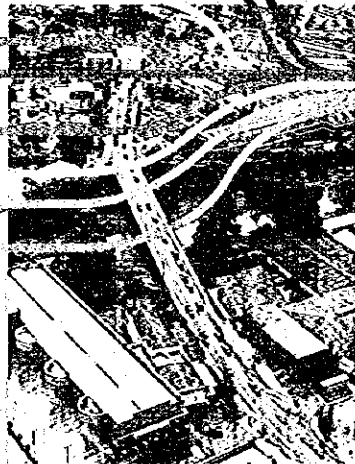社会開発調査部報告書

Japan International Cooperation Agency (JICA)

No. 22

Tegucigalpa Municipality of The Central District
The Republic of Honduras

THE TEGUCIGALPA URBAN TRANSPORT STUDY

FINAL REPORT
SUMMARY
VOLUME 1

NOVEMBER 1996

ORIENTAL CONSULTANTS COMPANY LIMITED
CENTRAL CONSULTANT INCORPORATED

SSF

JR

96-127 (1/4)

apan International Cooperation Agency (JICA)

egucigalpa Municipality of The Central District
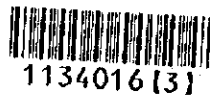he Republic of Honduras

THE TEGUCIGALPA
URBAN TRANSPORT STUDY

FINAL REPORT
SUMMARY
VOLUME 1

NOVEMBER 1996

ORIENTAL CONSULTANTS COMPANY LIMITED
CENTRAL CONSULTANT INCORPORATED

The following foreign exchange rate is applied in the study:

US$ 1.00 = 11.70 Lempira (as of July 1996)

PREFACE

In response to a request from the Government of the Republic of Honduras, the Government of Japan decided to conduct The Tegucigalpa Urban Transport Study and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Honduras a study team headed by Mr. Kazuro Yanagida, Oriental Consultants Co., Ltd., and composed of members from Oriental Consultants Co., Ltd. and Central Consultant Incorporated 3times between June 1995 to September 1996.

The team held discussions with the officials concerned of the Government of Honduras, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

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

November, 1996

Kimio Fujita
President
Japan International Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Kimio Fujita,
President
Japan International Cooperation Agency
Tokyo, Japan

We are pleased to submit to you the study report on the Tegucigalpa Urban Transport Study.

This study was conducted by Oriental Consultants Co., Ltd., in association with Central Consultant Co., Ltd., under a contract to JICA, during the period of May 1995 to November 1996. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Honduras and formulated the transportation master plan in Tegucigalpa.

We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, Metroplan. We would also like to express our gratitude to the officials concerned of the Tegucigalpa Urban Transport Study, the JICA Honduran Office and the Embassy of Japan in Honduras for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,
November 1996

Kazuro YANAGIDA
Project Manager,
Study Team on the Tegucigalpa Urban
Transport Study

PROJECT SUMMARY

1. COUNTRY	The Republic of Honduras.
2. NAME OF STUDY	The Tegucigalpa Urban Transport Study.
3. COUNTERPART AGENCY	Tegucigalpa Municipality
4. OBJECTIVE OF STUDY	Formulate a Transportation Master Plan up to the year 2010

1. STUDY AREA : The Tegucigalpa Metropolitan Region (12,000ha)

2. THE MASTER PLAN SUMMARY

① Selection of Urgent Projects

5 urgent projects was selected installation of traffic signal and improvement of intersection, since "Term is very short", Cost is low" and "Effect is large".

② Formulation of Transportation Master Plan

Master plan was formulated based on following concepts:
- Formulation of the city as a capital city
- Proper reallocation of commercial and business facilities
- Creation of a comfortable life environment for cities
- Formulation of a center of history, culture and education

Formulated transportation master plan is mainly road transportation and was composed of new road construction and improvement of existing road and public transportation system.

3. IMPLEMENTATION PROGRAM

24 master plan projects to be implemented are selected based on transportation master plan. The implement period of these projects were categorized into three groups, short term, mid term and long term, based on urgency, construction cost, easiness of fund procurement and benefit.

Short Term (1997-2000)   : Strength of north-south transportation axis and east-west transportation axis. (4 Projects, US$13,141,000)

Mid Team (2001-2005)   : Introduction of bus exclusive way, bus exclusive lanes and bus terminals and improvement of related road projects. (12 Projects, US$21,698,000)

Long Team (2006-2010)   : Strength of radial roads connecting Anillo Periferico. (8 Projects, US$39,639,000)

4. ECONOMIC EVALUATION

Below table shows the results of economic evaluation for proposed master plan projects. All the projects are evaluated to be feasible judging.

PROJECT	EIRR(%)	NPV(1000Lps)	B/C	PROJECT	EIRR(%)	NPV(1000Lps)	B/C
Project 6-1	16.24	1,160,000	1.33	Project 11-2	22.71	4,330,000	1.98
Project 6-2	13.61	811,000	1.12	Project 12	27.70	5,670,000	2.61
Project 7	46.95	10,900,000	6.42	Project 13	46.05	10,900,000	5.67
Project 8	36.38	8,160,000	4.03	Project 14	31.20	5,610,000	3.01
Project 9	46.25	15,000,000	6.18	Project 15	24.91	8,050,000	2.21
Project 10	19.72	4,430,000	1.66	Project 16	16.80	1,710,000	1.37
Project 11-1	26.35	4,420,000	2.43				

5. RECOMMENDATION

(1) To realize of master plan.
(2) To continue of Road Maintenance Work.
(3) To make use of review data obtains during at study.
(4) To conduct the further study.

OUTLINE OF THE STUDY

The Republic of Honduras, The Tegucigalpa Urban Transport Study
- Study Period   : May, 1995 - November, 1996
- Counterpart Agency : Tegucigalpa Municipality

1. Background

Although the roads in the central area of the city are very narrow and interlaced due to the city structure dating from the colonial era, many vehicles gather and / or pass through it, and the ring and radial road networks in this study area do not sufficiently meet traffic demand. In addition, the public transport systems such as buses and taxis are also somewhat insufficient. As a result, traffic congestion occurs everywhere in the city, creating traffic problems. The sound development of regional economy is also hampered.

The Government of the Republic of Honduras (GRH) needs realistic plans to improve transportation problems. In support of this, GRH has requested the government of Japan for technical assistance in formulation of a master plan, investment program for the transportation network.

2. Objective

The objective of the Study is mainly to formulate a Master Plan up to the year 2010 for the transportation network.

3. Study Area

The study area with the area of approximately 12,000 ha is the Tegucigalpa Metropolitan region.

4. Traffic Survey

The following traffic survey was conducted in order to obtain many basic data.
- Main Survey (Person Trip Survey, Cordon Line Survey, Screen Line Survey, Traffic Speed Survey)
- Supplementary Survey (Traffic Count Survey, Public Transport Survey, Parking Survey, etc.)

5. Urgent Projects

The urgent projects were selected from the measures related to the installment of traffic signals and the improvement of the configuration at congested intersections, since "Term" is very short, "Cost" is low and "Effect" is large. The places requiring an urgent project were selected 5 places as shown in Table 1 based on the intersection traffic analysis.

6. Outline of the Master Plan

6.1 Basic Concept

The Master Plan for the study area was formulated the following concepts;
(1) Formulation of the city as a capital city
(2) Proper reallocation of commercial and business facilities
(3) Creation of a comfortable life environment for citizens
(4) Formulation of a center of history, culture and education

6.2 Socioeconomic Framework, Land Use Plan and Future Urban Structure

1) Socioeconomic Framework

The future socioeconomic framework of the study area was projected under the control total of the future population projection of the entire Honduras projected by SECPLAN. As a result, the

number of the future population in the study area was forecast to increase by about 1.3 times from 674,920 persons in 1995 to 872,083 persons in 2010.

2) Future Land Use and Future Urban Structure

Future land use was determined by the future allocation of population and workers, considering the direction of urban development and the extension of the housing area in the inhabitable land, and the urban structure. On the other hand, the future urban structure was determined based on "Linear and Multiple Nuclei Pattern" together with the future land use, the location of urban facilities and the distribution of future population and workers, the future trunk transportation network.

6.3 Formulation of Master Plan

1) Formulation of Master Plan

The future socioeconomic framework and urban structure was determined in line with the basic concept for the master plan, and the traffic demand was estimated based on above results. The master plan was formulated based on traffic demand.

2) Selection of the Master Plan Projects

Various projects were planed based on transport policy and future traffic demand. These planned projects were divided into the following three categories from the critical impacts on the traffic situation;

(1) To introduce regulations prohibiting vehicle inflow into "Centro" (Regulation)

(2) To construct a toll road connecting "Centro" with Anillo Periferico using the river basin of the Cholteca River (Toll Road)

(3) To implement other projects, in consideration of the realization of the liner multi-nuclei urban structural pattern (Other Projects)

The four alternatives were selected based on the combination of above three categories. From the results of examination on aspects of possibility and economy, 24 desirable master plan projects were adopted. Master plan projects were categorized into three groups below based on considering their urgency, construction cost, easiness of fund procurement, benefit, etc. as shown in Table-1.

(1) Short Term : Project packages to strengthen the north-south transportation axis and the east-west transportation axis

(2) Mid Term : Project packages which introduce bus exclusive ways, bus exclusive lanes, bus terminals and improvement of related road project.

(3) Long Term : Projects to strengthen the radial roads connecting Anillo Periferico

6.4 Public Transportation Plan

The restructure plan of bus route system including hierarchic structure of bus (Key Route, Ordinary Route, Inter-Urban Route) and the detailed bus route network plan including the suitable fear system is proposed to examine to decrease traffic congestion by related organizations.

6.5 Traffic Management Plan

Based on the existing traffic conditions and anticipated problems in the future, the traffic management plan was examined as follows;

(1) While general information signs are not locking, many more regulatory and directional signs are recommended to be installed not only on major roads but also smaller roads with high traffic.

(2) In "Centro", it is necessary not only to strengthen regulations against illegal parking but also

Table 1 Estimated Project Costs and Implematation Program

Term	Category	Prj. No.	Project Description	Project Length(m)	Total Cost (US$1,000)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Urgent	Improvement of Intersection	1	Configuration Improvement and Traffic Signal Installation at Intersection of Subida al Estadio Nacional and the Circular Road of the National Stadium	-	28	28													
		2	Configuration Improvement at Intersection of Av. Cabanas and Blvd. Santa Fe	-	10	10													
		3	Configuration Improvement at Intersection in Front of Instituto Hondureno de Seguridad Social on Blvd. Comunidad Europea	-	318	223	95												
		4	Traffic Signal Installation at Intersection of Blvd. Jose Cecilio del Valle and Calle Gollan	-	44	44													
		5	Approach Road Construction at Grade Separation of Blvd. Miraflores and Blvd. Fuerza Armada	-	165	116	50												
Short-term	Improvement & Construction of Roads	7	Road Improvement of Estadio Nacional - Blvd Morazan up to the Intersection of Juan Manuel Galvez	600	2,662	2,662													
		8	Road Improvement of Calle Nickson - Calle 12 of the Central Area of Comayaguela - a new Bridge in the South of Puente de Juan Ramon Malino up to Blvd. Jose Cecilio de Valle	2,520	3,248	650	1,624	974											
		9	Road Improvement of Calle Isla - Jose Cecilio del Valle	2,100	3,500		1050	1,400	1,050										
	Bridge Const.	(8)	Bridge to calle 12	-	incl. 8														
		11-1	Bridge to Av. 6	1,000	3,731		1,119	1,492	1,119										
Mid term	Improvement of Roads	6-2	Inner Ring Road Construction Surrounding the Central Area of Tegucigalpa (South Section)	1,390	9,520					4,760	2,856	1,904							
		11-2	Road Improvement of the Southern Section of Av. 6 - New Bridge - San Jose - Lomas de Toncontin	4,740	5,346						1,604	2,138	1,604						
		12	Road Improvement of Av. 8 in the Center of Comayaguela	1,860	4,245							1,274	1,696	1,274					
	Construction of Bus Terminals	21	Santa Fe	-	198					198									
		22	21 de Octubre	-	198					198									
		23	Miraflores	-	198					198									
		24	Aeropuerto	-	198					198									
		25	Las Brisas	-	436					436									
		26	Estadio	-	1,220					1,220									
	Bus Transportation	18	Introduction of Bus Exclusive Lanes	-	-														
		19	Introduction of Bus Exclusive Ways	-	-														
	Community Road	20	Introduction of Transit Mall	530	139					139									
Long-term	Improvement & Construction of Roads	6-1	Inner Ring Road (North Section)	2,230	4,226										1,690	1,690	845		
		10	Road Improvement of Blvd. Juan Manuel Galvez	1,790	8,146											3,258	3,258	1,629	
		13	Road Improvement of Anillo Periferico - Colonia La Fuente - Blvd. Fuerza Armadas	1,860	2,669											1,808	801		
		14	Road Construction and Improvement of Colonia San Jose de la Vega - La Canada - Anillo Periferico	2,380	3,150												1,260	1,890	
		15	Road Construction of Colonia Kennedy - Residential Plaza - Anillo Periferico	2,300	7,635													2,291	5,345
		16	Improvement of Anillo Periferico - Colonia Loma de Jaleapa - Carretera a Oriente	3,115	5,243													3,146	2,097
	Parking Bldg.	27	Construction of Parking Building outside the CBD Area near Puente la Hoya	-	790														
	Truck Terminal	28	Construction of Truck Terminal in Laguna el Pedregal	-	7,780														
			Annual cost			3,723	3,904	3,909	2,169	4,760	4,460	5,356	3,902	1,274	1,690	6,817	6,164	8,956	7,442

to provide public parking lots with sufficient capacity.

7. Cost Estimation and Implementation Program

The project cost is estimated based on the results of preliminary design, the consideration of construction method, operation and maintenance. On the other hand, implementation program of selected project is prepared based on each objective of the term and engineering maters. As a result, estimated cost and implementation program are summarized as shown in Table 1.

8. Economic Evaluation

All the projects are evaluated to be feasible judging from the calculation of evaluation indicators as shown in Table 2. Project 6-2 cannot be judged to be feasible against the increase of the cost by sensitivity analysis.

Table 2   Result of Evaluation

PROJECT	EIRR(%)	NPV(1000Lps)	B/C	PROJECT	EIRR(%)	NPV(1000Lps)	B/C
Project 6-1	16.24	1,160,000	1.33	Project 11-2	22.71	4,330,000	1.98
Project 6-2	13.61	811,000	1.12	Project 12	27.70	5,670,000	2.61
Project 7	46.95	10,900,000	5.42	Project 13	46.05	10,900,000	5.67
Project 8	36.38	8,160,000	4.03	Project 14	31.20	5,610,000	3.04
Project 9	46.25	15,000,000	6.18	Project 15	24.91	8,050,000	2.21
Project 10	19.72	4,430,000	1.66	Project 16	16.80	1,710,000	1.37
Project 11-1	26.35	4,420,000	2.43				

9. Fund Source

Following new funds should be sought for the execution of the Master Plan.
- City Planning Tax
- Development Tax
- Automobile Fuel Surcharge Tax
- Automobile Tonnage Tax

10. Initial Environmental Examination

The environmental impacts are predicted as follows;
(1) Relief from traffic congestion (Positive Impact)
(2) Relocation of inhabitants, public facilities and cultural inheritances (Negative Impact)
(3) Fauna and Flora (Negative Impact)
(4) Air pollution and noise (Negative Impact)

11. Recommendation

The following points are concluded and recommended;
(1) Realization of master plan
- Implementation of urgent projects
- To construct two new bridges during the short term
- To continually implement the projects recommended in the master plan
- To reform the organization
- To make haste to complete the outer ring road
- To restructure the bus route network system
- To secure the financial sources for the projects
(2) To continue road maintenance work
(3) To make use of various data obtained during the study
(4) To conduct further study

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 10

CHAPTER 11

CHAPTER 16

CHAPTER 17

LIST OF TABLES

CHAPTER 1 INTRODUCTION

1.1 Background

The study area, composed of the Tegucigalpa and Comayagüela districts, is located in a basin formed by mountains. Originally settled near the site of colonial mines, the study area, designated the capital in 1880, is now the center for national government, education, national finance and insurance, regional construction, services, and retail and wholesale trade. Although the roads in the central area of the city are very narrow and interlaced due to the city structure dating from the colonial era, many vehicles are gathering and/or pass through it, and the ring and radial road networks in this study area do not sufficiently meet traffic demand. In addition, the public transportation systems such as buses and taxis are also somewhat insufficient. As a result, traffic congestion occurs everywhere in the city, creating traffic problems. The sound development of regional economy is also hampered.

The Government of the Republic of Honduras (GRH) has established some plans for improvement of transport in the past, but the majority have not been accomplished due to lack of budget and staff with expertise. Therefore, the GRH needs realistic plans to improve transportation problems.

In support of this, GRH has requested the government of Japan for technical assistance in formulation of a master plan, investment plan and implementation program for the transportation network.

1.2 Objectives

In order to improve the anticipated transportation problems occurring not only at present but also in the future, the objectives of this study were set as follows;

(1) Collection and analysis of data on the existing transport sector and road conditions by conducting field survey;
(2) Review and evaluation of on-going and/or proposed projects and programs, and, if necessary, preparation of a recommendation of a program to be urgently implemented.
(3) Formulation of a Master Plan up to the year 2010 for the transportation network.
(4) Technology transfer to the Honduran counterparts during the Study.

1.3 Study Area

The study area with the area of approximately 12,000 ha and a population of 670,000 inhabitants is the capital city of the Republic of Honduras, located in mountainous terrain 900 m above sea level. The study area is the administrative, political, academic and economic center of the nation. Fig. 1.1 shows the map of the study area.

The study area is divided into three parts by the Choluteca River and the Chiquito River, that is, the central area of Tegucigalpa (so called "Centro"), Comayagüela, and other areas of Tegucigalpa outside the Centro.
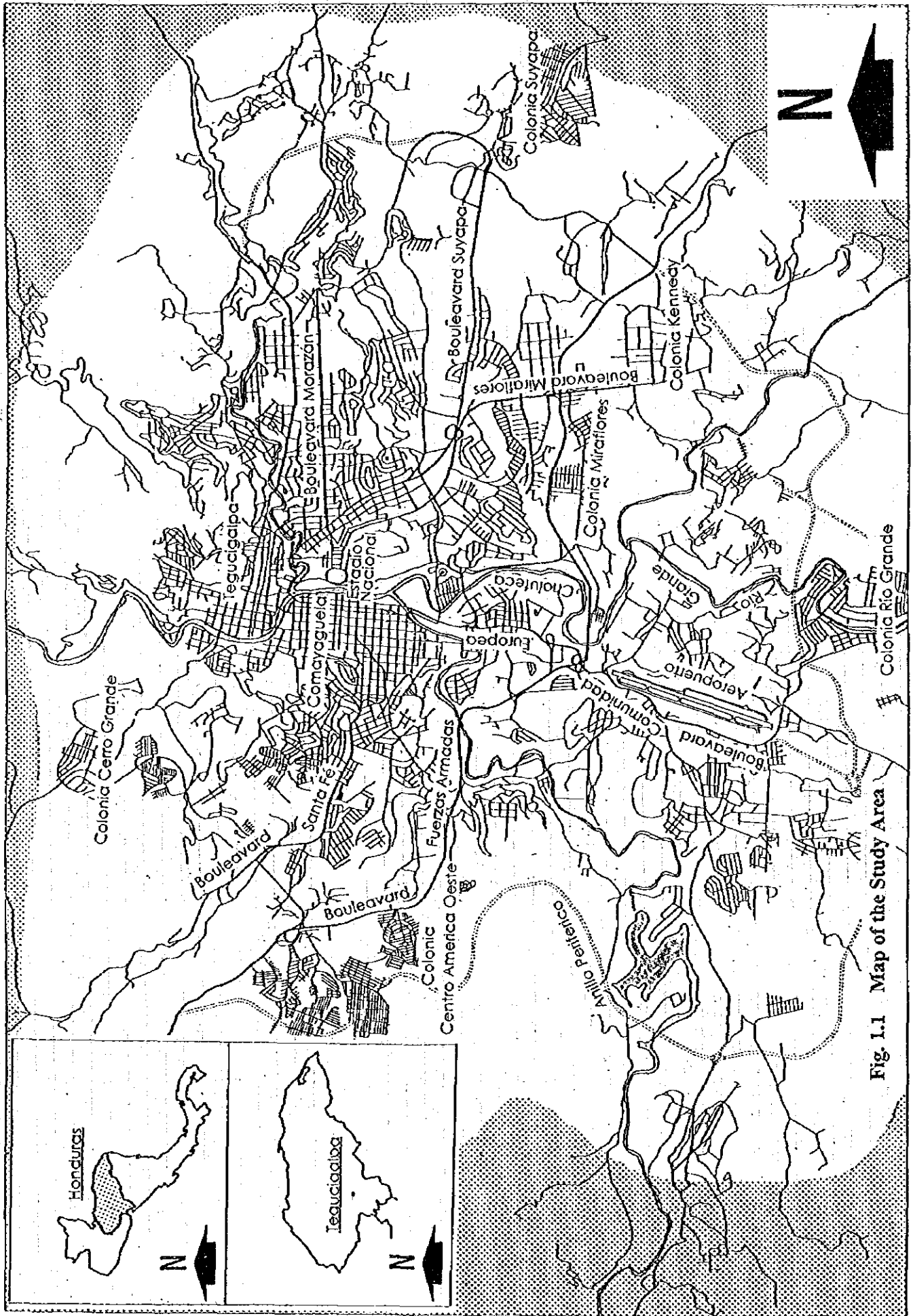
Fig. 1.1 Map of the Study Area

1.4   Study Procedure

The study is composed of three stages. A general flow chart of the study is shown in Fig. 1.2. And a general flow chart of the report is shown in Fig. 1.3.

(1) First Stage   : The review, analysis and evaluation of the existing transportation conditions is conducted.
(2) Second Stage : A transportation master plan is formulated.
(3) Third Stage   : An investment plan is prepared.
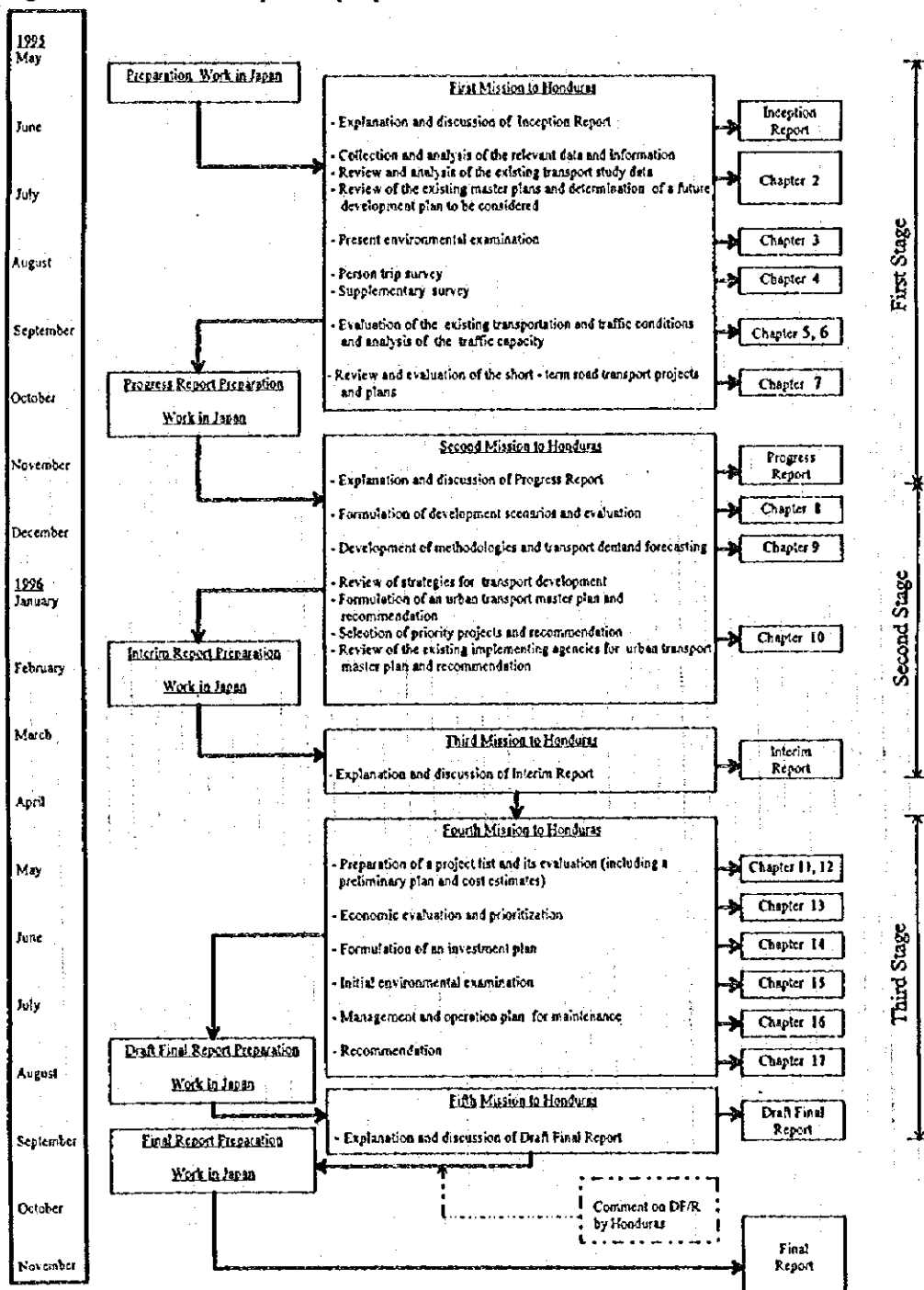
Fig. 1.2   Study Flow
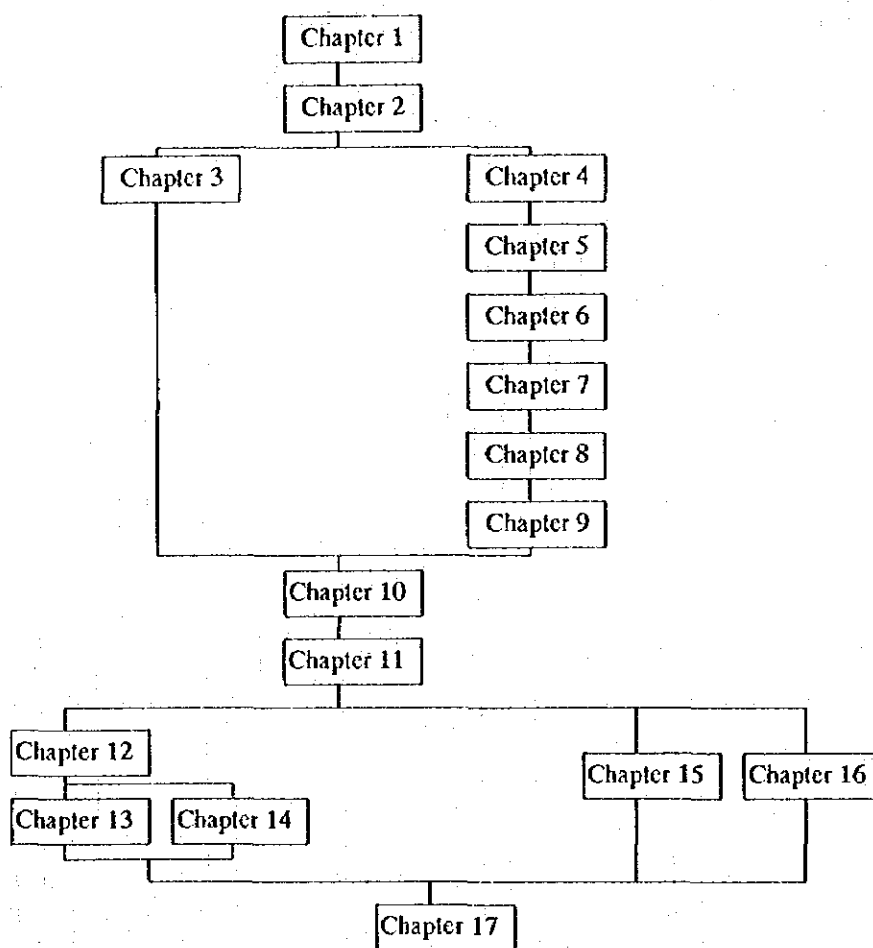
Fig. 1.3   General Flow Chart of Report

1.5   Study Organization

The member of the Honduras counterpart, steering committee, JICA Study Team, advisory committee and JICA staff are as shown below.

(1) Members of Counterpart Team (METROPLAN)

Mr. Norman Zuniga Rorjas	Chief of Counterpart Team
Mr. Lisandro Calderon	Member of Counterpart Team
Mr. Henry Banegas	Member of Counterpart Team
Ms. Delfina Maria Solorzano	Member of Counterpart Team
Mr. Felipe Mejia Cruz	Member of Counterpart Team
Ms. Katya Maria Aguilera	Member of Counterpart Team
Mr. Ovidio Andrade	Member of Counterpart Team
Mr. Carlo Balleta	Member of Counterpart Team

(2) Members of Steering Committee

Mr. Oscar R. Acosta Zepeda	Alcalde Municipal del Distrito Central

Mr. Alejandro Ulloa de Thuin	Asesor del Alcalde
Mr. Roberto Abadie Abarca	Comandante General de Bomberos
Mr. Virgilio Ordenez	HONDUTEL
Mr. Obdulo Garrido	Gerente de Infraestuctura / A.M.D.C
Mr. Hector Suazo	Direccion Nacional de Transito
Mr. Miguel Angel Valladares	Direccion General de Transporte, SECOPT
Mr. Jesus Valle	SECOPT
Mr. Issac Vilorio B.	Departamento de Señalizacion Vial, SECOPT
Mr. Roy Alonzo	SECPLAN
Ms. Zolia Estela Dominguez	SEDA
Mr. Mauro Mejia	Ministerio de Educacion Publica
Mr. Norman Zuniga Borjas	Gerente de METROPLAN / A.M.D.C.

(3) Member of JICA Study Team

Mr. Kazuro Yanagida	Project Manager
Mr. Takao Yamane	Deputy Project Manager / Traffic Planner
Mr. Takao Inami	Highway Engineer
Mr. Malcom MacNair	Regional Planner
Dr. Shouichi Haryu	Environment Specialist
Mr. Akio Tatsuno	Public Transportation Planner
Mr. Keiichi Ichikawa	Traffic Operation Planner
Mr. Shigeru Okutsu	Traffic Surveyor
Mr. Nobuhiro Kuboya	Structure Engineer
Mr. Hiroyuki Kotani	Economic Analyst
Mr. Hitoshi Okita	Project Coordinator

(4) Member of the JICA Advisory Committee

Dr. Mitsuyuki Asano	Head of Committee / Urban Planner
Mr. Jyun Nakamura	Road Planner
Mr. Akihiko Nagano	Public Transport Planner

CHAPTER 2   PRESENT CONDITIONS

2.1   Socioeconomic Conditions

1) Natural Conditions
The Tegucigalpa metropolitan area is located in the southern region of Honduras in mountainous terrain, about 1000 m above sea level. The climate is divided into two seasons: the rainy and dry seasons. Generally, the rainy season is from May to October and dry season is from November to April.

2) Population
The total population of Honduras was about 5,600 thousand as to 1995. The population within the study area was estimated at about 67.5 thousand in 1995. The average population growth rate in past 20 years has been more almost 5 %.

3) Economy
The per capita GNP of Honduras was 580 dollars in 1994. Among the Central American countries Honduras is placed second from last, followed only by Nicaragua.

4) Budget of the Municipality of Tegucigalpa
The Tegucigalpa municipal budget in 1995 totaled Lps. 133,364,000. The public works budget for construction and improvement was Lps. 18,747,000; about 14.1 % of the total budget.

5) Number of Registered Vehicles
The number of registered vehicles in the entire nation was about 180,000 in 1994. The number of registered vehicles in the study area is 63,140 vehicles, which accounts for 34.8 % of total number of vehicles in the entire Honduras.

2.2   Road Inventory

1) Road Network
The total length of roads in Honduras was about 14.2 thousand km in 1992, and are divided into three classes; the principal roads (3.1 thousand km), the secondary roads (2.5 thousand km) and the feeder roads (8.6 thousand km).The road network in Tegucigalpa metropolitan area is generally very narrow and steep gradient sections are found in several places.

2) Traffic Accident
The number of the traffic accidents is increasing year by year. In 1994 the total number of the accidents in all of Honduras reached about 12,000. In the study area the number of the traffic accidents was about 3,000, which accounts for one fourth of the total.

3) Traffic Control Facilities
The main traffic control facilities consist mainly of traffic signals and traffic signs. In the study area traffic signals are very few in number.

4) Design Standard
The road design standards in Honduras follow the Central American Standard. But when necessary, American standard (AASHTO) is adopted.

CHAPTER 3   PRESENT ENVIRONMENTAL CONDITIONS

3.1   Present Environmental Survey

To investigate the present environmental conditions, a local consultant was entrusted for 1) collection of statistical data of environment and 2) interview of 1,000 inhabitants concerning environmental issues.

3.2   Policy of Environmental Protection

The Honduran government has already established protection laws regulating the use of environmental pollutants, an environmental assessment system, and proposed a number of environmental protection projects. The Honduran Anthropology and History Institute is making appeals to the government and nation for the protection of cultural inheritances in Honduras. However, compensation projects are not yet firmly established at present.

3.3   Present Environmental Conditions

Natural Environment
- Tegucigalpa is situated in a mountainous basin, 900m above sea level. Basic formations around Tegucigalpa are shale (Mesozoic sedimentary rock) and tuff (Cainozoic volcanic rock).
  Landslides often occur in the rainy season.
- In Tegucigalpa, the temperature is predominantly high and humidity is basically low with weak wind velocity throughout the year.
- There are no flora or fauna that are rare or in danger of extinction. It is to be noted that there is a nature preservation park at the south of the national stadium.
- Hazardous areas : 110,000 inhabitants live within 4 sq.km of landslided or flooded areas

Socio-economic Environment
- Population : slightly more than 670,000
- Percentage of inhabitants over 50 years. : 10%
- Life expectancy : 70 years (women) and 65 years (men)
- Population in Economic Activity
    Primary industry : 1%
    Secondary industry : 29%
    Tertiary industry: 70%
- Illiteracy rate : 13%
- Number of schools : 200 primary schools and 100 secondary schools, all of which conduct daytime and evening classes.
- Rate of extreme poverty : 70%
- Rate of services of power and tap water : 70%
- Major death causes : respiratory disease, AIDS and infectious intestine disease
- Medical facilities : Number of hospitals : 5   Number of beds : 2000

Environmental Pollution
- Air pollution : concentrations of suspended particulate matter (TPS 0.6 - 570mg/m³) and lead (Pb 0.1 - 4.5mg/m³) are very high inside centro and along trunk lines.
- Water contamination : Rio Choluteca is too badly contaminated for any aquatic life to service
- Noise : Main cause is airplane traffic. Automobile traffic is not presently identified as a cause of noise

CHAPTER 4   TRAFFIC SURVEY

4.1   Main Survey

1) Person-Trip survey
The person-trip survey was conducted for 10,198 households (sample rate of 6.7%) in the study area with 74 traffic zones. The effective sample rate was 5.2%.

2) Cordon Line Survey
The cordon line survey was conducted at six survey points with the OD survey and cross section traffic volume counting survey. Among six survey points, four points were 24-hour surveys and the other two points were 16-hour surveys.

3) Screen Line Survey
In this survey, the cross-section traffic volume counting survey was conducted on ten bridges crossing the Rio Choluteca. Among ten survey points, three points were 24-hour surveys and the other seven points were 16 hour surveys.

4) Traffic Speed Survey
This survey was conducted on ten principal roads in the early morning (7:00 ~ 8:00), late morning (10:00 ~ 11:00) and evening (18:00 ~ 19:00).

4.2   Supplementary Survey

In order to supplement the above main surveys, supplemental surveys were carried out. Table 4.1 summarizes these supplemental surveys.

Table 4.1   Summary of Various Supplementary Surveys

Type of Survey	Scope of Survey
Traffic Count (Cross Section)	Traffic volume count was conducted along 17 principal roads
Traffic Count (Intersection)	Traffic volume count by direction was surveyed at 23 Intersections
Bus Users	No. of users, OD, etc., were investigated at 10 bus terminals, 10 bus stops, and 45 bus routes
Bus Terminal	Facilities, number of buses arriving and departing, etc. were investigated at 10 bus terminals
Bus Stop	Facilities, bus-bays, etc., were investigated at 45 survey points
Taxi Pool	Scale, parking fare, etc., of 41 Taxi Stands were investigated
On-Road Parking	No. of on-road parking along 10 major blocks in the central area of Tegucigalpa and Comayagüla
Off-Road Parking	The capacity, type of owner, etc., at 10 parking lots in the central area of Tegucigalpa and Comayagüela
Truck Terminal	Scale, capacity, etc., at 166 terminals
Road Inventory	Distance, Cross Section, etc., at 10 points of Screen Line Survey Points.

CHAPTER 5   RESULTS AND ANALYSIS OF TRAFFIC SURVEY

5.1 Person Trip Survey

1) Outline

The person trip survey sheets were distributed to 9,026 households and 26,757 persons were interviewed. 12,351 persons were male and 14,406 persons were female. Among those interviewed, about 18.8 % of persons made no trips during the survey day. The remaining 81.2 % made trips.

2) Trip Production

The average trips per day (trip production rate) was 2.88 . The average trip production rate of male was 3.2 trips and for female was 2.5 trips. Concurrently, the total number of person-trips per day was about 1.8 million. In the trip composition by "purpose", trips of "To Home" account for 47.5% and by "mode", trips by "Bus" occupy 44.3%. Fig. 5.1 shows the trip composition by mode and purpose.
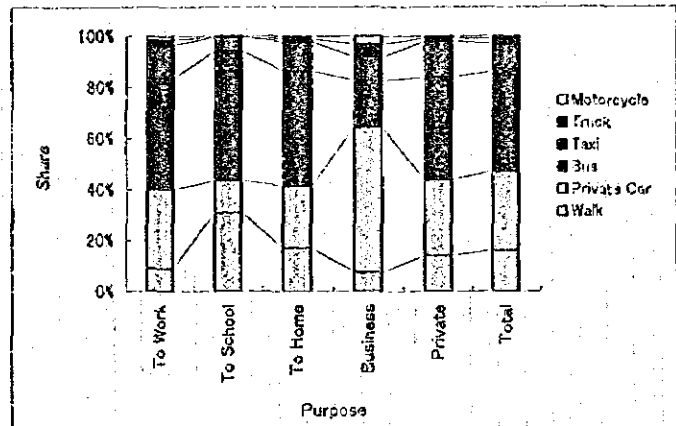
Fig. 5.1   Trip Composition by Purpose and by Mode

3) Trip Distribution

Among the total trips of 1.8 million, intra-trips accounts for 96.0% (1.68 million trips) and the remaining 4% (70,000 trips) is the trips between the study area and the outside of the study area. The trip distribution is illustrated in Fig. 5.2. The number of trips is great between Centro and other built-up area such as the center of Comayagüela, Santa Fé, Morazán, Miraflores, Kennedy, etc.
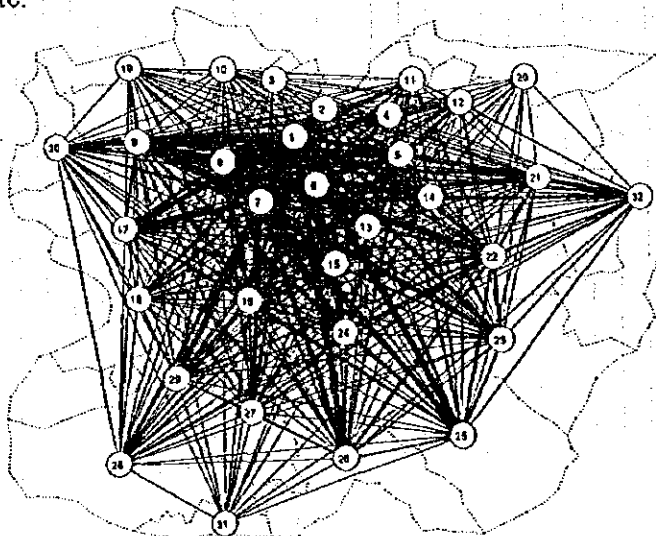
Fig. 5.2   Desired Line

Major Zone No. and Name

1 : Tegucigalpa Centro
5 : Morazán
7 : Comayagüela Centro
8 : Santa Fé
9 : Carrizal
15 : Alameda
25 : Kennedy
22 : National Autonomous
University of Honduras
23 : Miraflores
29 : Airport

4) Modal Split of Car-Owning Household and Non-Car-Owning Household

The population (over 5 years old) living in the study area is about 607,000 persons, of which 17% (103,000 persons) belong to the car owning households and remaining 83% (504,000 persons) belong to non-car-owning households. The modal split shows quite a difference depending on whether person belongs to a car-owning households or not as shown in Figs.5.3 (1) and (2).
More than two-thirds of trips made by persons belonging to car-owning households use "Car" for their trips except the trip purpose "To School". On the other hand, most trips made by persons belonging to non-car-owning households use "Bus" for all trip purposes.
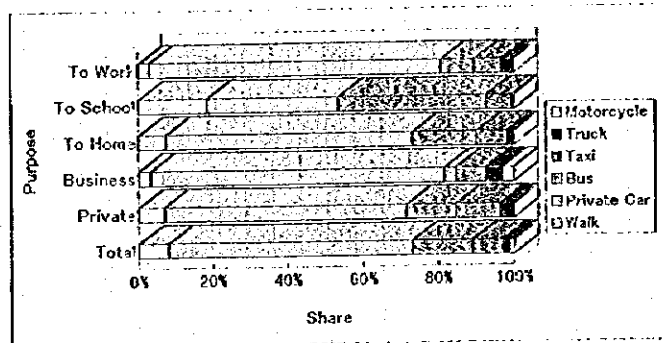
Fig. 5.3 (1)   Modal Split of Car Owning Household by Purpose
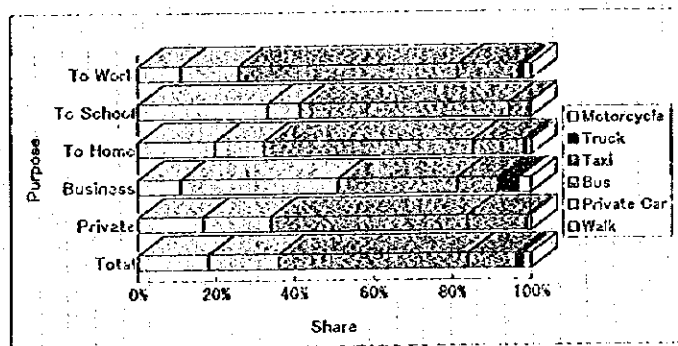
Fig. 5.3 (2)   Modal Split of Non Car Owned Household by Purpose

5.2   Cordon Line Survey

This survey was conducted to obtain the traffic volume entering and leaving the study area on six (6) major national roads connecting the study area and other regional centers. The survey results show that 9,056 vehicles flowed into the study area and 9,223 vehicles flowed out from the study area. The number of vehicles coming from and going to San Pedro Sula was the largest, with 4,655 vehicles counted, of which trucks accounted for approximately 30%. Fig. 5.4 shows the traffic volume at each survey point.
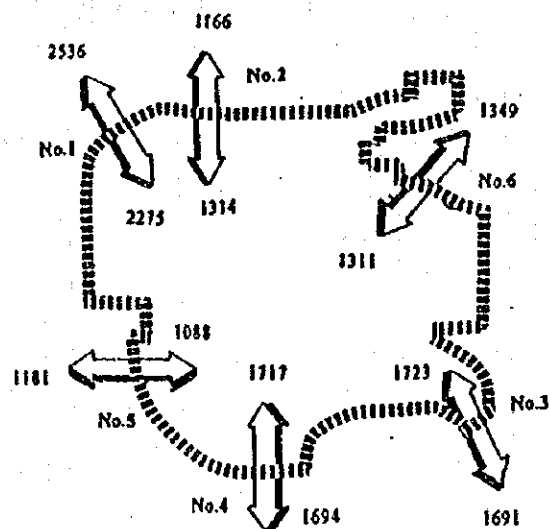
Fig. 5.4   Traffic Volume at Cordon Line

5.3 Screen Line Survey

Screen Line Survey was carried out on the Cholteca river. Fig.5.5 show the traffic volume passing through this Screen Line. The total number of vehicles crossing this Screen line was 172,320 vehicles per days. The number of vehicles crossing to the western side of the Cholteca river was a little more than those crossing to the eastern side of the river.
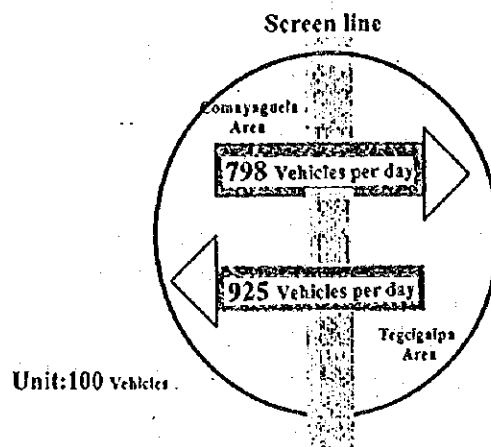
Fig 5.5 Traffic Volume Crossing the Screen Line

5.4 Traffic Volume Survey at Cross Section

Traffic volume was counted at 17 survey points on major roads in the Study Area. At the survey points of Boulevard Comunidad Europea and Boulevard Miraflores, the traffic volume exceeds 45,000 vehicles per day. More than 30,000 vehicles are registered at the survey points on Avenidad Santa Fé and Boulevard Fuerzaz Armadaz.

As for the traffic congestion, the congestion rate is high on Avenida Miguel de Cervantes and Avenidad Cristobal Colon in the Centro of Tegucigalpa, Avenida 1, 4, 6 and Calle 6 in Comayagüela, Boulevard Santa Fé, Boulevard Cominidad Europea, Boulevard Miraflorcs as shown in Fig. 5.6.
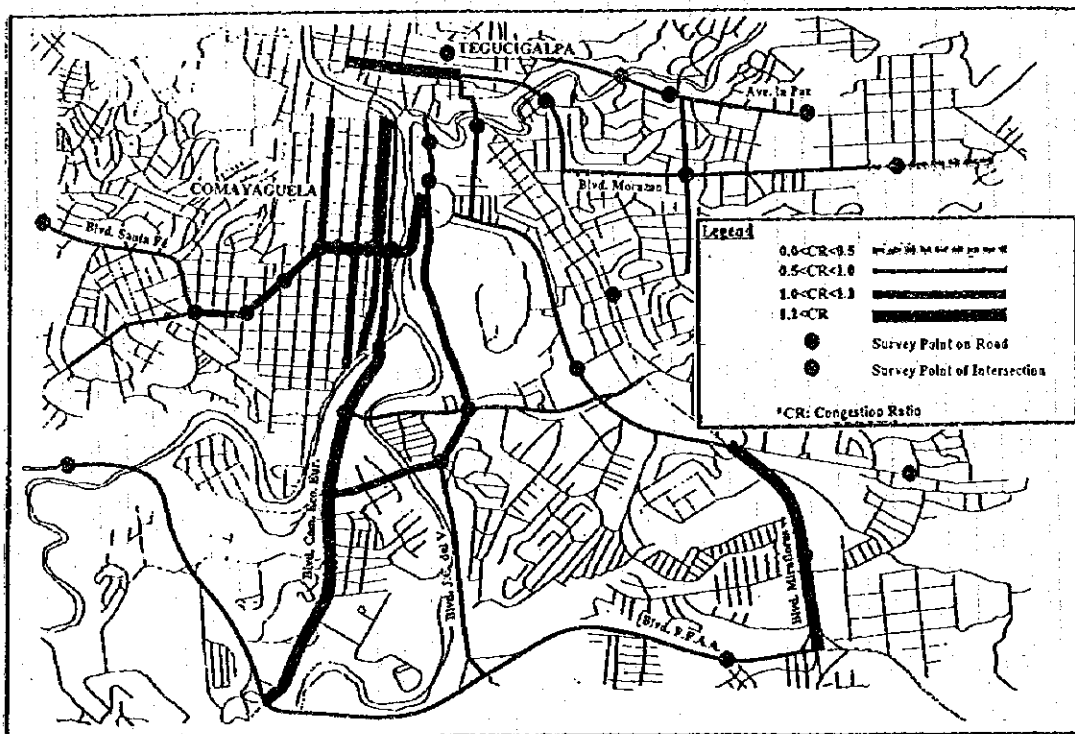
Fig. 5.6 Congestion on Major Roads

- 11 -

5.5 Vehicle Velocity Survey

The average daily vehicle velocity on roads within the central area of Tegucigalpa and Comayagüela is about 10-20 km/h; however, the vehicle velocity decreases to 5-10km/h during peak hours (7:30-8:30 and 17:30-18:30). On major roads within the study area such as Boulvard Cominidad Europea, Boulvard Miraflores, etc., the average daily vehicle velocity is 30-40km/h, however, during peak hours, the vehicle velocity decreases to 20-30km/h. The average daily vehicle velocity on major roads is shown in Fig.5.7.
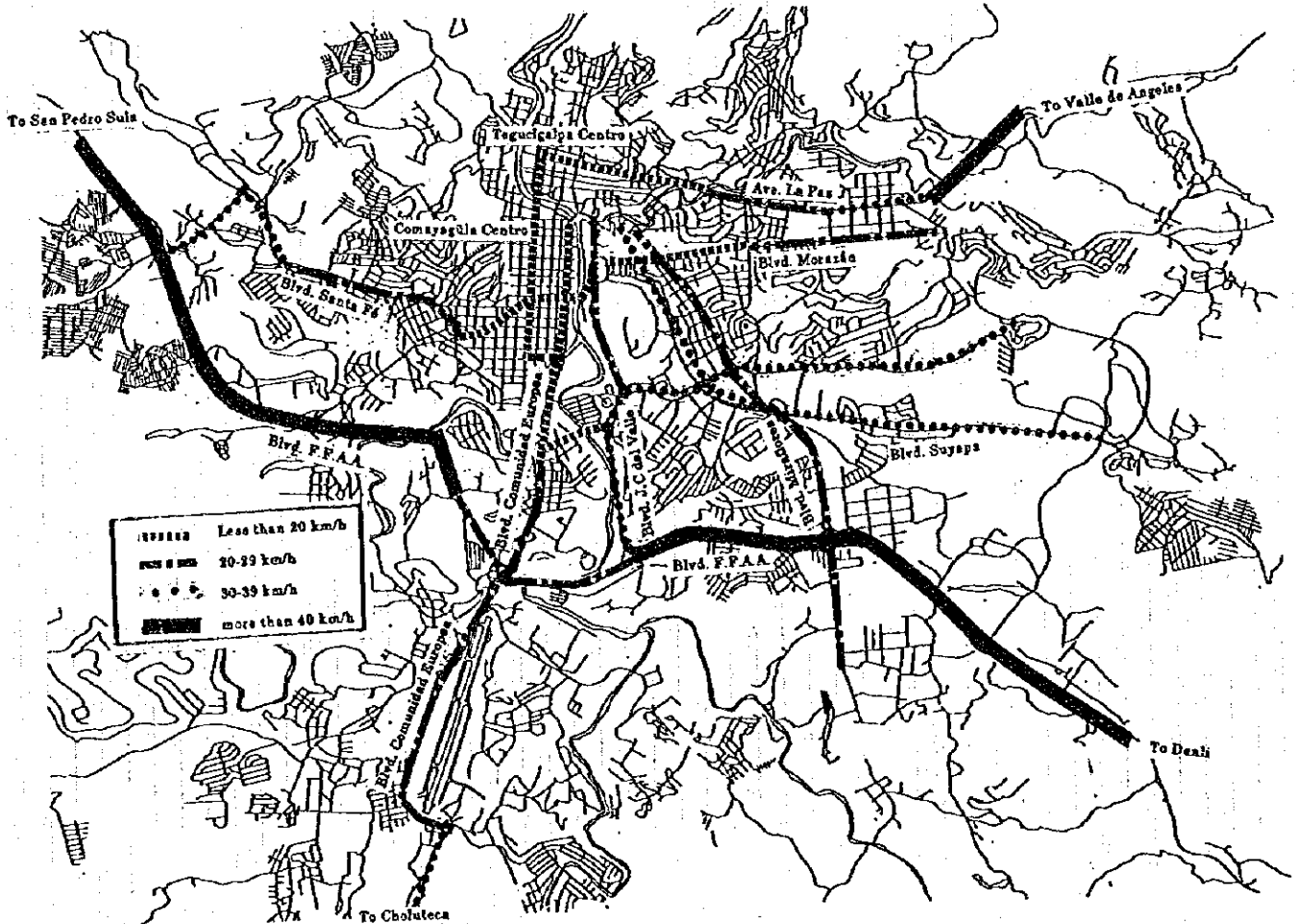
Fig. 5.7   Average Daily Vehicle Velocity

5.6 Traffic Volume Survey at Intersection

The analysis of the intersection survey results shows that the traffic congestion is quite serious at the following five (5) intersections, where the saturation degree exceeds 0.9 from the analysis (Fig. 5.8 shows these five intersection). Since more than 0.9 of the saturation degree suggests that the congestion is quite severe, it is desired that some effective countermeasures be taken at these intersections as soon as possible. The numbers in Fig. 5.8 correspond with the following intersections.

① Intersection of Comunidad Europea and the road from Puente Verde to Calle Golan

② Intersection of Jose del Valle and Calle La Salud

③ Intersection of Jose del Valle and Calle Golan

④ Intersection of Circular road around the National Stadium and Subida de Stadium

⑤ Intersection of Cabañas and Boulevard Santa Fé

Fig. 5.8   Congested Intersections

5.7 Public Transportation Survey

1) Outline of Public Transport

Buses are the most dominant public transportation in the study area and consist of urban bus, interurban buses and microbuses. Taxis operating on fixed routes also assume the role of a bus (called as "Colectivo"). The outline of the public transportation is summarized in Table. 5.1. Fig. 5.9 shows the number of urban bus routes on roads.

Table 5.1   Summary of the Public Transport in Tegucigalpa

	Bus		Urban Microbus	Taxi (Fixed Route)
	Urban	Interurban		
Type of Operator	5 cooperatives, 16 companies, 45 individuals	5 cooperatives, 61 companies, 91 individuals	109 companies, 58 individuals	vehicle owner
No. of veh.	1017 *	541	502	1250
No. of Routes	41	81	28	-
Fare	Lps. 0.9 (ordinarily)	Depending on route	Lps. 0.6-1.5 (Depending on route)	Lps. 2.5 per 1 person

Note: *   No. of vehicles subsidized   Source: SECOPT

Fig. 5.9   Number of Urban Route on Each Road

The following fact-finding was obtained through the survey;

- All of the present bus routes pass through the CBD.
- On some roads there are more than 30 bus routes for the CBD.
- Many bus routes connect the CBD with the direction of Carrizal (northwest of the study area) and Flor del Campo (southwest of the study area) outside the CBD.
- The urban bus rate is Lps. 0.9 per ride including Lps. 0.3 subsidy (only weekdays). The express bus rate is Lps. 2.0 and the microbus fare rate fluctuates Lps. 0.6 to 1.5 depending on their routes. There is no subsidy for the express bus and microbus.

2) Bus Terminals and Bus Stops

Urban bus and microbus terminals are located at a starting point or ending point of routes. All bus terminals have their station area, but bus waiting area, entrance/exit way, other service facilities for passengers are not installed at most bus terminals.

Among bus stop facilities on 10 selected urban bus routes, only 26% of the observed stops have stop signs and 10% have bus bays. Most of them do not have service facilities for passengers such as bus waiting area with roof, information board, etc. At major bus stops with bus bays, the number of buses arriving and/or leaving already exceeds capacity during peak hours.

3) Bus Passengers

At the 5 selected bus terminals within the CBD, about 3600 vehicles per day are arriving and departing, and the number of passengers getting on and off is about 53,900 persons per day. Bus operation is concentrated in the morning and evening peak hours, and many buses operate all day long.

The average number of the boarding passengers on all routes is about 100 persons/bus/trip and the average number of passengers is about 25 persons/bus. Observing bus passengers by route, Lolo-Buenos Aires (No.10), Cerro Grande-La Sosa (No.1) and Flor del Campo-El Sitio (No.16) have many boarding passengers. On the other hand, by time period, there is not a large fluctuation of the number of boarding passengers, however, the average number of passengers fluctuates greatly.

4) Bus Operation

The Sindicato de Transporte Urbano (S.T.U.) is organized by 2 partnerships, 2 private enterprises and 28 private companies with 713 operating. The S.T.U. manages every enterprise and partnership but does not fulfill the administrative function sufficiently. Though all public transportation in Honduras is organized, it can be said that the organization is inefficient because each agency manages his bus privately by itself.

5) Financial Conditions

As for financial situation of bus operators in 1995, the average revenue is Lps. 178 per day per bus and the average rate of profit is 26%.

6) Taxi Transport

There are two types of taxis in the study area. One is a route taxi similar to a bus called "Colectivo", and the other is a typical taxi. The former, at first, picks up passengers at fixed taxi stands and carries them to the fixed destination, picking up passengers along the way until full capacity (5 persons) is reached. The route taxis has 22 routes in Tegucigalpa and 27 routes in Comayagüela.

About 3,000 taxis are operating in the study area, of which 60% are private. Since no meter is installed, fares are determined through negotiation between drivers and passengers according to distance. On the other hand, the remaining 40% are Colectivo, of which the fare is Lps. 2.5 per passenger.
There are 18 taxi pools in the center of Tegucigalpa and 23 taxi pools in the center of Comayagüela. Most locations have their area ranging from 20 to 40 square meters, however, there is no space to wait for taxis at half of the locations.

The number of taxi passengers was counted at 10 major taxi pools selected in 5 locations in the center of Tegucigalpa and 5 locations in the center of Comayagüela. In Tegucigalpa, the number of taxi passengers is largest in the routes of Centro ~ Colonia Hato de Enmedio and Centro ~ Colonia Kennedy, about 3000 persons per 16 hours (6:00-22:00), followed by 2100 passengers in Centro ~ Torocagua. In Comayagüela, passengers to Colonia Kennedy are plentiful (1300 passengers).
Fig. 5.10(1) ~ (2) shows the number of passengers by time in Tegucigalpa and in Comayagüela.
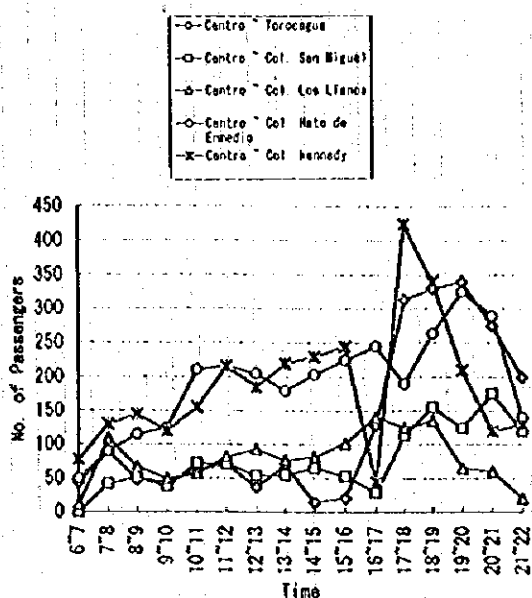
| Fig. 5.10 (1) | Number of Taxi Passengers in Tegucigalpa | Fig. 5.10 (2) | Number of Taxi Passengers in Comayagüela. |
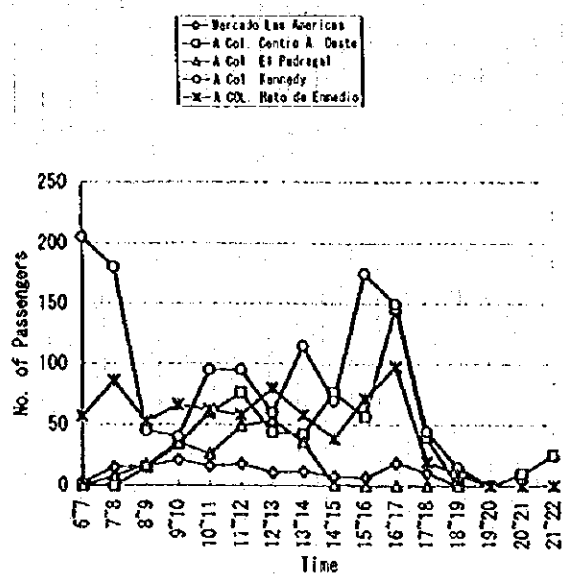
5.7 Parking Survey

1) Off Road Parking

Parking Capacity : In Tegucigalpa and Comayagüela, there are 73 parking lots with a capacity of 2,840 vehicles in Tegucigalpa and 122 parking lots with the capacity of 3,614 vehicles in Comayagüela. The average capacity of parking lots was 38.9 vehicles in Tegucigalpa and 29.6 vehicles in Comayagüela. The tariff per hour was Lps. 2 to 3, however, the tariff per month ranged from Lps.70 to 300. The number of parking lots and their capacity lots is shown in Table 5.2.

Table 5.2 Parking Lots by Type of Ownership

Manage-ment	Tegucigalpa		Comayagüela	
	No. of Lots	Capacity	No. of Lots	Capacity
Public	34	1,449	35	1,285
Private	39	1,391	89	2,329
Total	73	2,840	122	3,614

Parking hour by purpose : In the center of Tegucigalpa the parking hours for the purpose of "Social Life and Others" and "Work" were longer, that is, the former was 9.0 hours and the latter was 8.7 hours. In Comayagüela the parking hour of "Work" was 10.8 hours.

2) On Road Parking

Demand of On Road Parking : This survey was carried out over 20 blocks in Tegucigalpa (10 blocks) and Comayagüela (10 blocks). The total survey length was about 6.2 Km (Tegucigalpa 3.5 Km and Comayagüela 2.7 Km). The total number of parking vehicles was 6,393 (Tegucigalpa 3,444 and Comayagüela 2,949) over 16 hours.

Parking Hour by Purpose : The parking hours were surveyed by interview. The average parking hours were 1.2 hours in Tegucigalpa and 0.6 hours in Comayagüela. In Tegucigalpa the parking hours of "School" and "Home" were much longer than other purposes, which indicated 2.4 hours for the former and 2.0 for the latter. On the other hand, in Comayagüela the parking hours of every purpose are less than that in Tegucigalpa except "Returning to Office" and the parking hours of all purposes are less than one hour.

CHAPTER 6   EXISTING TRANSPORTATION PROBLEMS

The study area can be divided into two areas by their characteristics of structural formulation, one is the area in the center of Tegucigalpa and Comayagüela, where the central business district (CBD) of the study area is located and the other is the area outside of this CBD. In the following, the transportation problems are examined by area.

6.1   Problems in the CBD

1) Roads

(1) Tegucigalpa
- Most of road width of "Avenidas" are very narrow, less than 5.0 m with pedestrian walkways of 0.5 to 1.5 m, therefore, all the Avenida (East-West Roads) and Calles (North-South Roads) are regulated as one-way Roads.
- Avenida Miguel de Cervantes, Avenida Cristobal Colon and Avenida Maximo Jerez, three major roads along the east-west axis with much traffic (4,000 - 8,000 vehicles per day), are already over their capacity.
- The widths of "Calles", except those in the western part (Calles 2, 3, 4 and 5), are less than 3 m. On wider roads, "Colectivo" occupy some road space as their taxi stands.
- Many large-size buses pass on the narrow roads. They can not turn smoothly at corners.
- Many people are crossing roads in spite of heavy traffic around the central park area.

(2) Comayagüela
- A large market is located in the northwestern area; however, facilities of markets are very poor.
- Many venders occupy some road space to do business on the roads around this market, especially on main north-south road, Avenida 6.
- Except for the area around the market, there are not so many pedestrians.
- Avenidas 1, 2, 4, 6 and Calles 9,10,11 are main roads connecting with the center area of Tegucigalpa and other areas, therefore, the intersections of these roads are always congested.

2) Bridges
- Three bridges , Puente Carias, Puente Soberania and Puente Mallol, connect the center of Tegucigalpa and the center of Comayagüela. The traffic volume of these bridges is 6,000 vehicles per day on Puente Carias, 12,000 on Puente Soberania, and 20,000 on Puente Mallol. Puente Carias I not use effectively due to the congestion of Avenida 6 (many venders occupy the road space).
- The center of Tegucigalpa is separated from the rest of the city by the Chiquito River. These two areas are connected by 4 bridges, that is, Puente la Isla, Puente la Hoya, Puente San Rafael and Puente Guanacaste. The traffic volume on Puente Guanacaste is 21,000 vehicles per day and on the three other bridges is about 8,000 each.   Traffic volume on Puente Guanacaste is already over its capacity. On the three other bridges, traffic volume is reaching its limit of capacity .

3) Public Transportation

(1) Bus
- On some roads with a right-of-way of less than 6 meters, buses cannot pass other buses

or stopped/parked vehicles, resulting in traffic congestion.
- Since existing bus routes pass through the CBD, many buses concentrate there especially in the morning and evening peak hours.
- Some road sections have more than 30 bus routes heading for the CBD.
- Most of the existing operated buses are second-hand large buses mainly imported from the United States. Since these large-size buses are running on crowded narrow roads, the running speed of buses is very slow. In addition, the narrow width of the intersections make turning of buses much more difficult.

(2) Taxi
- Generally, these stands are located on a little wider roads, however, since the road width itself does not have enough width to accommodate the existing traffic volume, severe congestion occurs during the peak hours and when it is raining.
- Taxi drivers often zigzag while looking for passengers, which obstructs the smooth traffic flow.

4) On Road Parking
- The total capacity in the CBD area is approximately 6,500 vehicles. At present, not all these parking lots are fully used, and at some parking lots, only less than half of the capacity is in use all day long.
- On the other hand, there about 400 vehicles parking illegally on road within the CBD.

6.2 Problems Outside CBD

1) Roads
- The radial roads are the main roads in the study area. Since the traffic volume of these roads ranges from about 20,000 to 45,000 per day, these roads are crowded, because many commuters use these roads from the outskirts to the center of the city. The capacity is not enough to accommodate the present traffic volume.
- Since Calle 9 - Boulevard Santa Fé is the only road from the western part of the study area to the city center and Boulevard Comunidad Europea is the main road from the center to the direction of the airport, severe congestion on these two routes occurs throughout the day.
- At present some position of circular road exist in the study area dispersing traffic passing through the CBD. However, it is desired that the Anillo Periferico (outer ring road under construction) be completed as soon as possible.

2) Bridge
- A few bridges connect the CBD with other areas. Among them Puente Juán Ramón Molina, Puente Prado and Puente San Jose are most important. The traffic volumes are 21,000, 15,000 and 17,000 vehicles per day, respectively. The present traffic volume is already over of capacity; therefore, construction of a new bridge is of most importance.

3) Intersection
- There are some intersections where configuration is unfavorable, traffic signals are not installed, and lane markings and stop lines are not drawn. At these intersections congestion is chronic and the situation is inductive to traffic accident.

4) Bus
- Most people commute by bus to workplaces in the center of the city. During peak hours

a number of buses are waiting in long queues at every bus stop. Therefore, congestion is always observed around bus stops.

- In some cases the bus stops are installed on both sides on road at the same point. This causes congestion, because vehicles from behind can not pass buses when buses are stopped at both sides at the same time.
- Many bus routes concentrate on the road connecting the CBD with Carrizal direction and Flor Del Campo direction outside the CBD. There are so many roads with more-than-sufficient bus services; therefore, a rearrangement of bus routes is advised.

6.3 Entire Study Area

- At many intersections, especially along the secondary roads passing through the housing area near the CBD, there are no signs indicating which road has the right-of-way. At these intersections the potential for traffic accidents is very high.
- Guide signs have recently been installed here and there in the study area . Most of them were donated by the private companies for advertisement. Some of them need to reinforce their supporting poles, as they are liable to be damaged by winds.
- Lane marks and stop marks are almost totally defaced except in some road section of Avenida Cervantes (near Puente San Rafael). Therefore, in most roads the traffic flow is not orderly and the road capacity is not used properly.
- Some of the roads within the study area have not had sufficient maintenance work, with many potholes found here and there. In addition, weeds, garbage, pebbles, etc. on both sides of the roads make the road width narrow, and have deteriorated the roads' efficiency.
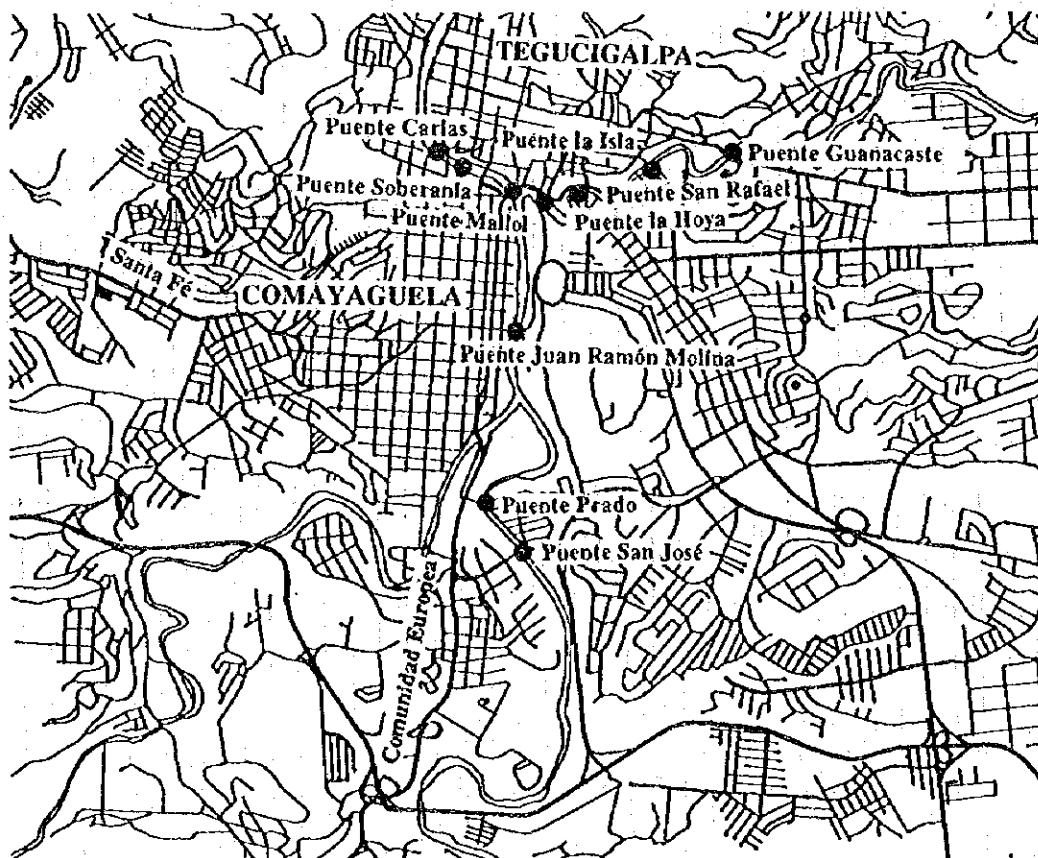
Fig. 6.1   Location of Major Bridges

CHAPTER 7   URGENT PROJECTS

7.1   Criteria of Selection

In the study area there are several critical places required for some urgent relief measures for mitigating congestion. Therefore in the formulation of the Master Plan, urgent projects are selected based on the following criteria:

① Projects which are simple in construction and completable within one year at the most

② Projects requiring less construction cost

③ Project of great benefit

Various countermeasures are evaluated by the above criteria; that is, "Term", "Cost" and " Effect" as shown in Table 7.1.

Table 7.1   Comparison of Countermeasures

Countermeasures	Term	Cost	Effect
Change of Urban Structure			
- Transfer of administrative organization, business offices, etc.	Long	High	Large
- Establishment of urban sub centers	Long	High	Large
Construction of Transportation Facilities			
- Construction of new roads	Long	High	Large
- Construction of new bridges	Long	High	Large
Improvement of Transportation Facilities			
- Improvement of roads	Short/Medium	High	Large
- Improvement of intersections	Very Short	Low	Large
Introduction of Traffic Management			
- Installment of traffic signals	Very Short	Low	Large
- Installment of traffic signs	Short	Low	Small
- Drawing lane marks and stop lines	Short	Low	Small
- Control of on-road parking	Medium	Low	Small
Improvement of Public Transportation			
- Construction of urban and interurban bus centers	Medium	High	Large
- Introduction of bus exclusive lanes	Medium	Low	Large
- Operation of small-sized buses	Medium	High	Large
- Improvement of bus stops	Short	Low	Small
- Improvement of taxi stands	Medium	Low	Small

Term : "Very Short"   Within 1 year
        "Short"   1 to 5 years
        "Medium"   5 to 10 Years
        "Long"   More than 10 years
Cost   " Low"   Possible to be implemented by municipality itself
        "High"   Foreign loan and/or donation necessary
Effect "Small"   Useful for keeping the traffic rule or maintaining
                          the traffic order
        "Large"   Mitigate the traffic congestion

7.2　Selected Urgent Projects

The urgent projects were selected from the measures related to the installment of traffic signals and the improvement of the configuration at congested intersections, since "Term" is very short, "Cost" is low and "Effect" is large. The places requiring an urgent project were selected according to the intersection traffic analysis.

The following were selected as the urgent projects. The locations of these projects are shown in Fig. 7.1.

(1) Improvement of Configuration and Installation of Traffic Signal
 ① Intersection of Subida al Estadio Nacional and its circular road (Project-1)
(2) Improvement of Configuration
 ② Intersection of Avenida Cabanäs and Boulevard Santa Fé (Project-2)
 ③ Intersection of Boulevard Comunidad Europea, Puente Verde 24 Calle Zona Guacerique and Calle Golan (Project-3)
(3) Installation of Traffic Signals
 ④ Intersection of Boulevard Jose Cecilio del Valle and Calle Golan　(Project-4)
(4) Construction of Rampway
 ⑤ Grade Separation of Boulevard Miraflores and Boulevard Fuerzas Armadaz (Project-5)

Fig. 7.1　Locations of Urgent Projects

CHAPTER 8 SOCIOECONOMIC FRAMEWORK, LAND USE PLAN AND FUTURE URBAN STRUCTURE

8.1 Socioeconomic framework

The latest socioeconomic data of the study area was 1988 Census data. The study team determined population figures, number of workers, etc., as of 1995 by examining past trends, existing land use , etc. As a result, the population within the study area was estimated at 674,920 persons, the population density 196 persons/ha and number of workers 194,321 workers.

The future socioeconomic framework of the study area as projected with the Cohort survival model, economic base model, and location quotient model; under the control total of the future population projection of the entire Honduras was projected by SECPLAN. The future population (2010) of the objective area was forecast 872,083 persons. The projected socioeconomic framework was summarized in Table 9.1 of this summary report.

8.2 Land Use Plan

1) Existing Land Use

The study team could not obtain a current land-use map; therefore, such a map was made by the comprehensive site reconnaissance (walking in and around the study area). Fig. 8.1 shows the present land use map on the basis of the result of this site reconnaissance. On the present land-use map, each land-use area was measured. The total area of the study area was about 12,000 ha, of which about 58 % is occupied by open space. The residential area accounts for almost 30 %, that is 3,500 ha. Table 8.1 shows the existing socioeconomic data together with their projection.

2) Present Urban Structure and Direction of Development

In the study area almost all governmental organizations such as the Legislative Palace, Ministry of Health, Ministry of Administrative Management, Ministry of Defense, the City Hall, etc., as well as commercial and other business activities are housed; in the central part of Tegucigalpa (area between the Choluteca and Chiquito Rivers, not including the center of Comayagüela). In this sense, this city is said to formulate a unipolar structure; however, nowadays, private activities tend to gravitate toward Boulevard Morazán, Boulevard Miraflores and Boulevard Suyapa.

On the other hand, the population is also rapidly moving away from the central area to the hillside located in the outskirts of the city in a sprawling manner , due to the topographic limits of the habitable land. Although manufacturing factories are few, the economic activities such as distribution and construction materials are concentrated into the areas near Santa Fé, the airport, etc. The future direction of development being considered if to promote further dispersion of business and governmental functions and suburban location of restaurants and other entertainment facilities as well as sprawl of housing area in order to avoid traffic jams in the central area. Fig. 8.2 shows the development direction in the study area.

Fig. 8.1 Present Land Use Map

LEGEND

- Outer Ring Road (Under Construction)
- Main Road
- Built-up Area
- Public Use
- Industrial Area
- Residential Area
- Green Area

N

- 24 -

Fig. 8.1 Present Land Use Map

LEGEND

.... Outer Ring Road
(Under Construction)

———— Main Road

Built-up Area

Public Use

Industrial Area

Residential Area

Green Area

Fig. 8.2   Development Direction in the Study Area

3) Objectives of Future Urban Structure

The following objective was set to examine the future urban structure of the study area.

① To reformulate the present single-core urban structure into the multi-core structure as much as possible

② To preserve historic, cultural and tourist places and buildings in the central area of Tegucigalpa

③ To transfer the central governmental functions in the central area of Tegucigalpa to the governmental area outside the CBD area

④ To regulate the new location of business offices in the central area of Tegucigalpa

⑤ To formulate the efficient transportation network connecting the core areas with residential areas

⑥ To strengthen the urban transportation axles connecting the central area and core areas

⑦ To establish the efficient operation of the public transportation

⑧ To decrease the traffic congestion in the central area.

4)   Future Urban Structural Pattern

Examining the four typical urban structural patterns shown in Fig. 8.3 to attain the above
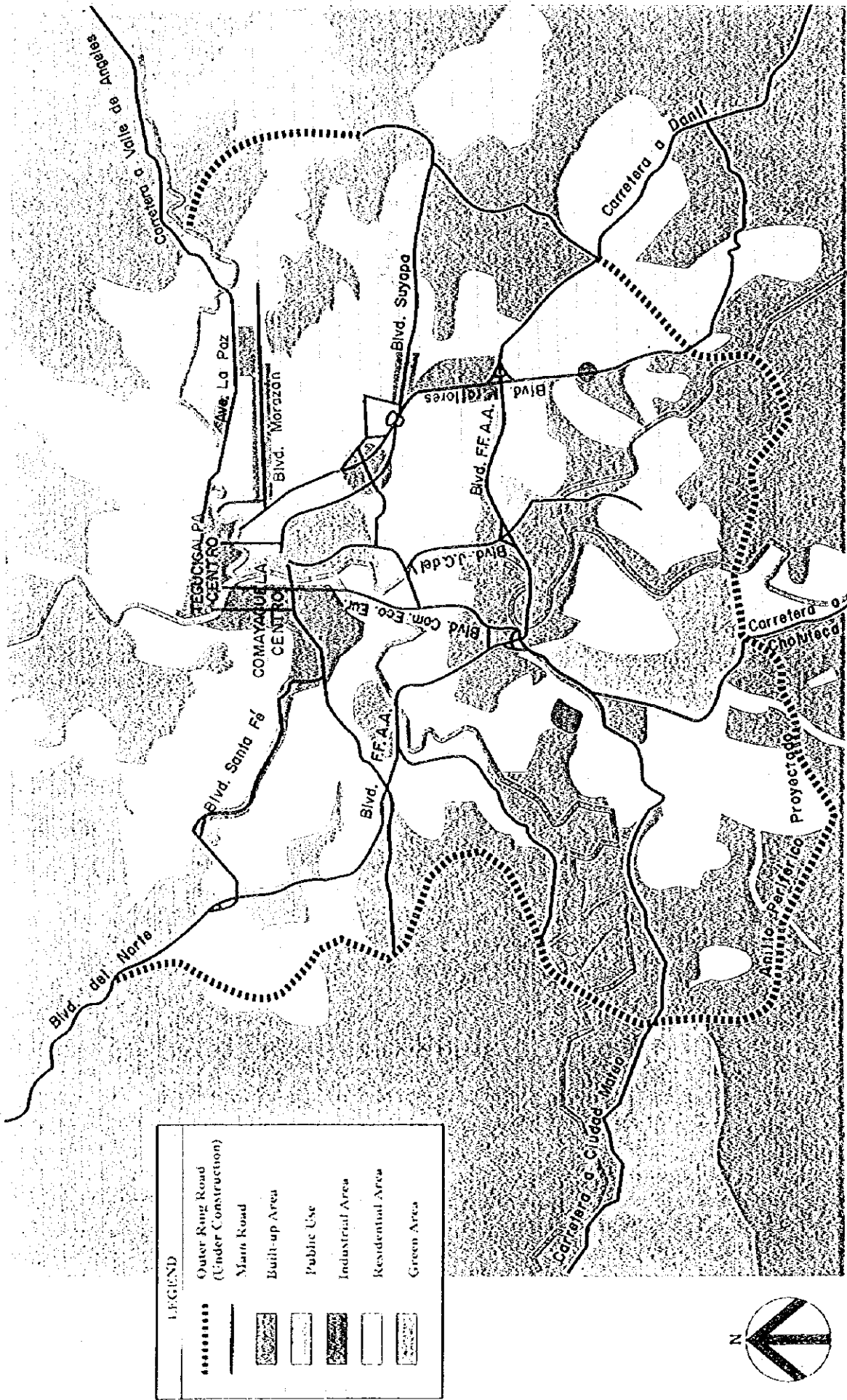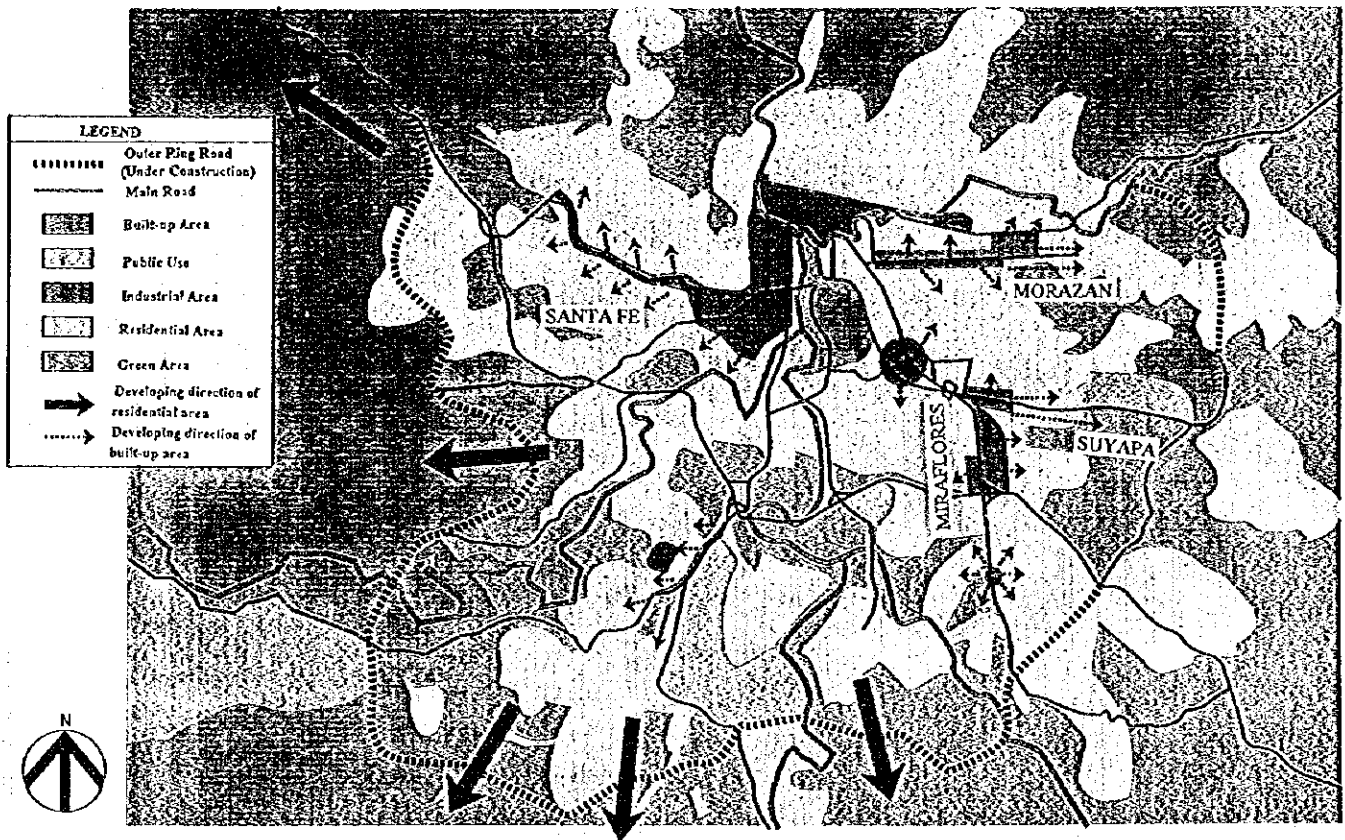
Fig. 8.2 Development Direction in the Study Area

3) Objectives of Future Urban Structure

The following objective was set to examine the future urban structure of the study area

(1) To reformulate the present single-core urban structure into the multi-core structure as much as possible

(2) To preserve historic, cultural and tourist places and buildings in the central area of Tegucigalpa

(3) To transfer the central governmental functions in the central area of Tegucigalpa to the governmental area outside the CBD area

(4) To regulate the new location of business offices in the central area of Tegucigalpa

(5) To formulate the efficient transportation network connecting the core areas with residential areas

(6) To strengthen the urban transportation axles connecting the central area and core areas

(7) To establish the efficient operation of the public transportation

(8) To decrease the traffic congestion in the central area.

4) Future Urban Structural Pattern

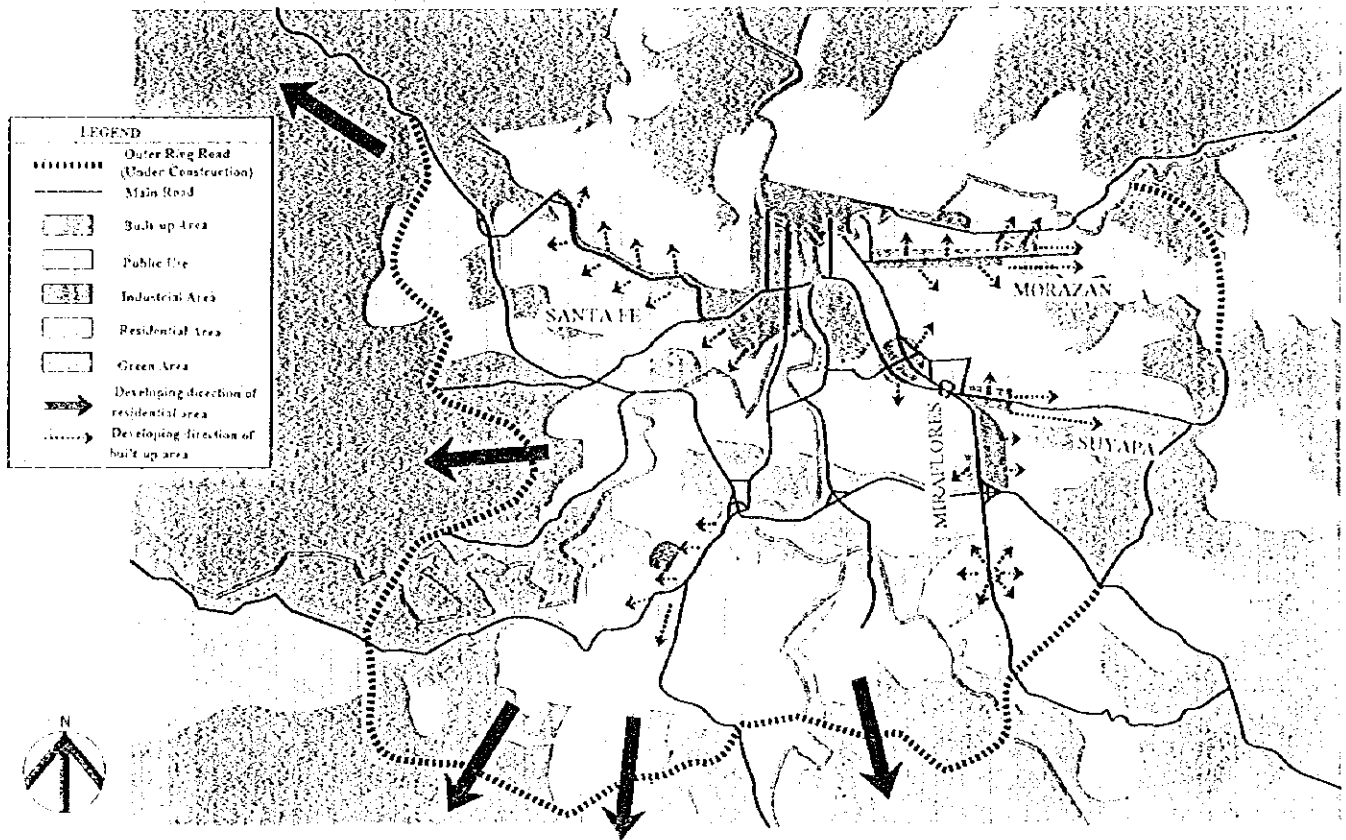Examining the four typical urban structural patterns shown in Fig 8.3 to attain the above

objectives, "Linear and Multiple Nuclei Pattern" is judged to be the most suitable urban structure for the study area, because this pattern aims to make urban functions moderately distributed by fostering medium scale nuclei on the principal transportation axes, leaving the necessary urban activities in the CBD area, together with formulating the built-up area linearly along the major transportation axes. This structural pattern could be considered to be the most realistic.
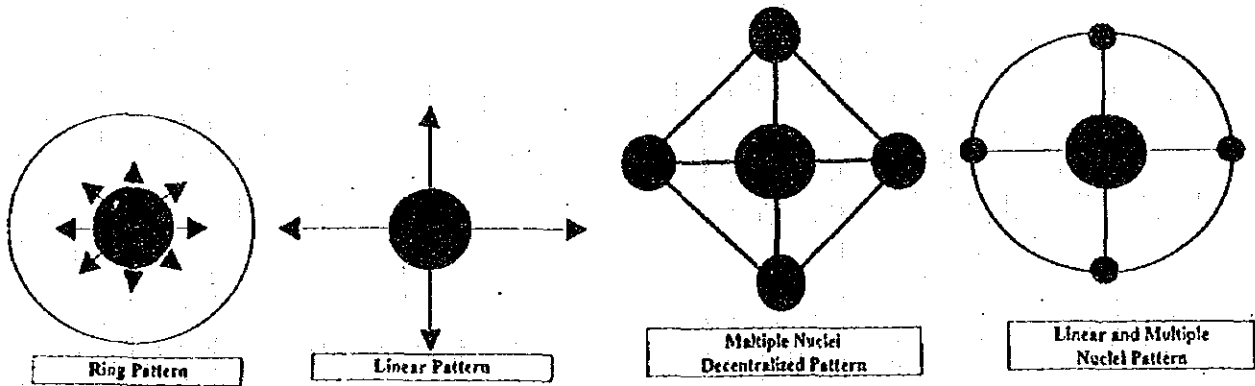
Fig. 8.3   Alternative Urban Structural Patterns

5)   Allocation of Population and Workers

Based on future land use, development direction, etc., the future population and workers were allocated as shown in Fig. 8.4 (1) and Fig. 8.4 (2), by distributing the projected total population and workers of the whole study area to traffic zones. The population increment is quite large in the western and southern parts of the outer ring road. The expansion rates in these parts was projected at more than 2 times. On the other hand, the number of workers was projected to increase in the subcores along Morazán, Suyapa, Miraflores, Santa Fé within the outer ring road. This different allocation of population and workers causes the large amount of commuting traffic flow between houses and working places. Therefore, it will be necessary to strengthen sufficiently the transportation network for these road sections.
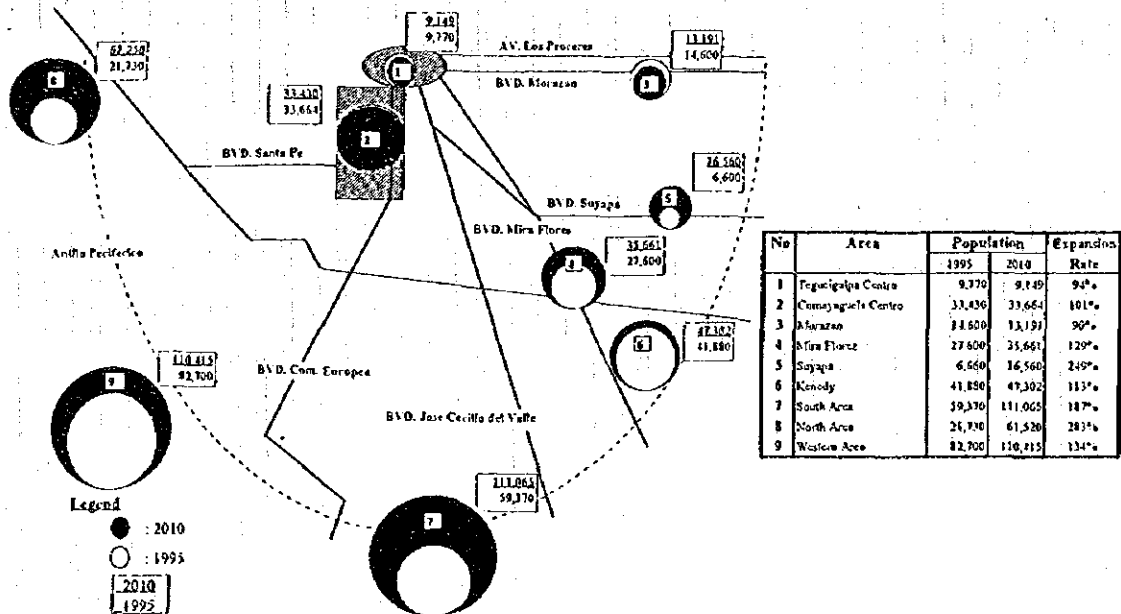
Fig. 8.4 (1)   Future Allocation of Population

No	Area	No. of Employees		Expansion
		1995	2010	Rate
1	Tegucigalpa Centro	43,749	46,312	106%
2	Comayaguela Centro	19,471	23,396	120%
3	Morazan	24,587	48,728	198%
4	Mira Florez	12,478	38,919	312%
5	Suyapa	6,118	24,323	398%
6	Tepeyca	8,612	21,632	251%
7	Airport	8,644	24,168	280%
8	Santa Fe	15,867	27,049	170%
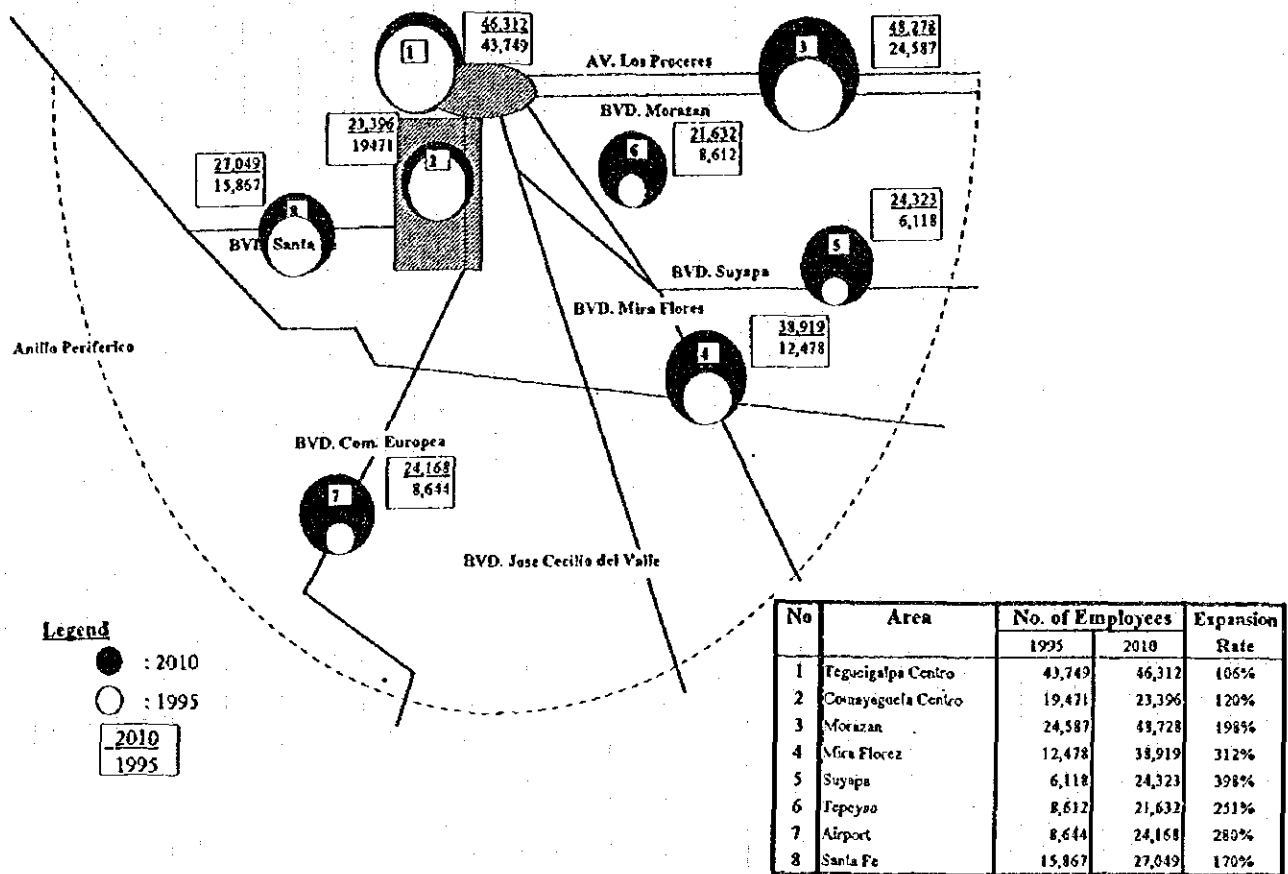
Fig. 8.4 (2) Future Allocation of Workers

6) Future Land Use

Future land use was determined by the future allocation of population and workers, considering the direction of urban development and the extension of the housing area in the habitable land, and the future urban structure, as shown in Fig. 8.5. Concurrently, the residential area is assumed to extend by 1.4 times from 3,441 ha in 1995 to 4,878 ha in 2010. The commercial area will extend 1.4 times by 2010. The future area by land use is also shown in Table 8.1.

Table 8.1   Area by Land Use

Land Use	1995 (ha)	Share (%)	2010 (ha)	Share (%)	2010/1995
Residential area	3,441.2	28.9	4,878.0	41.0	1.42
Public area	539.3	4.5	764.0	6.4	1.42
Commercial area	986.6	8.3	1,483.0	12.5	1.50
Industrial area	69.7	0.7	123.0	1.0	1.76
Open space	6,853.2	57.6	4,642.0	39.1	0.68
Total area	11,890.0	100.0	11,890.0	100.0	1.00

7) Zoning of Land Use

The zoning of land use is designated as shown in Fig. 8.6.

Fig. 8.5 Future Land Use

LEGEND

Main Road

Built-up Area

Public Use

Industrial Area

Residential Area

Green Area

Fig. 8.5 Future Land Use

LEGEND

Main Road

Built-up Area

Public Use

Industrial Area

Residential Area

Green Area

TEGUCIGALPA CENTRO

COMAYAGUELA CENTRO

Ave. La Paz

Blvd. Morazán

Blvd. Suyapa

Blvd. Miraflores

Blvd. F.F.A.A.

Blvd. J.C. del V.

Blvd. Com. Pco. Fra.

Blvd. Santa Fé

Blvd. F. F. A. A.

Blvd. del Norte

Carretera a Danli

Carretera a Choluteca

Anillo Periférico Proyectado

Carretera a Ciudad Mateo

Carretera Valle de Angeles

N

① CBD zone : Central area of Tegucigalpa and Comayagüela.
② Sub-core zone : Morazán, Suyapa, Miraflores, Toncontin and Santa Fé.
③ Central administrative zone : Centro Civico Gubernamental.
④ New residential zone : The western and eastern area outside area the Anillo
                                          Periferico.
⑤ Industrial zone : Amarateca along Carretera al Norte
⑥ Distribution Zone : Near Laguna El Pedregal
⑦ Recreational zone : El Picacho and Cerro Juan A. Lainez.
⑧ Central Market Zone : El Loarque outside the Anillo Periferico
⑨ Education Zone : Suyapa

Fig. 8.6 Zoning of Land Use

8.3 Future Urban Structure

1) Concept of Future Urban Structure

The basic concept to construct the future urban structure of the study area is as follows;
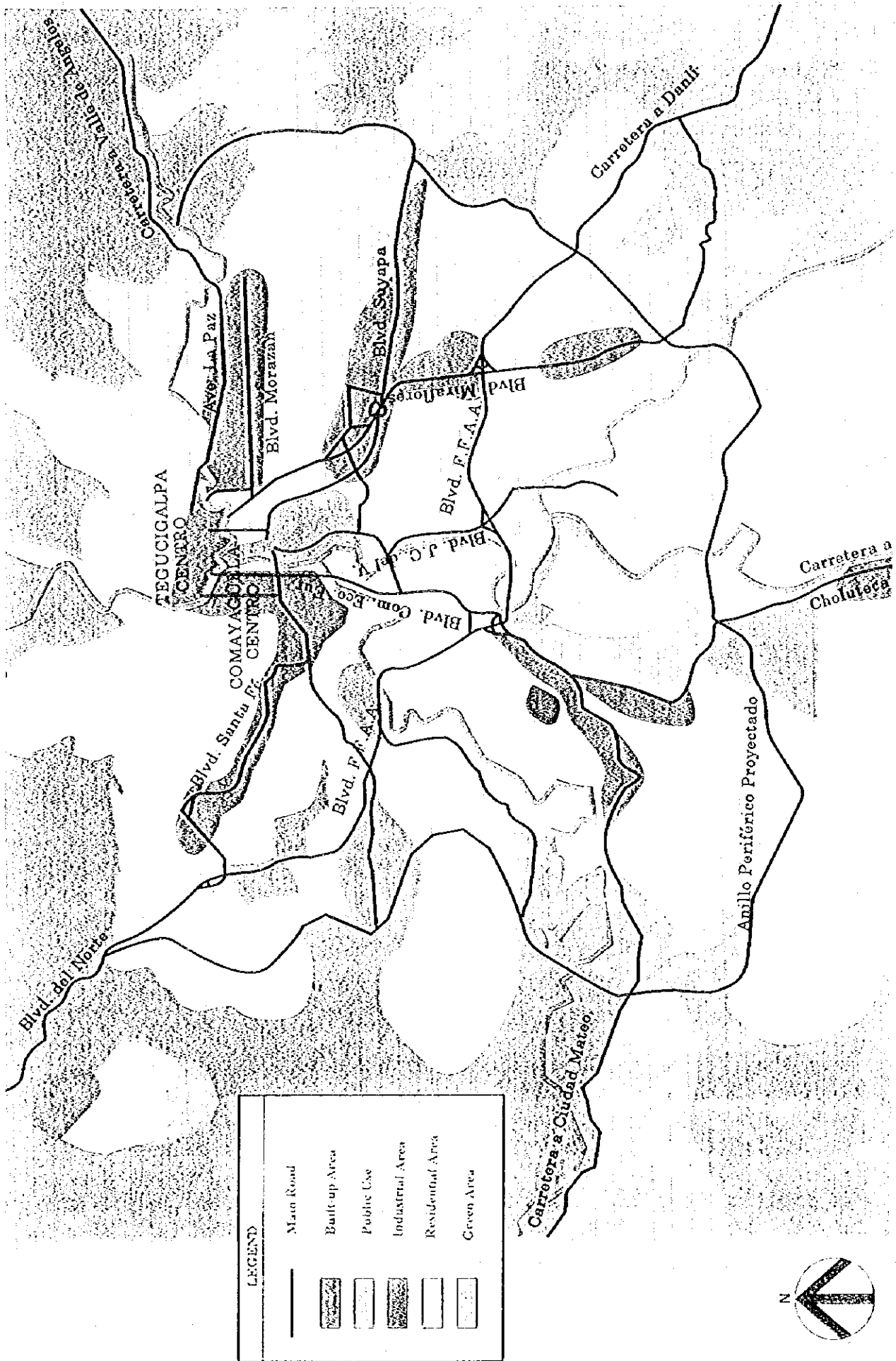
① CBD zone – Central area of Tegucigalpa and Comayaguela
② Sub-core zone – Morazan, Suyapa, Miraflores, Toncontin and Santa Fe
③ Central administrative zone – Centro Civico Gubernamental
④ New residential zone – The western and eastern area outside area the Anillo
                                   Periferico
⑤ Industrial zone – Amarateca along Carretera al Norte
⑥ Distribution Zone – Near Laguna El Pedregal
⑦ Recreational zone – El Picacho and Cerro Juan A. Lainez
⑧ Central Market Zone – El Loarque outside the Anillo Periferico
⑨ Education Zone – Suyapa
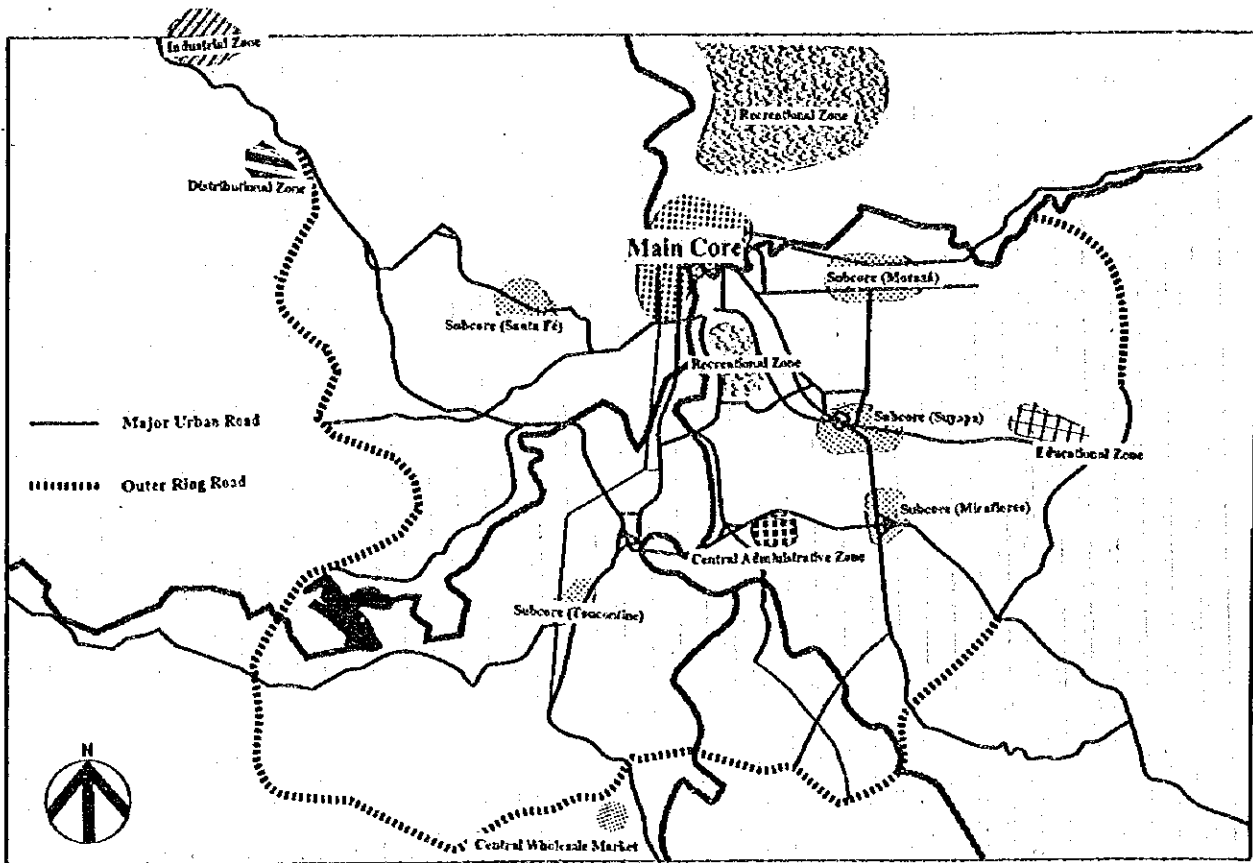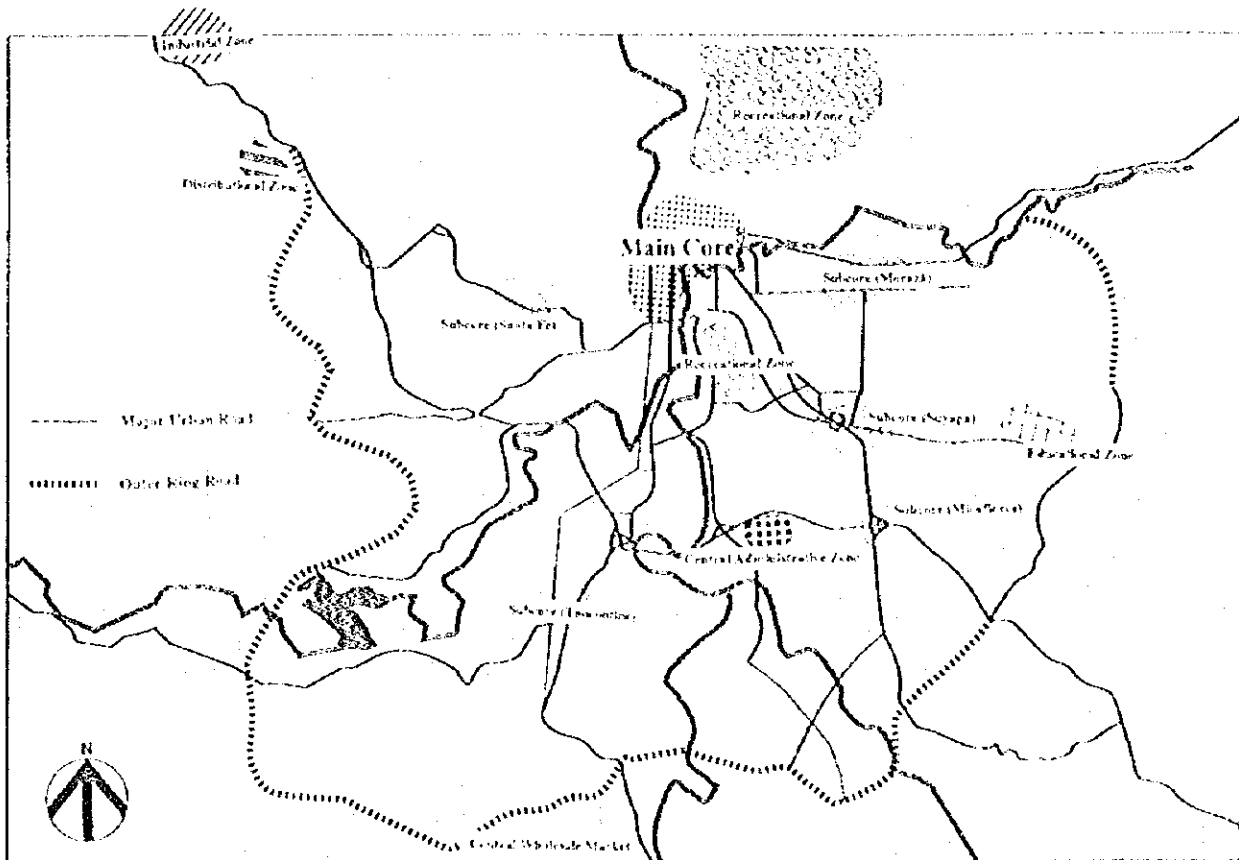

Fig. 8.6 Zoning of Land Use

8.3 Future Urban Structure

1) Concept of Future Urban Structure

The basic concept to construct the future urban structure of the study area is as follows.

① To distribute various functions located in the central area of Tegucigalpa to the outside of the CBD

② To foster sub-core districts

③ To develop the new residential areas in an orderly manager outside the outer ring road

④ To establish the efficient transportation system

⑤ To improve public transportation

2) Structural Image of the Future Urban Structure of the Study Area

Based on the above concept together with the future land use, the location of urban facilities and the distribution of future population and workers, the following are considered the trunk transportation network in the future urban structure;

(1) Inter-urban principal arterial road

This road is utilized as a nationwide principal road connecting the study area with other major regional cities such as San Pedro Sula, Danlí, etc. In addition, in the study area this road also takes a role of connecting subcores.

(2) Intra-urban principal arterial roads

① East - west transportation axis connecting sub-cores located in the west and the east

② North - south transportation axis connecting the central area of Tegucigalpa with the sub-core near airport and the southern part of the study area

(3) Principal radial roads

These are principal radial urban roads within the study area connecting the center of Tegucigalpa with sub-cores and the central governmental area. Therefore, most of these roads formulate the radial roads from the center of Tegucigalpa.

(4) Ring roads

① Inner ring road to mitigate the traffic congestion or alleviate the through-traffic within the center of Tegucigalpa

② Middle ring road to complement the east-west transportation axes as well as to exclude the through-traffic in the CBD area

③ Outer ring road to facilitate access from the central area and sub-cores to the newly-developing residential areas outside the outer ring road

The future urban structural image including the land use pattern and the structural transportation network is shown in Fig. 8.7.

8.4 Future Image of the Structure of the Central Area of Tegucigalpa

The central area of Tegucigalpa is the face of not only the study area but also Honduras. Although this area is already overcrowded by many vehicles, various activities continue to flow into this area. As suggesting by the policy of the municipality, through distributing the central administrative functions and office facilities toward the outside of this area, this area is advised to be redeveloped as follows;
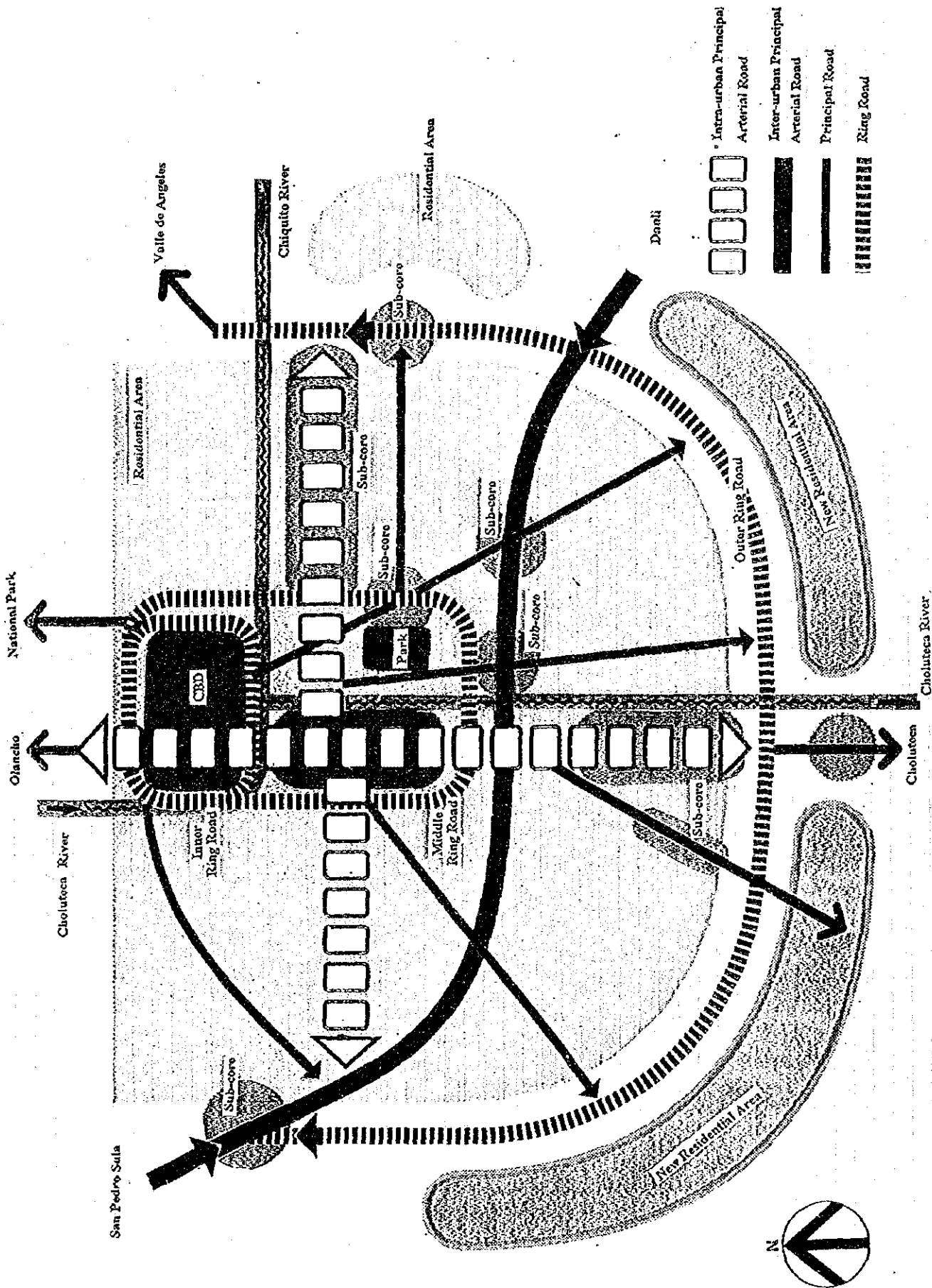
Fig. 8.7 Image of the Future Urban Structure

(1) To make clear the characteristics of this area as a district of historical, cultural, touristic and recreational district.
   * To preserve not only the historical buildings but also residences
   * To transfer the central administrative functions
   * To disperse the office facilities
(2) To improve the infrastructure from the viewpoint of the pedestrians
   * Introduction of pedestrian-only way
   * Introduction of community road
(3) To improve the access by the public transportation
   * Introduction of exclusive bus way
   * Construction of a bus terminal adjacent to the CBD area
(4) To exclude the through traffic
   * Construction of inner and middle ring road
(5) To attract tourists and citizens

CHAPTER 9   FUTURE TRAFFIC DEMAND

9.1   Process of Forecast

The future traffic demand was forecast based on the present OD table with the following four step method;

Step 1   Trip Generation and trip attraction
Step 2   Trip distribution
Step 3   Modal split
Step 4   Traffic assignment

The basic flow of forecasting the future traffic demand is shown in Fig. 9.1.

Fig. 9.1   Process of Forecasting the Future Traffic Demand

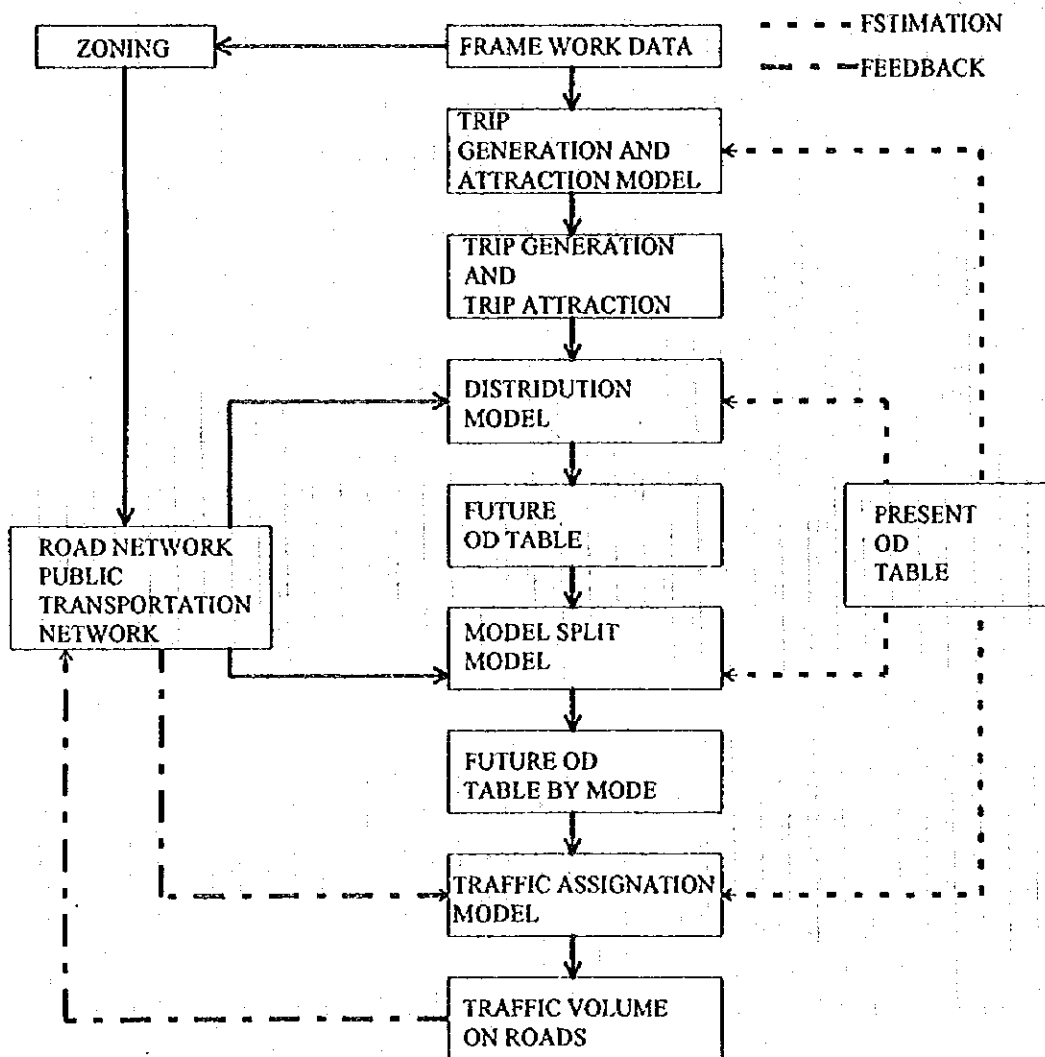

Fig. 9.1   Process of Forecasting the Future Traffic Demand

9.2 Socioeconomic Framework

The future socioeconomic framework was estimated with the cohort survival model, the economic base model and/or location quotient model, taking the future population projection by SECPLAN for the control total in the study area. As a result, the future population in the study area was forecast to increase by about 1.3 times from 674,920 persons in 1995 to 872,083 persons in 2010. On the other hand, the number of workers was projected to increase by 1.6 times from 194,321 workers to 305,860 workers. Table 9.1 shows the future socioeconomic framework.

Table 9.1   Socioeconomic Framework in the Study Area

Socioeconomic variables	1995	2010	2010/1995
Population (persons)	674,920	872,083	1.29
Density of the residential area (persons/ha)	196	179	0.91
Household (households)	150,880	211,158	1.40
Average household size (persons/household)	4.47	4.13	0.92
Workers (persons)	194,321	305,860	1.57
- Commercial sector (persons)	142,679	214,486	1.50
- Industrial sector (persons)	51,642	91,374	1.77

9.3 Model Building and Future Trip Demand

1) Trip Production

The analysis of the results of the person-trip survey indicates the significant difference of the production unit between the car-ownership and non-car ownership for their composition of trip purpose. Therefore, the future trip production in the whole study area was forecast with the trip production unit by car ownership and by trip purpose. This trip production unit is shown in Table 9.2.

Table 9.2   Trip Production Unit

Trip Purpose	Car Ownership	Non-Car Ownership
To Work	1.08	0.64
To School	0.43	0.44
To Home	1.80	1.28
Business	0.19	0.05
Private Matter	0.45	0.26
Total	3.95	2.66

The future trip production by trip purpose was projected by multiplying the future population by the trip production unit. The projection is shown in Table 9.3. The total number of trips in 2010 by persons living within the study area was projected to increase by 1.36 times to about 2.37 million trips from about 1.75 million trips in 1995. The expansion rate was 1.36 times, compared with that in 1995. The expansion rate of trips made by persons belonging to car-owning households was 2.12 times, considerably high, compared with 1.12 times of non-car-owning

households. The share of the trips made by persons belonging to car-owning households increased from 27.4 % in 1995 to 36.5 % in 2010, reflecting per capita income increment.

Table 9.3   Future Trip Production By Trip Purpose

(Unit: Trips)

Trip Purpose/ Year	1995			2010		
	Car-Owning	Non-Car-Owning	Total	Car-Owning	Non-Car-Owning	Total
To Work	111,578 (27.3%)	320,418 (23.9%)	431,996 (24.7%)	236,410 (27.3%)	359,762 (23.9%)	596,172 (25.1%)
To School	44,482 (10.9%)	219,895 (16.4%)	264,377 (15.1%)	94,248 (10.9%)	246,630 (16.4%)	340,877 (14.4%)
To Home	185,997 (45.5%)	644,762 (48.0%)	830,759 (47.5%)	394,088 (45.5%)	724,050 (48.1%)	1,118,138 (47.2%)
Business	19,743 (4.8%)	24,898 (1.9%)	44,641 (2.6%)	41,831 (4.9%)	27,718 (1.8%)	69,549 (2.9%)
Private	46,708 (11.4%)	130,772 (9.8%)	177,480 (10.1%)	98,964 (11.4%)	147,073 (9.8%)	246,037 (10.4%)
Total	408,508 (100%)	1,340,745 (100%)	1,749,253 (100%)	865,542 (100%)	1,505,232 (100%)	2,370,774 (100%)

2) Growth of Trip Generation and Attraction by Zone

Zonal trip generation and attraction   were projected with models by car-owning household/ non-car-owning household and by trip purpose, separately. Fig. 9.2 shows the volume and growth of trip generation by zone, comparing the future trip generation and the existing trip generation. A large volume of person-trips is generated in the central areas of Tegucigalpa and Comayaguela, and in zones along Boulevard Santa Fé. On the other hand, the large increase of trip generation can be seen in suburban zones, especially the western and southern parts of the study area.

LEGEND
Scale: 1cm2= 50000

2010(GEN)

1995(GEN)
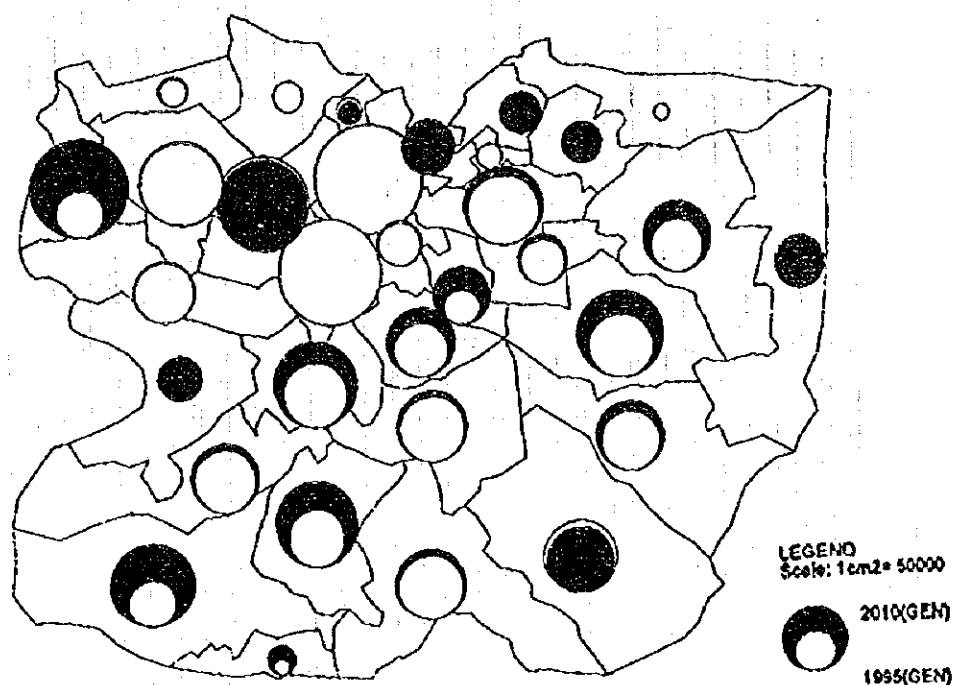
Fig. 9.2   Volume and Growth of Trip Generation by Zone

3) Trip Distribution

Trip distribution was projected with the gravity model by car-owning household/non-car-owning household and by trip purpose. Fig. 9.3 shows the total person-trip distribution between integrated traffic zones. As can be seen, the traffic still has a tendency to head for the central area of the study area. However, comparing with the present distribution pattern, the future trip distribution can be said to be dispersed further. The volume of trip distribution is larger between the central area and zones in the western part and between the central area and the southwestern area of the study area.
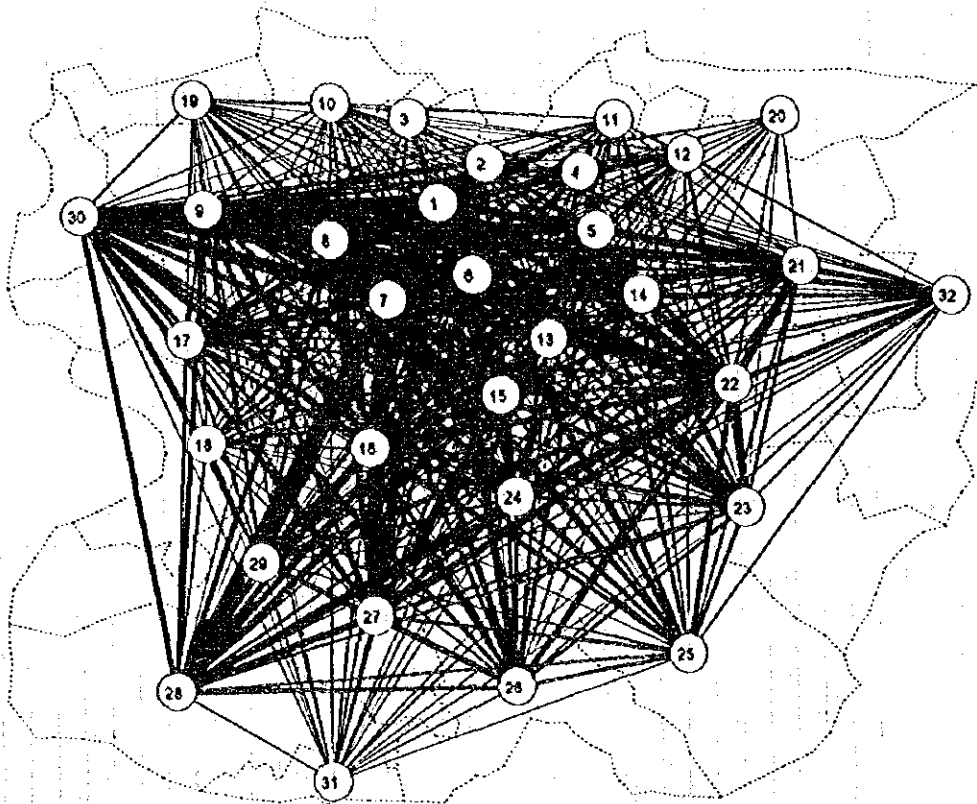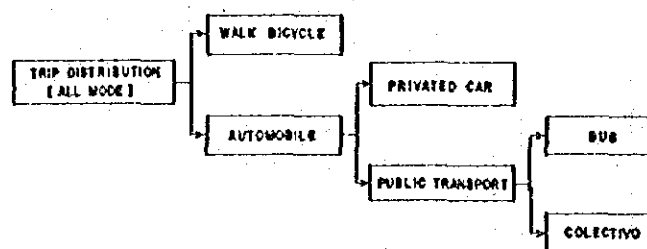

Fig. 9.3   Desired Line of All Trips in 2010

4) Trips by Mode

Trips by mode was projected with the binary choice model for "Walk Bicycle", "Private Car", "Bus" and "Taxi". The process of the binary choice is shown below; The future trips by mode shows the highest growth rate of trips of "private car" as shown in Table 9.4.

Table 9.4   Trips by Transportation Mode

Mode	1995	%	2010	%	2010/1995
Walk Bicycle	299,122	17.1	350,875	14.8	1.17
Private Car	458,304	26.2	739,681	31.2	1.61
Taxi	118,949	6.8	154,100	6.5	1.30
Colectivo	78,716	4.5	101,943	4.3	1.30
Bus	794,161	45.4	1,024,174	43.2	1.29
Total	1,749,253	100.0	2,370,774	100.0	1.36

9.4   Traffic Assignment

The future OD traffic volume was assigned on the existing road network with the QV method (this case corresponds to "Do-nothing case"). As shown in Fig. 9.4, almost all major roads will become congested by 2010. Especially, the traffic from the west to the east through Calle 9 in Comayagüela and Subida to National Stadium, traffic from the central area to the airport direction, or traffic to Colonia Kenedy through Miraflores is forecast to increase considerably. Therefore, it is necessary to make the urban transportation plan , making the focus on the above congested roads.
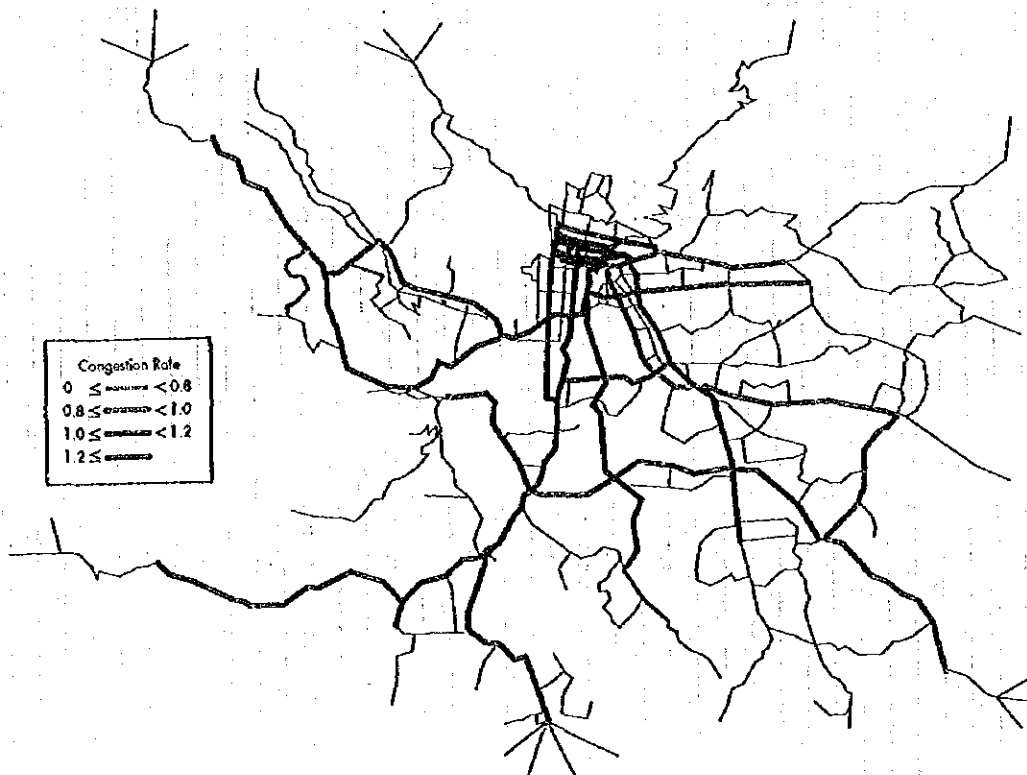
Fig. 9.4   Traffic Assignment of Future Traffic Volume
on Existing Road Network

CHAPTER 10   FORMULATION OF MASTER PLAN

10.1   Basic Concept of Master Plan

1) Position of the Study Area

The various central administrative and business functions agglomerate in this metropolitan area. As a result, all of the transportation axes start from this area to the remaining regional centers of Honduras. The basic considerations of the Master Plan were mainly identified pertaining to the characteristics of a capital city and a center of the administration, business, culture, etc., of the country. Therefore, Fig. 10.1 shows the location of these nationwide transportation axes.
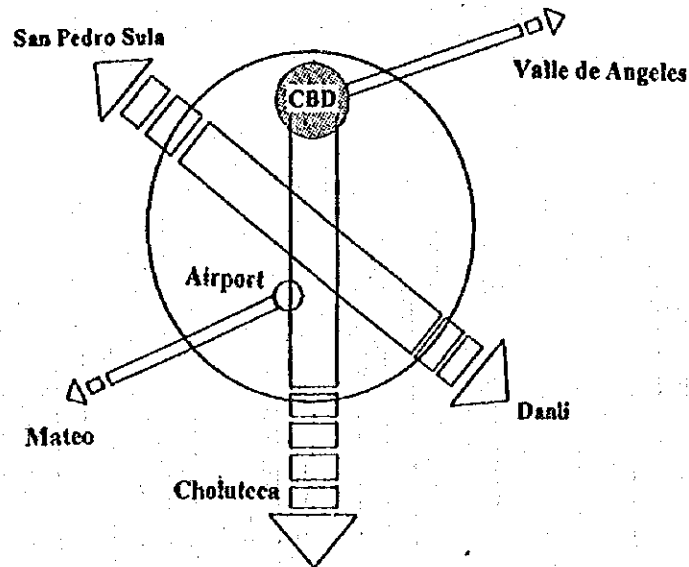

Fig. 10.1   Position of the Study Area in Honduras

2) Basic Concept

The Master Plan for the study area was formulated under the following concepts;

    ① Formulation of the city as a capital city
    ② Proper reallocation of commercial and business facilities
    ③ Creation of a comfortable life environment for citizens
    ④ Formulation of a center of history, culture and education

10.2   Issues to be Addressed and Countermeasures

1) Issues

Although the urban structure in the study area has not changed so much, comparing with the structure in the past, urbanization has sprawled drastically due to the rapid population increase. As a result, the heavy traffic congestion occurs in almost all roads in the study area. Considering that the future transportation demand will continue to increase, future traffic congestion is anticipated to become much worse. Judging from the above-mentioned goal, the following were identified as future transportation issues to be addressed in the study area;

(1) Tegucigalpa Centro
- To mitigate congestion
- To eliminate through-traffic
- To secure safety for pedestrians
- To promote utilization of public transportation
- To control on-road parking

(2) Comayagüela Centro
- To make efficient use of Avenida 6
- To improve the principal east-west transportation axes
- To control the on-road parking

(3) Transportation Network
- To improve certain sections of principal radial roads
- To improve access roads to the CBD area from planned transportation facilities such as bus terminals, truck terminals, parking lots, etc.
- To strengthen access to the airport and the new central administrative district
- To connect principal radial roads with Anillo Periferico (outer ring road) effectively
- To construct bridges at necessary places
- To improve configuration at necessary intersections

(4) Public Transportation
- To introduce the exclusive bus lanes and ways
- To secure bus U-turn areas on bus routes in the suburban areas
- To construct bus bays on necessary roads
- To rearrange the taxi stands (for "Colectivo") in the CBD area

(5) Traffic Management
- To install traffic signals at necessary intersections
- To strengthen control of on-road parking
- To improve traffic lanes, traffic signs, etc.

2) Examination of the Countermeasures

Generally, there are two critical principal countermeasures for tackling transportation problems; one is to restrain the traffic demand, the other is to increase the transportation capacity.

(1) Traffic demand restriction
- Introduction of the zone system to the CBD area

(2) Transportation network
- Construction of the new roads and bridges
- Improvement of roads
- Introduction of exclusive bus lane
- Introduction of exclusive bus way
- Introduction of railway system

As an effective measure to decrease the severe congestion on roads, the introduction of a railway system was examined, however, from a practical viewpoint, the introduction of a railway system

in the study area was abandoned, as it is financially difficult to operate railway projects in a city with a population of less than one(1) million. According to the rough cost estimation, it takes about 20 million dollars per kilometer to introduce a railway project. It is highly expensive compared with construction of an expressway (about 3 million dollars per kilometer). Considering the difficulty to charge a rate more than the existing bus fare level, it is not recommended to introduce a railway projects. Concurrently, only the road network plan can be considered in the following section.

10.3 Formulation of Master Plan

1) Goal and Policy of the Plan

(1) Goal
① To maintain a high level of transportation service
② To strengthen the public transportation network

(2) Policy
① To mitigate the traffic congestion through the increment of the transportation capacity in the Study Area
② To promote orderly urban development based on the future land use plan
③ To use the existing facilities effectively
④ To establish an efficient transportation network system
⑤ To introduce an efficient public transportation for the convenience of tbus users

2) Formulation of Transportation Network

Considering the above goal and policy, the following applicable countermeasures were judged to be necessary for formulating the Master Plan:

(1) To strengthen the intra-urban transportation axes
① The north-south transportation axis connecting the central area of Tegucigalpa with the south part of the study area including the airport
② The east-west transportation axis connecting the Santa Fe and Boulevard Morazán

(2) To strengthen the radial roads
① Centro - Southeast
② Centro - Southwest
③ Centro - West
④ Centro - Governmental area

(3) To strengthen ring roads
① Inner ring road surrounded the center of Tegucigalpa (to be newly constructed)
② Middle ring road
③ Outer ring road

(4) Access roads
① Access roads to the Anillo Periferico from the residential areas

To establish a suitable transportation network, the following projects are planned;

(1) Central area of Tegucigalpa
  • Introduction of exclusive bus way
  • Construction of an innering road around this area

(2) Central area of Comayagüela
  • Strength of the east-west transportation axis
  • Efficient utilization of Avenida 6
  • Introduction of exclusive bus way
  • Strength of the north-south transportation axis

(3) Connection of sub-core districts
  • Strength of the north-south transportation axis
  • Strength of the east-west transportation axis
  • Utilization of ring roads

(4) Connection of the outer ring road with the major radial roads
  • Efficient connection of the radial roads with the outer ring road to secure the access to the CBD and sub-core districts from the newly developed residential area.

Future transportation master plan is shown in Fig. 10.2.

10.4 Selection of Master Plan Projects

1) Alternatives of Master Plan Projects

Various projects were planned. These planned projects were categorized into the following three, judging from the critical impacts on the traffic situation;

  (1) To introduce regulations prohibiting vehicle inflow into the central area of Tegucigalpa (Regulation)
  (2) To construct a toll road connecting the central area of Tegucigalpa with Anillo Periférico using the river basin of the Cholteca River (Toll road)
  (3) To implement other projects, in consideration of the realization of the linear multi-nuclei urban structural pattern (Other projects)

The master plan project alternatives were made by combination of the above three categories. As a result, four alternatives were formulated as shown in Table 10.1.

Table 10.1 Alternatives of Master Plan Projects

Alternatives	Alternative-1	Alternative-2	Alternative-3	Alternative-4
Regulation	Implement	Implement	Not Implement	Not Implement
Toll Road	Construct	Not Construct	Construct	Not Construct
Other Projects	Implement	Implement	Implement	Implement

Fig. 10.2 Transportation Master Plan (Major Road Network)

NOTE:
Principal Road (4 lane)
Intra-urban Principal Road (4 lane)
Intra-urban Principal Road (2 lane)
Inter-urban Road (2 lane)

Carretera a Valle de Angeles

Carretera a Danlí

Blvd. Suyapa

Blvd. Miraflores

Blvd. Morazán

TEGUCIGALPA

ALAMEDA

Blvd. F.F.A.A.

Blvd. F.F.A.A.

COMAYAGUELA

Blvd. Del Norte

Aeropuerto