)

(4) Bus Transportation

Figure 3.2-5 shows the traffic volume of type of buses in the morning peak hour during 8:00 a.m. to 9:00 a.m. The composition ratios of bus fleets are shown in Figure 3.2-6. The traffic volume of Microbus on Av. Arica (Breña and Lima central areas) is approximately 300 vehicles/hr, equivalent to 56 to 70% of the total bus volumes in the locations E3, E4 and E5.

On Carretera Central (E9, E10, E11 and E12), Camioneta-rural (Combi bus) accounts for 50-60% of total bus traffic. Especially, approximately 600 Camioneta-rural buses/hr pass on the location E9. As for autobus, the ratio to all buses is as low as 10%.

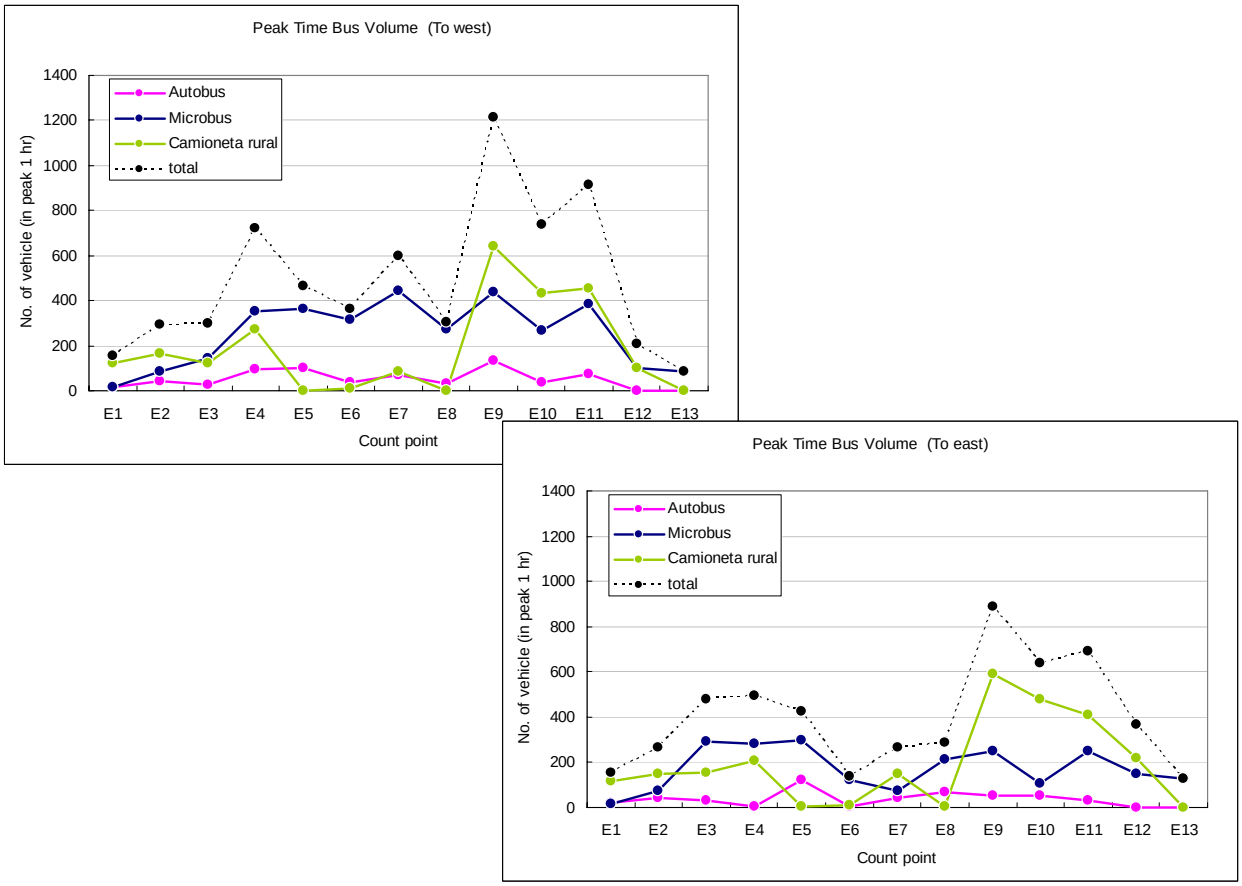


Figure 3.2-5 Bus Volume in the Morning Peak Hour (8:00-9:00)

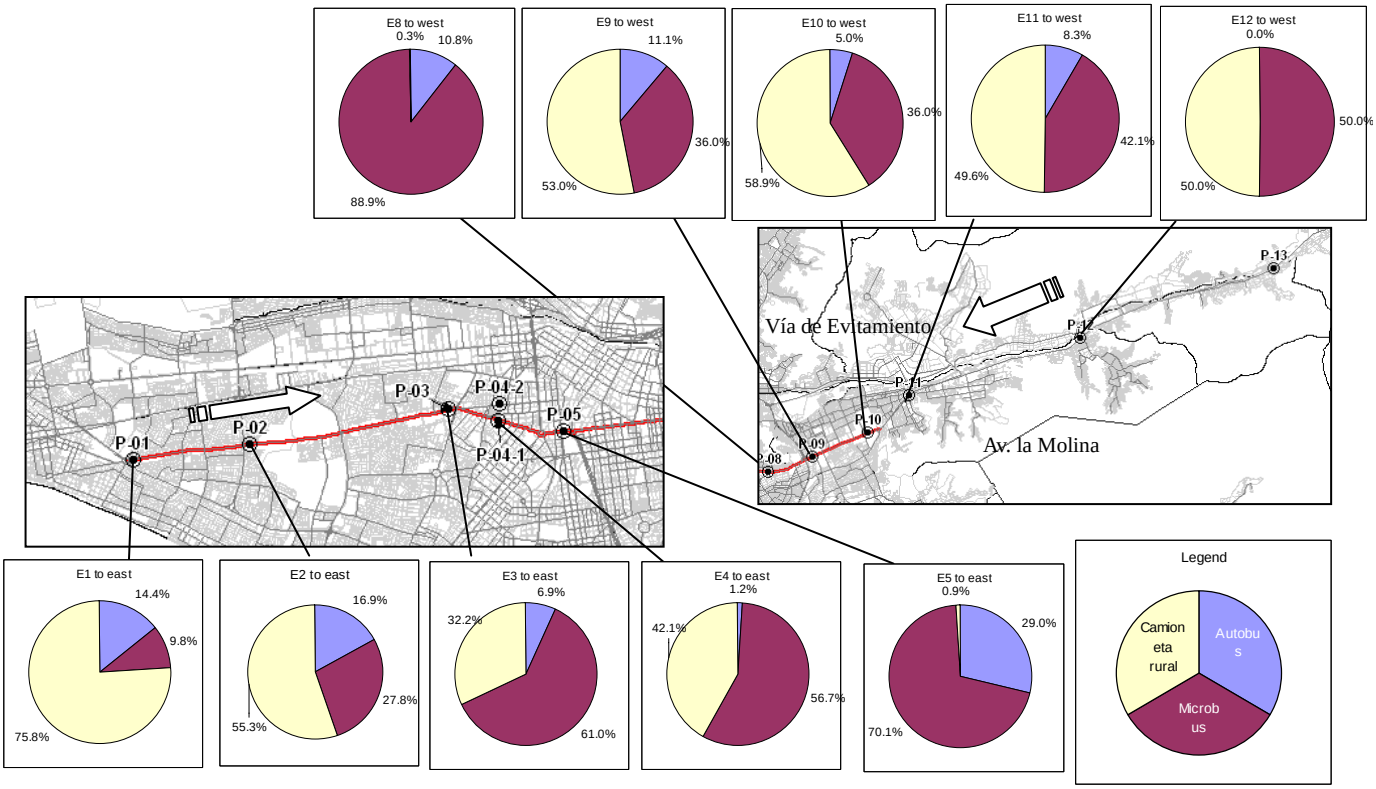


Figure 3.2-6 Ratio of Bus Fleet Type in the Morning Peak Hour (8:00-9:00)

3.3. BUS OPERATION ROUTE CHARACTERISTICS

Figure 3.3-1 indicates the number of bus operation routes by segment passing the East-West Trunk Bus Corridor. The segments in which the bus lines mainly concentrate are the following:

- Central Lima(Plaza Bolognesi to Plaza Grau) : 142 routes
- Av. Grau : 151 routes
- Av. Carretera Central (Intersection of Vía de Evitamiento to Av. La Molina) : 178 routes

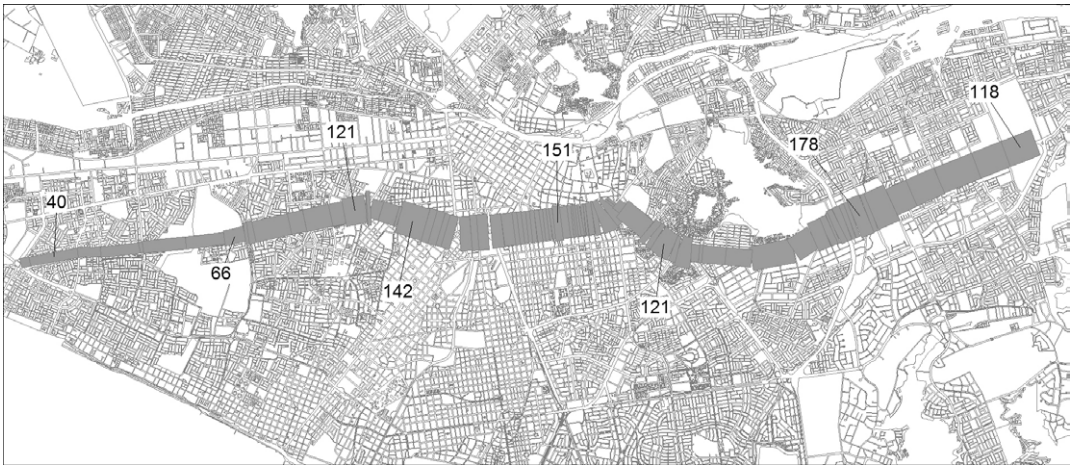


Figure 3.3-1 Number of Present Bus Lines on the East-West Trunk Bus Corridor

3.4. BUS PASSENGER TRAVEL CHARACTERISTICS

3.4.1. PASSENGER VOLUME ON THE EAST WEST CORRIDOR

(1) Passenger Volume

Figure 3.4-1 shows the estimated passenger volumes in the morning peak hour based on the bus occupancy survey.

1) To the East

The largest passenger volume is observed in the locations E5 (west of Plaza Grau) and E9 (east of Vía de Evitamiento). These volumes are approximately 15,000 passengers in the morning peak hour.

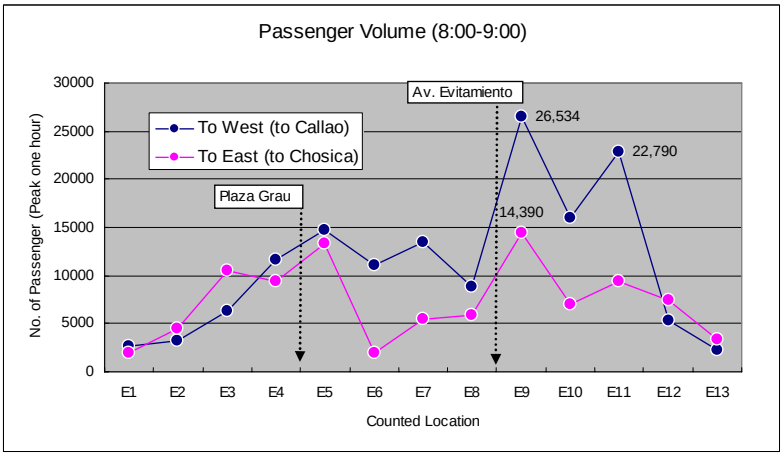


Figure 3.4-1 Bus Passenger Volumes in the Morning Peak Hour (All Buses)

2) To the west

The largest volume of the passenger flow in the westerly direction is observed in the location E9 at approximately 25,000 passengers in the morning peak hour. The passenger volume in the location E11 (Santa Clara) is also higher at approximately 23,000 passengers per hour.

Considering the passenger volume by each bus type, the microbus plays an important role in the transportation of passengers in the westerly direction as shown in Figure 3.4-2, though the autobus accounts for the largest position in passenger volume in the location E5.

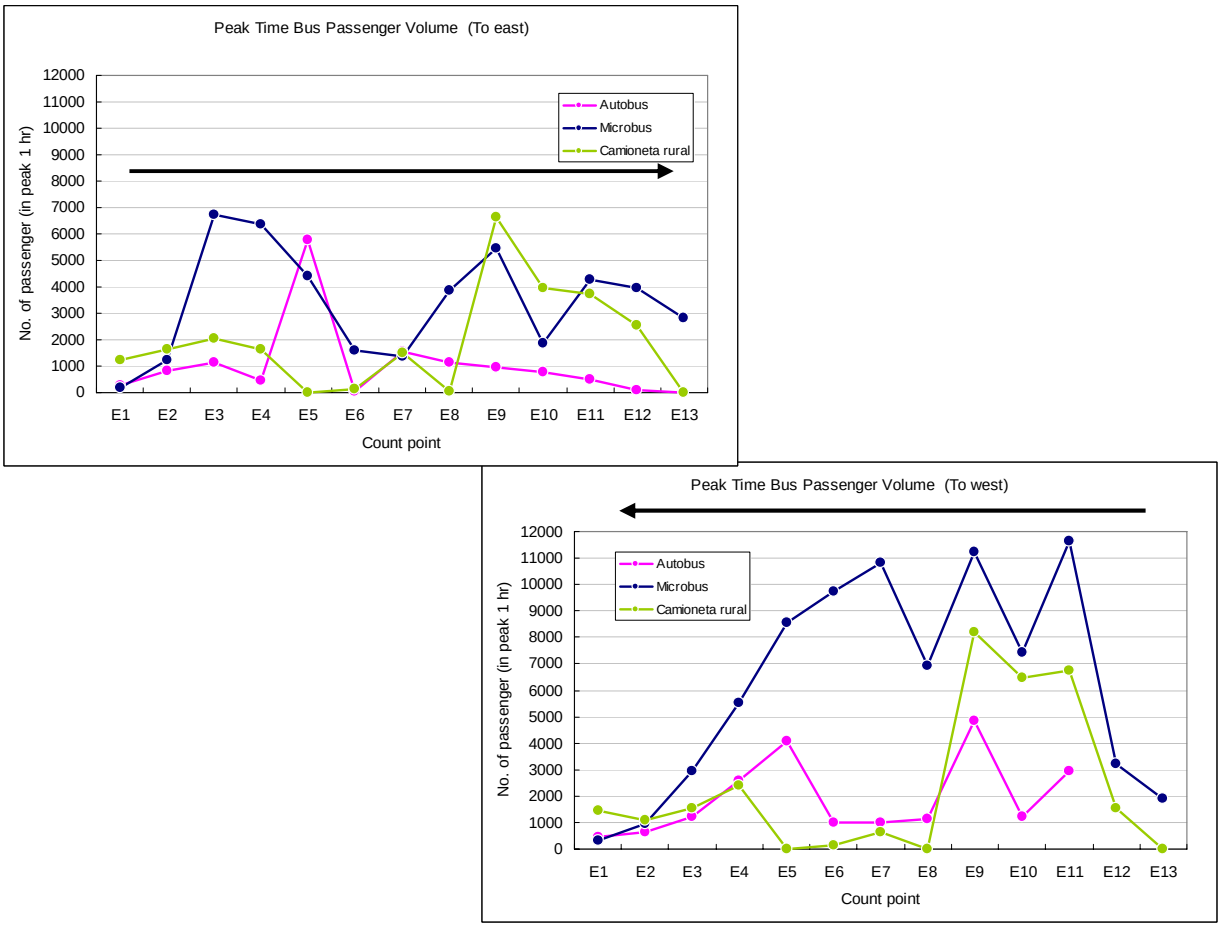


Figure 3.4-2 Total Bus Passenger Volumes in the Morning Peak Hour by Bus Fleet Types

(2) Characteristics of Bus Passenger Boarding and Alighting

The bus passenger volume survey was carried out on the 10 conventional bus lines passing through the East-West trunk bus corridor of which the boarding/alighting passengers are counted at each bus stop or intersection as shown in Figure 3.4-3. The 10 bus lines were selected from among the bus lines which are a longer line of an overlap length with the East-West corridor. This is because the passenger characteristics on the East-West corridor are understood and are available in the trunk bus system plan.

Figure 3.4-4, Figure 3.4-5 and Figure 3.4-6 show the boarding and alighting passenger behaviors on the typical bus routes Nos.EM-38, OM-75 and EO-29.

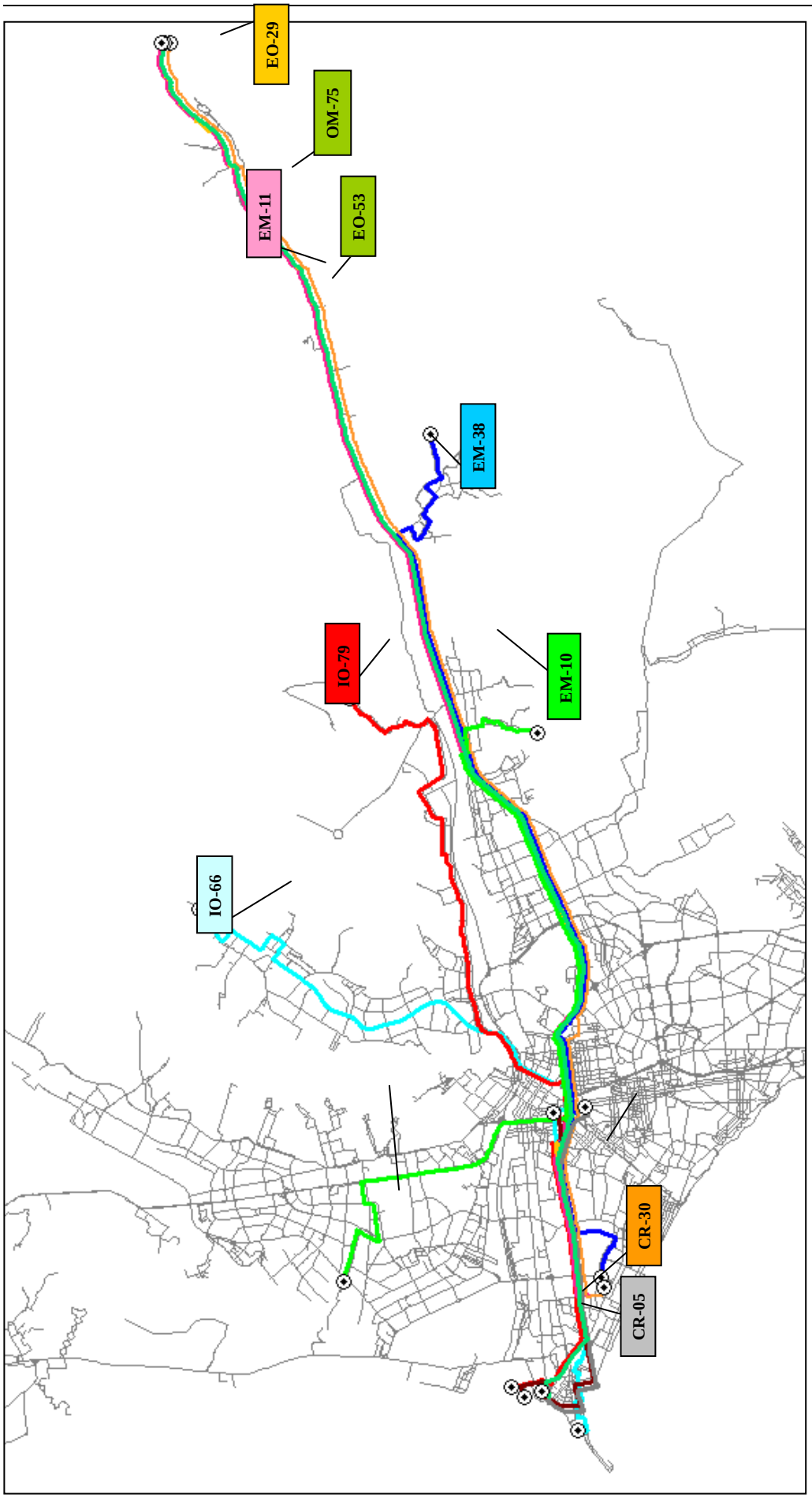


Figure 3.4-3 10 Surveyed Bus Line Configuration

EM-38 originates in Huaycan and passes through Carretera Central, and terminates at the end of Av. Venezuela in Callao (section of Av. Universitaria- Av. Las Leyendas). Its line length is approximately 40km. The microbus operates with a total of 59 passengers on average. Passenger volume on board almost reaches the capacity of the bus fleet at the exit from Huaycan on Carretera Central. Until the bus arrives at Av. Separadora Industrial (near the Eastern terminal of Trunk Bus Corridor), there is an average of 30 passengers on board. After that, the number of passengers gradually decreases towards the terminal.

OM-75 originates in Chosica, and also terminates at the end of Av. Venezuela by way of Carretera Central and Av. Faucett, with a line length of some 57km. The microbus operates on the route with a total of 101 passengers on average. The number of passengers gradually increases and reaches the maximum at the intersection of Huaycan with 43 passengers, which exceeds the microbus seat capacity (37 passengers). And then, the number of passengers gradually decreases.

EO-29 originates in Callao and terminates in Chosica with a line length of some 53 km. The microbus operates on the route with a total of 83 passengers in average. The number of passengers on board gradually increases and reaches the maximum at the intersection between Av. Venezuela and Av. Tingo Maria, with 28 passengers. Then the number of passengers on board gradually decreases until Av. Las Torres, and there is an average of 15 passengers until Puente Los Ángeles before Huaycan.

As mentioned above, the bus operation is effective until Centro Lima from Callao and until Vía Evitamiento from Eastern suburbs. Therefore the bus operation from Central Lima/Vía Evitamiento to the suburban area is not efficient from the viewpoint of transportation capacity.

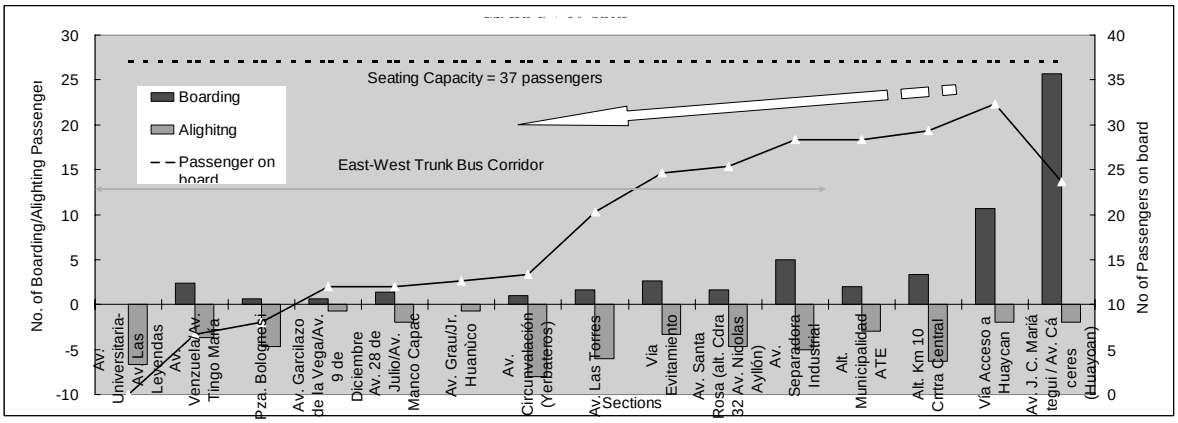


Figure 3.4-4 Characteristics of Boarding and Alighting on the Route EM-38 (Huaycan-Lima-Callao)

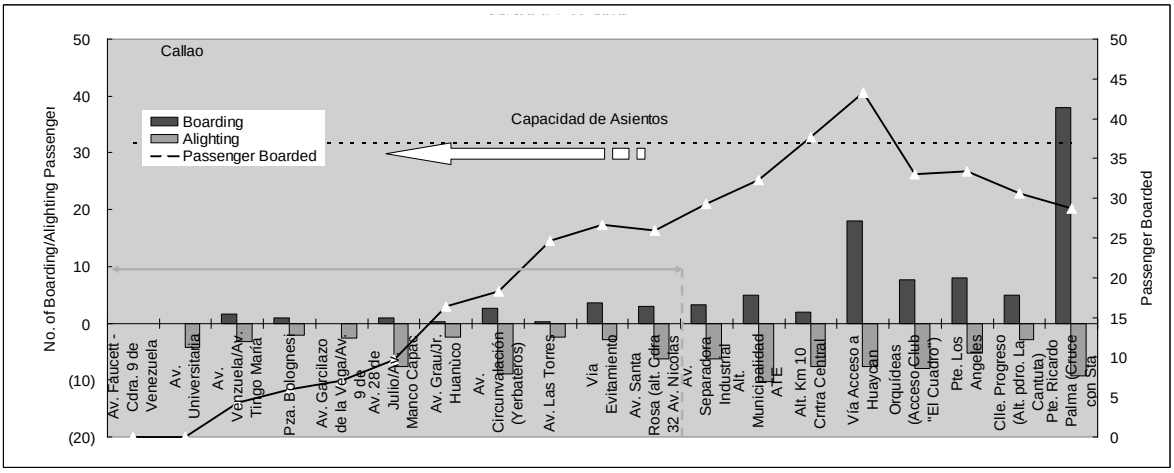


Figure 3.4-5 Characteristics of Boarding and Alighting on the Route OM-75 (Chosica-Lima-Callao)

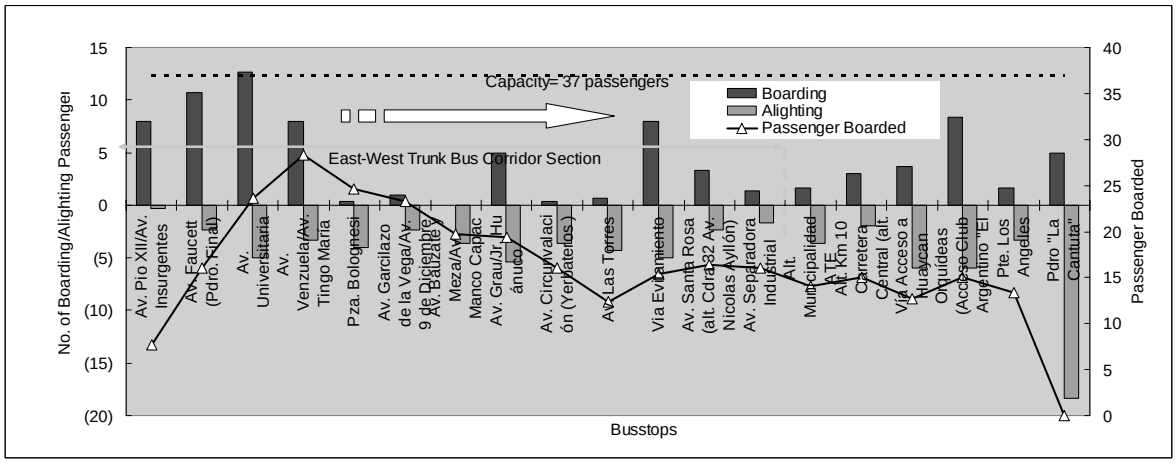


Figure 3.4-6 Characteristics of Boarding and Alighting on the Route EO-29 (Callao-Lima Centro-Chosica)

3.4.2. PASSENGER TRIP CHARACTERISTICS

(1) OD Trips of Passengers

The origin and destination of bus passengers were interviewed in the passenger interview survey. Based on the OD trips of passengers on board in the sampling base and number of the bus service frequencies in each line, the OD trips are expanded into the actual number in the morning peak hour (8:00-9:00). The origin and destination trips are integrated into 16 zone blocks to indicate the desire line of the present bus passengers on the East-West corridor.

Figure 3.4-7 shows the overall trip OD desire lines in the morning peak hour. The heavy desire lines are concentrated in Zone 7 (Bella Vista/San Miguel) -Zone 8 (Central Lima), and between the corridor and adjacent roads.

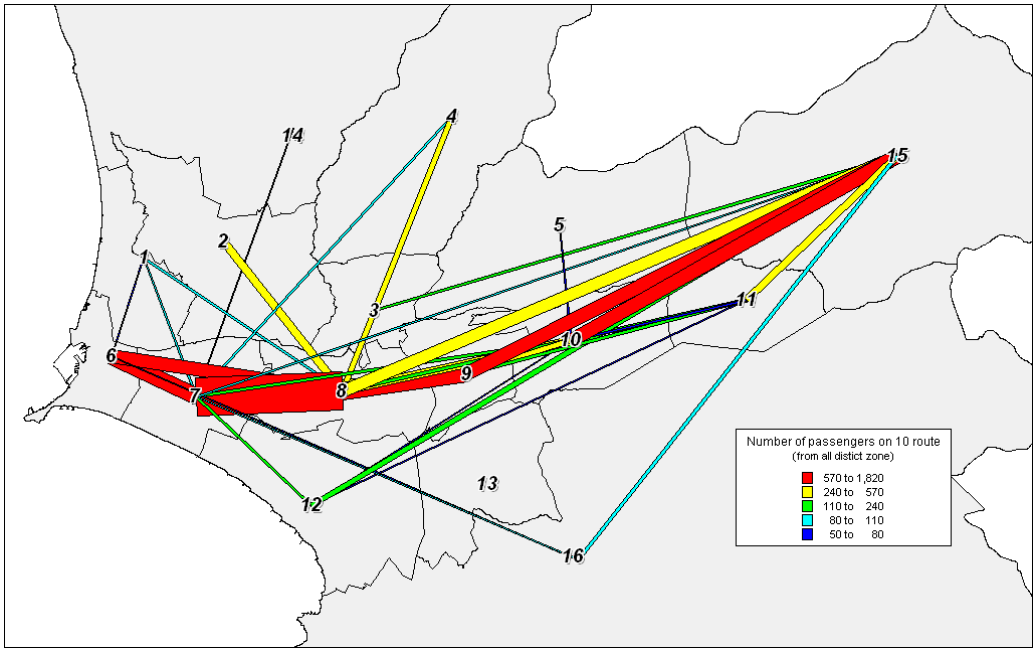


Figure 3.4-7 Trip Desire Lines of the Passenger in the Morning Peak Hour on the 10 Surveyed Route

Figure 3.4-8 shows the desire lines from/to the suburban areas of the Corridor, which are zone Nos.1 and 6 (Callao), zone No.10 (Santa Clara), zone No.11 (Huaycan) and zone No.15 (Chosica).

Passenger OD trips in Callao concentrate in zone Nos. 7 and 8, while the OD trips in Santa Clara, Huaycan and Chosica concentrate in zone No.9 (Santa Anita), though several passengers come to the Central Lima (zone No.8)

Comparatively, the passenger trip characteristics on the corridor are divided into two segments. One is from Callao to Central Lima and the other is from the Eastern area to Santa Anita and Santa Clara.

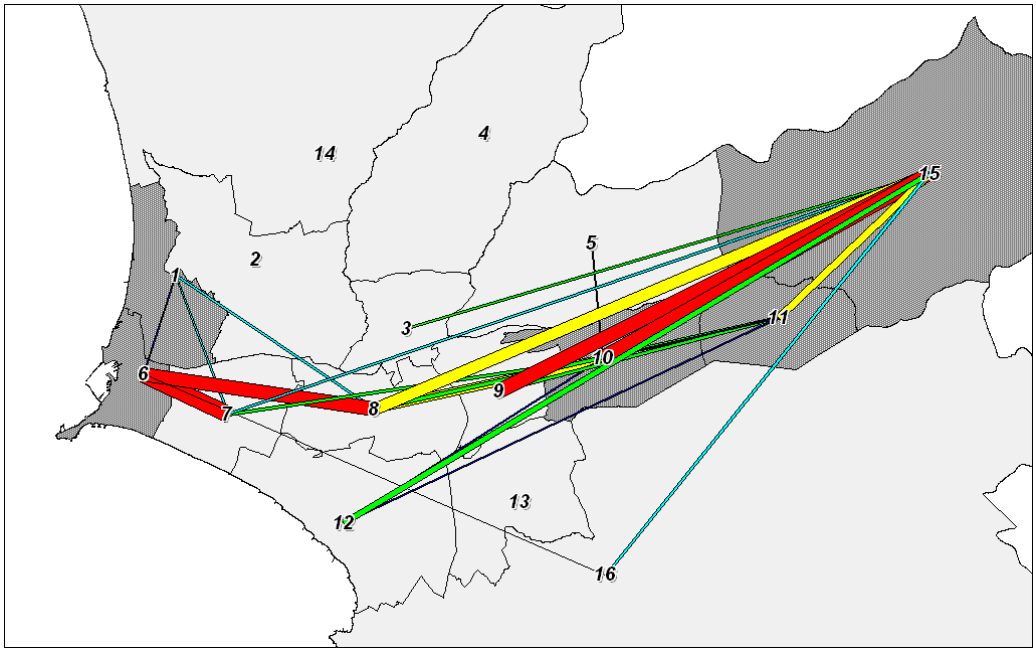


Figure 3.4-8 Trip Desire Lines of Passengers in the Morning Peak Hour based on the surveyed route (Origin or Destination is Callao, Santa Clara, Huaycan and Chosica)

(2) Passenger OD Trips between Bus Stops

The bus stop OD survey was carried out on the 10 same lines in the bus passenger interview survey. The purpose of this survey is to see passenger OD trips between bus stops at which a passenger boards and alights in each trip. Figure 3.4-9 shows the code No. of segment which is divided at main intersections to represent a major bus stop in order to see a major passenger flow between bus stops. The actual bus stop is provided at a shorter distance.

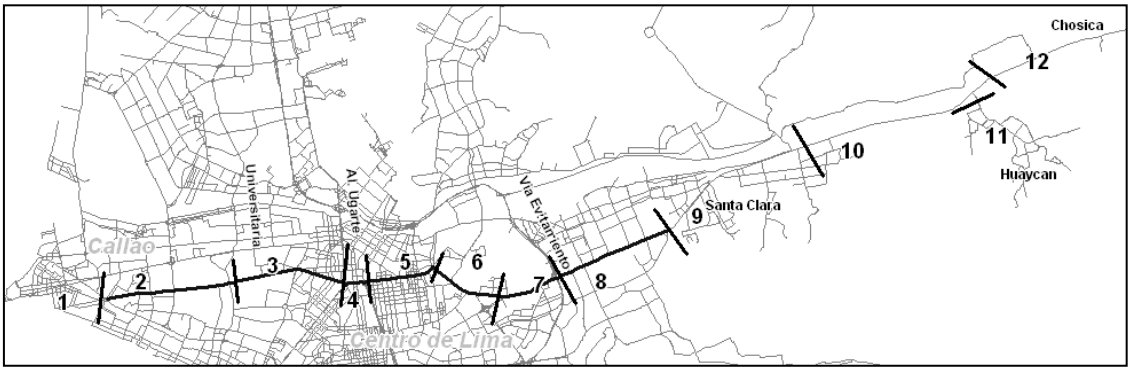


Figure 3.4-9 Location of Segment Code

Figure 3.4-10 and Figure 3.4-11 show the passenger flows between bus stops on Line Nos. OM-75 and EM-38 in the form of a width band in proportion to the OD trips between bus stops to represent the segment codes.

The major flows between bus stops on Line No. OM-75 (to Chosica) can roughly be divided into the following 3 patterns.

- Trips between the code Nos. 2 (Callao) and 5 (Central Lima)
- Trips between the code Nos. 5 and 8 (Santa Anita)
- Trips between the code Nos. 8 and 12 (Chosica)

As for Line No. EM-38 (to Callao), the major flows are divided into the following two patterns.

- Trips between the code Nos. 11 (Huaycan) and 8 (Santa Anita)
- Trips between the code Nos. 8 (Santa Anita) and 2 (Callao)

The boarding and alighting passengers at code Nos. 5 and 8 are a majority in volume. Since the trunk bus system on the East-West corridor proposes the terminal at Santa Anita, the location reflects the boarding and alighting characteristics.

OD Matrices of all the surveyed routes are shown in the Technical Report "Present Bus Transit Characteristics on the East-West Corrieor".

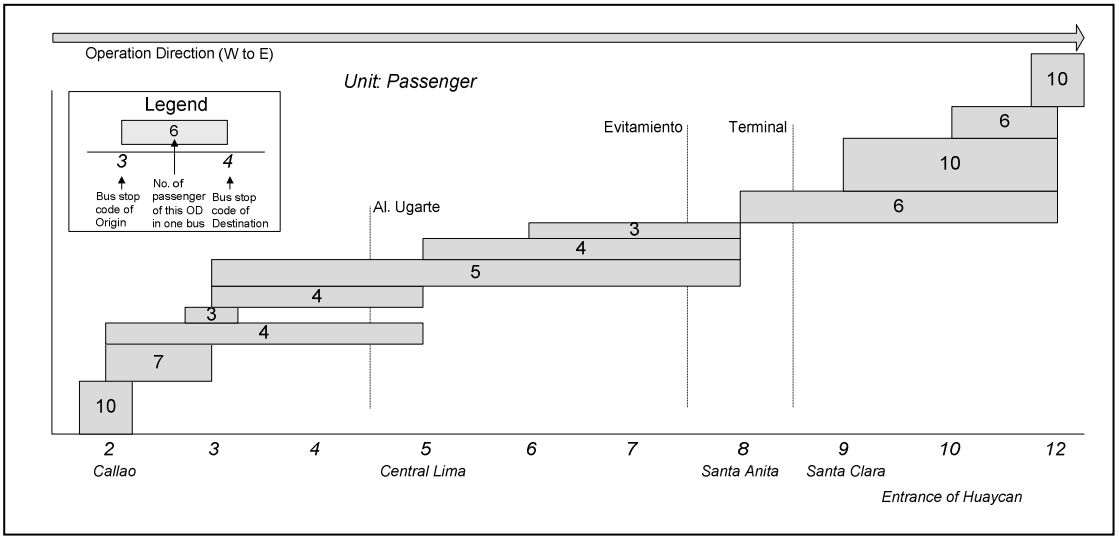


Figure 3.4-10 Major Passenger Flows between Bus Stops (Route OM-75 to East)

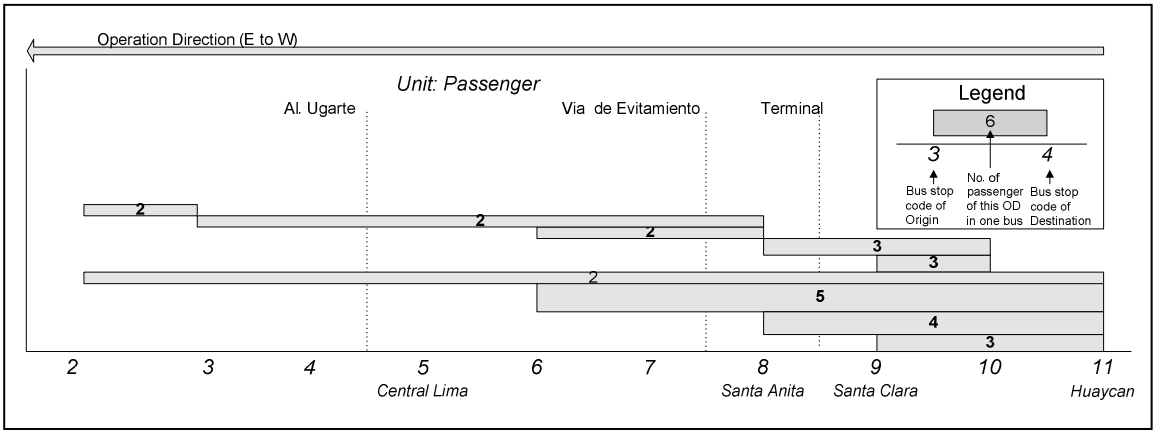


Figure 3.4-11 Major Passenger Flows between Bus Stops (Route EM-38 to West)

3.5. BUS OPERATION CHARACTERISTICS

(1) Bus Operation Speed

The bus operation speed in the morning peak hour was measured on the same 10 main bus lines. The departure time and arrival time at main bus stops or intersections were measured in each direction. The average operation speed was calculated from 3 separate time measurements in the field. Figure 3.5-1 shows the average bus operation speed on the Line No. OM-75.

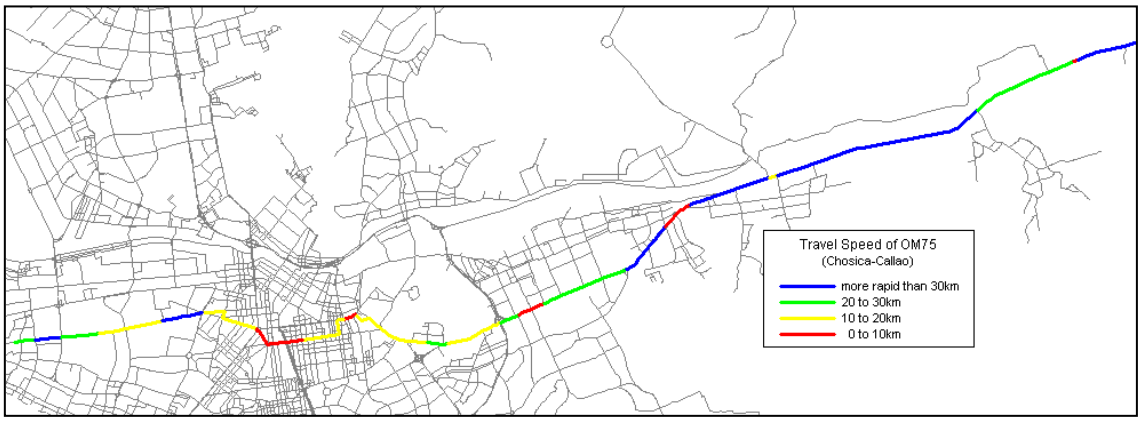


Figure 3.5-1 Bus Operation Speed on Line OM-75

1) To the East (Callao to Huaycan, Chosica)

The bus operation speed in the easterly direction is summarized as shown in Figure 3.5-2. Approximately 50% or more of the total line length in the following segment are less than 20km/h.

- Av. Venezuela (Av. Universitaria – Av. Roberto Thorndike Galup) (shown as "2" on Figure 3.5-2)
- Av. Arica (in the district of Breña) (4)
- Av. Nicolás Ayllon (Jose de la Riva Agüero- Av. Nicolás Arriola) (5)
- Carretera Central (Vía de Evitamiento – Av. la Molina) (6)
- Carretera Central (Av. Industrial – Av. Separadora Industrial) (7)
- Carretera Central (Prolongación Javier Prado – Av. Marcos Puente Llanos) (8)

The bus operation speeds on the following segments are less than 10km/h in the approximately 50% or more of the total length.

- Av. Venezuela (intersection of Av. Universitaria) (1)
- Av. Nicolás Ayllon (Av. Miguel Grau – José de la Riva Agüero) (4)

2) To the West (Huaycan, Chosica to Callao)

Figure 3.5-3 summarizes the bus operation speed in the westerly direction. Approximately 50% or more of the total line length in the following segment are less than 20km/h.

- Av. Venezuela (intersection of Av. Universitario) (shown as "1" on Figure 3.5-3)
- Av. Arica (in the district of Brena) (2)
- Av. Grau – Av. Ayllon (Av. Nicolás Arriola) (4)
- Carretera Central (Santa Rosa – Av. la Molina) (5)
- Carretera Central (Av. Separadora Industrial – Av. Vista Alegre) (6)

The bus operation speeds on the following segments are less than 10km/h in approximately 50% or more of the total length.

- Central Lima (Plaza Bolognesi – Av. 28 de Julio) (3)
- Carretera Central (Prolongación Javier Prado – Av. José Carlos Mariategui) (7)

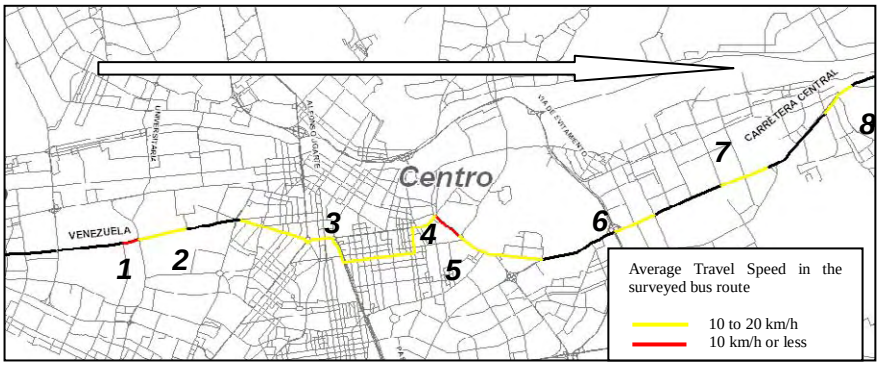


Figure 3.5-2 Bus Operation Speed Characteristics in the Morning Peak Hour (To East)

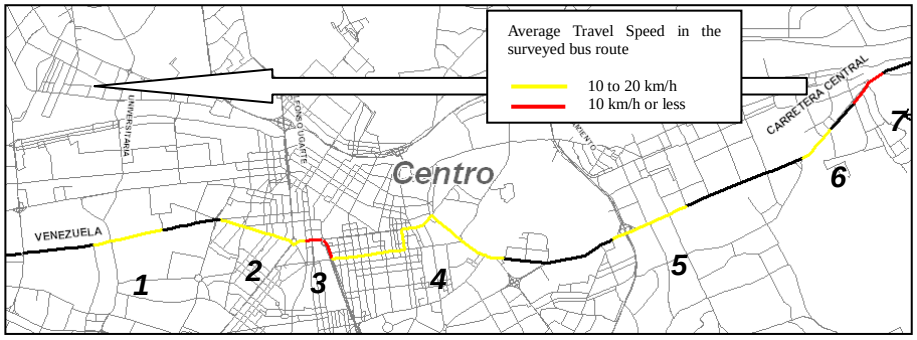


Figure 3.5-3 Bus Operation Speed Characteristics in the Morning Peak Hour (To West)

Velocity survey results of each route are shown in the Technical Report "Present Bus Transit Characteristics on the East-West Corridor".

(2) Bus Fare

The bus fare distribution in the surveyed line is shown in Figure 3.5-4. As can be seen, approximately 82 % of the total interviewed passengers pay a bus fare of less than S/. 2.0. The range of S/.1.0 to 1.9 shows the largest ratio at 62 % of the total.

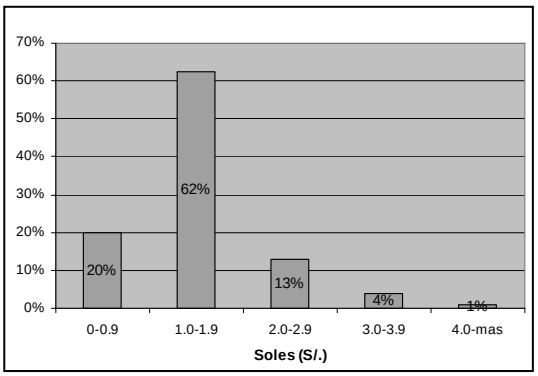


Figure 3.5-4 Distribution of Bus Tariff on the East -West Corridor

A passenger's opinion related to the present bus fare was interviewed and the result is shown in Figure 3.5-5. Approximately 40% of the total passengers answer "expensive". As can be seen in Figure 3.5-6, approximately 95% or more of the total who pay less than 1.0 answer "Medium" or "Reasonable". The opinion of passengers who paid between S./1.0 and 2.0 is divided into two groups: "Expensive" or "Inexpensive". The passengers who paid more than S./2.0 think the bus fare is "expensive".

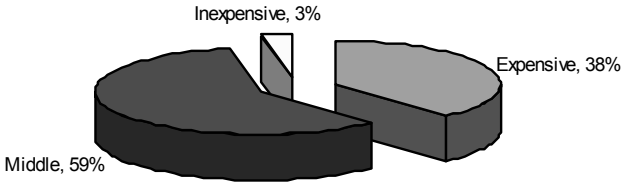


Figure 3.5-5 Passenger Impression of the Bus Fare

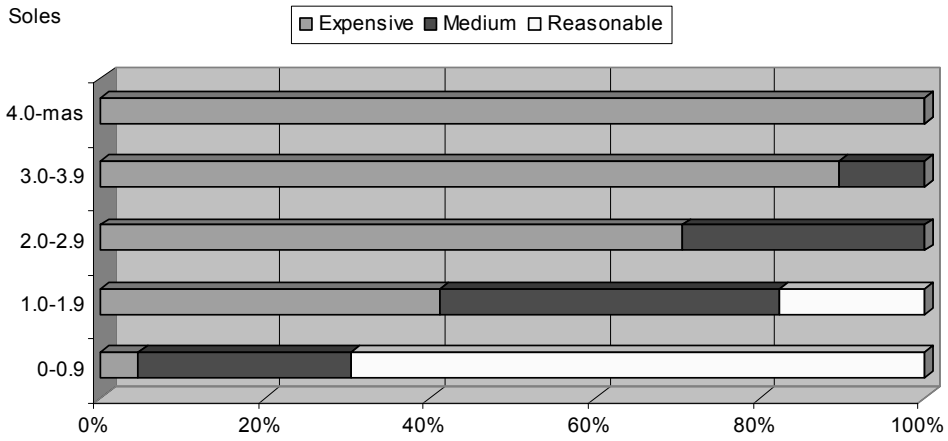


Figure 3.5-6 Passenger Impression by Actual Payment Amount

Figure 3.5-7 indicates the fare opinion integrated by origin area of the trip (Central Lima, Chosica, Huaycan, Santa Clara and Callao). The passengers from Callao consider the fare rate as medium or reasonable, while in Chosica and Huaycan approximately half of the passengers consider the fare as expensive.

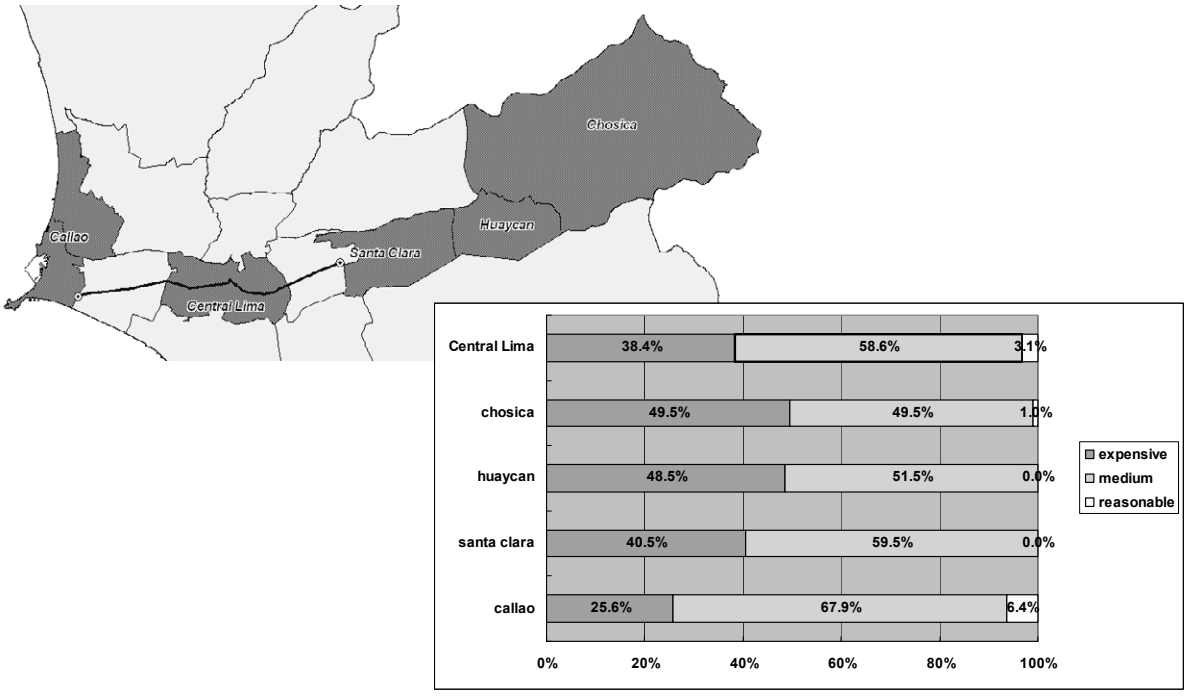


Figure 3.5-7 Fare Opinions in Each Area

3.6. BUS PASSENGER TRIP CHARACTERISTIC AND OPINION

The bus passenger travel conditions on the east-west trunk bus corridor were surveyed in the bus passenger interview survey. The purpose is to understand the present passenger characteristics and find the issues to formulate the trunk bus system plan. The interviewed items are as follows:

- Basic Information about bus passenger trip
- Access to the bus
- Waiting time
- Travel Time
- Problems

3.7. BUS COMPANY CHARACTERISTICS SURVEY

To identify the characteristics of administration, operation and productivity of the most representative urban transportation companies in Lima, and also to propose actions and strategies for the implementation of the operating design and concession of routes for the East-West Trunk Bus System, the 15 bus company survey were carried out in 2006. The analyses of the survey are shown in the Technical Report "Present Bus Transit Characteristics on the East-West Corridor".

3.8. ON-GOING RELATED PROJECTS

The latest data and information regarding on-going projects and studies of road and transportation development in Lima and Callao were collected and reviewed. The collected information includes a project profile, project volume, cost, financial sources, organization, and period construction. The information is used in planning the Study projects of the trunk bus system and traffic management projects. The work includes the following:

- COSAC Project by PROTRANSPORTE
- The North-South Electric Train Extension Line Project by AATE
- The Study of the Concession of Lines on 9 Metropolitan Roadway Axes by GTU
- Elmer Faucett- Callao Expressway Project
- Av. Grau Expressway Project