COMPONENT II

TRAFFIC MANAGEMENT PLAN

CHAPTER 11

Introduction of
Traffic Management Strategies

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

11. INTRODUCTION OF A TRAFFIC MANAGEMENT STRATEGY

11.1. ROAD SAFETY EDUCATION PLAN

11.1.1. OBJECTIVES

The objective of road safety education plan is to formulate the road safety education and campaign program for target groups of children and public entities operators.

11.1.2. STRATEGY FOR ROAD SAFETY EDUCATION PLAN

(1) Current Conditions and Issues

Peruvian drivers, considered collectively, have been described as undisciplined through actions such as ignoring red traffic lights, making sudden and frequent lane changes without notice, ignoring speed limits, jumping queues, and blocking intersections. In particular, bus drivers are among the worst offenders. Such driving behavior leads to a lower traffic capacity and the occurrence of traffic accidents.

Drivers/pedestrians should obey traffic signals/regulations and understand the merit of traffic safety. Improving the road/traffic facilities and implementing traffic safety measures including effective driver/pedestrian education programs can minimize the conflicts between vehicular traffic and pedestrians, which reduce the efficiency of the urban street network. Such measures and programs, if successfully implemented, will not only improve traffic flows but will also improve the safety, convenience, and comfort of both pedestrians and drivers.

(2) Formulation of Road Safety Education Plan by Target Groups

The target group for the road safety education plan will be divided to two (2) groups; 1) children's group, such as infants, school students, and junior high school students, 2) public entity operators.

Children in many motorized countries are more likely to die or be injured as a result of road accidents, than through any other cause. In developing countries, 20% of traffic deaths are people under the age of 15 and the threat of traffic accidents will increase with motorization. Road safety education is needed to provide the necessary structure for the acquisition of safety skills and knowledge. These include decision making skills, and the identification and assessment of risks and strategies to reduce these risks. The road safety education plan attempts to prepare children for the different tasks at each stage of their independent use of the road network and, later, as adults

Bus drivers are among the worst offenders, since they habitually load and unload passengers everywhere inside intersections and between center lanes. They overtake or change lanes near intersections in order to pick up extra passengers, and they wait for passengers even when at green lights. Such driving behavior leads to a lower traffic capacity and the occurrence of traffic accidents. Road safety education includes advanced driving skills and knowledge necessary for safe travel and faster drivers who can be models for other drivers.

Based on foregoing context, a traffic safety education plan focuses on traffic safety education for children and public transport operators by introducing institutional improvement, and augmenting the traffic safety education program and campaign program.

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

11.1.3. PLAN FOR ORGANIZATION OF COORDINATION AND MANAGEMENT OF ROAD SAFETY

The best way to ensure that budgets are available and protected, and that trained staff are assigned to road safety is for the central government to create an organization dedicated to initiating and coordinating road safety activities. This is usually best done by establishing a "National Road Safety Council (NRSC)" or a road directorate. The NRSC will need the following fundamental items to able to deal efficiently and effectively with road safety issues: 1) adequate political support, 2) adequate funds, 3) adequate technical and administrative resources, 4) an understanding of the problems, and 5) coordinated efforts among at least the organizations working in this area.

(1) Current Organization for Road Safety

Acting on the request of the Ministry of Transport and Communication (MTC), the President of the Republic of Peru signed Supreme Decree No.010-96-MTC on August 22 1996 establishing the National Council of Road Safety (CNSV) in order to promote and coordinate activities related to road traffic safety in Peru. The CNSV is chaired by the Minister of Transport and Communication (MTC), and the council consists of four (4) representatives of Government Agencies, namely, Ministry of Transport, Communication, Housing and Construction, Ministry of Interior, Ministry of Education and Ministry of Health (see Figure 11.1-1).
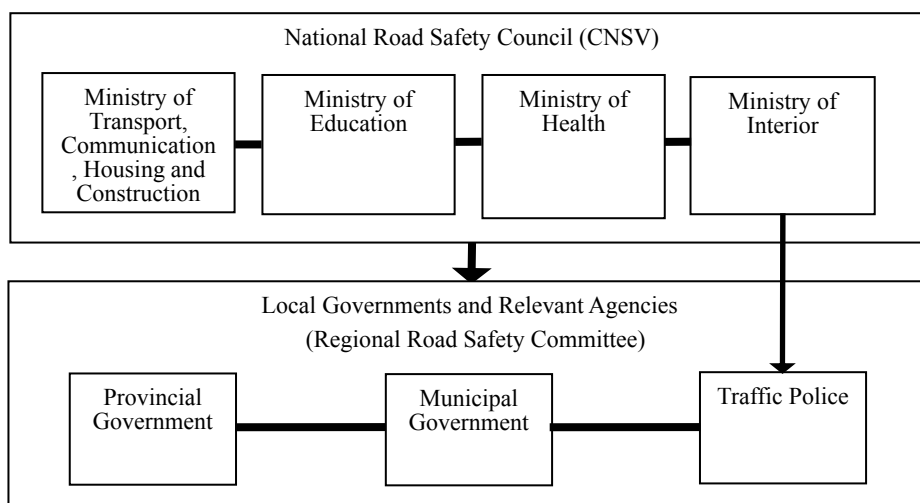

Figure 11.1-1 Current Organization for Road Safety

(2) Improvement Plan for National Council of Road Safety (CNSV)

1) Problems and Issues

In Peru, the National Council of Road Safety (CNSV) was formed with the aims of proposing prevention policy, coordinating execution of plan action for the medium and long terms. Its main activities are: the design and evaluation of actions for traffic safety and education, promotion and organization of training courses for the prevention of traffic accidents in order to carry out the campaign of traffic safety and traffic education, and the proposal of a legal manual for improvement of traffic safety. With regard to CNSV, the following problems and issues have been identified.

- CNSV has been limited in its activities due to a small annual budget.

- Human resources for the CNSV will be required in order to develop the skills of CNSV staff and enhance its institutional capacity.

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

2) Enhancement Plan of CNSV Function

CNSV office should be enhanced by effective function and staffing. CNSV should function as four (4) sections, in order to implement their duties of administration, statistical data, training and education, and operation and management. The staff for CNSV will be seconded to the secretariat from member agencies such as the cities of Lima and Callao, traffic police, etc. The organization and activities of the CNSV are shown in Figure 11.1-2.
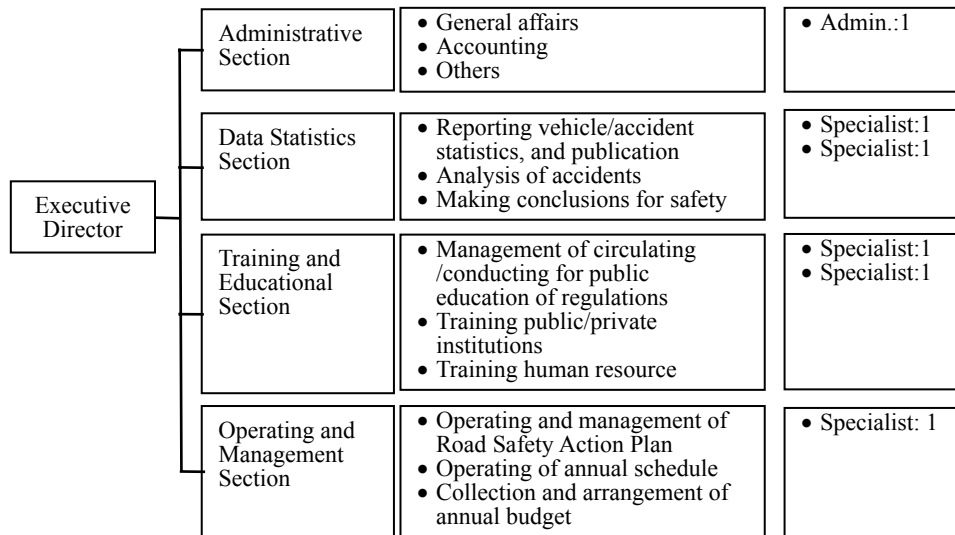
Executive Director	Administrative Section	• General affairs • Accounting • Others	• Admin.:1
	Data Statistics Section	• Reporting vehicle/accident statistics, and publication • Analysis of accidents • Making conclusions for safety	• Specialist:1 • Specialist:1
	Training and Educational Section	• Management of circulating /conducting for public education of regulations • Training public/private institutions • Training human resource	• Specialist:1 • Specialist:1
	Operating and Management Section	• Operating and management of Road Safety Action Plan • Operating of annual schedule • Collection and arrangement of annual budget	• Specialist: 1

Figure 11.1-2 Organization and Activities of CNSV

3) Plan for Formulating Funding for CNSV

Figure 11.1-3 shows an ideal proposal of funding sources for CNSV. The funding sources for the CNSV can be typically considered as coming from an annual budget from government or via a levy on motor insurance policies, drivers' licenses, fuel, or other sources, which increase in line with growth in vehicles. About 60-70% of CNSV income should come from such a levy and about 20-30% from commercial sponsorship and CNSV fund raising activities

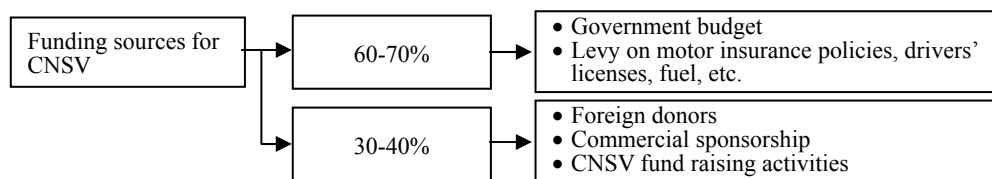| Funding sources for CNSV | 60-70% | • Government budget
• Levy on motor insurance policies, drivers' licenses, fuel, etc. |
| | 30-40% | • Foreign donors
• Commercial sponsorship
• CNSV fund raising activities |

Figure 11.1-3 Ideal Proposal of Funding Sources for CNSV

In order to implement successfully the sustainable sources of funding for medium and long term activities, a sustainable funding mechanism will be established. Figure 11.1-4 shows the proposed sustainable funding mechanism for CNSV and NGOs/Private Sectors. In the short term, funding of road safety should be supported by the private sector, such as fuel companies, transport operators, motor insurance industry involvement, the legislative measures necessary to provide financial support from private funding will be introduced. In addition, the major private sector companies and NGOs can support the CNSV, by organizing national road safety conferences, publishing road safety documents, researching psycho-physical tests for driving and implementing campaigns on the streets. In the medium and long term, in terms of vehicle insurance, all drivers should have at least third party insurance stipulated by legislation. This should allow for a levy to be imposed on

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

total insurance premiums collected and dedicate it to road safety; for instance, legislation establishing CNSV stipulates 10% of third party premiums. This proposed measure should be dealt through an organization system between CNSV and NGOs/Private Sectors.
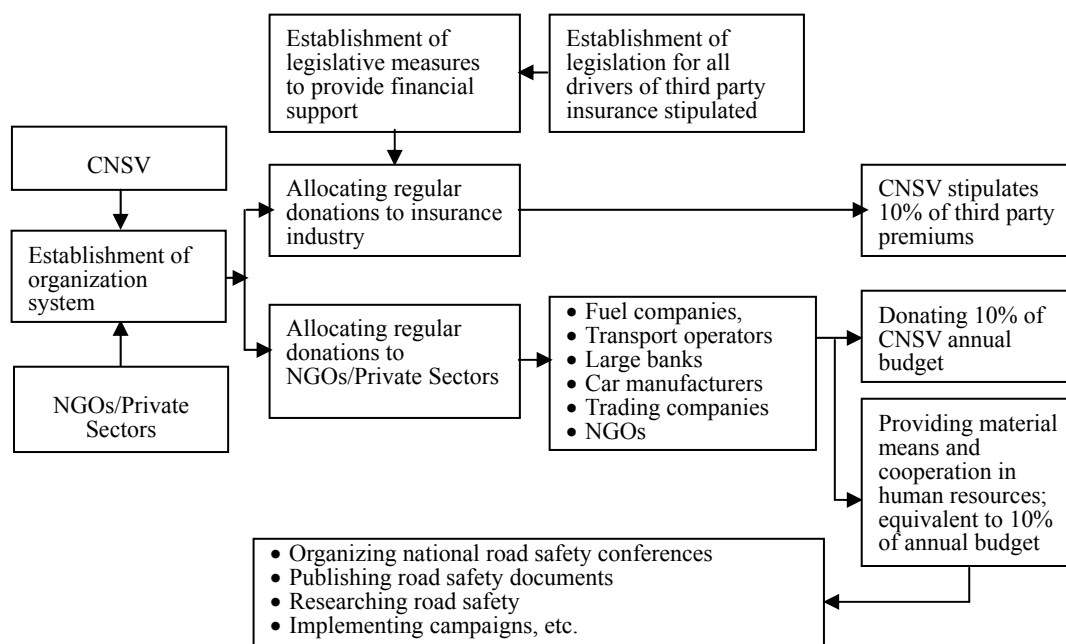

Figure 11.1-4 Proposed Sustainable Funding Mechanism for CNSV and NGOs/Private Sectors

4) Development Plan of Human Resources for CNSV

A training program to develop the human resource skills of the CNSV staff and to enhance its institutional capacity will be developed. The program will be formulated on the basis of training courses, such as on the job training with assistance from international specialists, training by workshops or seminars, and sending staff abroad for training in developed countries. On the job training will be implemented within the scope of consulting services, international consultants would be engaged to provide advisory services for the 5-Year program. Training by workshops/or seminars held once or twice each year generally matches the implementation schedules of the Action Plan. Training in developed countries will be executed once every year. A proposed training schedule for development of human resources is shown in Figure 11.1-5.

Training Course	Description	2007	2008	2009	2010	2011
On the job training	• Preparation of action plan • Instruction for local bodies • Coordination and management • Assessment of efficiency					
Workshops or seminars	• General introduction for road safety • Implementation of Action Plan					
Training in developed countries	• Staff of CNSV and local bodies					

Figure 11.1-5 Training Schedule for Development of Human Resources

5) Plan for Local Coordination and Management

Based on the proposed 5-Year programs, the CNSV should oversee the implementation of 5-year programs and the coordination of the efforts of the different agencies to produce 5-year programs. Each local government and agency that is a member of the CNSV, should prepare, within its own sphere of activity and influence, a 5-year action plan to

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

enhance or improve road safety. In terms of the effectiveness and the implementation process, the CNSV reviews the completed activities and assesses their efficiency, and makes revisions if necessary (see Figure 11.1-6).

It is important for activities at local level to be harmonized with initiatives being taken at national level. CNSV prepares an annual program of proposed activities and circulates it to the local bodies so that their local activities can be integrated with the 5-year programs, such as road safety campaigns. CNSV provides special presenters to support local bodies; the special presenters are placed by rotation at the disposal of CNSV, and they will organize the workshops for instruction and assessment of activities.
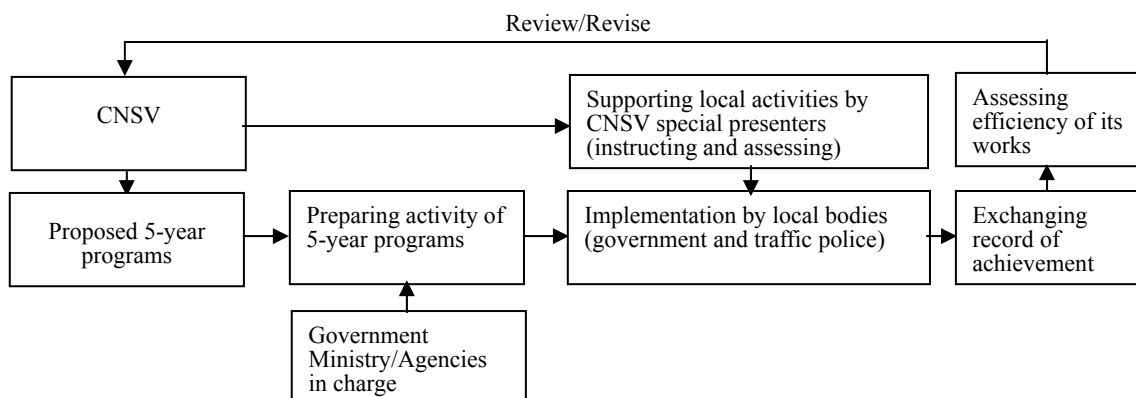

Figure 11.1-6 Management and Coordination for 5-Year programs

11.1.4. REVIEW OF 5-YEAR PROGRAMS FOR ROAD SAFETY

(1) Current 5-Year programs by CNSV

The current 5-Year Strategic Plan (2006-2010) was developed by CNSV, and is proceeding, however, the plan is running late due to the small annual budget. The general program and implementation schedule are shown in Figure 11.1-7.

Program	2006		2007		2008		2009		2010	
	1-6	7-12	1-6	7-12	1-6	7-12	1-6	7-12	1-6	7-12
1. Education program for road safety	▬▬								▬▬	
2. Communication program	▬▬	▬	▬	▬	▬	▬	▬	▬	▬	▬
3. Road infrastructure program		▬								
4. Accident data program			▬		▬	▬				
5. Driving license program				▬						
6. PNP strengthening program						▬				
7. Emergency and rescue program							▬▬			

Figure 11.1-7 General Program and Implementation Schedule for 5-Year Strategic Plan

The following issues pertaining to the 5-Year Strategic Plan (2006-2010) have been identified from current road safety conditions.

- A Program for enhancement of CNSV should be included, such as 1) funding for CNSV, and 2) development of human resources. This was pointed out in the issues of current CNSV activities.

- A Program for traffic accident monitoring system should be included, such as 1) investigation and database system, 2) analysis system of hazardous locations and confirmation of problems, 3) planning of measures system, 4) implementation of measures system, and 5) follow-up system. This was pointed out in the issues of

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

current data analysis and accident prevention measures; which can be approached generally through the procedure from database to planning of countermeasures.

- Program for local coordination and management of local bodies should be included, especially, the development of human resources by introducing workshops and seminars.

11.1.5. PLAN FOR ROAD SAFETY EDUCATION AND CAMPAIGN PROGRAMS

CNSV is aimed at performing the activities of the road safety education and campaign programs. The target group comprises children and the public transport operators. The plan of traffic education and campaign programs by target group is described below:

(1) Training Program Plan for Children

The training program for children consists of a program for infants, a program for schoolchildren, and a program for junior high school students.

1) Review of Current Road Safety Activities

Currently, road safety education activities are implemented by CNSV, local governments and Traffic Police, such as edition/reprinting of road safety education methodological guide, video editing, design and printing of road safety educational kits, delivery and distribution of educational material, execution of the first traveling school for road safety education, organization and execution of traffic safety campaign, and design and implementation of road safety children's parks.

The educational textbooks are classified into three kinds, namely, two levels of textbooks for elementary school students (level I and II), two integrated textbook for junior high school students ($1^{st}/2^{nd}$ grade and $3^{rd}/4^{th}$ grade), and a teacher's guide for junior high school students. In addition, the textbook for infants should be formulated.

2) Improvements of Current System Identified

a) Activities for Road Safety

The road safety activities of education projects are effectively implemented by CNSV and Traffic Police, however, as road safety education in Peru has been initiated, it is important to extend road safety education to a national level in collaboration with the road safety network, by introducing periodic road safety publicity, campaigns, and seminars. In addition, it is necessary to implement a systematic education program, based on adequate textbooks and skilled teachers.

b) Current Road Safety Textbooks

The present textbooks and teacher's guide are identified issues, based on the category of basic descriptions such as a) purpose, b) basic rule, c) rules for pedestrians, d) rules for riding in a car (passenger), etc., e) rules for riding a bicycle, f) matters to bear in mind about cars, etc. g) action to take in case of an accident. The qualitative assessment of current textbooks is shown in Table 11.1-1, and Table 11.1-2 shows the major issues by textbook. The criteria for assessment are based on with or without a description by basic category, and an expression of description.

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

Table 11.1-1 Qualitative Assessment of Present Education Textbooks

Textbook	Purpose	Basic rule	Rules for pedestrian	Rules for riding in a car (passenger)	Rules for riding a bicycle	Matters to bear in mind about cars, etc,	Action to take in case of accident
1) Infants	C	C	C	C	-	C	C
2) Elementary school (II)	A	A	A	C	C	B	C
3) Elementary school (III)	A	B	A	C	C	B	C
4) High school (1st/2nd grade)	A	A	B	-	C	C	C
5) high school (3rd/4th grade)	A	A	A	-	B	C	B
6) Teacher's guide	A	A	A	A	A	A	A

Notes: Rating from A: Sufficient, B: Tolerable, C: To be revised or to be added

Table 11.1-2 Major Issues of Current Education Textbooks

Textbook	Major issues
1) Infants	• Necessary to formulate the textbook for infants
2) Elementary school (II)	• Revises and adds key structure (rules for riding in a car and on a bicycle, matters to bear in mind about cars, action to take in case of accident) • Some chapters could be summarized and emphasize the contents more (chapter II and III) • Chapter IV "Road traffic element" shows many descriptions, which should be reduced
3) Elementary school (III)	• Revises and adds key structure (basic rule, rules for riding in a car and on a bicycle, matters to bear in mind about cars, action to take in case of accident) • Some chapters could be summarized and emphasize the contents more
4) High school (1st/2nd grade)	• Revises and adds key structure (rules for pedestrian, rules for riding on a bicycle, matters to bear in mind about cars, action to take in case of accident) • Necessary to revise illustration corresponding to target description
5) High school (3rd/4th grade)	• Revises and adds key structure (rules for riding on a bicycle, matters to bear in mind about cars, action to take in case of accident) • Necessary to make sensible recipients with topics
6) Teacher's guide	• The manual may be suitable as a teacher's guide • Chapter 4 should give an important warning about drinking and drug abuse, however, it is not necessary to include this in the textbook

3) Plan for Basic School Classroom Materials and Teacher's Guide by Age Group

a) Road Safety in the Curriculum

Peru has shown repeatedly that visiting speakers (CNSV member or traffic police) are not particularly effective unless they are part of ongoing activity in the school through a structured program for road safety. It is essential for the long term prospects of road safety education in schools that there is adequate provision in the national curriculum. The curriculum content must of course be well-defined, based on sound educational principals and should reflect local needs and accident problems.

b) Structure of Guidelines for Road Safety Education by Target Age Group

Specific road safety lessons can be included in the school timetable, in addition to being appropriate for the target age group; road safety lesson content should also include practical roadside training, and actual problems based on accident data. The structure of the guidelines for road safety education by age group will be proposed in Table 11.1-3. The structure will comprise eight (8) key categories and major descriptions.

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

Table 11.1-3 Structure of Guidelines for Road Safety Education by Target Age Group

Target Age group	Purpose	Basic rule	Rules for pedestrians	Rules for riding in a car	Rules for riding on a bicycle	Matters to bear in mind about cars, etc.	Rules for drivers of motorcycles and cars	Action to take in case of a accident
1. Infants	• Instill participants with right attitude to observe basic traffic rules • Practice traffic manners • Teach skills and knowledge for safe passage on road in daily life	-	• Basic attitude • Types and meaning of signs (passage on road) • Dangerous behavior that causes accident • Area for passage of pedestrians • How to cross road	• Sit in rear in a child seat, etc. • Behave so as not to interfere with driver • Do not cross in front of or behind a car immediately after getting out of it	-	• Basic matters regarding car, etc. • Signals • Braking distance • Danger of blind corners and difference between radii of inner wheels of car	-	• Ask for help from people near site of accident • Lets parents know that their child has had an accident
2. School-children	• Teach skills and knowledge for pedestrians or cyclists • Increase awareness and ability to predict and avoid danger on road for safety passage • Teach how to pass along road safely depending on situation of road and traffic	• Necessity of traffic rules • Types and meanings of traffic lights • Types and meanings of signs • Obeying instructions from police officers • Things not to do on road • Safety on road while commuting to and from school	• Basic attitude • How to walk safely at night • Understanding to help for safety of infants, lower graders, elderly, and physically disabled	• Sit in rear in a child seat or wearing seatbelt • Do not jump into or out of car • Check front and back before opening door • Get in or out through right-side door	• Basic matters regarding bicycles • Situations where you cannot ride a bicycle • Inspection of bicycle • Right way to ride bicycle • Road where bicycles are allowed • Points to note when riding a bicycle • How to cross street at crossing • Points to pay attention to regarding pedestrians and other vehicles • Points to note when parking bicycle	• Degree of impact at the time of accident • Relationship between speed and braking distance • Reasons why blind corners and differences between radii of inner wheels occur	-	• Give your name, etc. those near site of accident • See a physician for examination • How to call police at 105 or 117

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

Target group	Purpose	Basic rule	Rules for pedestrians	Rules for riding in a car	Rules for riding on a bicycle	Matters to bear in mind about cars, etc.	Rules for drivers of motorcycles and cars	Action to take in case of a accident
3. Junior high school students	• Teach skills and knowledge to travel safely on road on bicycles • Teach how necessary it is to be considerate of others on road and pay attention not only to one's own safety but also to safety of others	• Teach situations in which traffic accidents occur (by statistics) • Teach outline of traffic safety measures • Awareness as a member of traffic society • Responsibility for a traffic accident • Participation in traffic safety activities	• Observance of traffic rules and practice of traffic manners • Predict and avoid danger depending on situation of road and traffic • Understanding to help for safety of infants, lower graders, elderly, and physically disabled	-	• Practice right way to ride a bicycle • Inspection of a bicycle	• Characteristics of cars, etc. • Fastening seatbelt • Rules as a future driver	-	• How to handle a traffic accident • Necessity of first-aid treatment and its procedure

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

4) *Teacher's Training Plan by Local Workshop*

a)   Outline of Teacher's Training

Once there is adequate provision in the curriculum, it is necessary to give teachers correct information to be able to teach road safety effectively.   By producing a teacher's guide, and distributing it to schools, the ability of teachers to teach road safety will be increased substantially.   Production and dissemination of a full teacher's guide will facilitate the process of encouraging road safety teaching in schools and will give teachers a permanent reminder and source of reference in the classroom.

Based on the teacher's guide, teacher training should be of existing teachers, through a series of local workshops, and of new teachers entering the profession, through the teacher training colleges.   To train all teachers in basic road safety teaching throughout a country is a large commitment.   It is unlikely to be achievable unless a dedicated person is appointed to this task, full time, for at least two years.   Such a person's primary role should be to train trainers to run road safety seminars, for head teachers initially, but then covering all class teachers.   They could also be involved in resource development to gradually build up the road safety materials available in a country.

It is important that effective road safety education does not rely simply on talks by visiting speakers at irregular intervals.   It is beneficial to establish specialist road safety officers to assist and support teachers, by providing resources and teaching materials for use in the classroom, which can include, but are not limited to, items such as a) worksheet, b) posters, c) teaching pack, d) slides, e) books and games, and f) videos.   Figure 11.1-8 shows the outline of teacher training by local workshops.

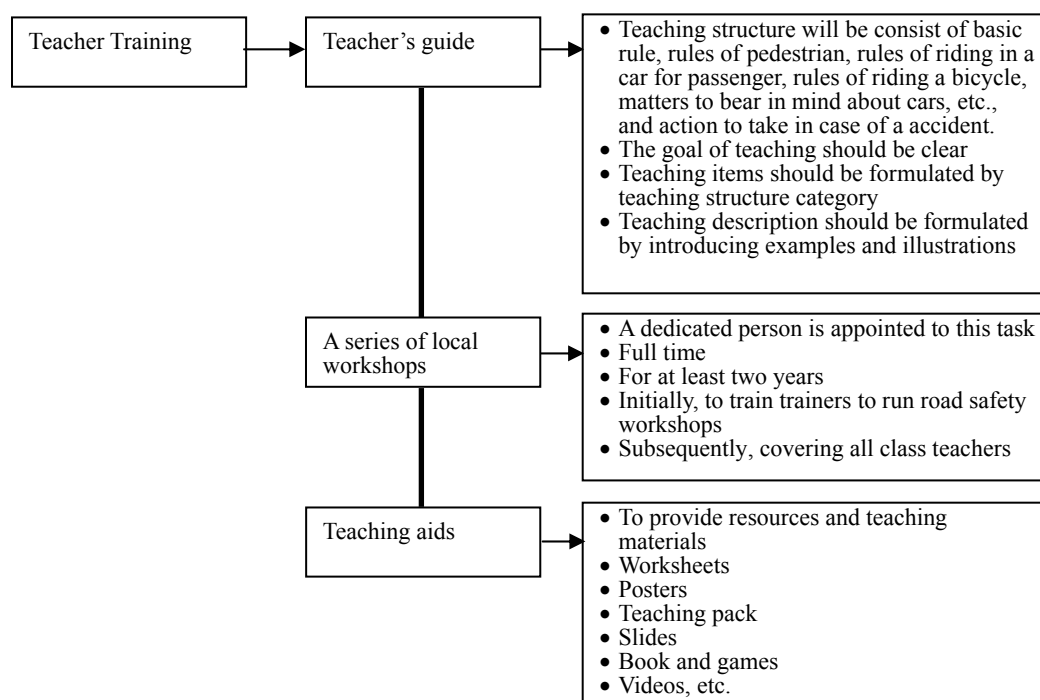| Teacher Training | → | Teacher's guide | → | • Teaching structure will be consist of basic rule, rules of pedestrian, rules of riding in a car for passenger, rules of riding a bicycle, matters to bear in mind about cars, etc., and action to take in case of a accident.
• The goal of teaching should be clear
• Teaching items should be formulated by teaching structure category
• Teaching description should be formulated by introducing examples and illustrations |
| | | A series of local workshops | → | • A dedicated person is appointed to this task
• Full time
• For at least two years
• Initially, to train trainers to run road safety workshops
• Subsequently, covering all class teachers |
| | | Teaching aids | → | • To provide resources and teaching materials
• Worksheets
• Posters
• Teaching pack
• Slides
• Book and games
• Videos, etc. |

Figure 11.1-8 Outline of Teacher Training by Local Workshops

b)   Introduction of Teacher's Guideline for Road Safety Education by Target Age Group

Based on the structure of the guideline for road safety education by target age group, a teacher's guideline for road safety education by target age group will be introduced in

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

Table 11.1-4 to Table 11.1-6.   The text of road safety education for children will also be adopted as well as the contents of teacher's guideline.

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

Table 11.1-4 Teacher's Guideline for Road Safety Education by Target Age Group (Infants) (1/2)

Structure	Goal	Teaching Item	Teaching Description
1. Basic rule	• Teach skills and knowledge for safe passage on road by getting into basic traffic rules for pedestrians	1) Basic attitude	• Explain that, the failure of pedestrian to consider others, by moving as he or she pleases, can cause accidents, even though individual may not be injured or inconvenienced. Teach necessity of the traffic rules. • Teach children to have a clear understanding of basic attitude; do not walk alone on road, without their parents or responsible adult.
		2) Types and meaning of signs	• Teach knowledge of types and meaning of signs, such as "pedestrian crossing" "closed to pedestrians" and "crossing by pedestrian prohibited", necessity for passage on the road.
		3) Dangerous behavior that causes accidents	• Almost all traffic accidents involving children occur when the child is crossing the road or when the child dashes onto the road. • Teach a clear understanding of dangerous behaviors, by illustrating an example.
2. Rules for pedestrians		4) Area for passage of pedestrians	• Teach a clear understanding for safe passage on road, that pedestrian must walk on the sidewalk or inside the pedestrian zone, and pedestrians are required to walk along the left side of the road if there is no curbed sidewalk or pedestrian zone of sufficient width. In addition, pedestrian may walk as they please on roads designated for pedestrian use.
		5) How to cross road	• Where to cross: teach that pedestrian must cross at crosswalk or an intersection with a traffic light if there is one nearby. • When crossing with a traffic light: teach the types and meaning of pedestrian signals, and pedestrian must follow the signal at intersection where there is a signal light for pedestrians. In addition, teach that pedestrian is encouraged to use pedestrian bridges and underground pedestrian passes if they are within a reasonable distance. • Where crossing there is no traffic light: teach items as follows: 1) look for a place that offers good visibility in all direction, 2) stop at the edge of the sidewalk or side of the road, look both ways, and make sure that no vehicles are approaching, 3) if the road is clear of traffic, you can begin to cross, if a car stops for you, look out for other cars before you begin to cross, don't cross the road at an angle or running.
3. Rules for riding on a car	• Teach skills and knowledge for safe riding on a car by getting into basic traffic rules for passengers	1) Sit in near in a child seat, etc.	• Teach that child must wear a Child's Seat in the rear seat while inside the vehicle.
		2) Behave so as not to interfere with driver	• Teach that a child must behave so as not to interfere with driver
		3) Do not cross in front of or behind car immediately after getting out car	• Teach a clear understanding of safe passage on road, such as "A child does not cross the road immediately after he/or she gets out of a car, it is dangerous to cross immediately behind or in front of the car".
4. Rules for riding on a bicycle	-	-	-

11-12

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

Table 11.1-4 Teacher's Guideline for Road Safety Education by Target Age Group (Infants) (2/2)

Structure	Goal	Teaching Item	Teaching Description
5. Matters to bear in mind about cars, etc.	• Teach skills and knowledge of safe passage on road for passengers by avoidance of danger, through the prediction of vehicular behavior, getting into basic automobile feature and signals.	1) Basic matters regarding car, etc.	• Teach to take special **attention to vehicular behavior** for passage on road. • Explain that **heavy damage is caused to pedestrian** in case of traffic accidents involving pedestrians. • Explain vehicles are generally **heavy weight and travel at high speed**, as compared with pedestrian.
		2) Signals	• Teach a clear **understanding of meaning of signals** from vehicles such as directional lights and reverse lights.
		3) Braking distance	• Teach that **cars do not stop immediately**. • Teach that **braking distance for a vehicle on a wet road surface may be twice** as long as that of a vehicle on a dry road surface. • Teach that a car traveling at **high speed car may need a longer breaking distance**.
		4) Danger of behind corners and difference between radii of inner wheels of car	• Teach an understanding of the **danger when children play on roads with traffic or near parking cars**. • Because, pedestrians or bicycles which are walking or running behind a **vehicle may not be visible** from driver's seat. • And the rear end of a turning vehicle tends **to pull over to the inside** much further than the front end. • This is because of the **wheel-base differential**, which is wider among larger vehicles
6. Rules for drivers of motorcycles and cars	-	-	-
7. Action to take in case of a accident	• When there is a traffic accident, teach skills and knowledge of measures necessary for passengers	1) Ask for help from people near site of accident	• Teach that you **must take basic measures** when there is a traffic accident. • Teach to **look for help from those present** at the scene or near the accident.
		2) Lets parents know that their child had an accident	• Teach **how to communicate to their parents** when there is a traffic accident.

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

Table 11.1-5 Teacher's Guideline for Road Safety Education by Target Age Group (Schoolchildren) (1/3)

Structure	Goal	Teaching Item	Teaching Description
1. Basic rule	• Teach skills and knowledge for safe passage on road by getting into basic traffic rules for pedestrians.	1) Necessity of traffic rules	• Teach to reconfirm the necessity of traffic rules as to **"Basic attitude"**.
		2) Types and meanings of traffic lights	• Teach to reconfirm the knowledge of traffic lights, such as **"When crossing with a traffic light"**. • Teach a clear understanding of safe passage, such as **"Pedestrians must follow the signal at intersection where there is a signal light for pedestrians"**.
		3) Types and meanings of signs	• Teach to reconfirm the **"Types and meanings of signs"**. • Teach the knowledge of types and meanings of signs, necessity for riding on a bicycle such as **"Stop"** and **"Bicycle crossing"**.
		4) Obeying instructions from police officers	• Teach knowledge for obeying instructions from police officers, when a police officer or traffic warden is on the spot directing traffic, **"Follow his hand signals or those indicated via hand-held flashlight"**.
		5) Things not to do on road	• Teach a clear understanding of dangerous actions on the road, such as **"Don't play where there is a lot of traffic"**.
		6) Safety on road while commuting to and from school	• Instruct to pay special attention to safety on road while commuting to and from school, such as **"Hazardous intersections with a lot of traffic"**.
2. Rules for pedestrians	• Teach skills and knowledge for safe passage on road, without their parents or guardian, and teach understanding to help with safety of infants, lower graders, elderly, and physically disabled.	1) Basic attitude	• Teach to reconfirm the basic attitude, such as **"Area for passage of pedestrians"** and **"How to cross road"**. • In order to understand such basic attitude, **"Instruct to have a discussion about the causes of accidents, by introducing an example"**. • Make them to consider points such as **"Cause of establishment of traffic rules"** and **"To obey traffic rules"**.
		2) How to walk safely at night	• Teach a clear understanding of safe walking at night, such as **"Intensifying their care more than daytime; at night, drivers often fail to recognize people walking on the street"**. • Teach knowledge of safe passage on road, such as **"Wear light- or brightly-colored clothing when walking at night, it would help drivers identify you if you attach reflectors to your shoes, clothing, bag, cane, or other belongings"**. • In addition, teach special attention to safe crossing at non-signalized intersection, **walk as near to the road lighting as possible.**
		3) Understanding to help with safety of infants, lower graders, elderly, and physically disabled	• Teach clear understanding of help with safety of infants, lower graders, elderly, and physically disabled, such as **"When you see the disabled walking with a cane or with the aid of a waking cart, or when you see a disabled person who has difficulty walking, who is crossing or about to cross a road, help him/her cross safely by leading or gesturing"**.
3. Rules for riding in a car	• Teach skills and knowledge for safe riding in a car by getting into basic traffic rules for passenger	1) Sit in rear with a seat belt, etc.	• Teach to reconfirm the **"Basic attitude for safe riding in a car"**, wearing a seat belt while they are inside the vehicle, and sitting in the rear seat.
		2) Do not jump into or out of car	• Teach a clear understanding of dangerous behaviors, such as **"Do not jump into or out of car"**.
		3) Check front and back before opening door	• Teach knowledge of safe riding in a car, such as **"Check front and back before opening door"**.
		4) Get in or out through right-side door	• Teach knowledge of safe riding in a car, such as **"Get in or out through right-side door"**.

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

Table 11.1-5 Teacher's Guideline for Road Safety Education by Target Age Group (Schoolchildren) (2/3)

Structure	Goal	Teaching Item	Teaching Description
4. Rules for riding on a bicycle	Teach skills and knowledge for safe riding on a bicycle by getting into basic traffic rules	1) Basic matters regarding bicycle	• Teach that cyclist must **obey traffic rules and regulations and riding manners.** • Teach that training of bicycle riding should be done at a safe location outside of the public road. • Teach the knowledge of **basic rules related to the bicycle.**
		2) Situations where you cannot ride a bicycle	• Teach a clear understanding of situations where you cannot ride a bicycle, such as "A bicycle must have good brakes" and "**Don't ride a bicycle at night without a taillight or reflector**".
		3) Inspection of bicycle	• Teach a clear understanding of bicycle inspection, before you ride a bicycle, **be sure to check it, if you find anything wrong with your bicycle.**
		4) Right way to ride bicycle	• Teach the knowledge of the right way to ride a bicycle, such as "**Look in both directions to see if the traffic is clear**", "**Turn right and left, signal well in advance**", "**Hold the handle bars securely**", and "**When you want to stop your bicycle, check for safety and signal your intention to stop well in advance**".
		5) Road where bicycles are allowed	• Teach a clear understanding of precautions to take on your bicycle, such as "**When on the road, the bicycle must travel on the right hand side**", "**Stop when it would seriously obstruct pedestrian traffic**", and etc.
		6) Points to note when riding a bicycle	• Teach the knowledge of precautions to take when riding, such as "**Don't ride behind vehicles**", "**When crossing or turning, choose a place with good visibility and wait for the traffic to clear**", "**Don't ride abreast of another bicycle, zigzag, or run speed races**", "**Turn on your lights at night**", "**Take special care to look out for vehicles which are making a right turn**", and "**When riding a bicycle, wear bright or colorful clothing that makes you conspicuous to drivers**".
		7) How to cross the street at a crossing	• Teach the knowledge for traveling through intersections, such as "**Wait for the traffic light to turn green before you cross**", "**When you cross an intersection without traffic lights, you must come to a full stop and check all directions**", "**When you are turning right and left, check behind you first and signal your intention to turn well in advance**", etc.
		8) Points to pay attention to regarding pedestrians and other vehicles	• Teach the knowledge of cyclist's duty to watch out for pedestrians, such as "**Go slowly when you ride along a sidewalk**", "**If your bicycle interferes with the movement of pedestrians, bring it to a stop**", "**If you see an unattended child, handicapped or elderly person walking with the aid of cane or walking aid cart, or walking difficulty, stop or slow down**", and "**When you pass near a parked vehicle, beware that someone might open the vehicle's door or dash out from behind the vehicles**".
		9) Points to note when parking a bicycle	• Teach the knowledge of parking a bicycle, such as "**Park your bicycle so as not to inconvenience or interfere with pedestrians and vehicular traffic**".
5. Matters to bear in mind about cars, etc.	Teach skills and knowledge of safe passage on road for passengers by avoidance of danger, through the prediction of vehicular behavior, getting into basic automobile features and signals	1) Degree of impact at the time of an accident	• Teach to reconfirm the "**Basic matters regarding the car**". • Teach the knowledge of the degree of impact at the time of an accident, by using actual illustrations, such as "**The heavier the object in a collision, and greater the speed at the point of impact, the greater will be the overall impact**".
		2) Relationship between speed and braking distance	• Teach to reconfirm the "**Basic matters regarding the car**". • Teach the knowledge of the relationship between speed and breaking distance, by using actual illustrations, such as "**The breaking distance and centrifugal force increase in proportion to the vehicle's speed squared**".
		3) Reasons why blind corners and difference between radii of inner wheels occur	• Teach to reconfirm the "**Basic matters regarding the car**". • Teach the knowledge of reasons why blind corners and difference between radii of inner wheels occur, by using actual illustrations, such as "**Danger when children play on roads with traffic or near parking cars**", "**Rear end of a turning vehicle tends to pull over to the inside much further than the front end, due to wheel-base differential**"

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

Table 11.1-5 Teacher's Guideline for Road Safety Education by Target Age Group (Schoolchildren) (3/3)

Structure	Goal	Teaching Item	Teaching Description
6. Rules for drivers of motorcycles and cars	-	-	-
7. Action to take in case of an accident	• When there is a traffic accident, teach skills and knowledge of measures necessary for passengers, in addition, he/she must take the basic measures.	1) Tell your name, etc. those near the site of the accident	• Teach to reconfirm that "**You must take basic measures when there is a traffic accident**". • Teach to do whatever **you can, tell your name**, etc. to those near to the site of the accident.
		2) See a physician for examination	• Teach the need to see a doctor, such as "**If you have sustained a head impact, get a medical check-up, even if there aren't any external injuries**".
		3) How to call police at 105 or 117	• Teach knowledge of **calling police by dialing 105 or 117**.

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

Table 11.1-6 Teacher's Guideline for Road Safety Education by Target Age Group (Junior High School Students) (1/2)

Structure	Goal	Teaching Item	Teaching Description
1. Basic rule	• Teach how necessary it is to be considerate of others on the road and pay attention not only to one's own safety but also to the safety of others.	1) Teach situations in which traffic accidents occur (by statistics)	• Teach the knowledge of **accident characteristics involving junior high school students**, by using statistical data of traffic accidents.
		2) Teach outline of traffic safety measures	• Teach a clear understanding of traffic accident measures, such as "**Measures against traffic accidents are composed of 3"E"s, namely, Education, Engineering and Enforcement**", "**Traffic safety education has wide-ranging connotations that include various publicity and discussion activities in homes, schools and communities**", and "**People learn the ideas and knowledge concerning traffic safety which they need as pedestrians, cyclists, or drivers**".
		3) Awareness as a member of traffic society	• Make them consider that it is important that the items of **basic rules should be practiced**, such as "Necessity of traffic rule", " "Types and meanings of traffic lights", "Types and meanings of signs", "Obeying instructions from police officers", "Things not to do on the road", and "Safety on road while commuting to and from school". • Make them understand that they should practice it, **through their discussion**. • Teach how necessary it is to be considerate of others on the road and pay attention not only to one's own safety **but also to the safety of others.**
		4) Responsibility for a traffic accident	• Teach the fundamental knowledge of civil, criminal and administrative responsibility for traffic accident perpetrator, such as "**Teach the importance of impact on the victim's family and friends caused by a traffic accident**", and "**A traffic accident makes no difference to concerned parties of accident**".
		5) Participation in traffic safety activities	• Introduce the **actual example** of traffic safety activity. • Teach the large part **school students have played** in traffic safety activities. • Prompt them **to become involved** in the traffic safety activities.
2. Rules for pedestrians	• Reconfirm the traffic rules for pedestrians to be obeyed, which is to be considerate of others on the road and pay attention not only to one's own safety but also to the safety of others. • Teach skills and knowledge of safe passage on road for passengers by avoidance of danger, through the prediction of vehicular behavior	1) Observance of traffic rules and practice of traffic manners	• Teach to reconfirm the **basic attitude for the pedestrian**, such as "Area for passage of pedestrians" and "How to cross the road". • Teach to reconfirm the **rules and manners for pedestrian to be practiced**, through their discussion.
		2) Predict and avoid danger depending on situation of road and traffic	• Teach the knowledge of **safe passage on road for pedestrian by avoidance of danger, through the prediction of vehicular behavior at hazardous locations**, such as "Narrow street", "Steep slope", "Sharp bend", and "Blind intersection".
		3) Understanding to help with safety of infants, lower graders, elderly, and physically disabled	• Teach **to prompt from own motive**, such as "Help with safety of infants, lower graders, elderly, and physically disabled", and "When you see a disabled person walking with a cane or with the aid of a waking cart, or when you see a disabled person who has difficulty walking is crossing or about to cross a road, help him/her cross safely by leading or gesturing".

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

Table 11.1-6 Teacher's Guideline for Road Safety Education by Target Age Group (Junior High School Students) (2/2)

Structure	Goal	Teaching Item	Teaching Description
3. Rules for riding in a car	-	-	-
4. Rules for riding on a bicycle	• Teach skills and knowledge to travel safely on the road or on a bicycle	1) Practice right way to ride a bicycle	• Teach **to reconfirm the rule for riding on a bicycle**, such as "Basic matters regarding a bicycle", "Situations where you cannot ride a bicycle", "Inspection of bicycle", "Right way to ride a bicycle", "Roads where bicycles are allowed", "Points to note when riding a bicycle", "How to cross street at crossing", "Points to pay attention to regarding pedestrians and other vehicles", "Points to note when parking a bicycle". • Teach **the practice of all the rules for riding on a bicycle**
		2) Inspection of a bicycle	• Teach **the practice of the rules of bicycle inspection.**
5. Matters to bear in mind about cars, etc.	• Based on the knowledge of vehicle characteristics, teach skills and knowledge of safe passage on road for passengers by avoidance of danger, through the prediction of vehicular behavior	1) Characteristics of cars, etc	• Teach the **deepened understanding of the** relationship between speed and breaking distance, reasons why blind corners and difference between radii of inner wheels occur. • Instruct the **practice of safe walking and safe riding of bicycle**, through their discussion, by using actual examples.
		2) Fastening seatbelt	• Teach the **practice of fastening the seatbelt in a car**, and to understand the merit of seatbelts, by using accident information involving fastening seatbelts.
		3) Rules as a future driver	• Teach the basic knowledge, such as **"Significance of driving license system", "Type of driving license", "Applicant must be 20 years old"**, and **"Method of Issuing of driving license".** • Teach the acquiring of consciousness of a **uture driver**, by giving information of anti-social activities or penalty for offenders, such as "Group of reckless drivers", "Noisy driving", and "Driving without a license".
6. Rules for drivers of motorcycles and cars	-	-	-
7. Action to take in case of a accident	• Teach skills and knowledge of first aid necessary for the passenger when there is a traffic accident	1) How to handle a traffic accident	• Teach the **reconfirmation of the action to take in case of an accident**, such as "Tell your name, etc. those near the site of the accident", "See a physician for examination", and "How to call police at 105 or 117". • Teach the skills and knowledge **for protection of secondary accidents.**
		2) Necessity of first-aid treatment and its procedure	• Teach **the knowledge of first aid**, if anyone is injured, administer whatever first aid you can until the doctor or ambulance arrives, such as "Try not to move the injured any more than necessary", "If victim has head injuries, don't move them", and "If there is any danger that the accident may trigger another one, you should carry the injured person to safety as quickly as possible".

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

(2) Training Program Plan for Public Transport Operators

This section discusses the training program for public transport operators for road safety by introducing a safe driving manager in public entities.

1)   Review of Current Activities for Road Safety

At, present, the Lima City and Callao City are responsible for public transport operators by obligating to a technical school during a certain periods.   It is appeared to be reality those public transport drivers and conductors do not have any activities for road safety, with exception of initial road safety education.

2)   Improvements of Current System Identified

a)   Activities for Road Safety

Employers meaning owners of commercial fleets (public transport vehicles), have the obligation to see that all drivers employed obey traffic rules and safe driving supervisors carried out a safely driving program.   In this study, it is highly recommended to be staffed safe driving managers in each public transport entity, in order to manage the vehicle operation and safety driving.

b)   Present Textbook for Road Safety

Current textbook for public transport operators is formulated by a lot of questionnaires, such as a textbook of driving school.   The textbook is qualified to be issued a driving license, can be assessed as guideline well.   In this study, it is recommended especially to teach advanced driving skills and knowledge necessary for safe travel and foster drivers who can be models for other drivers, after issued license for public transport operators.

3)   Plan of Guideline for Safe Driving Manager in Entities

a)   Road Safety in the Curriculum

The goal and target aims are to deepen the driver's understanding of skills and knowledge necessary for safe driving, for passengers, and for other drivers.   Major teaching items are consists of general matters for public transport drivers, and points to note when driving public transport.   In addition, the skills and knowledge of safe driving by avoidance of danger will be included by the prediction of accident, through their discussion.   Any transport entities should staff the safe driving manager, in order to protect traffic accident and driver's health care, the safe driving manager is responsible for managing the vehicle operation and safety driving.

b)   Structure of Guideline for Road Safety Education of Public Transport Operators

The structure of guideline for road safety education of public transport operators is shown in Table 11.1-7.

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

Table 11.1-7 Structure of Guideline for Road Safety Education of Public Transport Operators

Target group	Purpose	General matters	Points to note when driving public transport

Public transport operators	• Teach advanced driving skills and knowledge necessary for safe travel
	• Foster drivers who can be model for other drivers
		• Basic safety education after issuing of driving license
		• Points to note when driving vehicle for business use
		  - Difficulty in concentration due to busyness and long driving
		  - Feeling impatient due to time restriction
		• Staffing safe driving manager
		• Drafting and utilizing a driving plan or service plan
		• Understanding role of safe driving managers, etc.
		  - Preparing adequate driving plan or service plan
		  - Instructing reports of driver's health condition and
		    implementation of vehicle inspection
			• Basic rule of driving attitude for passengers
			• Securing safety of passengers
			• Selecting safe place for passengers to get in and out, and paying attention to the surroundings when opening and closing door
			• Conforming prediction and avoidance of danger

4) Plan for Safe Driving Manager Training by Local Workshop

a) Outline of Safe Driving Manager Training

It is necessary to give safe the driving manager in public entities the correct information to be able to teach road safety effectively. By producing a safe driving manager's guide, and distributing it to public entities, the safe driving manager's ability to teach road safety will be increased substantially. Initially, based on the safe driving manager's guide, safe driving manager training should be carried out, through a series of local workshops. CNSV provides special presenters to support public entities, the special presenters are placed by rotation at the disposal of CNSV, and they will organize the workshops for instruction and assessment of activities. CNSV instructors should assess their work efficiency, through the exchange of performance records. Figure 11.1-9 shows the outline of safe driving manager's training by local workshops.
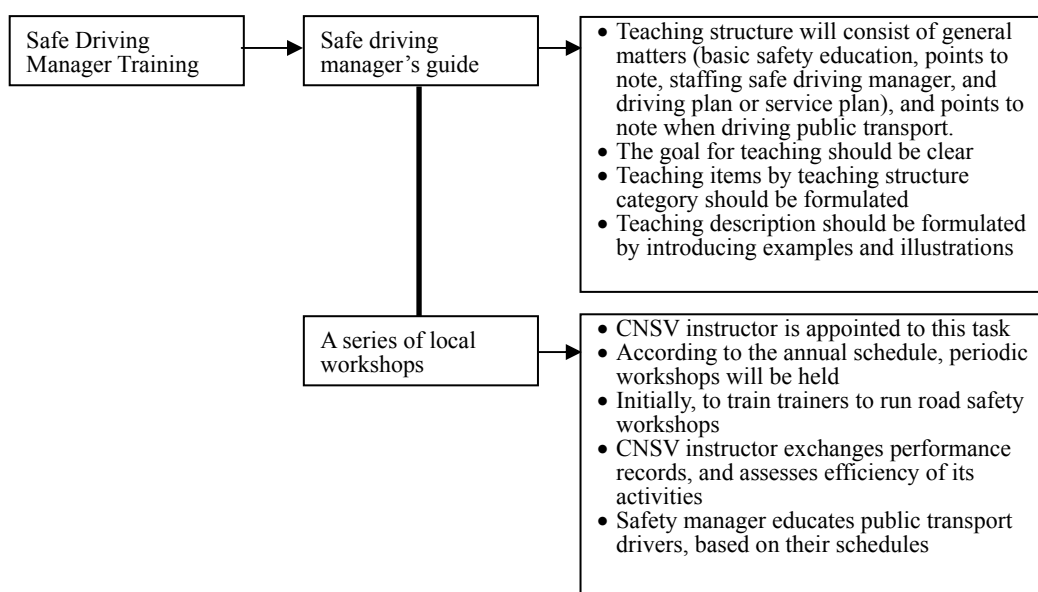

Figure 11.1-9 Outline of Safe Driving Manager Training by Local Workshops

11-20

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

b) Introduction of Safe Driving Manager's Guideline of Road Safety Education for Public
Transport Operators

Based on the structure of guideline for road safety education of public transport operators,
a safe driving manager's guideline for road safety education of public transport operators
will be introduced in Table 11.1-8.   The text of road safety education for public transport
driver will be also adopted as well as the contents of the safe driving manager's guideline.

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

Table 11.1-8 Safe Driving Manager's Guideline for Road Safety Education of Public Transport Operators (1/1)

Structure	Goal	Teaching Item	Teaching Description
1. General matters	• Deepen the driver's understanding of skills and knowledge necessary for safe driving • Teach skills and knowledge of safe driving necessary for passengers • Teach advanced driving skills and knowledge necessary for safe travel • Foster drivers who can be models for other drivers	1) Safety education after issuing of driving license	• Teach **to reconfirm the knowledge of basic driving matters**, such as "Self-vehicle inspection", "Proper seat adjustment and posture", "Braking correctly", "When there is a traffic accident", and "Situation in which traffic accidents occur according to statistics". • Teach **avoidance of danger, through the prediction of vehicular and passenger behavior**, such as "Avoidance of danger according to actual scene assumption", "Traffic characteristics based on actual example", "Influence by braking hard suddenly", and "Danger of side slip". • Teach **to enhance the driving technique responding to situational driving**, such as "Driving at night", "Driving in bad weather", and "Driving on expressway". • Teach **the deepening of the scientific knowledge of safety driving**, such as "Properties of vision", "Laws of physics and their impact on driving (friction and centrifugal force, and impact)", and "Causes of traffic accidents". • Teach the improvement in the driving attitude, such as "Instruction of driving attitude", and "Instruction of driving skills".
		2) Points to note when driving vehicle for business use	• Teach paying attention to **the difficulty in concentration due to overwork and long driving.** • Teach paying attention to **the feeling of impatience due to time restrictions.**
		3) Staffing safe driving manager	• The safe driving manager is responsible for managing the vehicle operation and safety driving, **all transport entities should staff the safe driving manager**, in order to prevent traffic accidents and protect driver's health care. • The role of safe driving manager includes, **"Preparation of driver's operating record for monitoring"**, **"Implementation of periodic safety education workshop"**, and **"Preparation of measures for traffic accidents".**
		4) Drafting and utilizing a driving plan or service plan	• Teach clear understanding of **making good use of a driving service plan** for public transportation, in order to protect against overwork and drowsiness. • Teach **understanding of the importance of complying with a safe driving plan**; it is prepared by the safe driving manager.
		5) Understanding role of safe driving managers, etc	• Teach **understanding of the role of the safe driving manager in the entity**, the safe operating manager monitors driver's conditions by operating record, such as "Driver's health condition", "Implementation of vehicle inspection", and driving schedule".
2. Points to note when driving public transport	• Teach skills and knowledge of safe driving necessary for passengers	1) Basic rule of driving attitude for passengers	• Teach a clear understanding of taking care of passengers, such as **"Importance of passenger transport in socio-economic activities"**, **"Passenger transport driver has considerable impact on other vehicle drivers"**, and **"Should be drivers who can be models for other drivers".**
		2) Securing safety of passengers	• Teach a clear understanding of ensuring passenger safety, such as **"Drivers should avoid abrupt braking or starting so as not, to disturb the passengers".**
		3) Selecting a safe place for passengers to get on and off the vehicle, and paying attention to the surroundings when opening and closing door	• Teach the instruction of the selection of a safe place for passengers to get on and off, at present, bus drivers habitually load and unload passengers everywhere inside intersections and between center lanes, such as **"Don't overtake or change lanes near intersections, in order to pick up extra passengers"**, and **"Don't wait for passengers even when at green lights".** • Teach the **instruction of paying attention to the surroundings when opening and closing door.**
		4) Conforming prediction and avoidance of danger	• Teach the skills and knowledge of **safe driving by avoidance of danger, by the prediction of accidents, through their discussion**, such as "Accident due to passenger's carelessness", "Accident when getting in and out", "Accident due to abrupt break", "Accident when opening and closing door", "Accident when turning", "Accident due to blind angle", "Accident due to changing lane or sudden stop, requested by passenger", etc...

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

(3) Plan for Campaign Programs

National traffic safety movements such as traffic safety campaigns for the general public should be conducted by the utilization of mass media, public participation, etc. On the other hand, the traffic safety campaign for children will be conducted by visiting public kindergartens or public schools for instruction. Summary of campaign programs by target audience is proposed in Table 11.1-9.

1) *Periodic Traffic Safety Campaign on Street*

The periodic traffic safety campaign on street will be conducted to vitalize safety education in regions and the entire country for the purpose of spreading the idea of traffic safety among all the people and encouraging them to acquire the habit of observing traffic rules and manners. In this study, two types of campaign will be recommended, namely, as a) a pilot campaign program, and 2) national traffic safety campaign.

- A pilot campaign program

- National traffic safety campaign program

a)   A Pilot Campaign Program

The purpose of a pilot campaign program is to conduct a traffic safety campaign in specified regions, in order to improve driving manners, driver's compliance with traffic law and regulations; the campaign will be carried out by packaged activities, such as propaganda by mass media, driving guidance and enforcement on site, and participation of primary school children in campaign. This activity should be held for a few days.

b)   National Traffic Safety Campaign Program

CNSV sponsors a national traffic safety program every year for the purpose of spreading the idea of traffic safety among all people and encouraging them to acquire the habit of observing traffic rules and manners. This activity should be held for 7 to 10 days, emphasizing certain slogans such as "seat belt fastening regulation" and "prevention of traffic accidents involving children". These movements are extended to all groups of people under joint efforts of the Central Government, local governments, and private traffic safety groups.

2) *Periodic Traffic Safety Campaign by Mass Media Publicity*

A few minutes television/radio commercial to foster proper driving will be aired in prime time. The scale of a mass media traffic safety campaign will be constrained by financial resources; it is, therefore, recommended that the resources must be supported by donations of private companies, such as automobile companies or auto club.

3) *Visiting Kindergartens or Public Schools for Instruction*

Traffic safety education for children and students is provided mainly at schools, and the education for infants at kindergarten It is important to have children and students understand traffic safety related items in their daily life, and acquire the attitude and ability always to behave safely with appropriate judgment. In this study, as pointed out in the traffic safety education system by target group, teachers teach students through the specific road safety lessons in the school timetable. The visiting campaign team with police is sent to kindergartens or schools to help with practical training.

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

Table 11.1-9 Summary of Campaign Programs by Target Audience

Campaign programs	Target audience	Campaign method and activities	
		General description	Detailed items
1) Periodic traffic safety campaign on street	General public	• Campaign will be conducted to vitalize safety education in regions and entire country for the purpose of spreading the idea of traffic safety among all the people and encouraging them to acquire the habit of observing traffic rules and manners. • In this study, two type of campaign will be recommended, namely a) a pilot campaign programs, and b) national traffic safety campaign program • A pilot campaign program is used to conduct a traffic safety campaign in specified regions • National traffic safety campaign program is conducted in the entire country.	<u>A pilot campaign program</u> • In specified regions • During a few days • Mass Media publicity • Participation of school students in the campaign • Distribute stickers and pamphlets to pedestrians and drivers • Driving guidance and enforcement on site by traffic police officers • Materials: stickers, pamphlets, banners, T-shirts, etc. <u>National traffic safety campaign program</u> • 7 days to 10 days once a year • Emphasizing some slogans • Traffic police conduct • Proper driving guidance and enforcement on the street • Staff of CNSV distributes pamphlets
2) Periodic traffic safety campaign by mass media publicity	General public	• Periodic traffic safety campaign will be conducted through mass media advertisements	• A few minutes of television/radio commercials to foster proper driving will be aired on prime time • Campaign by mass media will be constrained by financial resources • Resources must be supported by donations of private companies such as a automobile companies or auto club
3) Visiting kindergarten and public elementary schools for instruction	Infants/ Children	• Traffic safety staff will conduct teach-ins and visit public elementary schools to instruct children on basic traffic signs, road safety and discipline.	• In principal, safety education will be done by school time table (curriculum) • visiting campaign team with police is sent to kindergartens or schools to help with practical training

11.1.6. IMPLEMENTATION PLAN

(1) Outline of Task Items

The road safety education plan will be considered as a contract package of final design and supervision. International consultants would be engaged to provide advisory services for the program of road accident monitoring system.

The road safety education plan shall be elaborately implemented based on the following procedure; a) improvement plan for the organization of coordination and management of road safety (enhancement of CNSV function, formulating CVSV fund, development of human resources for CNSV, and local coordinating and managing), b) review of 5-year programs for road safety, c) training program for children (plan for basic school classroom materials and teacher's guide by age group, and training plan of teacher by local workshop), d) training program plan for public transport operators (plan of guideline for safe driving manager in entities, and plan for safe driving manager training by local workshop), e) plan for campaign programs (periodic traffic safety campaign on street, periodic traffic safety campaign by propaganda of mass media, and visiting kindergarten or public school for instruction). The outline of each task work is described as below:

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

1) Improvement plan for Organization of Coordination and Management of Road Safety

The improvement of organization shall be promoted by the plan of enhancement of CNSV function by staffing, formulating CVSV fund, training of human resources for CNSV, and implementation of local coordinating and managing. The task for enhancement of CNSV will be conduct in short term period, and the plan for local coordinating and managing is conduct based on the 5-year programs.

2) Review of 5-Year Programs for Road Safety

Current 5-year programs for road safety will be reviewed according proposed additional programs of the road accident monitoring plan and managing, the task will be conduct in parallel with the plan of enhancement plan of CNSV.

3) Training Program for Children

The training program for children shall be implemented as part of the education program for road safety in the 5-year programs. The plan focuses on the education programs for road safety, and should be implemented during 5-years. The task will be carried out in through two steps, in the first stage, preparation of school classroom materials and training of teacher by local workshop, in the second stage, actual teaching for school/junior high school students will be done.

4) Training Program Plan for Public Transport Operators

The training program for public transport operators shall be implemented as part of the education program for road safety in the 5-year programs. This plan also focuses on the education programs for road safety, and should be implemented during 5-years. The task will be conduct by workshops with the text material of guideline. In this project, in first stage, it is necessary that government legislation allows the introduction of staffing of safe driving manager in each public transport entity, in order to manage the vehicle operation and safety driving.

5) Campaign Programs

The campaign programs consist of the periodic traffic safety campaign on street, the periodic traffic safety campaign by propaganda of mass media, and visiting kindergarten or public school for instruction. The occasional campaign has already implemented by CNSV, however, this task is conducted by introducing periodic campaign programs. The program shall be attained depending on the budget, and the programs shall be arranged by annual funding programs. In this study, the campaign program will be recommended taking into no consideration of budget issues.

(2) Implementation Schedule

The implementation schedule for the package project of road safety education is proposed in Figure 11.1-10. The road safety education project is scheduled to start in second quarter of 2007 and be completed by forth quarter of 2011. After implementation of the final deign and bidding, the improvement plan for organization of coordination and management for road safety will be started in the first quarter of 2008, and be completed by the forth quarter of 2011, in parallel with review of 5-year programs for road safety. The preparation of school classroom materials and training teachers on the training program for children will be started from first quarter of 2008 to forth quarter of 2008, after then, actual teaching for students may be started by intermittent work. In terms of the training program plan for public transport operators, the legislative provision is expected to complete during one year, the training for safe

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

driving manger may be complemented by second quarter of 2010. The campaign program will be conducted from 2009 depending on the annual budget.

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

Task Name	2007			2008				2009				2010				2011		
	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12

1. Final design and tender document
2. Bidding
3. Improvement plan for organization of coordination and management of road safety
3-1 Enhancement of CNSV function by staffing
3-2 Formulating CNSV fund
3-3 Training of human resources for CNSV
3-4 Implementation of local coordinating and managing
4. Review of 5-year programs for road safety
5. Training program for children
5-1 Preparation of school classroom materials
5-2 Training of teacher by local workshop
5-3 Actual teaching for school/junior high school students
6. Training program for public transport operators
6-1 Legislative provision
6-2 Preparation of text material
6-3 Safe driving manager training by local workshop
7. Campaign program
7-1 Preparation of campaign programs
7-2 Implementation of periodic traffic safety campaign on street
7-3 Implementation of periodic traffic safety campaign by propaganda of mass media
7-4 Implementation of visiting kindergarten or public school for instruction

Notes: ▬▬ Continuous work during specified periods ■■■■■ Intermittent work ▬ ▬ ■ Intermittent work ■ ■ ▬ ■ Remuneration for CNSV staff necessary

The target road safety education plan covers Lima/Callao Metropolitan Area

Figure 11.1-10 Implementation Schedule for Road Safety Education Plan

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

11.1.7. COST ESTIMATION

The project of road safety education plan is mainly software technique items for formation of road safety education and campaign program for target groups of children and public entities operators, on the basis of consulting service of supervision and training trainer. The project cost for the road safety education plan consists of 1) improvement plan for organization of coordination and management of road safety, 2) review of 5-year programs for road safety, 3) training program for children, 4) training program for public transport operators, and 5) campaign program, based on the contract package during 5 years. The project cost by items is shown in Table 11.1-10.

Table 11.1-10 Project Cost for Traffic Safety Education Programs

Investment Items *1)	Project Cost (x 1,000 USD)
1. Improvement plan for organization of coordination and management of road safety	896
1-1 Enhancement of CNSV	576
1-2 Formulating CNSV fund	54
1-3 Training of human resources for CNSV	162
1-4 Implementation of local coordinating and managing	104
2. Review of 5-year programs for road safety	36
3. Training program for children	300
3-1 Preparation of school classroom materials	18
3-2 Training teacher by local workshop	82
3-3 Actual teaching for school/junior high school	200
4. Training program for public transport operators	74
4-1 Legislation provision	14
4-2 Preparation of text materials	8
4-3 Safe driving manager training by workshop	52
5. Campaign program	303
5-1 Preparation of campaign program	37
5-2 Implementation of periodic traffic safety campaign on street	175
5-3 Implementation of periodic traffic safety campaign by propaganda of mass media*2)	16
5-4 Implementation of visiting Kindergarten/public school	75
6. Supervision by international expert *3)	400
Total	2,009
Engineering Cost (Totalx10%)	200
Administration Cost (Totalx10%)	200
Contingencies Cost (Totalx15%)	301
Grand total	2,710

Notes: *1) The target road safety education plan covers Lima and Callao area. *2) The cost of mass media campaign by TV, radio and newspaper exclude by using state of government broadcast or newspaper. *3) The cost of supervision by international experts indicates the total account of each investment items.

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

11.2. ROAD ACCIDENT MONITORING PLAN

11.2.1. OBJECTIVES

The objective of road accident monitoring plan is to formulate the road accident monitoring system by introducing five functions of database system, analysis system, planning system, implementation system, and follow-up system, for target groups of road planners and engineers, and traffic police.

11.2.2. STRATEGY FOR ROAD ACCIDENT MONITORING PLAN

(1) Current Conditions and Issues

Currently, the statistics for analysis of traffic accident are insufficient. There is a weak monitoring system for traffic accident and traffic safety countermeasures. Especially, in terms of database, an accident-recording sheet should be properly formatted, in order to identify the collision diagram and hazard black spot.   These items are suitable for extracting traffic accident patterns and assessing the causes of accidents, and confirmation of problems should be followed up based on detailed analysis. A monitoring system for traffic safety, such as a routine work system for traffic accidents, is necessary.

(2) Formulation of Road Accident Monitoring Plan by Target Group

The target group for the road accident monitoring plan will be divided to two (2) groups; a) road planners and engineers for relevant government agencies, and b) traffic police such as investigating police and statistics police for traffic accidents.   The road accident monitoring plan focuses on the introduction of technical method for traffic accident measures.   The road accident monitoring plan consists of the following five (5) functions:

- Investigation and database system: study of accident statistics, and investigation of user's behavior

- Analysis on hazardous locations and confirmation of problems: examination of accident records, collection of relevant materials, field investigation, extraction of accident pattern frequently, and presumption of accident causes.

- Planning of measures: selection of measures corresponding to presumed causes, examination of applicability on measures, clarification of effects and side effects of measures, and examination of combination on measures.

- Implementation of countermeasures: cost estimation for measures, examination of finance, consultation with agencies concerned, explanation to residents, decision on sequence of implementation, and implementation.

- Follow-up system: measurement of effect of countermeasures, comparison before and after, campaign of traffic safety education, and strengthen of traffic enforcement by traffic police.

11.2.3. PLAN FOR ORGANIZATION OF COORDINATION AND MANAGEMENT OF ROAD ACCIDENT MONITORING

(1) Current Organization for Road Accident Monitoring

With regard to the database system of the traffic police, current reporting procedures for road traffic accidents are managed by the Ministry of the Interior. Accident information is relayed to the traffic police station.   Then, information is given to the municipal and provincial offices of the traffic police.   The municipal and provincial offices of traffic police report the accident to the Ministry of the Interior.   The investigating police collect,

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

investigate and complete the accident record at the site. The system for collection of road accident data and its processing has been established by the Ministry of the Interior. A record document is kept for summarizing the results of road traffic accidents at the end of each month.

Currently, the system for developing planning measures through accident analysis is not completely established in Lima City and Callao City. It is essential to develop and enhance a program for measures to reduce or minimize the impact of accidents. The system should comprise analysis of hazardous locations and confirmation of problems, planning measures, implementation of countermeasures, and a follow-up system.

(2) Improvement Plan of Organization System for Road Accident Monitoring System

Road safety is a multidimensional social problem involving many government agencies, so that safety must play a leading role in initiating, organizing and coordinating the national assault on road safety problems in a country. The relevant agencies should implement good coordination and management, via CNSV (See Figure 11.2-1).
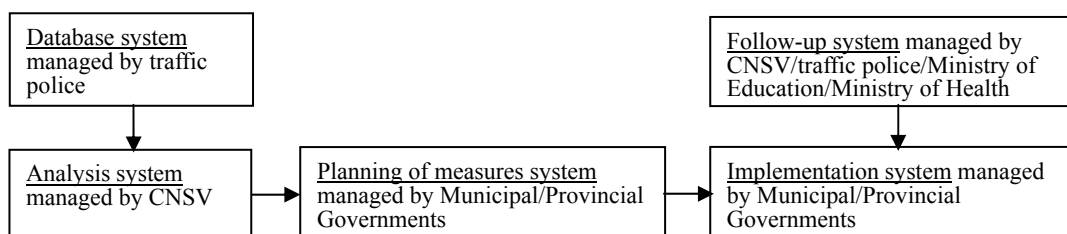
Figure 11.2-1 Ideal Coordination and Management of Road Accident Monitoring

(3) Development Plan of Human Resources for Local Government and Traffic Police

It is important that activities at local level are harmonized with initiatives being taken at national level. The CNSV prepares an annual program of proposed activities and circulates it to Municipal/Provincial governments and traffic police so that their local activities can be integrated with the 5-year programs, such as the Action Plan. The CNSV provides special presenters to support local governments and traffic police, the special presenters are placed by rotation at the disposal of the meeting, and they will organize the workshops for instruction and assessment of activities. The major activities for development of human resources to manage the local bodies are shown as below.

- Development of programs: formulating/circulating 5-year and annual programs

- Technical support: CNSV special presenters instruct by workshops and seminars

- Assessment of activities: CNSV special presenters monitor and assess by exchange of progress reports

11.2.4. PLAN FOR INVESTIGATION AND DATABASE SYSTEM

The task is to collect the basic information for analysis of traffic accidents. The key tasks are a) study of accident statistics and b) identification of hazardous locations. For the analysis of accidents, it is important to look into the traffic accident reporting with the statements of the drivers and pedestrians concerned and the opinion of the police regarding the accidents. Thereafter, the database of the accident-recording sheet will be prepared appropriately. The accident-recording sheet should generally include coded items explaining traffic accidents, and such data are important for statistics.

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

(1) Plan of Accident Statistic

1) Coded Items for the Accident-Recording Sheet

Information for any one accident should be contained in a single accident report form, and should be designed so that it can be used directly for computer data entry.   Current coded items of accident-recording sheets in Peru are insufficient for assessment of road safety.   The information related to collision type and location details should be revised, in order to analyze hazardous locations (black spots) and confirmation of problems.   The type of collision and road conditions should be described in more detail.

The following coded items by category will be proposed in the formulation of accident-recording sheet (See Table 11.2-1).   Table 11.2-2 shows a proposed accident-recording sheet.

Table 11.2-1 Coded Items by Category

Category	Major Items
1. Registration of report	• Police station/report No./officer name/date.
2. Date of accident	• DD/MM/YY
3. Time of accident	• H/M
4. Severity of accident (4 items)	• Fatal injury/serious injury/slight injury/damage only
5. Place of accident (4 items)	Street name/administrative zone/detailed location (distance from landmark)/GPS coordinates (in middle term)
6. Weather conditions (4 items)	Clear/cloudy/foggy/rain.
7. Road type (20 items)	Straight/roundabout/curve/X-junction/T-junction/Y-junction/ bridge/slope National road/provincial road/km No./major road in city/minor road in city/local road/track/other Paved/unpaved/construction site/unknown
8. Cause of accident (36 items)	Human error: speed/failure to respect traffic rights/failure to respect/right of way/driving against flow of traffic/failure to respect traffic signs/ dangerous over taking/using mobile phone/wrong use of high beam/alcohol abuse/drug abuse/careless lane change/fatigue or illness/other Road condition: potholes/dirt/sand/gravel/dust/animal on the road/object on the road/other Weather condition: Rain/cloudy/mist/wet road/other Vehicle defeat: brake failure/tire blow out/steering wheel failure/headlight failure/load falling off/other
9. Collision type (12 items)	Head-on/rear end/right-angle/side swipe/overturned/fell alone (for two wheelers)/hit object on the road/hit object off the road/ hit parked vehicle/hit pedestrian/hit animal/other
10. Hit and run	Yes/No
11. Vehicle involved (10 items)	Bus/microbus/combi/trailer/truck/mini truck/car/motorcycle/ mototaxi/other
12. Movement condition (10 items)	Going straight ahead/right turn/left-turn/U-turn/overtaking/ reversing/sudden start/sudden stop/parking/other
13. Violation (9 items)	Excess speed/driving against traffic flow/failure to respect right of way/failure to respect necessary distance/careless lane change/ without driving license/aggressive driving/mechanical failure/ other
14. Driver: name/gender/age	Xxxx/male/female/xx
15. Driver: residence (4 items)	Province/other province/foreigner/unknown
16. Driver: occupation (19 items)	Child/student/worker/vender/moto taxi driver/taxi driver/ house keeping/farmer/fisherman/professional/business man/teacher/ tourist/police/solder/other government employ ee/unemployed/ unknown/other
17. Driver: wearing helmet or sheet belt	Yes/No/N.A/unknown
18. Driver: driving license	Yes/No/N A/unknown
19. Driver: substance use	Alcohol: Yes/suspected/No/unknown Drugs: Yes/suspected/No/unknown
20. Driver: severity of injure	No apparent injury/superficial injury/moderate/severe/died at the accident site
21. Detailed accident scene sketch	Place conditions/place of collision
22. Brief description of accident	Comments by reporter, about accident condition
23. Name of reporter	Signature/traffic department/officer

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

Table 11.2-2 Proposed Traffic Accident-Recording Sheet

Traffic Accident-Recording Sheet

1. Register No. ☐☐☐☐

PART I.- INTERVIEW INFORMATION

PROVINCE:	TRAFFIC POLICE UNIT CODE:	OFFICER NAME AND POSITION:	DATE: ☐☐☐☐☐☐

PART II.- REPORT INFORMATION

2. DATE OF ACCIDENT (DD,MM,YY) ☐☐☐☐☐☐   3. TIME OF ACCIDENT (use 24-hour clock) ____:____

4. SEVERITY OF ACCIDENT: ☐ Fatal injury   ☐ Serious injury   ☐ Slight injury   ☐ Damage only

5. PLACE OF ACCIDENT: Street name: _____   District: _____
Detailed location (intersection or landmark): _____
GPS coordinate: _____ - _____

6. WEATHER CONDITION: ☐ 1. Clear   ☐ 2. Cloudy   ☐ 3. Foggy   ☐ 4. Rain

7. ROAD TYPE:

☐ Straight road	☐ National road No.	☐ Paved
☐ Roundabout	☐ Provincial road No.	☐ Unpaved
☐ Curve	☐ Major road in city	☐ Construction site
☐ X-junction	☐ Minor road in city	☐ Unknown
☐ T-junction	☐ Local road/ track	
☐ Y-junction	☐ Other:	
☐ Bridge		
☐ Slope		
☐ Other:.........................		

8. CAUSE OF ACCIDENT:

8.a Human error	8.b Road condition:	8.c Weather condition:	8.d Vehicle defect:
☐ Speed	☐ Potholes	☐ Rain	☐ Brake failure
☐ Not respect traffic lights	☐ Dirt/Sand/Gravel	☐ Cloudy/mist	☐ Tire blow cut
☐ Not respect right of way	☐ Dust	☐ Wet road	☐ Steering wheel failure
☐ Driving against flow of traffic	☐ Animal on the road	☐ Other:	☐ Headlight failure
☐ Not respect traffic signs	☐ Object on the road		☐ Load falling off
☐ Dangerous overtaking	☐ Alcohol abuse		☐ Other: ....
☐ Using mobile phone	☐ Drug abuse		
☐ Wrong use of high beam	☐ Change lane without due care		
	☐ Fatigue or illness		
	☐ Other:.....................		
	☐ Other:		

9. COLLISION TYPE: ☐ Head-on   ☐ Rear end   ☐ Right-angle   ☐ Side swipe   ☐ Overturned   ☐ Fell alone (for two wheelers)

☐ Hit object on the road   ☐ Hit object off the road   ☐ Hit parked vehicle   ☐ Hit pedestrian   ☐ Hit animal   ☐ Other ....

10. HIT AND RUN: ☐ Yes   ☐ No

11. VEHICLES INVOLVED:

Vehicle 1		Vehicle 2		Vehicle 3		Vehicle 4	
☐ Bus	☐ Car	☐ Bus	☐ Car	☐ Bus	☐ Car	☐ Bus	☐ Car
☐ Microbus	☐ Motorcycle/	☐ Microbus	☐ Motorcycle/	☐ Microbus	☐ Motorcycle/	☐ Microbus	☐ Motorcycle/
☐ Combi	Mototaxi	☐ Combi	Mototaxi	☐ Combi	Mototaxi	☐ Combi	Mototaxi
☐ Trailer	☐ Bicycle	☐ Trailer	☐ Bicycle	☐ Trailer	☐ Bicycle	☐ Trailer	☐ Bicycle
☐ Truck	☐ Other:..........	☐ Truck	☐ Other:..........	☐ Truck	☐ Other:..........	☐ Truck	☐ Other:..........
☐ MiniTruck		☐ MiniTruck		☐ MiniTruck		☐ MiniTruck	

12. MOVEMENT CONDITION:

Vehicle 1		Vehicle 2		Vehicle 3		Vehicle 4	
☐ Going straight ahead	☐ Reversing	☐ Going straight ahead	☐ Reversing	☐ Going straight ahead	☐ Reversing	☐ Going straight ahead	☐ Reversing
☐ Right turn	☐ Sudden start	☐ Right turn	☐ Sudden start	☐ Right turn	☐ Sudden start	☐ Right turn	☐ Sudden start
☐ Left turn	☐ Sudden stop	☐ Left turn	☐ Sudden stop	☐ Left turn	☐ Sudden stop	☐ Left turn	☐ Sudden stop
☐ U-turn	☐ Parking	☐ U-turn	☐ Parking	☐ U-turn	☐ Parking	☐ U-turn	☐ Parking
☐ Overtaking	☐ Other	☐ Overtaking	☐ Other	☐ Overtaking	☐ Other	☐ Overtaking	☐ Other

13. VIOLATION:

Vehicle 1	Vehicle 2	Vehicle 3	Vehicle 4
☐ Excess of speed	☐ Excess of speed	☐ Excess of speed	☐ Excess of speed
☐ Driving against traffic flow	☐ Driving against traffic flow	☐ Driving against traffic flow	☐ Driving against traffic flow
☐ Not respect right of way	☐ Not respect right of way	☐ Not respect right of way	☐ Not respect right of way
☐ Not respect necessary distance	☐ Not respect necessary distance	☐ Not respect necessary distance	☐ Not respect necessary distance
☐ Change lane without care	☐ Change lane without care	☐ Change lane without care	☐ Change lane without care
☐ Dangerous overtaking	☐ Dangerous overtaking	☐ Dangerous overtaking	☐ Dangerous overtaking
☐ Reversing without care	☐ Reversing without care	☐ Reversing without care	☐ Reversing without care
☐ Without driving license	☐ Without driving license	☐ Without driving license	☐ Without driving license
☐ Driving aggressive	☐ Driving aggressive	☐ Driving aggressive	☐ Driving aggressive
☐ Mechanical failure	☐ Mechanical failure	☐ Mechanical failure	☐ Mechanical failure
☐ Other	☐ Other	☐ Other	☐ Other

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

PART III.- DRIVER INFORMATION

DRIVER 1:
14.a. NAME: _____

14.b. GENDER: ☐ Male ☐ Female

14.c. AGE: _____

15. RESIDENCE:
☐ Province of accident ☐ Foreigner
☐ Other province ☐ Unknown

16. OCCUPATION: ☐ Student ☐ Worker ☐ Vendor ☐ Moto taxi driver ☐ Taxi driver ☐ House keeping ☐ Farmer ☐ Fisherman
☐ Professional ☐ Bussiness man ☐ Teacher ☐ Tourist ☐ Police ☐ Soldier ☐ Other government Employee ☐ Unemployed ☐ Unknown ☐ Other

17. WEARING A HELMET/SEAT BELT: ☐ Yes ☐ No ☐ N/A ☐ Unknown

18. HAVING DRIVING LICENSE: ☐ Yes ☐ No ☐ N/A ☐ Unknown

19. SUBSTANCE USE: **Alcohol:** ☐ Yes ☐ No ☐ Suspected ☐ Unknown **Drugs:** ☐ Yes ☐ No ☐ Suspected ☐ Unknown

20. SEVERITY OF INJURIE ☐ No apparent injury ☐ Superficial Injury (e.g. bruises, minor cuts) ☐ Moderate (fracture, sutures) ☐ Severe (requires surgery or ICU) ☐ Died on the accident site

DRIVER 2:
14.a. NAME: _____

14.b. GENDER: ☐ Male ☐ Female

14.c. AGE: _____

15. RESIDENCE:
☐ Province of accident ☐ Foreigner
☐ Other province ☐ Unknown

16. OCCUPATION: ☐ Student ☐ Worker ☐ Vendor ☐ Moto taxi driver ☐ Taxi driver ☐ House keeping ☐ Farmer ☐ Fisherman
☐ Professional ☐ Bussiness man ☐ Teacher ☐ Tourist ☐ Police ☐ Soldier ☐ Other government Employee ☐ Unemployed ☐ Unknown ☐ Other

17. WEARING A HELMET/SEAT BELT: ☐ Yes ☐ No ☐ N/A ☐ Unknown

18. HAVING DRIVING LICENSE: ☐ Yes ☐ No ☐ N/A ☐ Unknown

19. SUBSTANCE USE: **Alcohol:** ☐ Yes ☐ No ☐ Suspected ☐ Unknown **Drugs:** ☐ Yes ☐ No ☐ Suspected ☐ Unknown

20. SEVERITY OF INJURIE ☐ No apparent injury ☐ Superficial Injury (e.g. bruises, minor cuts) ☐ Moderate (fracture, sutures) ☐ Severe (requires surgery or ICU) ☐ Died on the accident site

DRIVER 3:
14.a. NAME: _____

14.b. GENDER: ☐ Male ☐ Female

14.c. AGE: _____

15. RESIDENCE:
☐ Province of accident ☐ Foreigner
☐ Other province ☐ Unknown

16. OCCUPATION: ☐ Student ☐ Worker ☐ Vendor ☐ Moto taxi driver ☐ Taxi driver ☐ House keeping ☐ Farmer ☐ Fisherman
☐ Professional ☐ Bussiness man ☐ Teacher ☐ Tourist ☐ Police ☐ Soldier ☐ Other government Employee ☐ Unemployed ☐ Unknown ☐ Other

17. WEARING A HELMET/SEAT BELT: ☐ Yes ☐ No ☐ N/A ☐ Unknown

18. HAVING DRIVING LICENSE: ☐ Yes ☐ No ☐ N/A ☐ Unknown

19. SUBSTANCE USE: **Alcohol:** ☐ Yes ☐ No ☐ Suspected ☐ Unknown **Drugs:** ☐ Yes ☐ No ☐ Suspected ☐ Unknown

20. SEVERITY OF INJURIE ☐ No apparent injury ☐ Superficial Injury (e.g. bruises, minor cuts) ☐ Moderate (fracture, sutures) ☐ Severe (requires surgery or ICU) ☐ Died on the accident site

DRIVER 4:
14.a. NAME: _____

14.b. GENDER: ☐ Male ☐ Female

14.c. AGE: _____

15. RESIDENCE:
☐ Province of accident ☐ Foreigner
☐ Other province ☐ Unknown

16. OCCUPATION: ☐ Student ☐ Worker ☐ Vendor ☐ Moto taxi driver ☐ Taxi driver ☐ House keeping ☐ Farmer ☐ Fisherman
☐ Professional ☐ Bussiness man ☐ Teacher ☐ Tourist ☐ Police ☐ Soldier ☐ Other government Employee ☐ Unemployed ☐ Unknown ☐ Other

17. WEARING A HELMET/SEAT BELT: ☐ Yes ☐ No ☐ N/A ☐ Unknown

18. HAVING DRIVING LICENSE: ☐ Yes ☐ No ☐ N/A ☐ Unknown

19. SUBSTANCE USE: **Alcohol:** ☐ Yes ☐ No ☐ Suspected ☐ Unknown **Drugs:** ☐ Yes ☐ No ☐ Suspected ☐ Unknown

20. SEVERITY OF INJURIE ☐ No apparent injury ☐ Superficial Injury (e.g. bruises, minor cuts) ☐ Moderate (fracture, sutures) ☐ Severe (requires surgery or ICU) ☐ Died on the accident site

21. DETAILED ACCIDENT (SCENE SKETCH):

22. BRIEF DESCRIPTION BY POLICE:

23. NAME OF REPORTER:

Sign
Traffic Department ....

Sign
Officer ....

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

2) Guideline of Coded Items for Accident-Recording Sheet

Data collection officers should record data based on a guideline of coded items for the accident-recording sheet.   The guideline consists of Part I of interview information, Part II of accident information, and Part III of driver and/or casualty information.   The coded system should be primarily to train trainers to run database workshops, initially for senior officers initially, then, they transmit this knowledge to data collection officers in a country.   The important items to be taken into account are shown below:

- Place of accident: make sure that the exact detailed location is indicated (e.g. street xx, corner with street xx),

- Cause of accident: make clear the meaning of the type of cause by using illustrations or actual examples.

- Collision type: make clear the meaning of the type of collision by using illustrations or actual examples.

- Detailed accident scene sketch: provide detailed location of accident (e.g. xx m distance from corner of supermarket, or xx m from pedestrian crossing at entrance of xx street)

- Brief description of accident: provide brief description of how the accident happened. (e.g. motorbike-vehicles 1 from xxx street turned left, but did not see truck-vehicle 2 hit front wheel of motorbike and, car-vehicle 3 bumped into rear of truck)

3) Accident Storage and Retrieval System

To analyze traffic accidents, the collection, accumulation, and analysis of various fundamental data, by location and by area, are essential.   The data structure has to be such that information stored on individual accidents can be retrieved either as a single record or in combination with other records.   The software package used to enter data, therefore, needs to be standardized and easy-to-use.   The software, irrespective of the system, should facilitate standard analysis techniques, such as listing of worst accident locations (black spots) and stick diagram analysis.

4) Computer Software Package Analysis Facilities

Currently, the following features of standard analysis techniques should be included.

   a) Data validation

The package should be simple to use, enabling easy data entry, full editing and back-up facilities.   It is important to validate data, which is easier done close to its sources so that queries with particular accidents can be answered as quickly as possible.

   b) Tabulations

One of the main features of general accident data analysis is the ability to provide cross-tabulations that can be done by accident frequencies, casualties, or the vehicle type involved.   Traffic police will need to produce certain standard tables on a regular basis, but the software must also be flexible enough to allow non-standard cross-tabulations to be produced easily with any combination of data, for specific studies or provide rapid answers to ad-hoc queries.

   c) Presentation graphics

It has generally become common practice to display figures and tabular results graphically in the form of bar charts or pie charts, which can illustrate a point much more clearly to the reader than columns of numbers (See Figure 11.2-2).

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

d) Location identification

Another important facility of any software package is to provide the user with a list of the black spots, however defined, in any area of interest. This can be done using any location identifier such as nodes or distance references along the road. It is often useful to view how accidents are distributed spatially by automatically producing a histogram plot of accidents along a road. A more recent method of visually determining where problem areas exist is by the display of accident locations on a road map (i.e., accident map). For example, some software can analyze groups of accidents within any polygon drawn on a computer screen map (See Figure 11.2-2).

e) Stick diagrams

Another useful analysis tool frequently used by highway engineers is the stick diagram, which offers the user the facility to view groups of accident, with each accident record being represented by a "Column" or "Sticks" of information (e.g., type of collision, time of day, and vehicle type). By rearranging these "Sticks", the accident investigators can often discover patterns in the accident at a particular location, and thus identify underlying causes (See Figure 11.2-2).
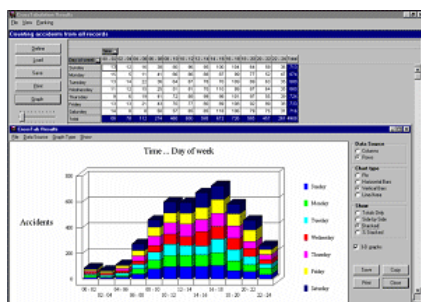
Presentation Graphic
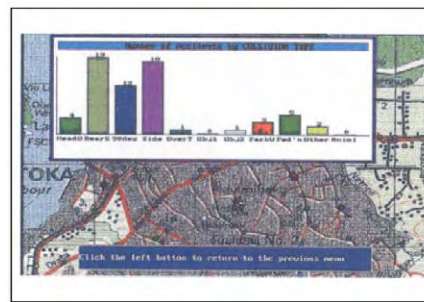
Polygon Analysis
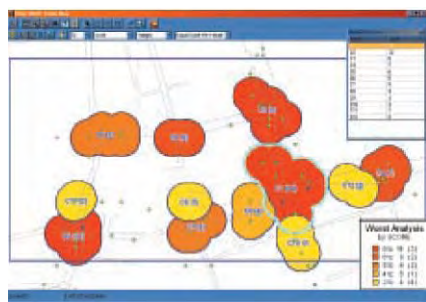
Cluster Analysis
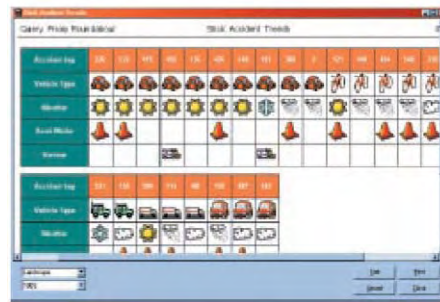
Stick Analysis

Source: TRL's road traffic accident data storage and analysis package, MAAP for Windows, ADB Guideline.

Figure 11.2-2 Examples of Computer Software Package Analysis

(2) Plan of Extraction of Hazardous Locations (Black Spots)

1) Definition of Black Spots

A good accident data system will allow the easy determination of where accidents cluster and will thus allow the preparation of priority lists of hazardous locations (black spots) needing attention. This is carried out in various ways around the world, typically by ranking locations by a) actual accident numbers, b) injury accident numbers, c) weighting system to take account of the severity, and d) cost of the accidents. The actual definition of black

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

spots will depend on local conditions, and should be determined after a preliminary summary of all the worst locations has been carried out (See Figure 11.2-3)

| Statistical Data of Traffic Accidents | → | Definition of Black Spots <br> a) Actual accident numbers <br> b) Injury accident numbers <br> c) Weighting system to take account of the severity <br> d) Cost of the accidents | → | Should be determined after a preliminary summary of all the worst locations has been carried out |
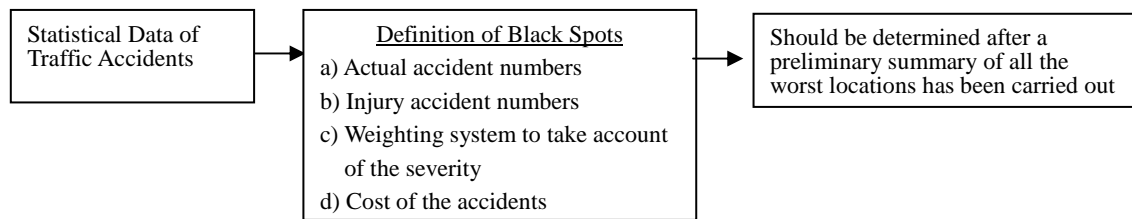
Figure 11.2-3 Extraction of Hazardous Locations (Black Spots)

2) Area to be Covered by the Investigation

It is not sufficient to observe or to investigate only those traffic accidents which have occurred at an intersection, because, for example, rear-end collision occur over the long area at the approaches to intersections. The traffic accident mode (e.g., vehicle to vehicle, and vehicle to pedestrian) varies with the type of roads and the features on the road sections.   In general, it was observed that 80% of the accidents occurred within a 20 meter range from the intersection, and 95% within 50 meters, although these figures vary with the accident mode (See Figure 11.2-4).

Collision mode of Vehicle to vehicle

Collision mode of Pedestrian to vehicle

Japan Society of Traffic Engineers
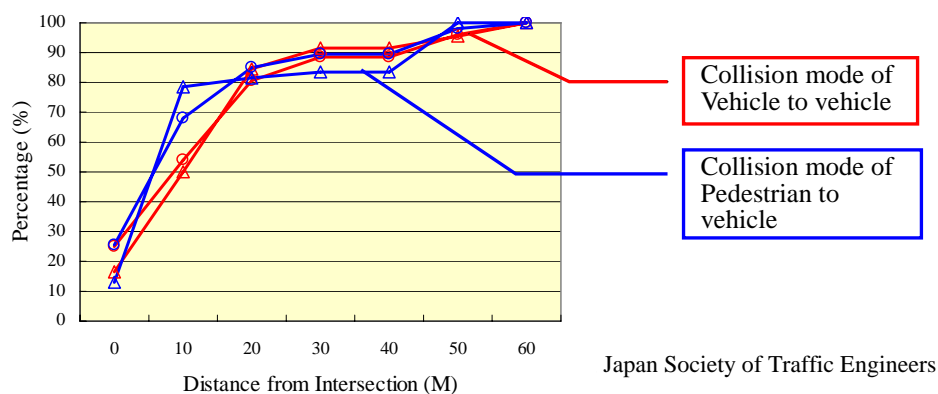
Figure 11.2-4 Percentage of Accidents by Distance form Intersection

11.2.5. PLAN FOR ANALYSIS SYSTEM OF HAZARDOUS LOCATIONS AND CONFIRMATION OF PROBLEMS

The task is to analyze accidents based on the pervious process. The key tasks are, a) interpretation of accident records, b) collection of relevant materials, c) field investigation, d) extraction of frequent accident pattern, and e) assessment of accident causes.   In this section, the analysis is made by introducing a collision diagram focuses for the extraction of frequent accident patterns.

(1) Plan for Interpretation of Accident Records

Based on the collection of statistical data of traffic accidents which have occurred at and around hazardous locations, an interpretation of traffic accident record will be made.   The following interpretation should be recommended (See Figure 11.2-5).

- Traffic accident-recording sheets which include coded items explaining traffic accident are important for statistical analysis,, and the key items of the accident-recording sheet are; type of accident, road and traffic conditions, state of traffic violation, outline of accident, carelessness of secondary person involved, degree of responsibility, and sketch of scene with primary/secondary person involved

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

- Traffic accident report in which the statements of drivers and pedestrians concerned and the views of the police on the accidents. Key items for statement of drivers/pedestrians concerned and views of the police are; primary cause of the accident, a driver's perception of who is in danger, action taken to avoid an accident, the state of accident occurrence, and final positions of vehicles/pedestrians after the accident (See Figure 11.2-6).
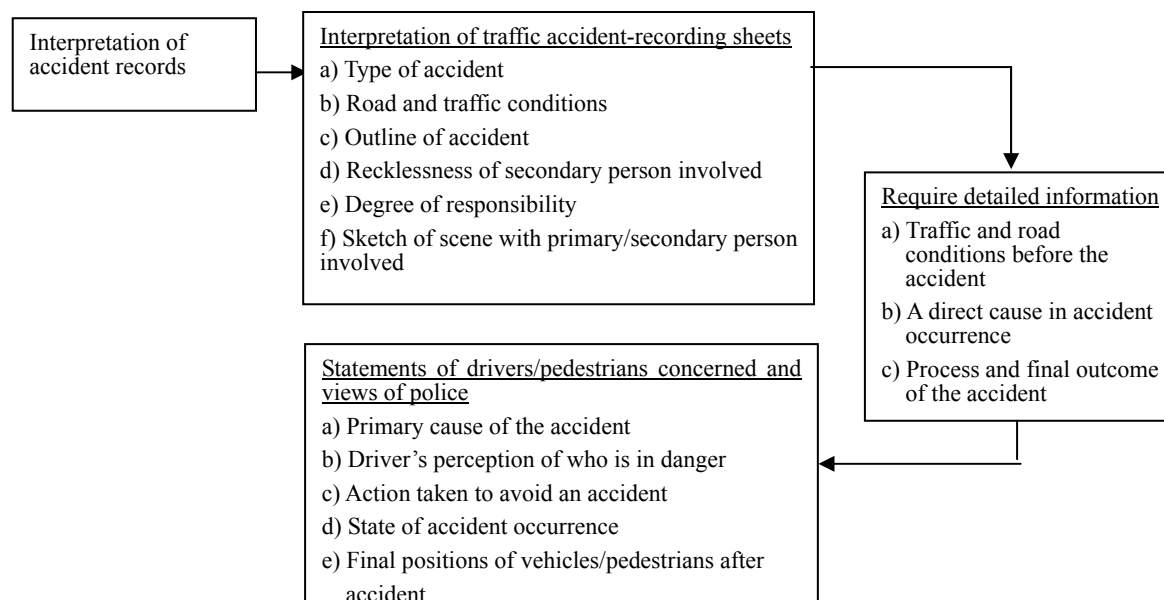
Figure 11.2-5 Interpretation of Accident Records

Type of accident	Right angle collision occurred between private medium sized commercial vehicle	State of traffic violation	Ignored traffic signal (a vehicle tried to run through intersection in spite of red light)
Road and traffic conditions	Large intersection with traffic signals which are composed of asphalt paved roads, and heavy traffic		
Outline of traffic accident (due to violation of traffic regulation)	Mr. xxx primary concerned: He was proceeding from the direction of xx street in the direction of xx street, ignored the traffic light which turned red when he was at a point about 5.4 meters before the intersection and accelerated the vehicle up to a speed of 40km/h, because he was convinced that there was no vehicle on the other road. Finally, the front left-side of his vehicle collided with the right-side of the vehicle driven by Mr. xx, secondary concerned, who was proceeding on the other road with a green light. Mr. xx secondary concerned: He has accelerated his vehicle to proceed in the direction of xx form the direction of xx.		
Recklessness of person secondarily concerned	No safety check on left-hand side in case of acceleration		
Factor of accident	Degree of danger (responsibility): Large/Medium/Small Key point of rating degree of responsibility: the primary concerned party was convinced that he could manage to avoid an accident by passing quickly		
Sketch of scene		Person primarily concerned	From A to C (street name: xxx)
			About 40km/h (speed limit: 50km/k)
		Person secondarily concerned	From B to A (street name: xxx)
			About 20km/h (speed limit: 50km/h)
		Measured distance in sketch	①–② 12.4m ②–③ 14.5m ②–A 16.5m A–X 5.3m X–C 2.6m X–④ 2.4m

Figure 11.2-6 Example of Outline of Accident and Sketch of Scene

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

(2) Plan for Collection of Relevant Materials

In addition to the summarization of traffic accidents records, it is necessary to summarize road and traffic conditions at and around the hazardous locations, based on the existing relevant information. The following interpretation should be recommended (See Figure 11.2-7).

- Road conditions should be summarized, such as road width, pedestrian crossing, stopping line of vehicles and lane mark, placement of guard fence, roadside conditions, traffic lights and signs, and bus stop.

- The items relating to traffic conditions should be summarized, such as traffic flow volume, and pedestrian traffic crossings.

- In addition, signal phase and traffic regulations should be summarized.
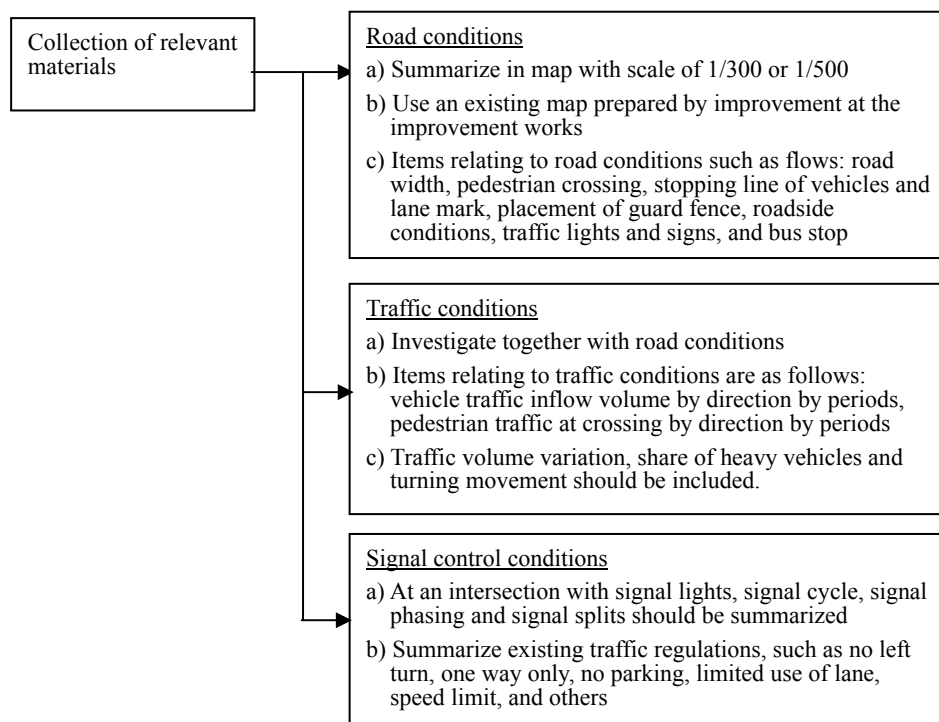
Figure 11.2-7 Collection and Summarizing of Relevant Materials

(3) Plan for Field Investigation

Macroscopic data such as number of yearly traffic accidents by type and daily/hourly traffic volume are important and necessary to explain the cause of accident. However, traffic accident analysis using only the macroscopic data is insufficient for better improvement design, and it is, therefore, indispensable to carry out detailed field observation and investigation to clarify primary causes of accident and formulate appropriate and practical road safety measures. The following two (2) key items should be identified.

- Initial preparation for target location will be summarized, such as basic accident data and road conditions; and

- Key points of field observation will be identified.

The key points of field observation are summarized in Table 11.2-3.

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

Table 11.2-3 Key Points of Field Observation

Key items	Key points of field observation
1) Traffic control condition	• Key items of traffic control condition consists of a) type of intersection and b) type of signal control • Observe signal control system by machine or police control • In case of signal control by machine, observe signal phasing and splits
2) Road condition	• Key items of Road condition consists of a) channeling condition, b) physical condition, and c) public space. • Observe channeling means such as road marking, pedestrian crossing and correct island installation. Observe shape/size of intersection area, median and corner cut, further, of side clearance and sidewalks • Traffic control at an intersection is largely affected by public facilities, observe public space condition such as bus stops, gas stations, and parking lots, because these are directly related to the frequency of vehicle movement • Many conflicts arise due to congestion with buses near bus stops, and due to merging and diverging from/to parking lots • Carefully observe the road surface on which there are many traces of vehicles running through. • In addition, observe any parts of road surface on which sand/dust are accumulated. • Observe sectional gradients of the road surface, especially, at the entrance and exit of an intersection • As to secondary and side streets, observe carefully that pedestrians and automobiles using these roads often play the primary role in accidents, the problem is that these roads are not taken into account in signal phase design in most cases. It is important to analyze the whole road network concerned and actual traffic, and to formulate an appropriate plan in order not to negatively affect other areas.
3) Traffic flow condition	• Key items of traffic control condition consists of a) traffic volume, b) vehicle behavior, c) pedestrian behavior, d) left- and right-turning traffic, and e) conflict points • Observe traffic volume, especially, left-turning traffics • Observe behavior of vehicles which run through the intersection just at the moment of change in light phase • Observe also behavior of vehicles under acceleration at the moment of light phase change from red to green. • Other key points are the decelerating behavior of vehicles approaching and entering intersection, stopping position of a vehicle at pedestrian crossing • Carefully observe the head and tail of groups of pedestrians and observe their crossing speed, hurrying behavior, the remaining number of pedestrians at the given side. • Also carefully observe the pedestrian who crosses suddenly • Other key points to follow-up are the crossing trace of pedestrians, crossing behavior at other than pedestrian crossing, and bus passengers on alighting and boarding • Observe carefully the behavior and trace of vehicle on a turning lane • Other key points are the sand accumulation on the road surface, stopping positions of vehicles making a left turn while waiting for clearance of vehicles on the opposite through lane, and positions of stationary right-turn vehicles also waiting for a gap to occur between pedestrians who are crossing the road • Carefully observe where the conflict points have happened, both vehicles to vehicles, and vehicles to pedestrians
4) Problem and issues	• Based on the information obtained, major problems and issues should be recorded
5) Sketch of location	• It is important to sketch, take photos and recorded by video

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

(4) Extraction of Frequent Accident Pattern

Collect data on traffic accidents which have occurred in the vicinity of the hazardous location concerned, and record these data in a sample of collision diagram as shown in Figure 11.2-8, it is desirable to collect a lot of data ranging over a long period subject to the condition that road and traffic conditions have not significantly changed.
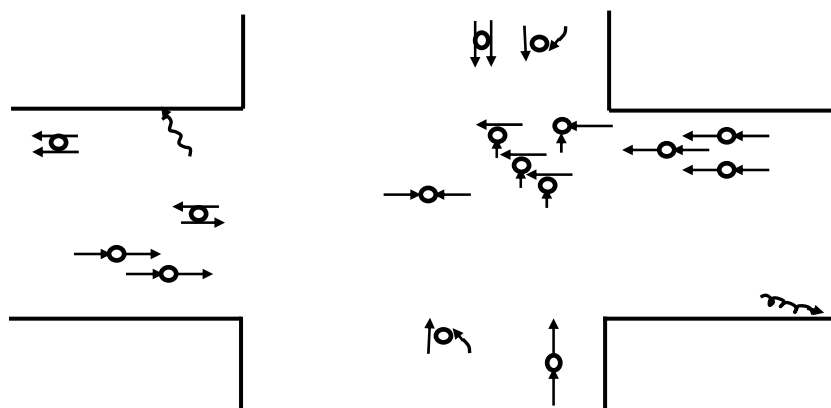
Driver Involved		Injury or Damage		Accident Type		Weather	
Symbol	Meaning	Symbol	Meaning	Symbol	Meaning	Symbol	Meaning
←	Vehicle (Forward)	●	Fatality	→O←	Head-on collision	R	Raining
↔	Vehicle (Backward)				Side-swipe on passing		
◄ - -	Motorcycle	⊗	Serious		Side-swipe on overtaking	S	Snow
◄	Bicycle			←O←	Rear-end collision		
◄ -	Pedestrian	⊘	Injury		Right angle collision	W	Wet surface
←	Train				Side collision		
◄⊠	Parking/stopping vehicle	O	Physical damage		Side collision at left-turn	F	Fog
					Deviation from road		
					Fall before collision	I	Icy surface

Figure 11.2-8 A Sample of a Collision Diagram

(5) Plan for Presumption of Accident Causes

Based on the analysis of field investigation, including the road/traffic conditions, and extraction of frequent accident patterns, the accident causes at the hazardous location will be assessed. Generally, the causes of traffic accident will be indicated by accident pattern and road conditions. There are four (4) basic strategies for accident reduction at hazardous locations as follows (See Figure 11.2-9):

a) Single Location or Black Spot Program: the treatment of the specific type of accidents at a single location, where large numbers of accidents occur

b) Mass Action Plan: the application of a known remedy to locations with common accident problems

Four Basic Strategies

c) Route action plan: the application of known remedies along a route with a high accident rate

c) Area-wide scheme: the application of various treatments, usually over an area of a town or city

Figure 11.2-9 Four Basic Strategies for Accident Reduction at Hazardous Locations

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

This study gives guidance in developing single location or black spot programs. The assessment of accident causes will usually be identified based on the results of the following three-stage investigation process as follows:

1) Preliminary Analysis by Frequent Accident Patterns

A preliminary analysis will be carried out of the accident data to understand the accident types and condition, based on collision diagrams, accident factor diagrams, and etc.

2) Site Investigation Analysis by Specialist Accident Investigators

Based on the site investigation of specialist accident investigators, the exact conditions at locations will be identified. The investigation will observe traffic flows and road user behavior at the times accidents most frequently occur, such as i) traffic flow conditions of turning movement, traffic congestion (i.e., traffic queues), track ratio, and conflict points, ii) road user behavior at stop places, lane change, and left- /right-turn places.

3) Overall Judgment by Preliminary Analysis and Site Investigation Analysis

The accident causes at black spots will be assessed, through the overall judgment of frequent accident patterns and investigation of traffic flow/road user behavior. A sample of assessment of accident causes at a black spot is shown in Figure 11.2-10.
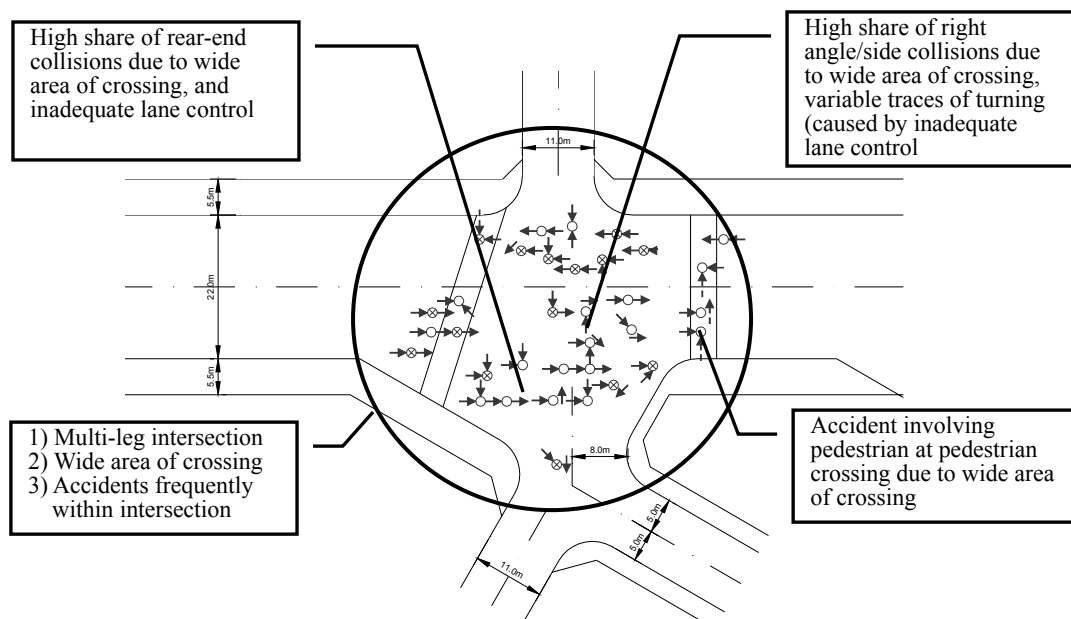
Figure 11.2-10 A Sample of Presumption of Accident Causes at a Black Spot

11.2.6. PLAN FOR PLANNING MEASURES SYSTEM

The task is to plan measures based on the accident causes. The key tasks are, a) selection of measures corresponding to assessed causes, b) examination of applicability of measures, c) clarification of effects and side effects of measures, and d) examination of combination of measures. In this section, the hazardous target location for planning measures will be assumed to be an intersection.

(1) Selection of Measures Corresponding to Presumed Causes

For the improvement of an accident-prone intersection (black spot), the basic conditions of the intersection such as its area (sufficient or not), and actual traffic flow (smooth or

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

complicated) should be identified.   These items are fundamental to minimize accidents and should be identified prior to detail planning (See Figure 11.2-11).

- Primary countermeasures for optimizing the area of an intersection: 1) expansion of intersection corner, 2) channeling, 3) improvement of road markings (stop-line, pedestrian crossing, etc.), 4) adjustment of yellow and/or all-red interval time of signal splits

- Primary countermeasures for achieving smooth traffic flow: 1) traffic regulation (one-way and left-turn prohibition), 2) revision of signal phase (introduction of exclusive left-turn phase, etc.), 3) channeling, and 4) separation of pedestrian flow (exclusive pedestrian crossing phase or pedestrian bridge).

- An example of channeling by road marking which can reduce accidents at left-turn. An example in which the area of a multi-leg intersection is optimized and improved by channeling, which can reduce various types of accidents at right-angle collision, side collisions at left/right-turns, pedestrian accidents at crossing.

- Presumed countermeasures by types of accidents are generally described in

- Table 11.2-4. And a sample of presumed countermeasures at black spot is shown in Figure 11.2-12.
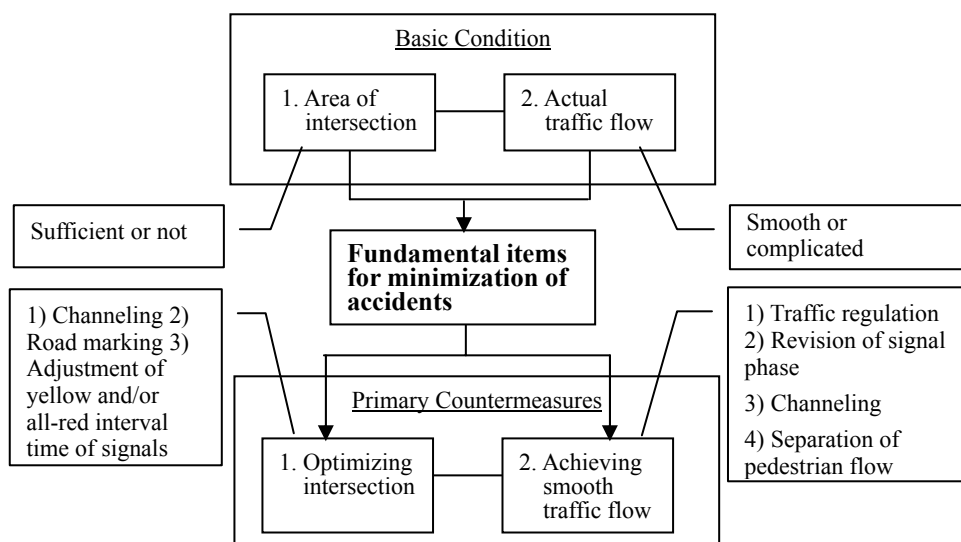
Figure 11.2-11 Fundamental items for Minimization of Accidents

Feasibility Study on Urban Transportation in
the Lima and Callao Metropolitan Area in the Republic of Peru
Final Report
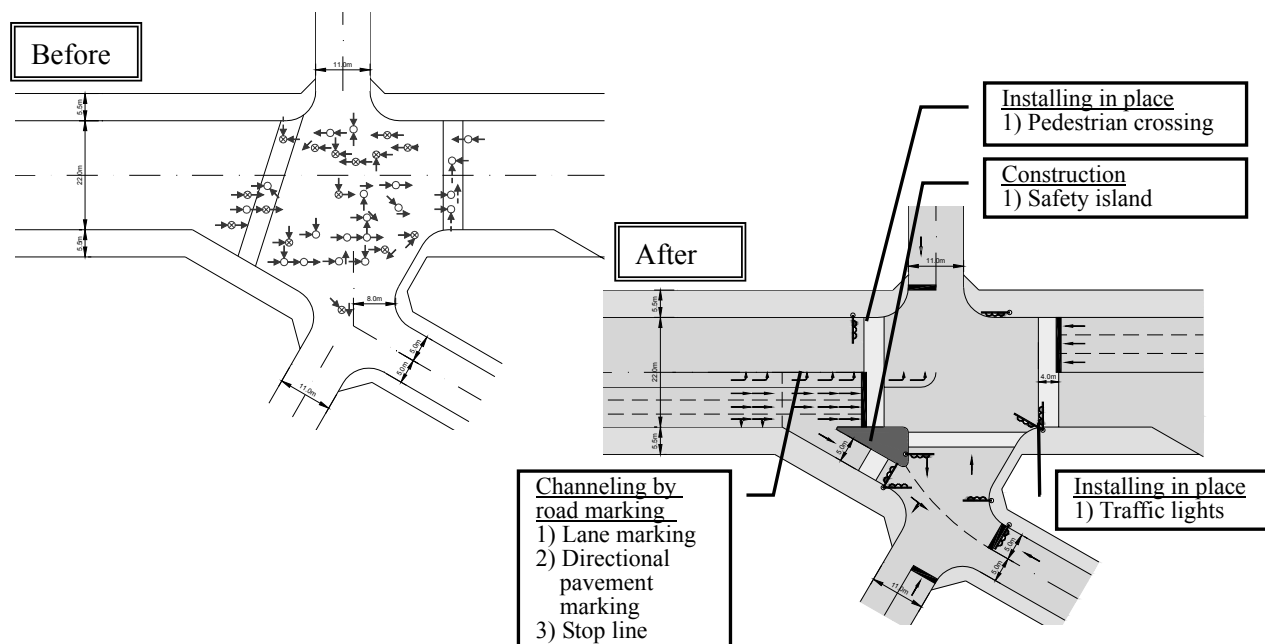
Figure 11.2-12 A Sample of Presumed Countermeasures at Black Spot

Table 11.2-4 Presumed Countermeasures by Types of Accident

Countermeasures and Accident Types	Vehicle-to-vehicle accident			Pedestrian accident	Bicycle accident
	Right angle collision	Side collision at left-turn	Rear-end collision at crossing		
1. New installation of traffic lights [1]	O	-	-	O	?
2. Addition of signal light for vehicles [2]	O		O	-	-
3. Exclusive left-turn phase (green arrow) [3]		O		O	?
4. "Stop" regulation (installation of signs and markings)	O	-	-	-	-
5. Improvement of visibility of "Stop" sign (illuminated sign)	?	-	-	-	-
6. Exclusive left-turn lane (change of center line) [4]	-	-	O	O	-
7. High skid resistant pavement at entrance of intersection [5]	-	-	O	-	

Source: The planning and Design At-Grade Intersection, Japan Society Traffic Engineer
Notes: O: Effective.　?: It is thought to be effective, but has not been made clear as of yet.　More follow-up survey is necessary.　-: The relation between the accident type and countermeasures has not been clarified.
1: There are some cases where rear-end collisions occur more. 2: Side-collision at left-turn increases. 3: Rear-end collision increases. 4: Rear-end collision increases. 5 Attention should be paid to noise level.　Road surface conditions should be continuously maintained.

(2) Plan for Examination of Applicability of Measures

Adequate countermeasures must be examined for preventing accidents according to the details of accidents.　It is, however, regrettable that the present conditions, which affect many kinds of countermeasures at intersection, are only rarely grasped.　Therefore, based on the understanding of field conditions and effects of measures, an examination of applicability of selected measures corresponding to presumed causes should be implemented carefully.

(3) Plan for Clarification of Effects and Side Effects of Measures

Actually, some countermeasures are implemented simultaneously.　In medical treatment, for example, just as the administration of medicines always has the problem of side effects, it is also necessary to pay attention to side effects and ripple effects without fail when implementing measures for preventing accidents.　In some cases, there is a transformation in

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

accident type as a result of measures for preventing accidents.   Even though the measures are implemented especially to prevent one accident type, not only this accident type but also other types must be compared. Sufficient study is also necessary when other accident types increase even if that accident type decreases.   This is because there are some cases in which measures give rise to negative influence; i.e. side effects of the implementation of measures.

(4) Plan for Examination of Combination of Measures

Since Table 11.2-4 comprehensively shows measures according to the type of accidents, a minute study is absolutely necessary because the best countermeasure for an accident type varies with many kinds of factors of each intersection and even the same countermeasure will have different effects depending on the spots or method adaptation.

11.2.7.   PLAN FOR IMPLEMENTATION OF MEASURES SYSTEM

The task is to implement the proposed measures based on selected planning measures.   The key tasks are, a) cost estimation of measures, b) examination of finance, c) consultation with agencies concerned, d) explanation to residents, and e) implementation.

11.2.8.   PLAN FOR FOLLOW-UP SYSTEM

The task is to follow up the measures implemented.   The key tasks are 1) measurement of effects of countermeasures, 2) comparison of before/after surveys, and 3) execution of campaign and enforcement.

After implementation of measures, it is necessary to check in the after study whether or not measures are functioning as expected.   Among evaluations for implemented measures, the main method is the comparison between the before-and-after studies for traffic accidents. The following main factors for evaluation will be recommended as shown in Table 11.2-5.

In addition, the follow-up for traffic safety education for drivers, pedestrians and traffic trainers will be executed by introducing the implementation of workshop and campaign propaganda.

Table 11.2-5 Main Factor for Comparative Evaluation between Before-And-After Studies

Evaluation Items	Comparison Method	Factor
a) Comparison of number of accidents	• Number of decrease	-
	• Rate of decrease	• All accidents, • By accident type.
b) Comparison of accident rate	• Difference in accident rate	-
	• Rate of decrease in accidents	• All accidents, • By accident type.
c) Comparison of the degree of the damage	• Decrease in number of casualties	• Decrease in number of casualties of much greater damage than definite standard. • Decrease in number of casualties of much greater damage than special standard (fatalities, etc.).
	• Rate of decrease in degree of damage (number of casualties per accident, etc.)	-
d) Comparison of accident cost	• Comparison with all accident costs.	-
	• Comparison between investment in measures for preventing accidents and benefit of decrease in number of accidents	-

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

11.2.9. PILOT STUDY OF ROAD ACCIDENT MONITORING SYSTEM IN CRITICAL AREA

This section discusses a pilot study of traffic accident prevention at black spots in the critical area, by introducing the road safety accident monitoring system. The pilot study is to identify and improve the specified hazardous locations (black spots) according to the road accident monitoring system. At the same time, a realistic strategy plan for the road safety monitoring system will be introduced.

(1) Selection of Target Area and Locations

The target area and locations were selected by cooperative work between JICA Study Team and the Counterpart Team; the areas managed by six (6) police stations in Lima metropolitan area were identified. The 6 police stations are Santa Luzmila (Comas), Caja de Agua (SJL), San Juan (SJM), La Legua (Callao), Ingunza (Callao) and San Isidro (San Isidro). The target area is shown in Figure 11.2-13.
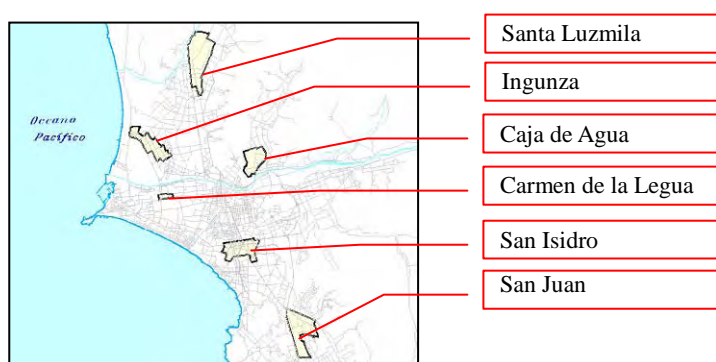
Figure 11.2-13 Target Area Managed 6 Police Stations in LMA

(2) Extraction of Hazardous Locations (Black Spots)

The hazardous locations (black spots) were extracted through the process of four (4) steps, which are 1) collection of single accident-recording data, 2) compilation of accident data by location, 3) extraction of black spots, and 4) extraction of high frequency black spots(top 10 black spots plus top 2 black spots involving fatality).

1) Collection of Single Accident-Recording Data

In 2005, there were 3,867 traffic accidents in the area managed by six (6) police stations, the highest numbers of traffic accidents are observed in the San Isidro Police Station, indicating about 38% of the total number of accidents. With regard to the density rate of accident per km^2 in area, the highest density rate is seen in the Carmen de la Legua Police Station at 510 accidents per km^2, and next highest density rate is in the San Isidro Police Station at 235 accidents per km^2. The lowest density rate is indicated in Santa Luzmila Police Station at 55 accidents per km^2 (See Figure 11.2-14).

Police Station	Area (km^2)	Annual Accidents	Density (accident/ km^2)
San Isidro	5.35	1.256	234.8
Santa Luzmila	9.69	531	54.8
San Juan	7.71	641	83.1
Caja de Agua	4.31	617	143.2
Ingunza	5.01	450	89.6
Carmen de la Legua	0.73	372	509.6
Total	32.8	3,867	117.9
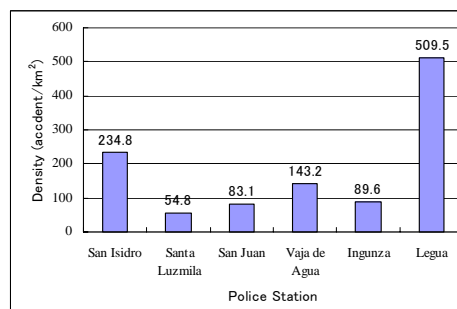
Figure 11.2-14 Annual Traffic Accidents and Accident Density by Police Station

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

2) Compilation of Accident Data by Location

Based on the annual statistics of traffic accidents, 3,867 accidents by location were investigated.   However, only a total of 2,675 accidents could be located in the digital process, of total statistic accidents, 31% of accident data was not filed due to the lack of single accident-recording sheets in each police station.   Accordingly, 2,675 accidents data was compiled by location, the target accident data is shown in Table 11.2-6.   Figure 11.2-15 shows the locations of traffic accidents by traffic police.

Table 11.2-6 Target Accident Data for Extraction of Black Spot

Police Station	District	Total accidents registered	Single accident-recording sheet filed		Not filed	
			Number	%	Number	%
San Isidro	San Isidro	1,256	924	74	332	26
Santa Luzmila	Comas	531	267	50	264	50
San Juan	San Juan de Miraflores	641	449	70	292	30
Caja de Agua	San Juan de Lurigancho	617	522	85	95	15
Ingunza	Callao	450	291	65	159	35
Carmen de la Legua	Callao	372	222	60	150	40
Total		3,867	2,675	69	1,192	31
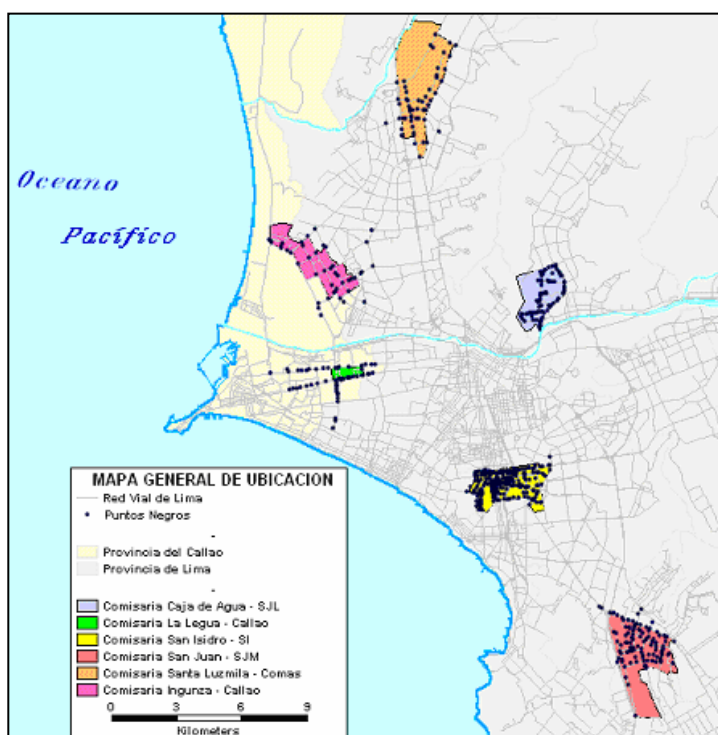
Figure 11.2-15 Location of Traffic Accidents by Traffic Police

3) Extraction of Black Spots

a) Location of Black Spot Identified

As pointed out in the analysis system of "Investigation and Database System", the extraction of black spots is carried out in various ways around the world.   The actual definition of black spots will depend on local conditions.   In this study, in determining the location of black spots, the black spot will be considered to define that amount of actual accident numbers which exceeds the average number of accident by 5 accidents.   As a result of analysis, 167 locations are identified as black spots.   Figure 11.2-16 shows the location of black spots.

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

Police Station	Number of single accidents	Number of locations	Black spots identified	Ratio of black spot
San Isidro	924	211	57	27%
Santa Luzmila	267	57	18	32%
San Juan	449	103	28	27%
Caja de Agua	522	82	33	40%
Ingunza	291	44	15	34%
Carmen de la Legua	222	58	16	28%
Total	2,675	555	167	30%
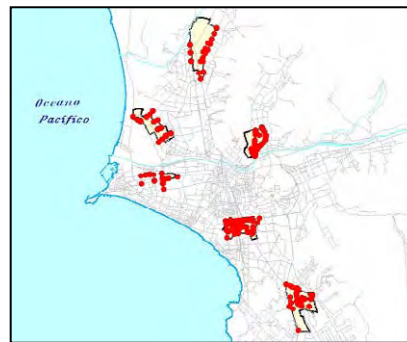
Figure 11.2-16 Extraction of Black Spots in Six Traffic Police Stations

b) Injury and Casualty

Table 11.2-7 shows victim's condition by injury and casualty at Black Spots. Of total 167 black spots, the share of black spots in San Isidro police station is extremely high at 34%, other high number occur in Caja de Agua and San Juan police stations at 17% and 20% respectively. In terms of victims, there are 167 black spots causing 2,226 injuries and 14 fatalities, a high number of injuries in Caja de Agua and San Juan police stations are seen in the range of 598 persons and 669 persons. The total number of fatalities is 14 persons, especially, 6 fatalities are shown in San Juan police station. Detailed locations of black spots by police station are shown in Figure 11.2-17.

Table 11.2-7 Victim's Condition by Injury and Casualty at Black Spots

Police Station	District	Number of black spots		Total number of accidents	Total number of fatalities	Total number of injury
		Number	%			
San Isidro	San Isidro	57	34.1%	1,256	1	351
Santa Luzmila	Comas	18	10.8%	531	4	154
San Juan	San Juan de Miraflores	28	16.8%	641	6	598
Caja de Agua	San Juan de Lurigancho	33	19.8%	617	3	669
Ingunza	Callao	15	9.0%	450	0	300
Carmen de la Legua	Callao	16	9.5%	372	0	156
Total		167	100.0%	3,867	14	2,226
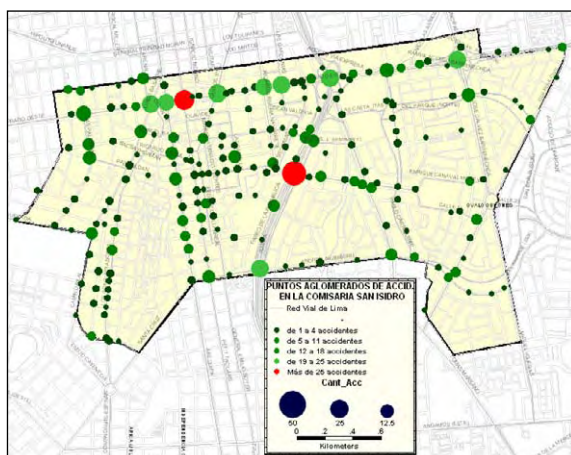
(San Isidro Police Station)

(Santa Luzmila Police Station)

Feasibility Study on Urban Transportation in
the Lima and Callao Metropolitan Area in the Republic of Peru
Final Report
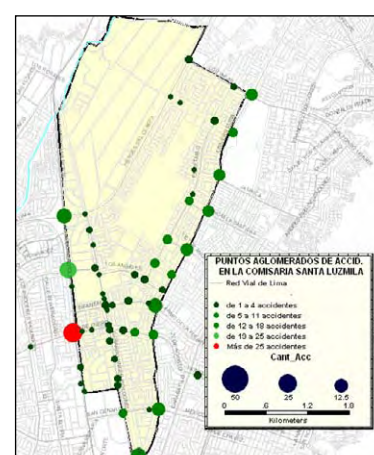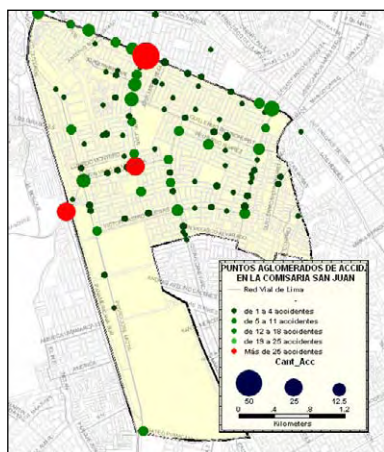
(San Juan Police Station)
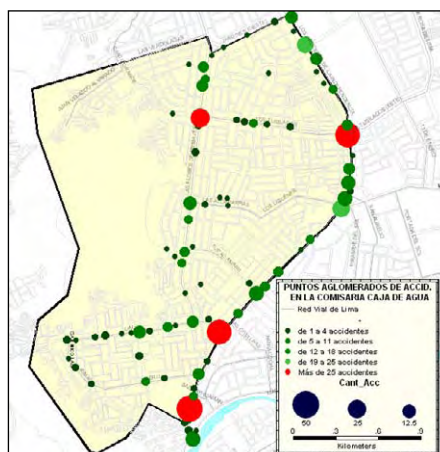
(Caja de Agua Police Station)
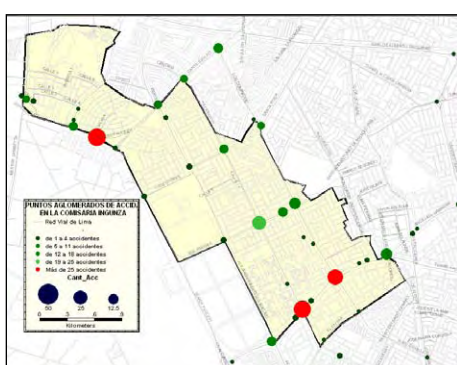
(Ingunza Police Station)
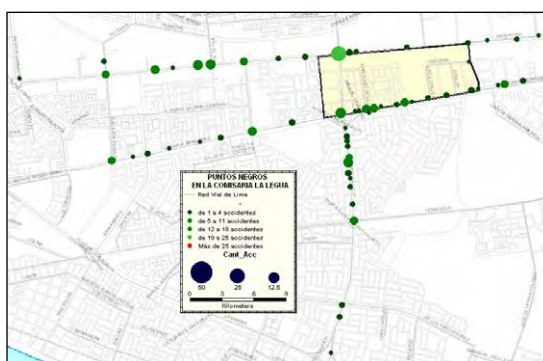
(Carmen de la Legua Police Station)

Figure 11.2-17 Detailed Location of Black Spots by Police Station

4) Extraction of Black Spots for the Improvement Plan

Based on the extraction of black spots by police station, target black spots for improvement plan are extracted. In order of number of accident, the top ten (10) black spots were identified, in addition, the top two (2) black spots involving a high number of fatalities were also identified. The target black spots for the improvement plan are shown in Figure 11.2-18 and Figure 11.2-19.

Police Station	Target black spots
San Juan	1) Av. Los Héroes – Av. San Juan: 53 accidents
San Isidro	2) Av. Canaval y Moreyra–Paseo de la República : 40 accidents. 3) Av. J Prado–Av. Petit Thouars: 28 accidents.
Caja de Agua	4) Av. Próceres de la Independencia–cdra 1: 49 accidents. 5) Av. Próceres de la Independencia–Av. Lima: 44 accidents. 6) Av. Próceres de la Independencia–Av. Tusilagos: 42 accidents
Ingunza	7) Av. Canta Callao–Av. Faucett: 39 accidents 8) Av. T. Valle-Av. Dominicos: 29 accidents 9) Av. T. Valle–Av. Pacasmayo: 36 accidetns
Santa Luzmila	10) Pan. Norte–Av. 2 de Octubre: 27 accidents
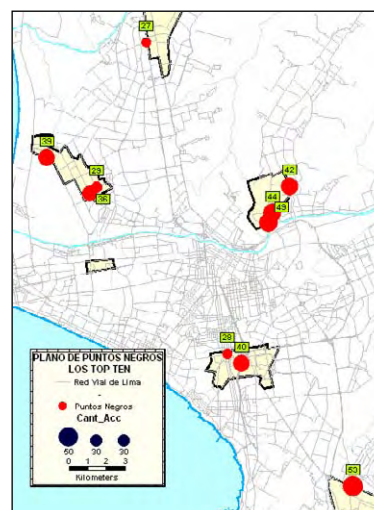
Figure 11.2-18 Target Black Spots with High Number of Accidents for the Improvement Plan

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

San Juan Police Station:
Av. Alipio-Panamaricana Sur: 26 accidents

Santa Luzmila Police Station:
Av. Heroes del Cenepa-Panamericana Norte: 15 accidents
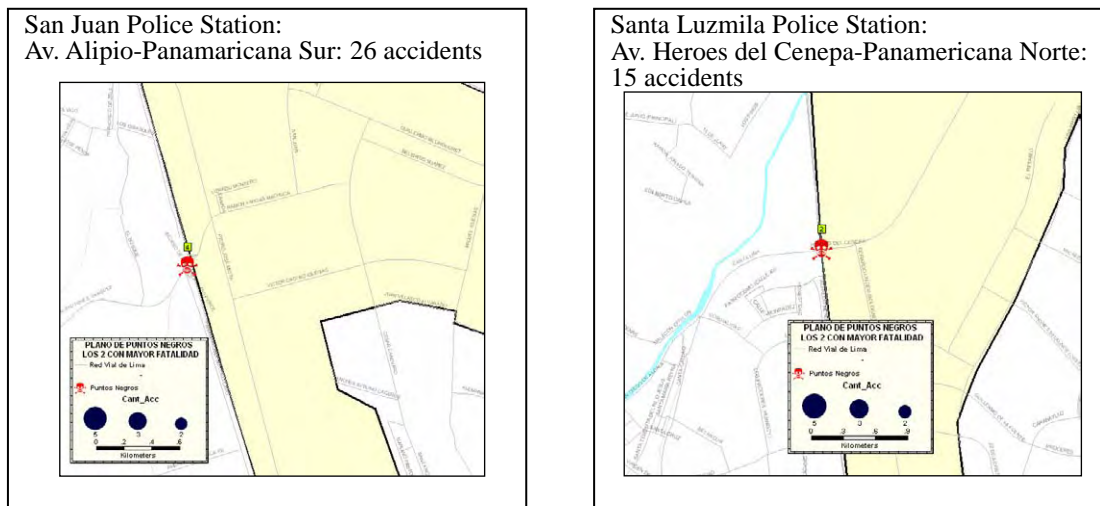
Figure 11.2-19 Target Black Spots Involving Fatalities for Improvement Plan

(3) Analysis of Target Black Spots for Improvement Plan

The characteristics of traffic accidents in the twelve (12) target black spots for the improvement plan are shown as follows:

1) Interpretation of Accident Records

In order to assess the causes of accidents, the interpretation of accident records will be done. The analysis was carried out in terms of a) location of accident, b) type of accident, c) causes of accident, d) type of vehicles involved, e) date/time of accident, and f) general description. A sample of the analysis of accident records in 12 black spots is shown in Figure 11.2-20.
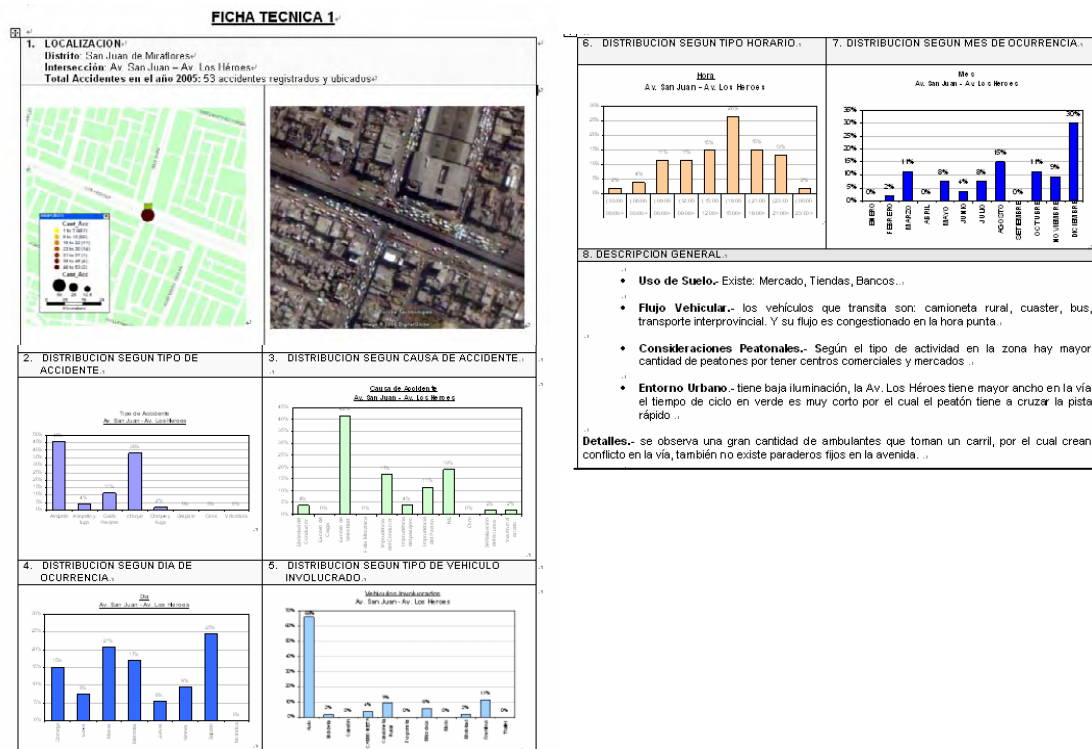
Figure 11.2-20 A Sample of Analysis of Accident Record in 12 Black Spots

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

The major characteristics of traffic accidents in 12 black spots are focused in Table 11.2-8.

Table 11.2-8 Major Characteristics of Traffic Accidents in 12 Black Spots

	Black spots	Major characteristic of traffic accident
1	Av. Los Héroes – Av. San Juan	• Located in urban principal road and two-way 4-lane local street • **Accident hit pedestrian (45%), and vehicle to vehicle (38%)** • **Accident caused by speeding (42%),** and poor observation of driver (17%) • High share on Saturday (25%), and on Tuesday (21%) • High share involving car (66%) • High share between 15:00-18:00 (26%) • High share in December (30%)
2	Av. Próceres de la Independencia–cdra 1	• Located in urban principal road and two-way 4-lane local street • **Accident of vehicle to vehicle (41%), and hit pedestrian (20%)** • **Accident caused by poor observation of driver (47%),** and by speeding (10%) • Share on Thursday (18%), and on other days (10-14%) • High share involving car (73%) • High share between 6:00-9:00 (20%) and 12:00-15:00 (20%) • High share in July (16%)
3	Av. Próceres de la Independencia–Av. Lima	• Located in urban principal road and two-way 4-lane local street • **Accident of vehicle to vehicle (41%),** and vehicle to vehicle and run (20%) • **Accident caused by poor observation of driver (39%),** and by speeding (11%) • Share on Sunday (30%), and on Wednesday (18%) • High share involving car (64%) • High share between 9:00-12:00 (26%) and 18:00-21:00 (18%) • High share in January and February (14%)
4	Av. Próceres de la Independencia–Av. Tusilagos	• Located in rural principal road and two-way 4-lane local street • **Accident of vehicle to vehicle (52%), and vehicle to vehicle and run (24%)** • **Accident caused by poor observation of driver (48%),** and by speeding (10%) • Share on Sunday (24%), and on Wednesday (21%) • High share involving car (86%) • High share between 18:00-21:00 (27%) and 15:00-18:00 (21%) • High share in February and October (14%)
5	Av. Canaval y Moreyra–Paseo de la República	• Located in viaduct intersection of major road and two-way 6-lane local street • **Accident of vehicle to vehicle (70%),** and hit pedestrian (15%) • **Accident caused by poor observation of driver (55%), by speeding (25%)** • High share on Friday (23%), and on Tuesday (20%) • High share involving car (70%) • High share between 15:00-18:00 (21%), 12:00-15:00 (18%) • High share in April (18%), and December (13%)
6	Av. Canta Callao–Av. Faucett	• Located in urban principal road and two-way 6-lane local street • **Accident of vehicle to vehicle (85%)** • **Accident caused by poor observation of driver (67%), by speeding (23%)** • Share on Thursday (21%), and on Wednesday (18%) • High share involving car (59%) • High share between 6:00-9:00 (21%) and 15:00-18:00 (21%) • High share in July (13%) and December (13%)
7	Av. T. Valle–Av. Pacasmayo	• Located in rural principal road and two-way 4-lane local street • **Accident of vehicle to vehicle (58%), and passenger fall (19%)** • **Accident caused by poor observation of driver (53%), by speeding (25%)** • Share on Thursday/Wednesday (19%), and on Sunday (17%) • High share involving car (50%), **and combi (28%)** • High share between 8:00-21:00 (25%) • High share in December (14%), others (6-11%)
8	Av. T. Valle-Av. Dominicos	• Located in rural principal road and two-way 4-lane local street • **Accident of vehicle to vehicle (59%), and hit pedestrian (31%)** • **Accident caused by poor observation of driver (59%), by speeding (14%)** • Share on Saturday (21%), and on Sunday (21%) • High share involving car (69%), **and combi (17%)** • High share between 9:00-12:00 (25%) and 12:00-15:00 (21%) • High share in April (17%) and June/November (14%)
9	Av. J. Prado–Av. Petit Thouars	• Located in urban principal road and 4-lane secondary one way road • **Accident of vehicle to vehicle (82%)** • **Accident caused by poor observation of driver (61%), by speeding (32%)** • High share on Friday (25%), and on Tuesday/Thursday (18%) • High share involving car (89%) • High share between 12:00-15:00 (25%), and 15:00-18:00 (21%) • High share in January (21%)
10	Pan. Norte–Av. 2 de	• Located in rural principal road and two-way 4-lane local street

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

	Octubre	• **Accident of hit pedestrian (44%)**, and vehicle to vehicle (44%) • **Accident caused by poor observation of driver (33%), by poor observation of pedestrian (30%)**, and by speeding (15%) • Share on Sunday (22%), and on Friday (21%) • High share involving car (55%), **mototaxi (15%), and minibus (15%)** • High share between 15:00-18:00 (22%) and 18:00-21:00 (19%) • High share in May and October (19%)
11	Av. Alipio-Panamaricana Sur	• Located in interchange of expressway • **Accident of vehicle to vehicle (46%), and hit pedestrian (23%), and hit/run pedestrian (19%)** • **Accident caused by poor observation of driver (50%),** and by speeding (19%) • Share on Tuesday (35%), and on Sunday (27%) • High share involving car (77%) • High share between 9:00-12:00 (25%) and 6:00-9:00/ 18:00-21:00(18%) • High share in November (28%)
12	Av. Héroes del Cenepa-Panamericana Norte	• Located in junction of expressway • **Accident of vehicle to vehicle (67%), vehicle to vehicle/run (13%), and hit pedestrian (13%)** • **Accident caused by poor observation of driver (53%), and by poor observation of pedestrian (27%)** • Share on Friday/Saturday/Sunday/Monday (20%) • High share involving car (67%), and **combi (20%)** • High share between 24:00-3:00 (27%) and 6:00-9:00/12:00-15:00/15:00-18:00 (20%) • High share in April/May(20%)

2) Field Investigation

In order to clarify the causes of accidents, the field investigation was carried out in addition to the analysis of accident record data. At present, due to the insufficient coded items of accident-recording sheets in Peru, it is difficult to identify the exact point of an accident by type of collision, therefore, in this study, the presumption of accident causes will definitely depend on detailed field investigation. The items of field investigation consist of a) road condition (type of intersection, type of signal control, phasing, cycle/split time, Channeling, physical condition, and public space), b) traffic flow condition (traffic volume, conflict point, vehicle behavior, pedestrian behavior, and turn-left/turn right), and c) problems and issues (road condition, traffic flow conditions, traffic control, and traffic violation). A sample of field investigation in 12 black spots is shown in Figure 11.2-21

Figure 11.2-21 A Sample of Field Investigation in 12 Black Spots

3) Problems and Issues Identified

The field investigation was carried out to observe road conditions, traffic flow conditions and road user behavior at the times accidents most frequently occur, determine what other information may be required, and the problems and issues associated with location were identified. The problems and issues in 12 black spots are pointed out in Table 11.2-9.

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

Table 11.2-9 Major Problems and Issues in 12 Black Spots (1/4)

Black spots	Major problems and issues			
	Road condition	Traffic flow condition	Traffic control	Traffic violation
1 Av. Los Héroes – Av. San Juan	• The crossing area is wide; it requires that the cross points be decreased as much as possible, by channeling system. • Pedestrian crossing on Av. Los Heroes should be relocated closer to center and right-angled along corner.	• Indiscriminate crossing by pedestrians may cause accidents involving pedestrians. • In order to decrease the accidents involving pedestrians, adequate pedestrian crossing need to be installed.	• Traffics crossing from side streets should be regulated. • For crossing by pedestrians, it is necessary to enforce pedestrian crossing behavior at other than pedestrian crossings by traffic police control • Current phasing must be checked due to contradiction of phasing	• As pointed out in the vehicular behavior, some drivers cross from side roads on Av. Los Héroes. • It is necessary to impose strong fines on traffic offenders who break traffic regulations. • Also, for crossing by pedestrians, it is necessary to enforce pedestrian crossing behavior at other than pedestrian crossings
2 Av. Próceres de la Independencia–Av.–cdra 1	• There are many points of left-turn allowed on Av. Proceres without signal control, major intersection should be controlled by signal lights. • The conflicts near bus stops (including mototaxis) along Av. Procerest may cause rear-end collision; it requires improvement of bus stop locations.	• Vehicles travel at high speed, it is necessary to control by using warning signs. • Pedestrian cross from/to both sides on Av. Proceres, because of location of school and markets, the existing pedestrian bridge is located away from such public facilities, an adequate pedestrian crossing should be installed.	• There are many cross points on Av. Proceres, the intersection in front of pedestrian bridge will be controlled by signal lights, at the same time, in order to lead pedestrians to the bridge, a guard fence will be installed along the median.	• It is necessary to impose strong fines on bus driver offenders who break traffic regulations, such as illegal stops along Av. Proceres. • Indiscriminate crossing of pedestrians will be regulated by traffic police.
3 Av. Próceres de la Independencia–Av. Lima	• The crossing area wide; a reduction in cross points is required where possible, by a channeling system. • Especially, vehicles from Southern fringe lanes on Av. Próceres should be regulated by closing of greenbelt.	• Mototaxis enter and exit carelessly from/to mototaxi stops at the corner of intersection; the mototaxi stops should be transferred. • There are conflicts between left-turn vehicles and through traffic in wide intersection; adequate lane control will be implemented.	• In spite of large intersection with heavy traffic, a signal light is not installed in place, it is highly necessary to install a signal light.	• It is necessary for mototaxi's illegal behavior to be restricted by traffic police.
4 Av. Próceres de la Independencia–Av. Tusilagos	• Due to weak traffic capacity at each entrance (2-lane) on Av. Próceres, there are chronic long queues, in addition, traffic flow at entrance is greatly affected by bus stops located in the entrance. Bus stops should be transferred to the exit of intersection with bus bay. • Inflowing traffic on the fringe street along Av. Próceres (N-S direction) affects poor visibility due to slope and difference of ground level; signal phasing should be revised.	• Due to the conflict between left-turn vehicles and through traffics from the fringe street, it may be caused right-angle/ sideswipe collisions, it is necessary to be controlled by signal phasing. • Conflicts among left-turn vehicles in central area of intersection, due to wide area; this should be controlled by channeling.	• Current fixed two phase system should be revised by introducing three phase system, in consideration of smooth diverging traffics from the fringe street.	• It is necessary to impose strong fine on bus driver offenders who breaks traffic regulations, such as illegal stops along Av. Próceres.

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

Table 11.2.9 Major Problems and Issues in 12 Black Spots (2/4)

Black spots		Major problems and issues			
		Road condition	Traffic flow condition	Traffic control	Traffic violation
5	Av. Canaval y Moreyra–Paseo de la República	• The crossing area is wide; it requires the cross points to be reduced as much as possible, by a channeling system. • Pavement markings such as directional arrows should be revised, in order to prevent sideswipe collision. • Channeling island at Western entrance on Av. C. y Moreyra will be revised	• The traffic queue from Vía Expresa to Av. Canaval y Moreyra, may cause rear-end collisions. • In order to mitigate the traffic congestion, capacity increase by revised signal control will be required.	• According to simple 2-phase, left-turn, vehicles from Vía Expresa tend to block intersection. This situation may cause rear-end collisions and side swipe collisions due to traffic congestion. • In order to achieve smooth traffic flow, it is necessary to revise signal phase by introducing exclusive left-turn phase or multi-phase.	• Many vehicles change lane at entrance abruptly quite often ignoring directional arrows at approach. • It is necessary to impose strong fines on traffic offenders who breaks traffic regulations.
6	Av. Canta Callao–Av. Faucett	• The crossing area is wide; it requires the cross points to be reduced as much as possible, by channeling system • The conflicts near bus stops along Av. Faucett, may cause rear-end collisions; it requires improvement of bus stop location.	• According to three phase signal by one direction, the conflict points with vehicles are not seen, therefore, accident involving vehicles may be mainly caused by vehicles which run through the intersection just at the moment of change in signal phase. • With regard to signal split, all red time or yellow time will be revised.	• Vehicles travel at high speed, it is necessary to control this by using warning signs. • In order to avoid conflicts between left-turn vehicles and through traffic, it is necessary to install exclusive left-turn lane • There is collectivo stop in front of intersection, the location must be moved	• It is necessary to impose strong fine on traffic offenders who breaks traffic regulations, especially, behavior of ignoring red traffic lights and speed limit.
7	Av. T. Valle–Av. Pacasmayo	• The crossing is very wide; it requires the cross points to be reduced as much as possible, by a channeling system. • Traffic flow at entrance affected by bus stops located in the entrance, bus stops will be transferred to the exit of intersection. • Due to wide road, adequate safety island for pedestrian will be installed.	• There are conflicts between left-turn vehicles and through traffic on Av. T. Valle, due to simple 2 phase system. • Due to wide intersection, exclusive left-turn phase with left-turn lane will be considered.	• Current signal phasing system will be revised, in order to avoid conflicts between left-turn vehicles and through traffics.	• It is necessary to impose strong fines on traffic offenders who break traffic regulations, especially, behavior of ignoring red traffic lights and speed limit.
8	Av. T. Valle–Av. Dominicos	• The crossing area is very wide; it requires the cross points to be reduced as much as possible, by a channeling system • Conflict near bus stops along Av. T. Valle will be considered. • There is an exit of vehicles from gas station (GRIFO), the entrance/exit must be moved	• There are conflicts between left-turn vehicles and through traffic; signal phase system will be revised. • Due to very wide intersection, many pedestrians cross at other than pedestrian crossing, pedestrians wander into vehicle lanes to shortcut their journey. • Safe pedestrian flow will be considered	• Traffic congestion during peak periods are observed, existing signal control should be revised, depending upon current demand. • Existing signal lights are not visible, location of signal lights should be considered	• For crossing by pedestrians, it is necessary to enforce pedestrian crossing behaviors at other than pedestrian crossing.

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

Table 11.2-9 Major Problems and Issues in 12 Black Spots (3/4)

Black spots	Major problems and issues			
	Road condition	Traffic flow condition	Traffic control	Traffic violation
9 Av. J Prado–Av. Petit Thouars	• Conflict between left-turning vehicles from Av. Javier Prado to Av. Petit Thouars between through traffic • Exclusive left-turn lane pocket should be provided, in order to achieve smooth flow of straight-through traffic along Av. Javier Prado, by cutting off the median and allotting space to the pocket, or by shifting the center line to the lane in the opposite direction	• Long traffic queue on Av. Javier Prado may cause rear-end collisions • In order to mitigate the traffic congestion, the traffic capacity should be increased by revised signal control system, such as synchronized system coordinating to next intersection.	• As pointed out in the traffic flow condition, the traffic control system should be developed along Av. Javier Prado (synchronized control system).	• No specific issues
10 Pan. Norte–Av. 2 de Octubre	• The crossing area is wide; the cross points should be reduced as much as possible, by a channeling system • In addition, in order to lead usage of pedestrian bridge, the guard fence on median at approach should be installed. • Channeling islands at N-S/S-N entrance on Av. P. Norte should be adjusted, in accordance with the angle of corner cuts, so as to achieve smooth traffic flow.	• The intersection is visible well, because of wide corner of intersection. Vehicles run through the intersection at high speeds, therefore, a warning sign should be installed near the entrance intersection, with clear information of "Reduce Speed ahead". • Since there is a pedestrian crossing near the bus stop, it is necessary to enforce pedestrian crossing by traffic police control. • The type of accident involving pedestrians is high share, it was observed that pedestrians cross into vehicle lanes to shortcut their journey; therefore, it is necessary to transfer the bus stop to a location near to the pedestrian crossing or existing bridge	• The signal control system is set by a 2-phase fixed type, in order to prevent not only the conflicts between through traffic and left-turning vehicles, but also the conflicts with pedestrians, yellow time should be increased. • In addition, all red phase will be added.	• At bus stop on N-S approach of Av. P. Norte, it is observed that some passengers cross directly to the opposite side, since pedestrian bridge or pedestrian crossing is far away from the bus stop. It is necessary to enforce the pedestrian behavior by traffic police. • Vehicles cross from U-turn spot on Av. Panamericana Nrte to the side road; such vehicle behavior should be penalized.
11 Av. Alipio-Panamaricana Sur	• The intersection is very complex; more simple design will be considered. • There are many cross points by vehicles and pedestrians, the number of cross points should be reduced as much as possible, by a channeling system.	• There are many left/right turn vehicles; traffic flow system will be revised by using a channeling system and signal control system. • There is a high share of accidents involving pedestrians, it is necessary to install safety devices.	• In spite of many cross points, a signal light has not been installed, it is very necessary to install a signal light.	• For crossing by pedestrians, it is necessary to enforce pedestrian crossing behaviors at other than pedestrian crossing

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

Table 11.2-9 Major Problems and Issues in 12 Black Spots (4/4)

Black spots	Major problems and issues			
	Road condition	Traffic flow condition	Traffic control	Traffic violation
12 Av. Héroes del Cenepa-Panamericana Norte	• Conflicts are observed at bus stops located in S-N entrance of intersection on Av. Trapiche, therefore, bus stop should be transferred to exit of intersection. • There is a high share of accidents involving pedestrians, since there is a pedestrian crossing near the bus stop, it is necessary to enforce pedestrian crossing behaviors at other than pedestrian crossings. • The number of cross points should be reduced as much as possible, by a channeling system. • Additional road lighting should be installed in place.	• In spite of many cross points, a signal light has not been installed, it is necessary to install a signal light, in the short term. • In the future, at-grade intersection should be changed to the flyover type.	• Signal lights will installed, in order to achieve smooth traffic flow, a three phase signal pattern, which sets one phase for each direction, will be prepared.	• It is necessary to impose strong fines on bus driver offenders who breach traffic regulations, such as illegal stops along roads

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

(4) Improvement Plan for Target Black Spots

1) Remedial Measures Corresponding to Presumed Causes

As pointed out in the planning measures system, the remedial measures will be generally prepared based on the presumed causes through the analysis of field investigation including the road/traffic conditions, and extraction of frequent accident patterns.   In this study, due to the lack of collision diagrams, the remedial measures will be simply identified from the results of the problems and issues of the road/traffic conditions and the characteristics of traffic accidents.   Table 11.2-10 shows the proposed remedial measures for 12 black spots.

Table 11.2-10 Proposed Remedial Measures for 12 Black Spots

	Black spots	Proposed remedial measures
1	Av. Los Héroes – Av. San Juan	• Install pavement marking for left-turn vehicles on Av. Los Heroes • Improve signal phase for pedestrian priority (3 phases plus all red time) • Arrange location of pedestrian crossing (shortest journey) • Close U-turn points on Av. Los Heroes • Arrange edge of median on Av. Los Heroes (reserving refuge space for pedestrian) • Transfer location of bus stops to exit of intersection, and install bus bay • Prohibit left-turn only from side street • Enforce vehicular behavior and pedestrian behavior
2	Av. Próceres de la Independencia–cdra 1	• Install signal lights at T-intersection • Install pedestrian crossing at planned signal lights • Install pavement marking for directional lane and stop line • Arrange edge of median on Northern approach on Av. Próceres • Transfer pedestrian bridge to location in front of high school/market • Transfer location of bus stops to exit of intersection, and install bus bay
3	Av. Próceres de la Independencia–Av. Lima	• Install signal lights at T-intersection • Install pedestrian crossing at planned signal lights • Install pavement marking for directional lane and stop line • Close Southern fringe greenbelt on Av. Próceres (reduction in cross points) • Arrange edge of median on Av. Próceres (reserving refuge space for pedestrian) • Transfer location of mototaxi stops to exit of intersection, and install bus bay
4	Av. Próceres de la Independencia–Av. Tusilagos	• Install pavement marking for left-turn vehicle on Av. Próceres • Improve signal phase for inflowing traffic from fringe street (3 phases) • Add exclusive left-turn lanes at both entrances on Av. Próceres • Add exclusive left-turn lanes at Eastern entrances on Av. Tusilagos • Transfer location of bus stops to exit of intersection, and install bus bay • Prohibit left-turn from fringe lane at Southern entrance on Av. Próceres
5	Av. Canaval y Moreyra–Paseo de la República	• Install pavement marking for left-turn vehicles at both entrances on Av. Paseo de la República • Prepare 2-lane for left-turn vehicles at Northern entrances on Av. Paseo de la República • Revise pavement markings of directional arrows • Enlarge size of channeling island at Western entrance on Av. C. y Moreyra • Improve signal phase for left-turn vehicles priority on Av. Paseo de la República (3 phases) • Enforce vehicular behaviors of changing lane at entrance of intersection
6	Av. Canta Callao–Av. Faucett	• Install pavement marking for left-turn vehicles at each entrance • Add exclusive left-turn lane at Northern entrances on Av. Faucett • Arrange edge of median on Northern approach on Av. Faucett • Take away central island • Transfer location of bus stops to exit of intersection, and install bus bay • Improve signal phase for pedestrian priority (3 phases plus all red time) • Install warning sign such as "Speed down ahead" • Enforce illegal vehicular behaviors
7	Av. T. Valle–Av. Pacasmayo	• Install pavement marking for left-turn vehicles at both entrances on Av. T. Valle • Improve signal phase for left-turn vehicle priority (3 phases) • Add exclusive left-turn lane at Northern entrances on Av. T. Valle • Arrange edge of median on Northern approach on Av. T.Valle • Take away central island • Transfer location of bus stops to exit of intersection, and install bus bay • Install open spaces for right-turn vehicles from main road at fringe greenbelt • Enforce illegal vehicular behaviors
8	Av. T. Valle-Av.	• Install pavement marking for directional lane and stop line in central part

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

	Dominicos	• Improve signal phase for inflow traffic from fringe street (3 phases) • Existing signal lights will be relocated to the opposite median or corners. • Arrange edge of median on Eastern approach on Av. T.Valle • Transfer location of bus stops to exit of intersection, and install bus bay • Transfer location of mototaxi stops to exit of intersection, and install bus bay • Close greenbelt in front of fuel station • Install acceleration lane at exit from fuel station on Southern exit of Av. Dominicos
9	Av. J. Prado–Av. Petit Thouars	• Adopt signal control system responding to traffic fluctuation by time periods • Add exclusive left-turn lanes at Western entrances on Av. Javier Prado • Install pavement marking for left-turn vehicles on Av. Javier Prado • Transfer location of bus stops to exit of intersection, and install bus bay • Enforce vehicular behaviors to block intersection
10	Panamericana Norte –Av. 2 de Octubre	• Improve signal phase for pedestrian priority (3 phases plus all red time) • Install pavement marking for left-turn vehicles on Av. P. Norte • Install guard fence on median at approach • Transfer bus stop to location near pedestrian crossing or existing bridge • Install warning sign such as "Reduce Speed Ahead" • Enforce vehicular behavior and pedestrian behavior
11	Av. Alipio- Panamaricana Sur	• Improve as a simple intersection with fringe lane (as crisscross type) • Install signal lights at intersection (3 phases) • Install pedestrian crossing at planned signal lights • Install pavement marking for directional lane and stop line • Add exclusive left-turn lane at both entrances on Av. Alipio • Install pavement marking for left-turn vehicles on Av. Alipio • Enforce vehicular behavior and pedestrian behavior
12	Av. Héroes del Cenepa-Panamerican a Norte	• Install signal lights at intersection (3 phases) • Install pedestrian crossing at planned signal lights • Install pavement marking for directional lane and stop line • Install pavement marking for left-turn vehicles on P. Norte • Transfer location of bus stops to exit of intersection, and install bus bay • Enforce vehicular behavior and pedestrian behavior

2) *Introduction of Typical Improvement Plan*

Table 11.2-10 is only proposed based on the results of the problems and issues of the road/traffic conditions and the characteristics of traffic accidents. It is very important that the remedial measures be examined to prevent accidents according to the details of accidents such as collision diagram and statements of drivers/pedestrians concerned and views of police. In this study, in order to understand the technique of the improvement plan, two typical improvement plans for accident prevention will be introduced in Figure 11.2-23(1)-(2), based on the proposed remedial measures mentioned above.

a) Improvement Plan for intersection Av. Los Héroes – Av. San Juan

This black spot shows the highest number of accidents in the study, indicating a high share of accidents involving hit pedestrian at 45% and vehicle to vehicle at 38%. The remedial measure was proposed to focus attention on the prevention of pedestrian accidents. (See Figure 11.2-22)

Figure 11.2-22 Intersection Av. Los Heroes-Av. San Juan

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

Vehicles cross at U-turn space from side street

Conflicts due to bus stop at entrance

Conflict between left-turn vehicle and through traffic

Pedestrians cross at other than pedestrian crossing

Inadequate location of pedestrian crossing

Conflict right-turn bus and others

Close U-turn points

Install pavement marking for left-turn

Improve signal phase for pedestrian priority

Transfer location of bus stops

Prohibit left-turn only from side street

Arrange location of pedestrian crossing

Reserve refuge space for pedestrian

Prohibit right-turn only

Figure 11.2-23 (1) Improvement Plan for Av. Los Héroes-Av. San Juan

b) Improvement Plan for intersection Av. Próceres de la Independencia–Av. Tusilagos

This black spot is located at the intersection on rural principal, indicating a high share of accident of vehicle to vehicle at 52%, and vehicle to vehicle hit and run at 24%. The remedial measure was proposed to focus attention on the vehicular behaviors and topographic conditions (See Figure 11.2-24).

Figure 11.2-24 Intersection Av. Próceres de la Independecia-Av. Tusilagos

Traffic queue due to bus stop

Poor visibility distance due to ...

Conflicts between diverging traffic and right-turn /through traffic

Conflict between diverging traffic and through traffic

Conflicts left-turn vehicles

Rear-end collisions may be due to long queue

Improve signal phase for inflow traffic from fringe street

Install pavement marking for left-turn

Add exclusive left-turn lanes

Transfer location of bus stops

Prohibit right-turn only

Figure 11.2-23 (2) Improvement Plan for Av. Próceres de la Independecia-Av. Tusilagos

11-58

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

11.2.10. IMPLEMENTATION PLAN

(1) Outline of Task Items

The road accident monitoring plan will be considered as a contract package of final design, supervision and construction of intersection improvement at black spots. International consultants would be engaged to provide advisory services for the program of road accident monitoring system.

The road accident monitoring plan shall be elaborately implemented based on the following procedure; a) improvement plan for the organization of coordination and management of road accident monitoring, b) plan for investigation and database system, c) plan for analysis system on hazardous locations and confirmation of problems, d) plan for planning measures system, e) plan for implementation of measures system, f) plan for follow-up system, and g) improvement plan of black spots. The outline of each task work is described as below:

1) Improvement plan for Organization of Coordination and Management of Road Accident Monitoring

The organization system for coordination and management of road accident monitoring will be harmonized being taken at national level, by promoting development of programs, technical support and assessment of relevant agency's activities. This task will be formulated by establishing clearly the organization mechanisms and functions of relevant agencies. The major task will be mainly done by managing human resources of relevant agencies, in line with promotion of 5-year strategy plan.

2) Plan for Investigation and Database System

The plan for investigation and database system shall be implemented as part of accident data program and PNP strengthening program in the 5-year strategy plan; the tasks will be carried out on the basis of function mechanism such as plan of accident statistic and plan for extraction of hazardous locations.

3) Plan for Analysis System on Hazardous Locations and Confirmation of Problems

The plan for analysis system on hazardous and confirmation of problems shall be implemented as part of additional program in the 5-year strategy plan; the tasks will be carried out on the basis of function mechanism such as plan for interpretation of accident records, plan for collection of relevant materials, plan for field investigation, plan for extraction of accident pattern frequently, and plan for presumption of accident causes.

4) Plan for Planning Measures System

The plan for planning measures system shall be implemented as additional program in the 5-year strategy plan; the tasks will be carried out on the basis of function mechanism such as plan for selection of measures corresponding to presumed causes, plan for examination of applicability on measures, plan for clarification of effects and side effects of measures, and plan for examination of combination on measures.

5) Plan for Implementation of Measures System

The plan for implementation of measures system shall be implemented as additional program in the 5-year strategy plan; the tasks will be carried out on the basis of function mechanism such as, plan of examination of finance, plan of consultation with agencies concerned, plan of explanation to residents, and implementation. In this project, after extraction of major black spots in the Lima/Callao metropolitan area, the major black spots shall be improved through the detailed design and construction of improvement.

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

6)   Plan for Follow-Up System

The plan for follow-up system shall be implemented as additional program in the 5-year strategy plan; the tasks will be carried out on the basis of function mechanism such as plan for measurement of effect of measures, plan for comparison of before/after survey, and plan for execution of campaign and enforcement.

7)   Improvement Plan of Black Spots

The improvement plan at black spots will be included as part of implementation plan, improvement plan for 12 black spots shall be conduct in short term periods.   The task will be divided into detail design and construction.

(2) Implementation Schedule

The implementation schedule for the package project of road accident monitoring is proposed in Figure 11.2-25.   The road accident monitoring project is scheduled to start in second quarter of 2007 and be completed by forth quarter of 2011.   After implementation of the final deign and bidding, the improvement plan for organization of coordination and management for road accident monitoring will be started in the first quarter of 2008, and be completed by the first quarter of 2008.   The plan for investigation and database system will be started from second quarter of 2008 to forth quarter of 2008. After then, the .plan for analysis system on hazardous locations and confirmation of problems will be completed by second quarter of 2009.   The plan for interpretation of accident records, the plan for collection of relevant materials, the plan for field investigation, and the plan for extraction of accident pattern frequently are collaterally implanted.   And the plan for planning measures system will be completed during six months.   In terms of the improvement plan of 12 black spots, the detail design will be started in the first quarter of 2008, and be completed by second quarter of 2008. Based on the completion of planning measure for black spots, the plan for implantation system of measures by detail design and construction shall be conducted from first quarter of 2010 to second quarter of 2010, after then, the plan for follow-up system is expected to start in third quarter of 2010, and be completed by end of 2011.

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

Task Name	2007				2008				2009				2010				2011			
	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12
1. Final design and tender document																				
2. Bidding																				
3. Improvement plan for organization of coordination and management of road accident monitoring																				
3-1 Establishment of organization mechanisms and functions of relevant agencies																				
3-2 Management of human resources of relevant agencies																				
4. Plan for investigation and database system																				
4.1 Plan of accident statistic																				
4.2 Plan for extraction of hazardous locations																				
5. Plan for analysis system on hazardous locations and confirmation of problems																				
5-1 Plan for interpretation of accident records																				
5-2 Plan for collection of relevant materials																				
5-3 Plan for field investigation																				
5-4 Plan for extraction of accident pattern frequently																				
5-5 plan for presumption of accident causes																				
6. Plan for planning measures system																				
7. Plan for implementation of measures																				
7.1 Construction of identified black spots																				
8. Plan for follow-up system																				
8-1 Plan for measurement of effect of measures																				
8-2 Plan for comparison of before/after survey																				
8-3 Plan for execution of campaign and enforcement																				
9. Improvement Plan of 12 Black Spots																				
9.1 Detail design																				
9.2 Construction																				

Notes: ▬▬ : Continuous Work during specified periods ■ ■ ■ ■ : Intermittent work
The target road accident monitoring plan covers lima/Callao Metropolitan Area

Figure 11.2-25 Implementation Schedule for Road Accident Monitoring Plan

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

11.2.11. COST ESTIMATION

The project of road accident monitoring plan is mainly software technique items for formation of road accident for target groups of traffic police, road planners, and engineers, on the basis of consulting service of supervision and training trainer. The project cost for the road accident monitoring plan consists of 1) improvement plan for organization of coordination and management of road monitoring, 2) plan for investigation and database system, 3) plan for analysis system on hazardous locations and confirmation of problems, 4) plan for planning measures system, 5) plan for implementation of measures, 6) plan for follow-up system, and 7) improvement plan of 12 black spots, based on the contract package during 5 years. The project cost by items is shown in Table 11.2-11.

Table 11.2-11 Project Cost for Road Accident Monitoring Project

Investment Items *1)	Project Cost (x 1,000 USD)
1. Improvement plan for organization of coordination and management of road monitoring	118
1-1 Establishment of organization mechanism and function of relevant agencies	8
1-2 Management of human recourses of relevant agencies	110
2. Plan for investigation and database system	202
2-1 Plan for accident statistics	180
2-2 Plan for extraction of hazardous locations	22
3. Plan for analysis system on hazardous locations and confirmation of problems	62
3-1 Plan for interpretation of accident records	9
3-2 Plan for collection of relevant materials	9
3-3 Plan for field investigation	26
3-4 Plan for extraction of accident pattern frequently	9
3-5 Plan for presumption of accident causes	9
4. Plan for planning measures system	9
5. Plan for implementation of measures	203
5-1 Construction of identified black spots	203
6. Plan for follow-up system	31
6-1 Plan for measurement of effect of measures	3
6-2 Plan for comparison of before/after survey	15
6-3 Plan for execution of campaign and enforcement	13
7. Improvement plan of 12 black spots	129
7-1 Detail design	6
7-2 Construction	123
8. Supervision by international expert *2)	400
Total	1,154
Engineering Cost (Totalx10%)	115
Administration Cost (Totalx10%)	115
Contingencies Cost (Totalx15%)	174
Grand total	1,558

Notes: *1) The target road safety education plan covers Lima and Callao area. *2) The cost of supervision by international experts indicates the total account of each investment items.

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

11.3. INTERSECTION IMPROVEMENT PLAN

11.3.1. OBJECTIVES

The objective of intersection improvement plan is to achieve a smooth traffic flow along specified heavy congestion road in the study area, by introducing a technical improvement of signal control and improvement of intersection.

11.3.2. SELECTION OF CRITICAL AREA FOR STUDY

Most major signalized intersections are manually controlled by traffic policemen and this manual control is not enough to keep linear coordinated signal control system (synchronized system).   In order to achieve a smooth traffic flow for major directions on seriously congested roads, the synchronized system of traffic signal lights including improvement of intersections will be introduced.

In determining the locations for installation of traffic signal lights by the synchronized system, the following criteria were used:

- One specific route will be selected from fifteen (15) routes in the Master Plan;

- Serious congested sections indicating less than 10km/h of average travel speed;

- Bottlenecks bring about spill-back conditions for downstream traffic;

- There are high-density neighbouring intersections, and

- Substantial traffic concentrates in one direction during peak hours.

Based on the foregoing consideration, the target route of the synchronized system is Av. Aviación and Av. Tomas Marsano as shown in Figure 11.3-1.

- Av. Aviacion from Av. Grau to Ovalo Los Cabitos (8.5km)

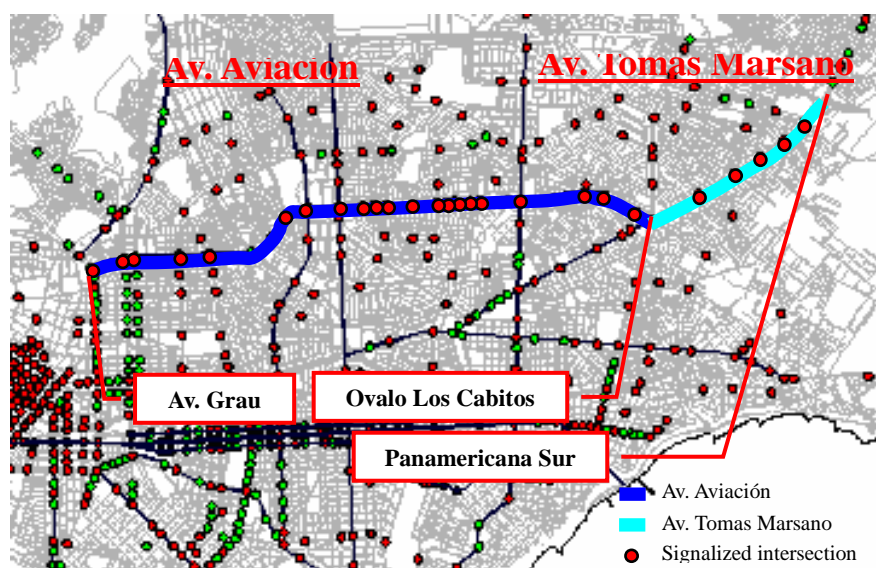- Av. Tomas Marsano from Ovalo Los Cabitos to Panamericana Sur (3.2km)

Figure 11.3-1 Identified Route for Intersection Improvement plan

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

11.3.3. CURRENT TRAFFIC CONDITIONS ON STUDY ROUTE

(1) Traffic Management Facilities

At present, there are twenty one (21) signalized intersections on Av. Aviación, and five (5) signalized intersection on Av. Tomas Marsano, as shown in Figure 11.3-1. They are almost installed in place, except for locations near Av. Grau. At some intersections, traffic lights are not visible because of low poles which frequently make it difficult for drivers who are behind large vehicles to see them. The traffic lights at Av. Bauzate y Meza and Av. Isabel la Católica are not working properly. All signalized intersections are controlled by independent fixed type systems. The number of signal phase patterns for most intersections ranges between 2 or 3. The blocked condition of intersection is quite often observed at signalized intersections due to heavy left-turn vehicles. In order to maintain smooth traffic flow conditions, an improvement of signal phase for left-turn traffics should be considered efficiently. The traffic safety facilities such as road marking and traffic signs are comparatively well arranged. Many vehicles change lane at the entrance of the intersection, ignoring directional arrows, even where the road signs of directional lane marking are installed. In addition, buses and combis are among the worst, offenders since they habitually load and unload passengers everywhere inside intersections. They overtake or change lanes near intersections in order to pick up extra passengers. These are also the causes of traffic congestion at intersection. Adequate traffic channeling measures for intersections, as well as measures of enforcement, such as imposing a strong fine on the traffic offenders, should be taken into account.

(2) Current Traffic Flow Conditions

1) Travel Time Survey

Information regarding average speed, with stopping time by reasons, on Av. Aviación and Av. Tomas Marsano was obtained from the travel time survey. The travel time survey was carried out during morning peak periods, midday peak periods and evening peak periods. The three peak periods are defined as: during 7:00-9:00 in the morning, during 12:00-14:00 in the afternoon and during 17:30-19:30 in the evening. Figure 11.3-2(1)-(3) shows the travel time and distance diagram on the study roads. The figure shows the running time and the stopping time in relation to the distance, in order to understand the bottleneck points and the causes in the context of the traffic engineering. In the analysis, the bottleneck point in the context of traffic engineering is defined as:

- Delay time: travel speed 10 km/h or less, and

- High ratio of stopping time to total travel time

The major causes of traffic congestion, characterized by a low travel speed of 10km/h or less during peak periods, are unsuitable traffic signal control systems, blocking of intersection due to heavy left-turn vehicles, conflict of buses/combis near bus stops, and merging and diverging from/to side roads without signal lights (including U-turn point). The sections with low average speed and causes of time delay by peak periods are shown in Table 11.3-1 (1)-(3) and Figure 11.3-2(1)-(3).

a) Morning peak periods (7:00-9:00)

Sections with travel speed of 10km/h or less, indicating traffic congestion, are on major signalized intersections on Av. Aviacion and Av. Tomas Marsano, towards the Lima central area, such as Av. Caminos del Inca, Av. Ayacucho, Av. Angamos, Av. Paul Linde, Jr. Albeniz, Jr. Ordonez, Av. San Borja Sur, Av. Fray Luis de Leon, Av. Javier Prado, Av. Las Artes, Av. Canada, and Ovalo Arriola. The major causes of traffic congestion are

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

unsuitable traffic signal control system, conflicts of buses/combis near bus stops and merging and diverging from/to side roads without signal lights (including U-turn point).

Table 11.3-1(1) Sections with Low Average Speed and Causes of Delay Time

Direction	Section	Major causes			
		Unsuitable traffic signal control system (including congestion due to heavy left-turn vehicles)	Conflicts of buses/ combis near bus stops (including congestion due to taxi stops)	Merging and diverging from/to side roads (including congestion due to weaving at roundabout and U-turn point)	Others (pedestrian crossing, congestion due to vehicles from/to parking lots along road, etc.)
Inbound	• Panamericana Sur-Av. Caminos del Inca	O			
	• Av. Sruco-Av. Ayacucho		O		
	• Ovalo Los Cabitos-Ca. Alicante-Jr. Valcarcel	O	O		O
	• Av. Villaran-Av. Angamos	O			
	• Av. Omega-Av. Paul Linder	O			
	• Ca. Gozzoli-Av. San Borja Sur	O			
	• Av. San Borja Sur-Av. Fray Luis de Leon	O	O		
	• Av. Las Artes-Av. Javier Prado	O			
	• Av. Javier Prado-Av. Canada	O		O	
	• Ovalo Arriola entrance-exit			O	
Outbound	• Av El Aire-Av. Canada	O			
	• Av. Javier Prado-Av. Las Artes	O	O		
	• Av. Fray Luis de Leon-Av. San Borja Sur		O		
	• Ca. Gozzoli-Jr. Albeniz	O			
	• Jr. Vesalio-Jr. Ordonez	O	O		
	• Jr. Ordonez-Av. Paul Linder	O			
	• Av. Villaran-Av. Valle de Sur	O			

Figure 11.3-2(1) Travel Time and Distance Diagram

b) Midday peak periods (12:00-14:00)

In the central sections between Av. Angamos and Av. Canada on Av. Aviacion, there is a concentration of traffic for business purposes. Sections with travel speed of 10km/h or less, indicating traffic congestion, are on major signalized intersections in both directions

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

of Av. Aviación, such as Av. Villarán, Av. Angamos, Av. Albeniz, Av. San Borja Sur/Norte, Av. Las Artes, and Av. Canada.   The major causes of traffic congestion are the same as those observed in the morning.

Table 11.3-1(2) Sections with Low Average Speed and Causes of Delay Time

Direction	Section	Major causes			
		Unsuitable traffic signal control system (including congestion due to heavy left-turn vehicles)	Conflicts of buses/ combis near bus stops (including congestion due to taxi stops)	Merging and diverging from/to side roads (including congestion due to weaving at roundabout and U-turn point)	Others (pedestrian crossing, congestion due to vehicles from/to parking lots along road, etc.)
Inbound	• Ovalo Los Cavitos, entrance-exit		○		
	• Ovalo Los Cabitos-Ca. Alicante-Jr. Valcarcel	○	○		○
	• Av. Valle de Sur-Av. Villaran	○			
	• Av. Villaran-Av. Angamos	○			
	• Av. Omega-Av. Paul Linder-Av. Madrid		○		
	• Jr. Albeniz-Ca. Gozzoli-Av. San Borja Sur	○		○	
	• Av. San Borja Sur-Av. Fray Luis de Leon	○	○		
	• Av. Fray Luis de Leon -Ca. Lopez de Ayala-Av. San Borja Norte	○	○	○	
	• Av. San Borja Norte-Av. Las Artes	○			
	• Av. Las Artes-Av. Javier Prado	○			
	• Av. Javier Prado-Av. Canada	○			
Outbound	• Av El Aire-Av. Canada	○			
	• Av. Las Artes-Av. San Borja Norte	○	○		
	• Av. Fray Luis de Leon-Av. San Borja Sur	○	○		
	• Av. San Borja Sur-Ca. Gozzoli-Jr. Albeniz	○	○	○	
	• Ca. Omega-Av. Angamos	○			
	• Av. Villaran-Av. Valle de Sur	○			

Figure 11.3-2(2) Travel Time and Distance Diagram

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

c) Evening peak periods (17:30-19:30)

Sections with travel speed of 10km/h or less, indicating traffic congestion, expand in both directions of all major signalized intersections, such as Ovalo Arriola, Av. Villaran, Av. Angamos, Av. San Borja Sur/Norte, Av. Fray Luis de Leon, and Av. Canada, especially, the section between Av. Angamos and Av. Canada shows heavy congestion. The major causes of traffic congestion are unsuitable traffic signal control systems, and conflicts of buses/combis near bus stops.

Table 11.3-1(3) Sections with Low Average Speed and Causes of Delay Time

Direction	Section	Major causes			
		Unsuitable traffic signal control system (including congestion due to heavy left-turn vehicles)	Conflicts of buses/ combis near bus stops (including congestion due to taxi stops)	Merging and diverging from/to side roads (including congestion due to weaving at roundabout and U-turn point)	Others (pedestrian crossing, congestion due to vehicles from/to parking lots along road, etc.)
Inbound	• Av. Jorge Chavez-Av. Surco		O		
	• Ovalo Los Cavitos, entrance-exit		O	O	
	• Ovalo Los Cabitos- Ca. Alicante-Jr. Valcarcel	O	O		O
	• Av. Villaran-Av. Angamos	O			
	• Ca. Omega-Av. Paul Linder		O		
	• Jr. Vesalio-Jr. Albeniz	O			
	• Jr. Albeniz-Ca. Gozzoli-Av. San Borja Sur	O	O		
	• Av. San Borja Sur-Av. Fray Luis de Leon	O			
	• Av. Fray Luis de Leon-Av. San Borja Norte	O	O		
	• Av. Las Artes-Av. Javier Prado	O	O		
	• Av. Javier Prado-Av. Canada	O	O		
	• Av. Canada-Av El Aire	O			
	• Ovalo Arriola-Av. Mexico	O			
Outbound	• Av El Aire-Av. Canada	O	O		
	• Av. Javier Prado-Av. Las Artes		O		
	• Ca. Lopez de Ayala-Av. Fray Luis de Leon	O	O		
	• Av. Fray Luis de Leon-Av. San Borja Sur	O	O		
	• Av. San Borja Sur-Jr. Albeniz	O	O		
	• Av. Angamos-Av. Villaran	O	O		Accident
	• Ovalo Los Cavitos-Av. Ayacucho	O	O		
	• Av. Ayacucho-Av. Sruco	O	O		O
	• Av. El Sol-Av. Caminos del Inca	O			

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

Figure 11.3-2 (3) Travel Time and Distance Diagram

d) Identified Key Bottlenecks

Based on the analysis of sections with low average speed and causes of delay time, the key bottlenecks will be identified in Figure 11.3-3.

Figure 11.3-3 Major Issues of Traffic Congestion at Key Bottlenecks

11-68

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

2) Traffic Count Survey

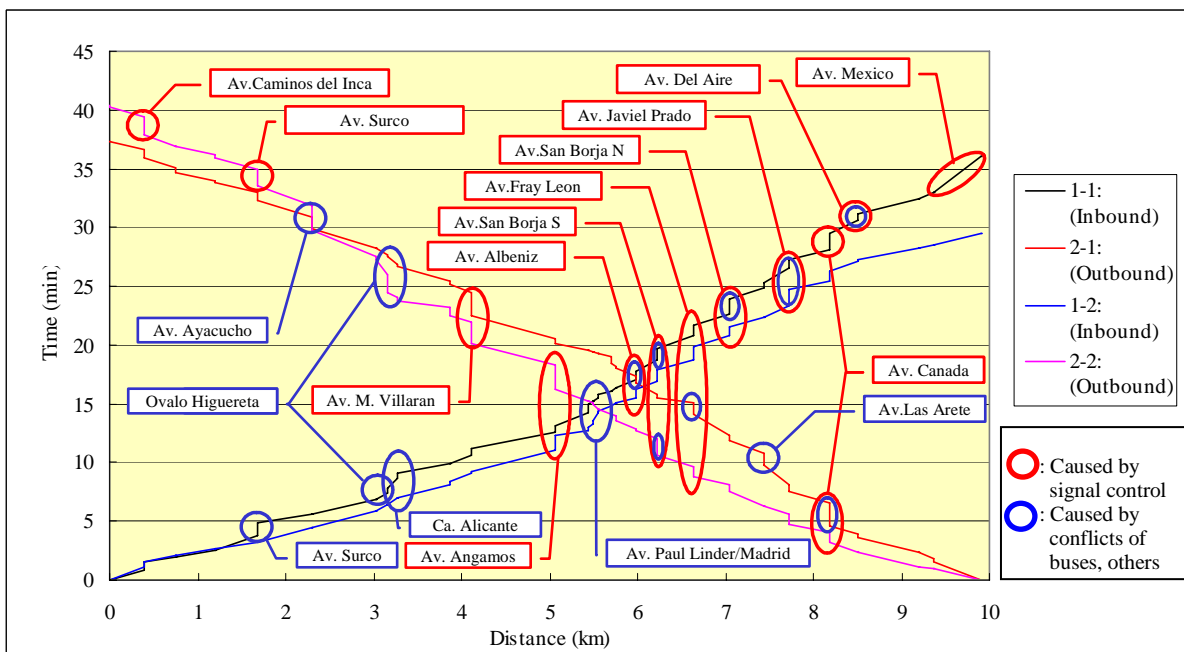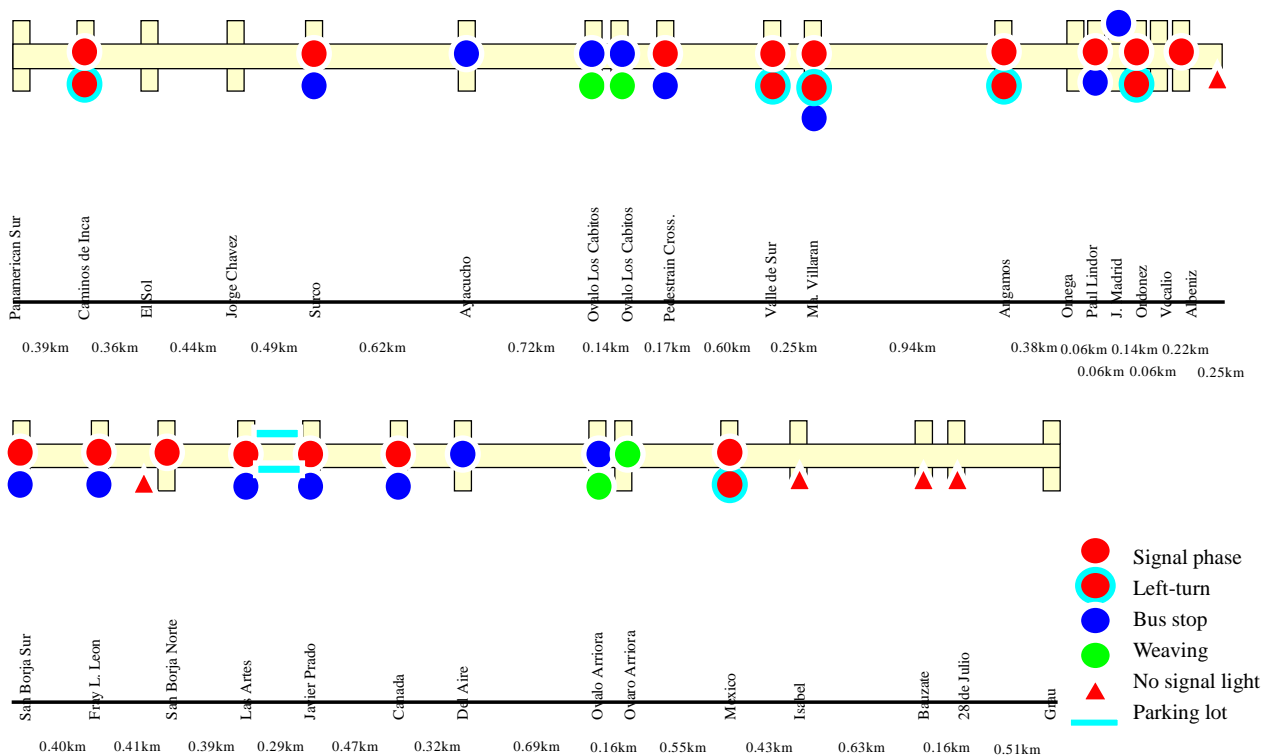The vehicle traffic count survey was carried out to formulate an intersection improvement plan at major 25 intersections on Av. Aviacion and Av. Tomas Marsano.   The types of vehicles for the counts are classified into the following two (2) types: passenger cars, taxis, minibuses, small trucks 1) cars (passenger cars, taxi, minibuses, and small trucks) and 2) large vehicles (buses and large trucks).   Survey hours are 1.0 hour in the morning peak hour (8:00-9:00) and in evening peak hour (between 17:00 and 19:00).

11.3.4. TRAFFIC SIGNAL CONTROL SYSTEM

This section discusses a traffic signal control system by introducing improvement of signal phasing and the synchronized system of traffic signal on the study route.

(1) Strategy for Traffic Control System

As previously pointed out in the analysis of the current traffic status on the study route, the traffic congested sections/or intersections and the causes in the context of traffic engineering were verified by the traffic investigations.   Major current traffic congestion is caused by inadequate road capacity, including the lack of a well-developed traffic management and control system.   A signal control and intersection improvement plan that takes into account the following basic strategies, based on the above issues, is envisioned for the study route.   The strategies for traffic control are as follows:

- Improve traffic signal phase and split system at signalized intersection, taking into account exclusive left-turn phase (including set type of one phase for each approach)
- Install signal control system at non-signalized intersection
- Introduce synchronized control system in sub-area of intersections

(2) Identified Intersection for Control System

1) Service Level at Major Intersections

Table 11.3-2 shows the service level at current major intersections on the study route. The service level was estimated by the factor of congestion degree, which indicates the ratio of traffic volume (V) to the design capacity (C), commonly known as the volume-capacity ratio (V/C).   The design capacity defines the maximum traffic volume which can pass through an intersection corresponding to the signal control program and on the basis of saturation flow rates at each approach.   The saturation flow rate is the maximum possible traffic volume per time unit that can pass the approaching road cross section.   The problems and issues has been identified, such as an improvement of signal phase system and lane control, due to weak points of traffic control method for left-turn vehicle, and lack of traffic capacity at approach.

Table 11.3-2 Service Level at Major Intersections on the Study Route

Major intersection	Congestion degree (V/C) at approach		Issues to be improved
	AM Peak	PM Peak	
Av. Grau	0.085-0.103	0.092-0.095	• No particular note
Av. Mexico	0.458-0.723	0.414-0.701	• Flow rate for left-turn vehicles at S-N approach should be increased, due to high left-turn share.
Ovalo Arriola	0.827	0.861	• High degree of congestion observed, it will be signalized.
Av. Canada	0.510-0.750	0.398-0.830	• Near saturation flow rate on both roads, existing flow late will be maintained.

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

Av. Javier Prado	0.347-0.554	0.321-0.691	• It will be improved, depending on high flow rates of both directions on Av. Aviación.
Av. Angamos	0.353-0.677	0.382-0.607	• High share of left-turn vehicles at S-N approach on Av. Aviación, an exclusive phase will be added, an exclusive left-turn lane will be provided due to high flow rate. • High share of left-turn vehicles on both approaches of Av Angamos, an exclusive left-turn lane will be provided, and an additional phase for left-turn.
Av. Villaran	0.624-1.027	0.637-1.115	• High share of left-turn on both roads, an exclusive left-turn lane will be provided and an additional phase for left-turn
Av. Ayacucho	0.497-0.645	0.344-0.692	• Average flow rate for each approach on both roads will be considered
Ovalo Higuereta	0.770	0.731	• High congestion degree shows comparatively, it will be better to introduce signalized intersection.
Av. Surco	0.435-0.747	0.436-0.857	• Flow rate for left-turn vehicles at S-N approach should be increased, due to high left-turn share, additional exclusive left-turn lane will be provided (total: 2 left-turn lanes).
Av. Camino del Inca	0.459-0.858	0.441-0.570	• Flow rate for left-turn vehicles on S-N approach should be increased, due to high left-turn share, exclusive left-turn phase will be provided

2) Identified Intersection for Improvement of Signal Control

Based on the analysis of current major issues and service level (degree of congestion of approaches) at major intersections, the following intersections will be identified as intersections subject to control by the proposed signal control system in Figure 11.3-4. Of a total of 30 intersections, the intersection subject will be identified, such as 16 intersections by revising the 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 intersections will be newly signalized.
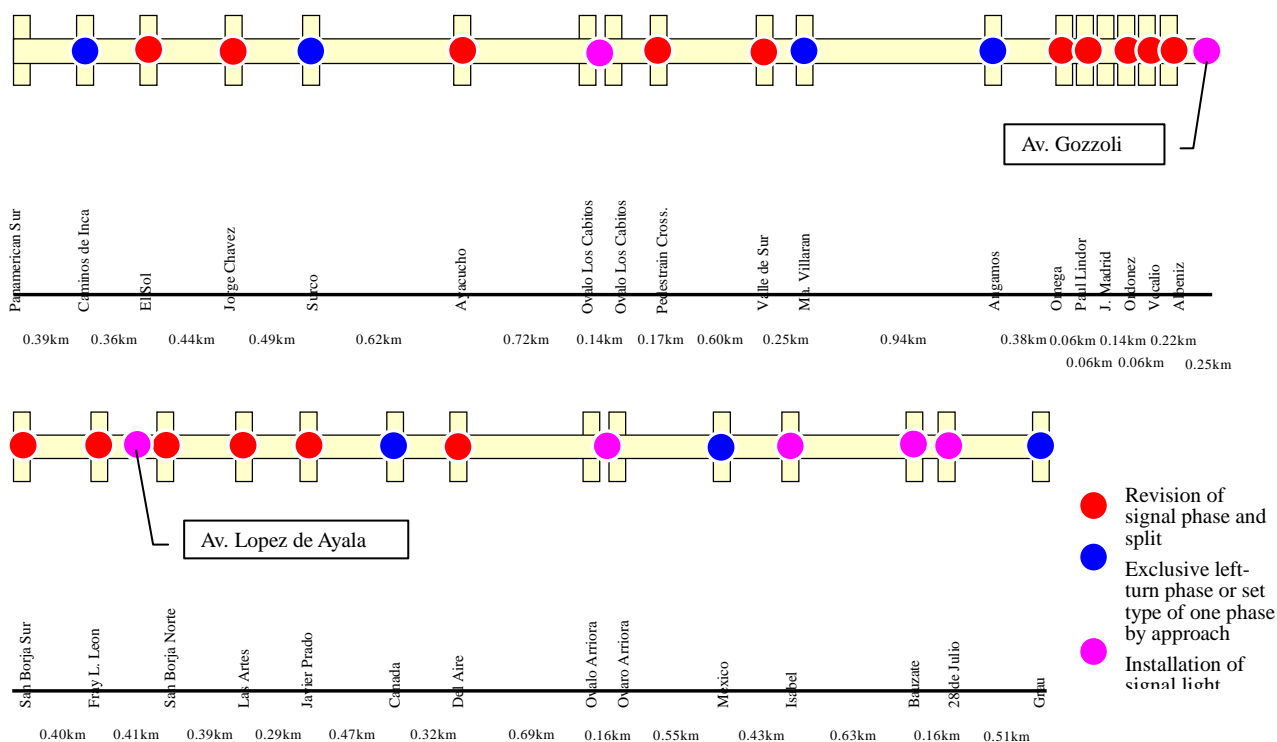
Figure 11.3-4 Identified Intersection for Improvement of Signal Control

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

(3) Improvement of Signal Phase and Split System

According to the issues of service level at major intersections, current signal control will be improved by introducing the techniques of signal phase, cycle length, signal split and green time, and lane control.   The improvement plan for signal phase and signal split at key current signalized intersection is proposed. The typical pattern of proposed exclusive left-turn phase dependent on the turning movement is shown in Table 11.3-3.

Table 11.3-3 Identified Intersection for Improvement of Signal Control

Typical pattern	Turning movement	Type of phase
1) High share of left-turn vehicles at one approach		
2) High share of left-turn vehicles at two approaches		
3) High share of left-turn vehicles at three or all approaches		

A summary of the improvement plan for signal phase and signal split is shown in Table 11.3-4.   Figure 11.3-5 shows a sample of improvement plans for the signal control system.

Table 11.3-4 Summary of Improvement Plan for Signal Phase and Signal Split

Major intersection	Number of phase	Cycle time and green time (sec)		Special notes
		Cycle	Green	
1. Av. Grau	3	100	23-35	• Set one phase by each approach
2. Av. 28 de Julio	2	100	25-35	• Revise after construction of intersection
3. Av. Bauzate y Meza	2	100	25-35	• Revise after construction of intersection
4. Av. Isabel la Católica	2	100	25-35	• Revise after construction of intersection
5. Av. Mexico	3	100	16-46	• Set left-turn phase for S-N approach
6. Ovalo Arriola	3	145	28-62	• Set cycle time 145 sec due to wide area
7. Av. Del Aire	2	100	30-40	• Install left-turn pocket for S-N/N-S approaches
8. Av. Canada	3	100	10-43	• Set left-turn phase for S-N approach
9. Av. Javier Prado	2	100	35-55	• Set cycle time 100 sec
10. Av. Las Artes	2	100	30-40	• Set cycle time 100 sec
11. Av. San Borja Norte	2	100	30-40	• Set cycle time 100 sec
12. Ca. Lopez de Ayala	2	100	30-40	• Set cycle time 100 sec
13. Av. Fray Luis de Leon	2	100	30-40	• Set cycle time 100 sec
14. Av. San Borja Sur	2	100	30-40	• Set cycle time 100 sec
15. Ca. Gozzoli	2	100	30-40	• Set cycle time 100 sec
16. Jr. Albeniz	2	100	30-40	• Install left-turn pocket for S-N approach
17. Jr. Vesallo	2	100	30-40	• Set cycle time 100 sec
18. Jr. Ordonez	2	100	30-40	• Set cycle time 100 sec

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

19. Ca. Omega	2	100	30-40	• Set cycle time 100 sec
20. Ca. Paul Linder	2	100	30-40	• Set cycle time 100 sec
21. Av. Angamos	4	100	15-25	• Set left-turn phase for all approaches • Install 2-lane left-turn pocket for S-N approach
22. Av. PedroVillarán	4	100	10-37	• Set left-turn phase for all approaches • Install left-turn pocket for all approaches
23. Av. Valle del Sur	2	100	30-40	• Install left-turn pocket for S-N/N-S approaches
24. Ca. Alicante-Valcarcel	1	100	30-40	• Set 1-phase for pedestrian crossing
25. Ovalo Higuereta	3	150	27-79	• Set cycle time 150 sec due to wide area • Install 1-lane for increasing capacity W-E/E-W approaches on Av. Benavides
26. Av. Ayacucho	2	100	30-40	• Set cycle time 100 sec
27. Av. Surco	3	100	10-55	• Increase flow rate for S-N approach • Install 1-lane for exclusive left-turn (total: 2-lanes)
28. Av. Jorge Chavez	2	100	30-40	• Set cycle time 100 sec
29. Av. El Sol	2	100	30-40	• Set cycle time 100 sec
30. Av. Camino del Inca	3	100	10-46	• Set left-turn phase for S-N approach

Feasibility Study of Urban Transportation in
the Lima and Callao Metropolitan Area in the Republic of Peru
Draft Final Report

Period: AM Peak

Approach	N-S (Aviacion) R	S	L	S-N R	S	L	W-E (Angamos) R	S	L	E-W R	S	L
1) No. of lanes	2	3	1	2	2	2	1	4	1	2	3	1
2) Basic value of saturation flow rate	1,800	2,000	1,800	1,800	2,000	1,800	1,800	2,000	1,800	1,800	2,000	1,800
3) Adjustment factor lane width	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4) Adjustment factor for heavy vehicles	0.96	0.96	0.96	0.96	0.96	0.96	0.98	0.98	0.98	0.94	0.94	0.94
5) Adjustment factor for right-turns	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6) Adjustment factor for left-turns	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7) Saturation flow rate	3,421	5,760	1,728	3,456	3,840	3,456	1,764	7,840	1,764	3,384	5,640	1,692
8) Traffic volume by direction (R+S+L)	14	852	138	178	1,405	465	471	1,444	242	28	1,341	190
9) Flow rate	0.094		0.080	0.217		0.135	0.199		0.137	0.152		0.112

Necessary phase ratio (AM Peak)

		S.D of phase	Total S.D
10) Necessary phase ratio	1Φ	0.094	0.217	
	2Φ	0.080	0.135	0.688
	3Φ	0.199	0.199	
	4Φ	0.152	0.112 0.137	
11) Ratio of heavy vehicles		6.2% - 6.1% - 3.3% - 9.2%	-

Note: R=Right-turn, S=Straight, L= Left-turn, S.D=Saturation Degree

Note: Loss time = 20 sec

Total S.D	Loss time	Cop	Cycle Time	Cycle Time
0.688	20	112	112	100

Phase	C-L	Cop	S.D/Total	Green(sec)	Green(sec)
1Φ	92	92	0.315	29	25
2Φ	92	92	0.196	18	16
3Φ	92	92	0.290	27	23
4Φ	92	92	0.199	18	16

Period: PM Peak

Approach	N-S (Aviacion) R	S	L	S-N R	S	L	W-E (Angamos) R	S	L	E-W R	S	L
1) No. of lanes	2	3	1	2	2	2	1	4	1	2	3	1
2) Basic value of saturation flow rate	1,800	2,000	1,800	1,800	2,000	1,800	1,800	2,000	1,800	1,800	2,000	1,800
3) Adjustment factor lane width	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4) Adjustment factor for heavy vehicles	0.95	0.95	0.95	0.97	0.97	0.97	0.98	0.98	0.98	0.94	0.94	0.98
5) Adjustment factor for right-turns	1.00	1.00	1.00	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
6) Adjustment factor for left-turns	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7) Saturation flow rate	3,420	5,700	1,710	3,352	3,880	3,492	1,764	7,840	1,764	3,528	5,880	1,764
8) Traffic volume by direction (R+S+L)	6	999	188	199	1,102	412	363	1,473	223	330	1,117	210
9) Flow rate	0.110		0.110	0.180		0.118	0.191		0.126	0.154		0.119

Necessary phase ratio (PM Peak)

		S.D of phase	Total S.D
10) Necessary phase ratio	1Φ	0.110	0.180	
	2Φ	0.110	0.118	0.615
	3Φ	0.191	0.191	
	4Φ	0.154	0.119 0.126	
11) Ratio of heavy vehicles		5.9% - 5.7% - 3.1% - 3.2%	-

Note: R=Right-turn, S=Straight, L= Left-turn, S.D=Saturation Degree

Note: Loss time = 20 sec

Total S.D	Loss time	Cop	Cycle Time	Cycle Time
0.615	20	91	91	100

Phase	C-L	Cop	S.D/Total	Green(sec)	Green(sec)
1Φ	71	71	0.292	21	23
2Φ	71	71	0.192	14	15
3Φ	71	71	0.311	22	25
4Φ	71	71	0.205	15	16

Intersection: Aviacion-Angamos

AM Peak — Proposed Signal Step: Cycle Time Length = 100 (sec)

Phase	Time (sec) 20	40	60	80	100
1Φ	G (24)	Y	R (71)		
2Φ	R (29)	GA (40) Y	R (56)		
3Φ	R (44)	G (37)	Y R (14)		
4Φ	R (86)		GA (9) Y		

Note: Yellow time = 5 sec

Intersection: Aviacion-Angamos

PM Peak — Proposed Signal Step: Cycle Time Length = 100 (sec)

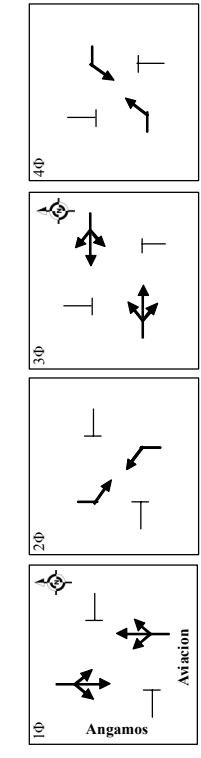| Phase	Time (sec) 20	40	60	80	100
1Φ	G (29)	Y	R (66)		
2Φ	R (34)	GA (15) Y	R (46)		
3Φ	R (54)	G (31)	Y R (9)		
4Φ	R (90)		G Y		

Note: Yellow time = 5 sec

Figure 11.3-5 A Sample of Improvement Plan for Signal Phase and Signal Split at Av. Aviacion-Av. Angamos Intersection

11-73

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

(4) Installation of Synchronized Control System in Sub Area of Intersections

In order to respond to unstable traffic fluctuation by time periods, the traffic control system for sub area of intersections adopts synchronized control system with sensors, which must be able to respond effectively to the different traffic conditions.

1) Identified Intersections for Synchronized Control System

Based on the analysis of current major issues, service level and distance of adjacent intersections, the key intersection and sub area will be formulated as shown in Figure 11.3-6. Four (4) sub areas for synchronized control system on Av. Aviación will be formulated, and, for the Av. Tomas Marsano, two (2) sub areas will be formulated.
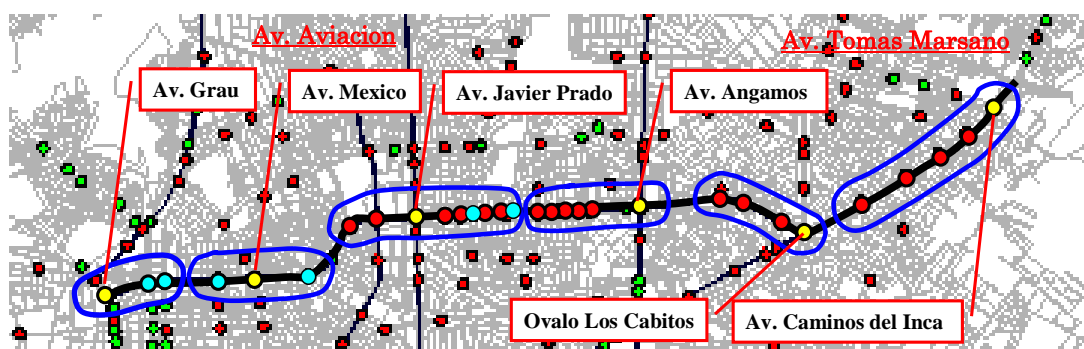

Figure 11.3-6 Identified Intersection for Improvement of Signal Control

a) Key Intersection

The above-mentioned 30 intersections, subject to control by the synchronized control system, are divided into 6 key intersections and 24 ordinary intersections. A key intersection serves as the base point for determining the synchronized cycle, split and offset pattern. In principle, the key intersection will be controlled based on the type of offset pattern which is prepared in advance.

b) Sub Area

The sub area will be formulated based on the plan of the key intersection. The cycle length and offset pattern for a given sub area, which is made up of a number of signalized intersections, are selected from the control plans which are prepared in advance. All signals in the sub area thus have the same cycle length and appropriate offset pattern. In the same way, offsets at intersections which are located at the boundaries of two sub areas (included in each sub area) can be adjusted if the two sub areas have the same cycle length

2) Basic Control Methods

The same cycle length at neighboring intersections will enable both to operate together by setting up the offset timing. This enables vehicles to drive without stopping at the intersection in the sub area of the synchronized traffic signal system. The system sets a real time control by using the sensors at signalized intersection, and controlled by the centralized system of the traffic control center.

3) Equipment and Devices

a) Detectors

Detectors will be provided for the purpose of supplying data, in order to determine control parameter. The detectors supply raw data on traffic conditions at key intersections, which

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

are necessary for determining signal control parameters such as cycle length, split and offset.   The type of ultrasonic detectors will be positioned at key intersections appropriate for obtaining such data.   The standard installation plan for detector and cabinet is shown in Figure 11.3-7.
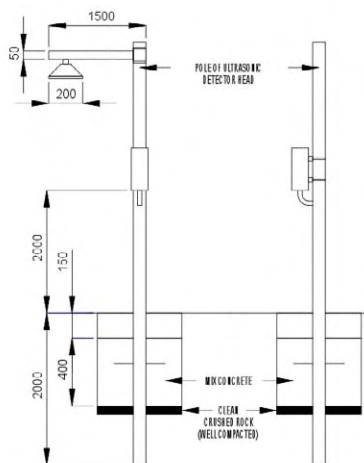

Figure 11.3-7 Standard Installation Plan for Detector and Cabinet

b)   Local Controllers, Signal Light and Cabling

Local controllers will be installed at all intersections and linked to the control center on an on-line basis.   Their functions are to control traffic signals in an appropriate manner and to transmit data obtained from nearby detectors.   Existing equipment related to the local controllers will be retained; this includes signal poles, lights, hand-holes, and underground conduits.   Figure 11.3-8 shows a standard installation plan for local controllers located near intersections.   The standard installation plan of signal lights for vehicles and pedestrians is shown in Figure 11.3-9.
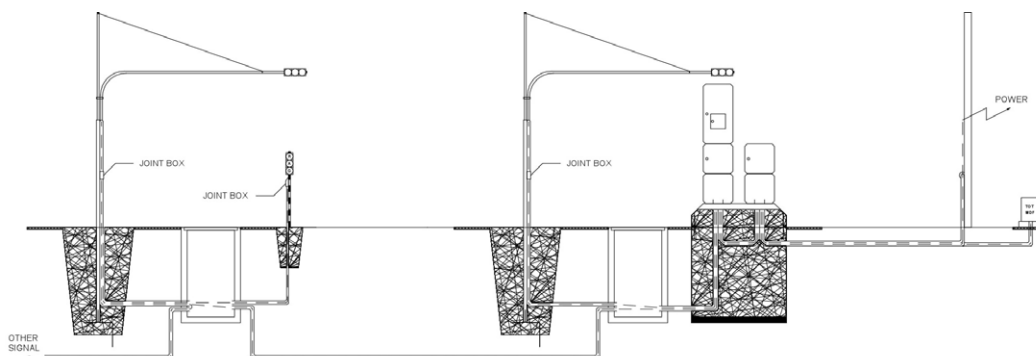

Figure 11.3-8 Standard Installation Plan for Local Controllers Located Near Intersections

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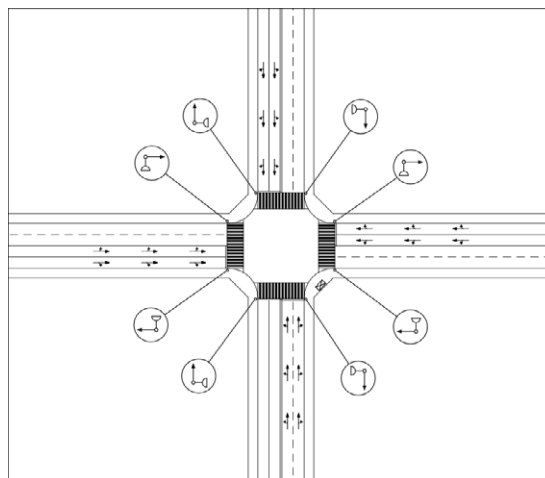Final Report

Figure 11.3-9 Standard Installation Plan of Signal Lights for Vehicles and Pedestrians

c) Central Processing Unit

The central processing unit is comprised of the host computer and front-end processor as follows: the host computer calculates signal control parameters based on data supplied by detectors and in accordance with established control methods.   It can communicate with operators via man-machine interfaces such as peripheral devices and map display, and the front-end processor processes raw data received from detectors via local controllers and sends the processed data to the host computer.   It also receives signal control parameters from the host computer, processes the data and sends them to the local controllers.

d) Accumulation of Traffic Data and Collection of Basic Data for Traffic Control Operation

The detected data for traffic control, such as traffic flow data, will be collected and processed by route, by areas and by time zones etc. as a database, which should be updated periodically.   The database will be utilized for the analysis and improvement of various traffic technologies as well as for setting the signal control parameters.

e) Control Center

The traffic control center will be established in the GTU building.   The traffic control center is composed of a control room and a computer room.

f) Organization

In order to maintain the above mentioned system in desirable condition, it is necessary for the organization for system operation and maintenance to be properly arranged.

With regard to operation, the appropriate operating organization should be established based on consideration of processing system area extension, grade up of system and coordinating to the other organizations.   The operating staff with sufficient technique and experience should be prepared.   The following main activities are necessary for operation:

- Signal planning and system area expansion.

- Traffic survey.

- Signal design.

- System operating and control.

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

In terms of maintenance, the maintenance organization should be established in order to support regular maintenance and prevention of problems related to system equipment. The following main activities are necessary for maintenance.

- Inspection.

- Trouble-shooting (Repair).

11.3.5. IMPROVEMENT OF INTERSECTIONS

(1) Technical Approach

The improvement of intersections will cover the intersections which, based on the analysis of the current situation, are considered to be bottlenecks, and will have traffic signal lights installed.   The traffic capacity of each intersection will be calculated.   At target intersections where the traffic volume is in excess of the calculated traffic capacity, the signal phases will be improved and/or the lane operation will be altered.   Traffic channeling measures will be introduced where it is deemed particularly necessary and where the shape of the intersection will change due to the lane operation of the approach.

(2) Improvement Measures by Intersection

1) Improvement Measures by Major Issues

Along with the introduction of a synchronized control system, it is necessary to improve intersections to enhance the beneficial effects of the system.   This section discusses traffic management facilities that should become necessary in conjunction with the installation of the signal control system.   A traffic channeling measure for the intersections will be prepared in order to achieve the smooth flow of traffic.   In addition, in accordance with the installation of traffic signals at the non-signalized intersection, a channeling measure is prepared in order to control traffic flow on major and minor approaches and to ensure the safety of pedestrians.   The improvement measures will be prepared on the basis of the following conditions:

- Improvement measures will be implemented by making maximum use of the existing road facilities with low cost;

- Improvement measure is particularly important to improve current capacity by introducing the traffic channeling measure;

- Intersection improvement works will be implemented without increasing the existing road width, and,

- The planned traffic will be used for the existing traffic volume.

These improvements are listed in. Salient points of the improvements are discussed below.

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

Table 11.3-5 Improvement Measures by Major Issues

Improvement Measures (Salient Points of Improvement)	Current major issues of traffic congestion			
	A	B	C	D
	Mitigating traffic congestion due to intersection blocking of heavy left-turn vehicles	Mitigating traffic congestion due to conflicts of buses near bus stop	Installation of planned traffic signal lights at non-signalized Intersection	Ensuring road safety of drivers and pedestrians
a. Improvement of pavement markings where lane operation to be altered	○	○	○	○
b. Addition of exclusive left-turn/right-turn lanes	○		○	
c. Installation of pedestrian crossings			○	○
d. Improvement of channelisng island			○	○
e. Improvement of median	○		○	
f. Improvement of corner cut			○	
g. Improvement of bus stop location		○	○	○
h. Enforcement of traffic regulations	○	○	○	○

a)   Improvement of Pavement Markings Where Lane Operation is to be Altered

Pavement markings such as directional arrows, stop lines, lanes, and center lines will be improved at intersections where the system of lane operation is to be altered.

b)   Addition Exclusive Left-Turn and Right-Turn Lanes

Exclusive left-turn/right-turn lanes will be installed at intersections with a high volume of left-turning traffic and right-turning traffic, in order to ensure the smooth flow of straight-through traffic and to process left-turning traffic and right-turning traffic more efficiently.   The plan for the addition of lanes should be designed based on the following items

- Exclusive left-turn lanes will be provided with left-turn pockets.

- Exclusive right-turn lanes will be provided with channelling islands.

- Left-turn pockets will be constructed either by cutting off the median and allotting the resulting space to the pocket or, where there is no median, by shifting the center line to the lane in the opposite direction.

c)   Installation of Pedestrian Crossings

In accordance with the installation of signal lights, pedestrian crossings will be provided at intersections.

d)   Improvement of Channeling Islands

Improvements with respect to the locations and shapes of channeling islands will be reviewed for intersections which have a high volume of right-turning traffic and which require more than the current number of exclusive right-turn lanes.

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

e) Improvement of Median

In accordance with the installation of exclusive left-turn lane (left-turn pocket) and U-turn space, medians that are U-turn traffic or left-turning traffic pass through will be cut away.

f) Improvement of Corner Cut

The corner cut will be reviewed as necessary for installation of signal lights at non-signalized intersection, and at intersections where channeling islands are provided.

g) Improvement of Bus Stop Location

In order to mitigate traffic congestion due to the conflicts near bus stop, at the exit of intersection, the bus stop will be provided by introducing the segregation of a bus bay.

h) Enforcement of Traffic Regulation

In order to promote the use of improvement measures, such as road marking and designated location of bus stops, it is important that drivers and pedestrians obey traffic regulations, and it is necessary to impose a strong fine on traffic offenders who break traffic regulations.

2) Improvement Measures by Intersection

Of the 30 intersections subject to control by the synchronized control system, 29 intersections require one or more of the improvements described above. The improvements required at each intersection are listed in Table 11.3-6.

Table 11.3-6 Improvement Measures by Intersection

Road	Intersection		Improvement Measures							
	No.	Name	a	b	c	d	e	f	g	h
Av. Aviación	1	Av. Grau								O
	2	Av. 28 de Julio	O	O	O		O	O	O	O
	3	Av. Bauzate y Meza	O	O	O		O		O	O
	4	Av. Isabel la Católica	O	O	O		O		O	O
	5	Av. Mexico	O	O	O	O	O		O	O
	6	Ovalo Arriola			O				O	O
	7	Av El Aire	O	O	O		O	O	O	O
	8	Av. Canada							O	O
	9	Av. Javier Prado							O	O
	10	Av. Las Artes							O	O
	11	Av. San Borja Norte							O	O
	12	Ca. Lopez de Ayala	O	O	O				O	O
	13	Av. Fray Luis de Leon							O	O
	14	Av. San Borja Sur							O	O
	15	Ca. Gozzoli	O	O	O				O	O
	16	Jr. Albeniz							O	O
	17	Jr. Vesalio	O	O					O	O
	18	Jr. Ordonez	O	O			O		O	O
	19	Av. Paul Linder							O	O
	20	Ca. Omega	O	O			O		O	O
	21	Av. Angamos	O	O			O		O	O
	22	Av. Villarán	O	O			O		O	O
	23	Av. Valle de Sur	O	O			O		O	O
	24	Ca. Alicante-Jr. Valcarcel							O	O
	25	Ovalo Los Cabitos			O				O	O
Av. Tomas Marsano	26	Av. Ayacucho							O	O
	27	Av. Surco	O	O			O		O	O
	28	Av. Jorge Chavez							O	O

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

Road	Intersection		Improvement Measures							
	No.	Name	a	b	c	d	e	f	g	h
	29	Av. El Sol							○	○
	30	Av. Caminos del Inca	○	○		○			○	○

Salient points of improvement for the subject intersections are generally divided into three (3) types e.g. a) improvement of pavement markings where lane operation to be altered, b) additional exclusive left-turn lane and c) improvement of bus stop location.   In terms of these salient points, the standard layout is shown in Figure 11.3-10 (1)-(3).
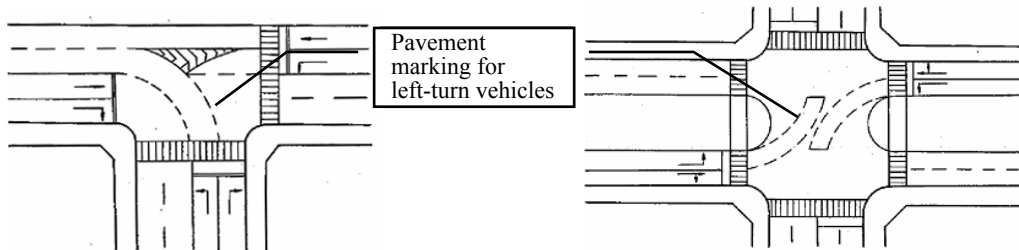

Figure 11.3-10 (1) Standard Layout for Pavement Marking Where Lane Operation to be Altered
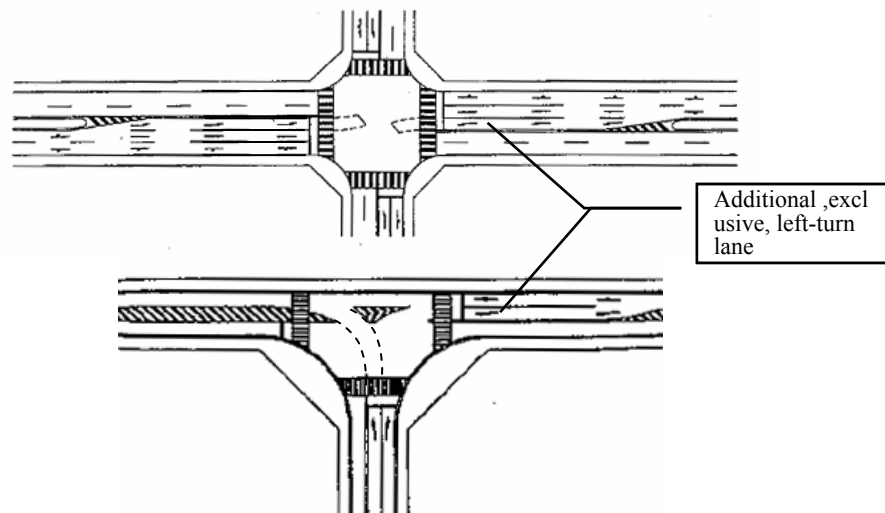

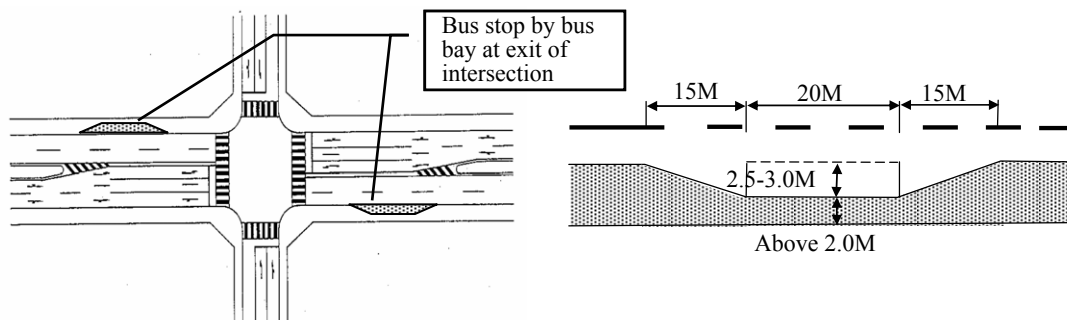Figure 11.3-10 (2) Standard Layout for Additional, Exclusive, Left-turn Lane

Figure 11.3-10 (3) Standard Layout for Improvement of Bus Stop Location

Based on the above-mentioned, the improvement measures by intersection, a sample of plans for intersection improvement is shown below:

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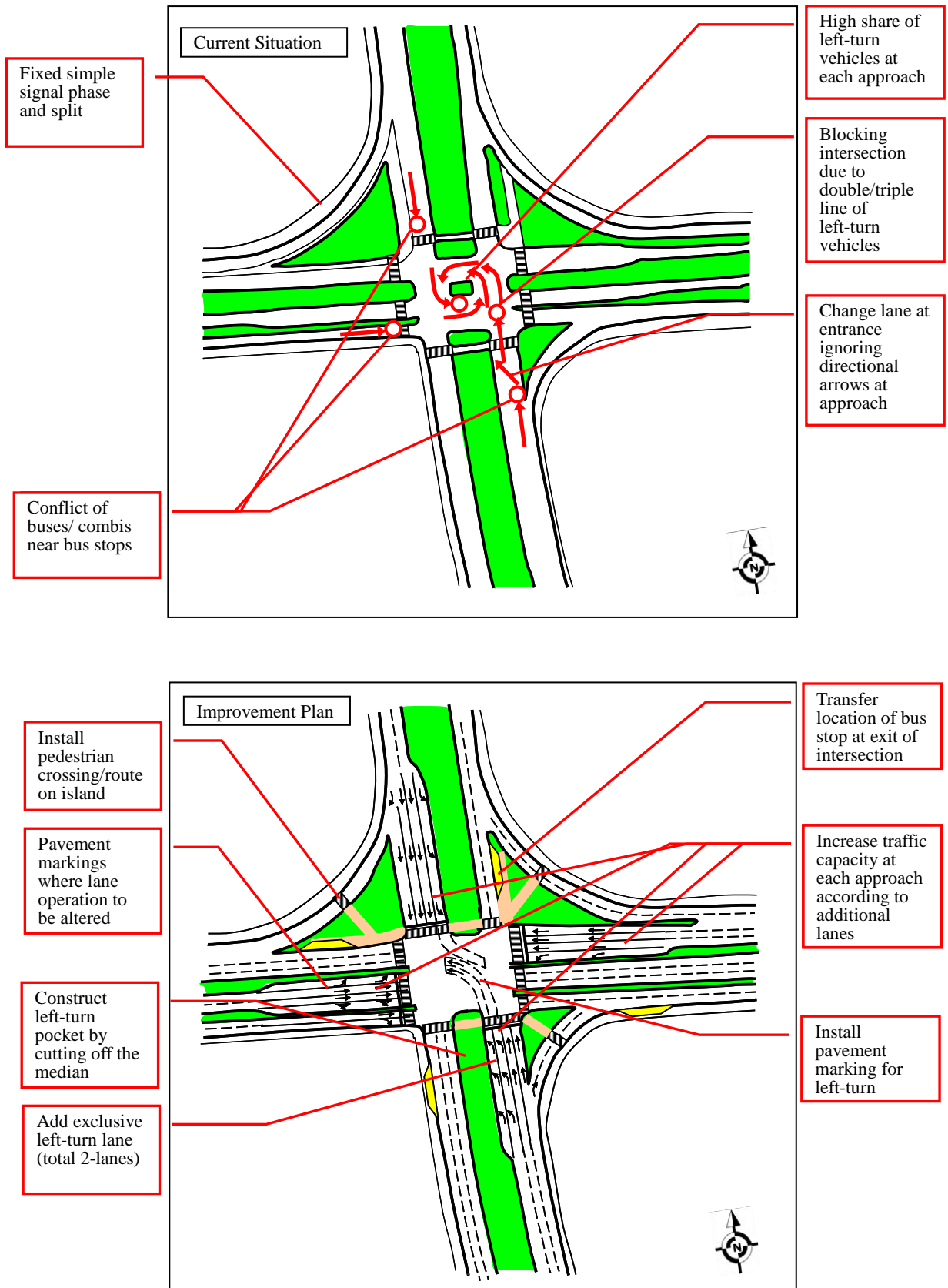the Lima and Callao Metropolitan Area in the Republic of Peru
Final Report

Av. Aviación-Av. Angamos Intersection

Figure 11.3-11 A Sample of Plan for Intersection Improvement

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

11.3.6. ADMINISTRATIVE ORGANIZATION

(1) Traffic Signal Control Plan

As pointed out in the traffic signal control plan, current signal control system shall be improved based on the proposed signal phase and synchronized control system, in addition, the inspection and maintenance will be implemented.   These tasks will be managed by the Gerencia de Transporte Urbano (GTU) of Lima Municipality.   The maintenance management requires a set number of technicians who have the expertise to deal with each system devoices.   A contractor with thorough knowledge of the system and its equipment in general will be entrusted with and be responsible for the maintenance work.   The administrative organization is recommended in Figure 11.3-12.
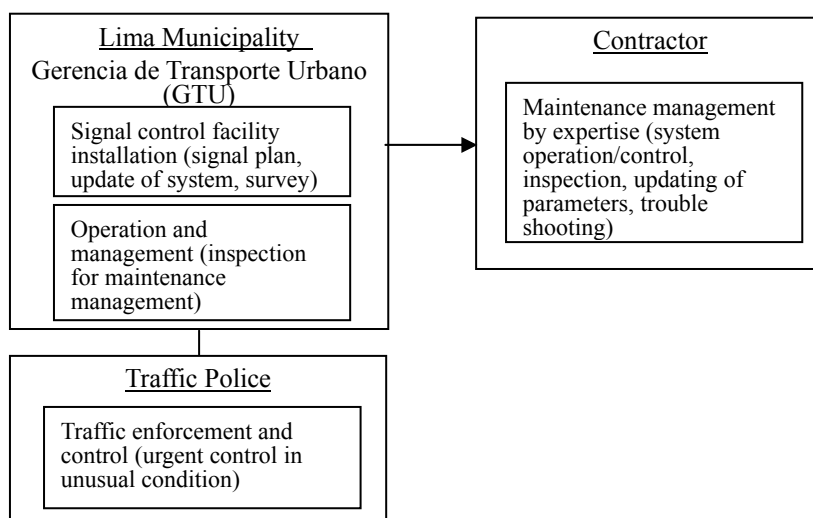

Figure 11.3-12 Administrative Organization for Traffic Signal Control Plan

(2) Improvement of Intersection

Along the lines of the signal control plan, the intersection shall be improved.   These tasks will be managed by the Gerencia de Transporte Urbano (GTU) of Lima Municipality, and Municiplida des Districtales in administrative regions.

11.3.7. IMPLEMENTATION PLAN

Based on the project description, the implementation schedule for the signal control system and intersection improvement project is proposed in Figure 11.3-13. The project is scheduled to start in second quarter of 2007 and be completed by third quarter of 2008. The tasks of final design, tender document and bidding will be completed during six months, the construction of facility work is expected to implement from first quarter of 2008, and be completed by third quarter of 2008.   The operation and maintenance management by contractor may start in fourth quarter of 2008.

Task Name	2007				2008			
	1-3	4-6	7-9	10-12	1-3	4-6	7-9	10-12
1. Final design and tender document		■	■					
2. Bidding				■				
3. Facility work					■	■	■	
4. Operation								● ● ● ●
5. Maintenance management by contractor								● ● ● ●

Figure 11.3-13 Implementation Schedule for Intersection Improvement Project

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

11.3.8. COST ESTIMATION

The project cost for the intersection improvement plan consists of 1) signal control facility and 2) improvement of intersection, based on the contract package during 2 years.　The project cost by items is shown in Table 11.3-7.　The maintenance cost for signal control facility during 1 year is shown in Table 11.3-8.

Table 11.3-7 Project Cost for Intersection Improvement Project

Investment Items	Project Cost (x 1,000 USD)
1. Signal control facility	3,109
1-1 Local facility at key intersections *1)	566
a) A Type: 3-leg intersection (1 intersection)	79
b) B Type: 4-leg intersection(4 intersections)	369
c) C Type: 5-leg intersection (0)	0
d) D Type: 6-leg intersection (1 intersection)	118
1-2 Local facility at ordinary intersections *2)	1,507
a) A Type: 3-leg intersection (6 intersections)	346
b) B Type: 4-leg intersection (17 intersections)	1,090
c) C Type: 5-leg intersection (1 intersection)	71
d) D Type: 6-leg intersection (0)	0
1-3 Central unit in control center and software	1,036
2. Improvement of intersection *3)	391
a) A Type: 3-leg intersection (7 intersections)	60
b) B Type: 4-leg intersection(21 intersections)	292
c) C Type: 5-leg intersection (1 intersection)	18
d) D Type: 6-leg intersection (1 intersection)	21
Total	3,500
Engineering Cost (Totalx10%)	350
Administration Cost (Totalx10%)	350
Contingencies Cost (Totalx15%)	525
Grand total	4,725

Notes: *1) The cost items include as signal controller/lamps for vehicles (LED)/lamps for pedestrians (LED)/poles of signal lights for both vehicle and pedestrian/cable of lamps/detectors/poles for detectors/Construction. *2) The cost items include as signal controller/ lamps for vehicles (LED)/lamps for pedestrians (LED)/poles of signal lights for both vehicle and pedestrian/cable of lamps/Construction. *3) The cost items include as pavement marking as pedestrian crossing/stop line, arrow, lane/earth work for exclusive left-turn pocket/pavement asphalt/base course/sub-base course for left-turn pocket/earth work for island/earth work for corner cut/pavement asphalt/base course/sub-base course for bus bay/earth work for bus bay.

Table 11.3-8 Maintenance Cost for Signal Control Facility

Maintenance Items	Cost (x 1,000 USD)
1. Maintenance cost during one year and supervision during one month	200

Notes: The maintenance cost for signal control facility during 1 year