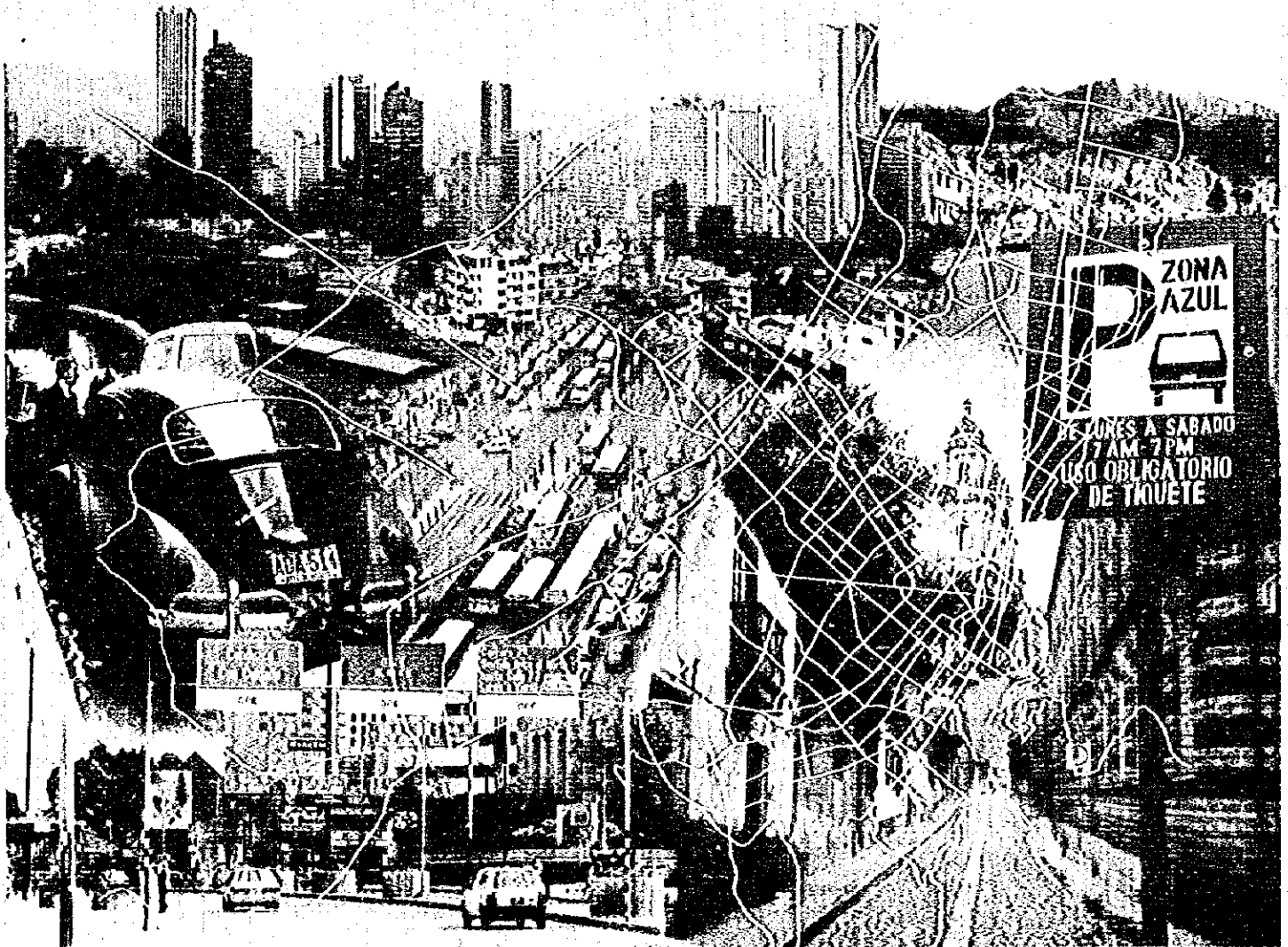


The Study on the Master Plan for Urban Transport of Santa Fe de Bogota in the Republic of Colombia

Final Report (Summary)



December 1996

JICA LIBRARY



J 1133890121

Chodai Co., Ltd.
In Association with
Yachiyo Engineering Co., Ltd.

SSF

JR

96-143

ARY



1133890 (2)

Japan International Cooperation Agency (JICA)
Santa Fe de Bogota, The Republic of Colombia

The Study on the Master Plan
for Urban Transport of Santa Fe de Bogota
in the Republic of Colombia

Final Report (Summary)

December 1996

Chodai Co., Ltd.
in Association with
Yachiyo Engineering Co., Ltd.

Exchange Rates : June 1996

- US\$ 1.00 = Peso\$ 1,059
- US\$ 1.00 = ¥109

Letter of Transmittal

December, 1996

Mr. Kimio Fujita
President
Japan International Cooperation Agency

Dear Sir,

It is a great honor for me to submit herewith the final reports of the Study on the Master Plan for Urban Transport of Santa Fe de Bogota in the Republic of Colombia.

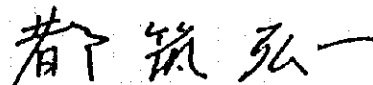
A study team, which consists of Chodai Co., Ltd. and Yachiyo Engineering Co., Ltd., headed by myself, conducted field surveys, data analysis and planning works of urban transport master plan in Colombia based on the terms of references instructed by the Japan International Cooperation Agency (JICA) from July, 1995 to December, 1996.

The study team held thorough discussions and investigations with officials concerned of the Government of Colombia, accordingly, conducted various traffic surveys, present condition analysis, future socioeconomic framework, travel demand, planning policy, and finally composed a comprehensive urban transport master plan. The results were collected in the final reports, main and urban transport training manual reports.

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

Also, I wish to express my sincere appreciation to JICA, the Ministry of Foreign Affairs, the Ministry of Construction, the Ministry of Transport, the Embassy of Japan in Colombia and other concerned government authorities for their valuable advice and cooperation given to us in the course of the site surveys and preparation of the final reports.

Yours Faithfully,



Koichi Tsuzuki

Team Leader
The Study on the Master Plan for
Urban Transport of Santa Fe de Bogota
in the Republic of Colombia

Preface

In response to a request from the Government of the Republic of Colombia, the Government of Japan decided to conduct the Study on the Master Plan for Urban Transport of Santa Fe de Bogota in the Republic of Colombia and entrusted the study to the Japan International Cooperation Agency (JICA).

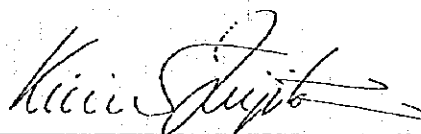
JICA sent to Colombia a study team headed by Mr. Koichi Tsuzuki, Chodai Co., Ltd., from July 1995 to December 1996.

The Team held discussions with the officials concerned of the Government of Colombia, and conducted a field survey 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 Colombia for their close cooperation extended to the team.

December 1996



Kimio Fujita

President
Japan International Cooperation Agency

The Study on The Master Plan for Urban Transport of Santa Fe de Bogota in The Republic of Colombia

Study Duration: July 1995 - December 1996
Requesting Organization: Santa Fe de Bogota

Outline of the Study

1. Study Background

Santa Fe de Bogota, the capital city of Colombia, is recently experiencing urban transport problems caused by insufficient transport facilities against to the rapid growth of population. Since Bogota does not have an urban railway transport system, road traffic is becoming heavily congested due to increase in car ownership. Although several types of transport plans were made as urgent measures, the investment effects of these projects were insufficient due to lack of comprehensive urban transport master plan.

In order to resolve the urban transport problems, assistance to prepare the comprehensive urban transport master plan study in Santa Fe de Bogota was requested by the Colombian government from the Japanese government. The Study was conducted in accordance with the agreed Scope of Work.

2. Objectives

The objectives of the Study are as follows;

- 1) To formulate a Master Plan on the Comprehensive Urban Transport System in Santa Fe de Bogota.
- 2) To transfer relevant technology to Colombia counterpart personnel in the course of the Study.

The year 2020 is defined as the target year for the Master Plan Study, and the years 2010 and 2001 are adopted as target years for the Mid- and Short- Term Plans, respectively.

3. Study Area

The Study Area for the Master Plan covers the city of Santa Fe de Bogota, but the socioeconomic framework study focuses on the city of Bogota and its surrounding areas.

4. Study Duration

The Study was commenced in July, 1995 and completed in December, 1996.

5. Outline of the Study

(1) Present Condition Analysis

- Data collection and its analysis.
- Various traffic and transport surveys.
- Identification of transport problems.

(2) Future Socioeconomic Framework and Travel Demand

- Population: 8.6 million in Bogota and 2.4 million in surrounding municipalities in 2020 (1.45 times the present population).
- Total number of person trips: 17.41 million (1.55 times that of the present).
- Car ownership: 1.35 million (2.7 times the present).

(3) Planning Policies

- To orient to a public transport network and system.
- To improve and to strengthen road network.
- To improve traffic management system.

(4) Comprehensive Urban Transport Master Plan

A total of 67 package projects are recommended in the Comprehensive Urban Transport Master Plan of Bogota. All projects are economically and technically feasible. Total cost is estimated at US\$ 9,239 million (1996 prices). The investment allocation is about 30% of the total amount for public transport projects. The balance will be 20% for urban expressway projects and 50% for road projects.

1) Road sector

- Existing Road Improvement Projects.
- New Road Construction Projects.
- Urban Expressway Construction Projects.

2) Public Transport sector

- Trunk Bus System Development Projects.
- Bus Express System Development Projects.
- Railway System Development Projects.

3) Traffic Management sector

- Traffic Control System Improvement Projects.
- Parking Facility Projects.
- Bicycle Road Network Projects.

(5) Evaluation of the Master Plan

1) Economic Aspects

- Economic evaluation: EIRR = 42.4%
B/C = 5.33
NPV = US\$ 12,100 million

2) Financial Aspects

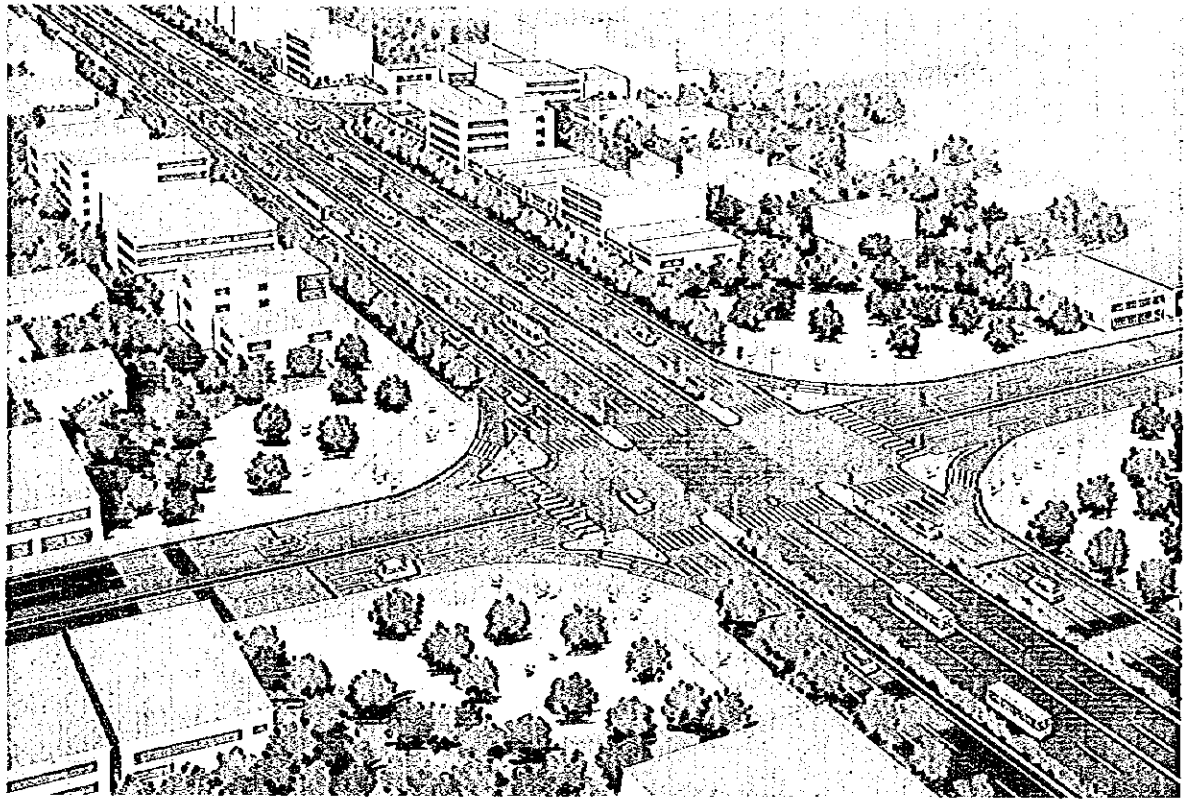
About US\$ 250 to 350 million will be required annually for execution, while the average annual budget for the infrastructure in Bogota is about US\$ 100 to 150 million. Therefore, introduction of the toll system, tax increase, and other financial measures should be considered for the implementation of the Master Plan.

3) Environment Aspects

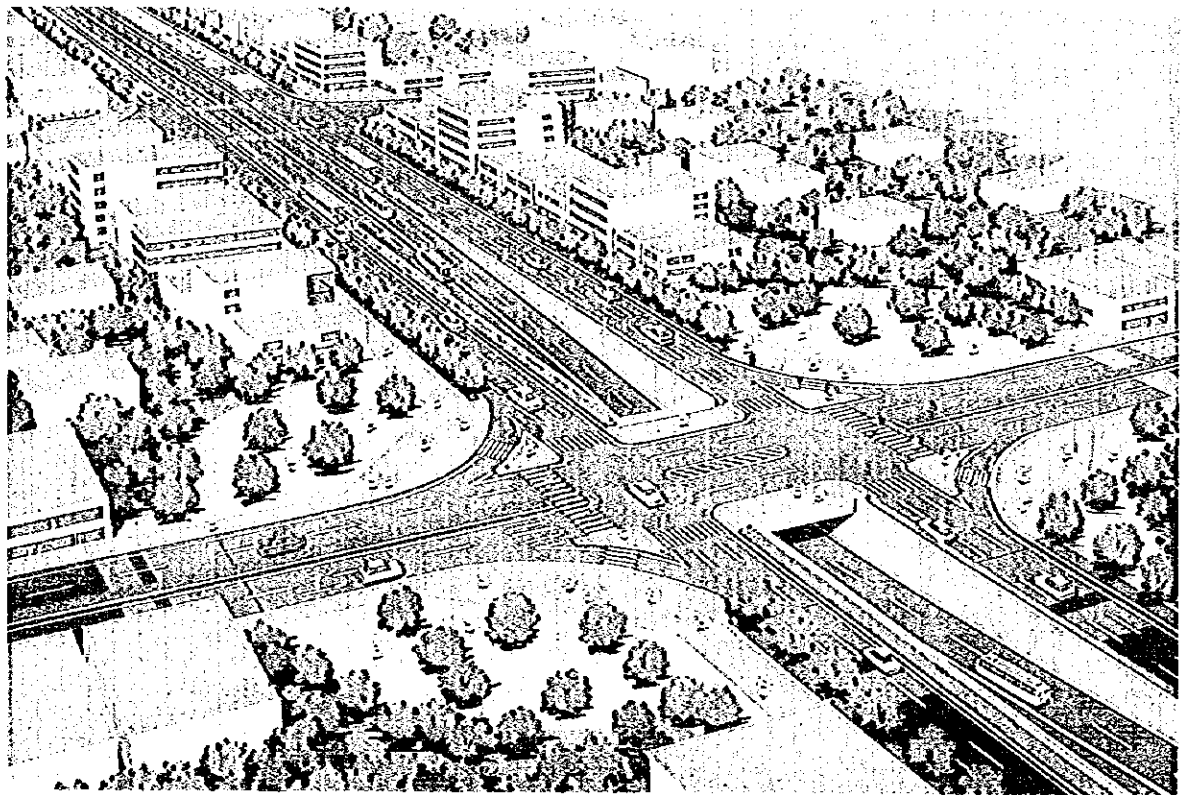
The adverse environmental impacts by proposed projects will be low near the project areas. In planning the urban expressway, landscape harmony with surrounding areas should be maintained.

4) Traffic Aspects

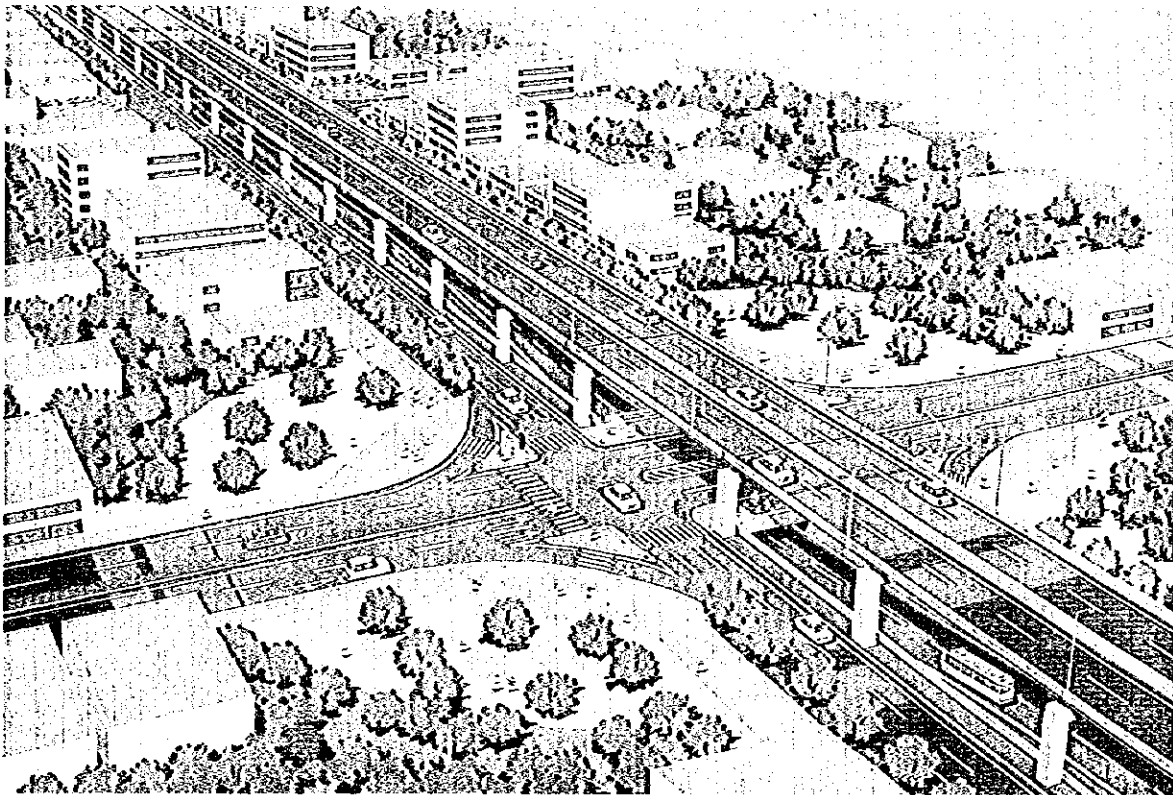
The traffic conditions in Bogota will be significantly improved by the Master Plan projects. The traffic service level in 2020, however, will be insufficient. It is necessary to execute traffic demand management measures for mitigation of the traffic congestion without large investment.



Perspective View of Proposed Trunk Bus Project



Perspective View of Proposed Express Bus Project



Perspective View of Proposed Urban Expressway and Express Bus Project

TABLE OF CONTENTS

1. Introduction	2
2. Socioeconomic Background	4
3. Person Trip Characteristics	6
4. The Problems in Urban Transport	8
5. Future Urban Development Plan	10
6. Future Transport Demand.....	12
7. Basic Planning Concept.....	14
8. Alternative Transport Networks.....	16
9. Road Sector Plan.....	18
10. Public Transport Sector Plan.....	22
11. Traffic Management Sector Plan.....	26
12. Implementation Plan.....	28
13. Comprehensive Transport Master Plan.....	32
14. Transport Demand Management (TDM).....	34
15. Recommendations.....	36
Study Organization Members.....	38

List of Tables

Table 2-1	Employed Population by Sector and Places of Work	4
Table 5-1	Future Population Distribution in the Study Area	10
Table 6-1	Summary of Socioeconomic and Travel Demand	12
Table 8-1	Transport Network Alternative Plans	17
Table 9-1	Traffic Demand on Major Roads in 2020	18
Table 9-2	Outline of Urban Expressway Plan	19
Table 12-1	Implementation Schedule and Corresponding Investment	29

List of Figures

Figure 1-1	Location of the Study Area	3
Figure 1-2	Study Organization	2
Figure 2-1	Land Use Compositions in the Study Area in 1995	4
Figure 2-2	Land Use Regulation for Bogota	5
Figure 3-1	Composition of Trip Purpose	6
Figure 3-2	Composition of Trip Mode	6
Figure 3-3	Trip Generation and Attraction by Trip Mode	7
Figure 3-4	Desire Line Chart by Trip Mode	7
Figure 4-1	Photograph of Traffic Conditions in Bogota	9
Figure 5-1	Population Increase in Bogota and Surrounding Cities	11
Figure 5-2	Future Urban Development Pattern	11
Figure 6-1	Trip Desire Line Chart by All Purposes and Modes in 1995 / 2020	13
Figure 6-2	Traffic Demand on Existing Road Network in 1995 and 2020	13
Figure 7-1	Characteristics of Population Distribution and Traffic Flows	15
Figure 7-2	Important Transport Axis in Bogota Metropolitan Area	15
Figure 8-1	Relation Between Service Level and Project Cost	17
Figure 8-2	Transport Network Alternative Plan-K, Plan-M and Plan-O	17
Figure 9-1	Location of Existing Road Improvement Plan	20
Figure 9-2	Location of Grade Separated Intersection Plan	20
Figure 9-3	Location of New Road Construction Plan	21
Figure 9-4	Location of Urban Expressway Plan	21
Figure 10-1	Trinity of Short-Term Subjects in Public Transport Plan	24
Figure 10-2	Structural Reform of Bus Service Industry	24
Figure 10-3	Trunk Bus Network Plan	24
Figure 10-4	Zoning for Zone Fare System	24
Figure 10-5	Schematic Chart of Public Transport Evolution	23
Figure 10-6	Mass-Transit Network Plan	25
Figure 10-7	Expansion of Railway Network and Change in Operation System	25
Figure 11-1	Location of Facility Improvement Plan	27
Figure 11-2	Underground Parking Facility	27
Figure 11-3	Image of Pedestrian Moll on Calle 85	27
Figure 11-4	Sidewalk Improvement Plan (Carrera 15)	27
Figure 11-5	Concept of Route Location of Bicycle Road	27
Figure 12-1	Investment Cost by Year	28
Figure 12-2	Implementation Projects by Each Phase Plan	30
Figure 13-1	Comprehensive Urban Transport Master Plan in 2020	33
Figure 14-1	Traffic and Financial Impact by TDM	35

1. INTRODUCTION

1.1 Background

Santa Fe de Bogota, the capital city of Colombia, faces acute urban transport problems caused by insufficient transport facilities combined with rapid growth of population. Since Bogota does not have urban railway transport system, road traffic has become heavily congested, aggravated by an increase in car ownership.

Recently, several types of transport plans were put into effect as urgent measures, such as Av. Caracas Trunk Bus Project assisted by the World Bank, in addition to other road improvement projects. However, the effects of these projects were insufficient due to the lack of a comprehensive urban transport master plan.

In 1993, in order to resolve the urban transport problems, the Colombian government requested the Japanese government for assistance to carry out a comprehensive urban transport master plan study in Santa Fe de Bogota.

1.2 Study Development

In response to the request of the Government of the Republic of Colombia, the Government of Japan decided to conduct the Study on the Master Plan for Urban Transport of Santa Fe de Bogota (hereinafter referred to as the Study). The Japan International Cooperation Agency (hereinafter referred to as JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, undertook the Study in close cooperation with the appropriate authorities in Colombia. The preparatory Study Team, headed by Dr. Koichi Yamagata, was dispatched by JICA to Colombia and the Scope of Work for the Study was agreed upon in March 1995.

The site study in Colombia began in July, 1995 and continued until December, 1996. In the course of the Study, the following Reports were submitted to the Government of Colombia.

- | | | | |
|--------------------------|-----------|----------------------------|----------------|
| a) Inception Report..... | July 1995 | c) Draft Final Report..... | September 1996 |
| b) Interim Report..... | June 1996 | d) Final Report..... | December 1996 |

1.3 Study Purpose

The objectives of the Study are as follows;

- 1) To formulate a Master Plan on the Comprehensive Urban Transport System in Santa Fe de Bogota.
- 2) To transfer relevant technology to Colombia counterpart personnel in the course of the Study.

1.4 Scope of the Study

- 1) Target Year; The year 2020 is defined as the target year for the Master Plan Study, and the years 2010 and 2001 are adopted as target years for the Mid- and Short- Term Plans, respectively.
- 2) Study Area; The Study Area covers Santa Fe de Bogota (see Figure 1-1).

1.5 Study Organization

To conduct the Study, JICA organized the Study Team, headed by Mr. Koichi Tsuzuki, and the Advisory Committee, chaired by Dr. Koichi Yamagata, to provide the advice for the Study. The Government of Colombia organized the Counterpart Team and created the Steering Committee, chaired by Dr. Antanas Mockus, Mayor of Santa Fe de Bogota. Figure 1-2 shows the study organization.

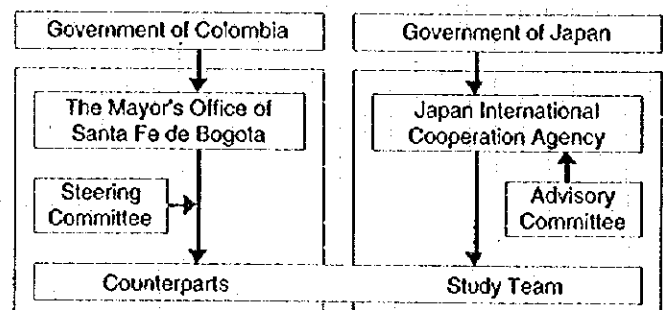
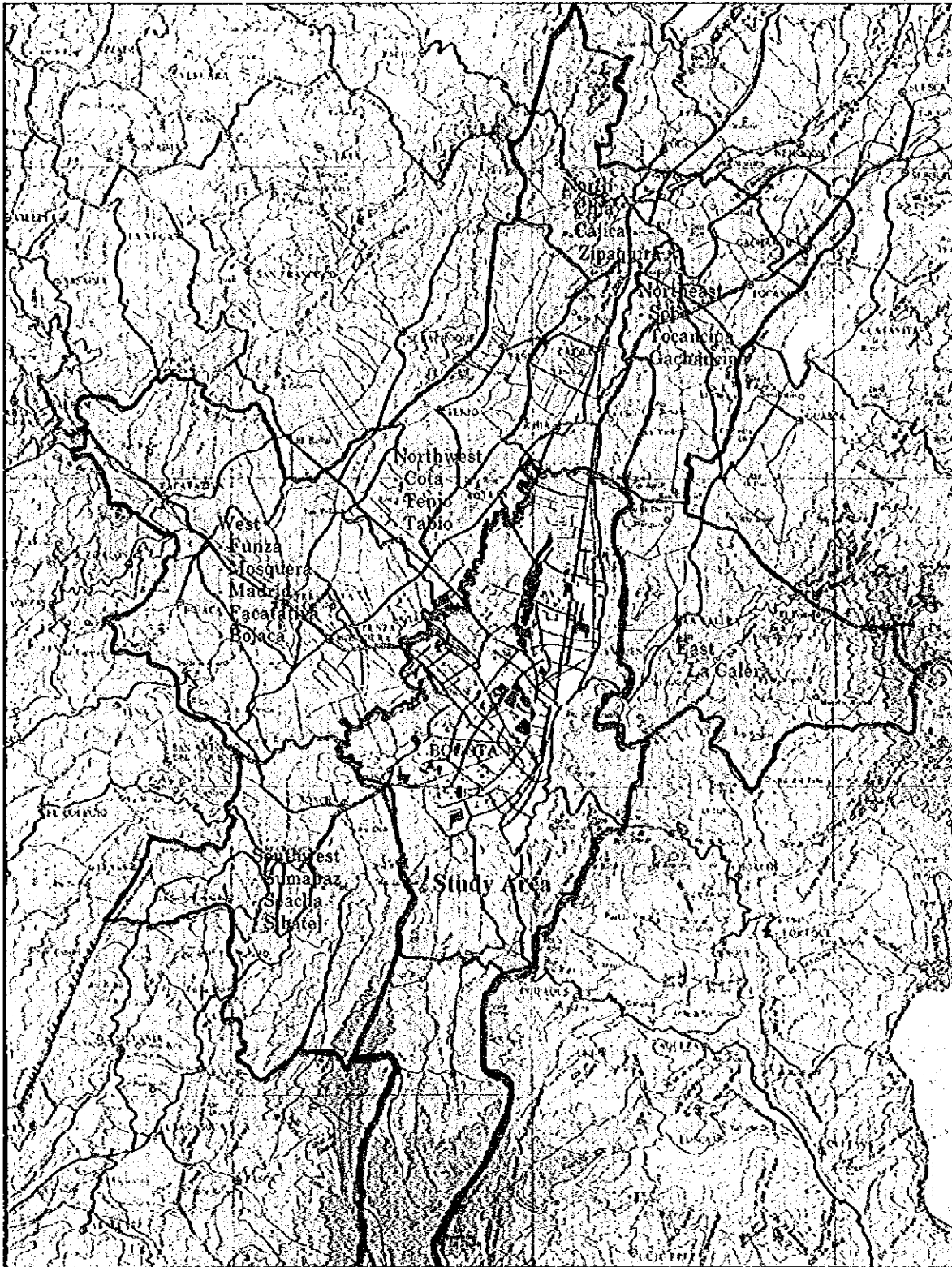


Figure 1-2 Study Organization



0 5 10 15 20km



Legend:
 — Study area boundary
 — Metropolitan area boundary
 — Municipality boundary outside study area

Figure 1-1 Location of The Study Area

2. SOCIOECONOMIC BACKGROUND

2.1 Profile

The Republic of Colombia is a country bordered by Panama on the north-west, Venezuela on the north-east, Ecuador and Peru to the south, and Brazil on the east, with a surface area of 1,140,000 km² and a population of 35,000,000. The Study Area, Bogota, is located on a plateau approximately 2,600 meters above sea level in the center of the country with an area of 49,000 hectares. Bogota has grown as the national Capital, and also as the economic, financial, social, and cultural center. As the city grows, Bogota and its surrounding cities have been formed into the Bogota Metropolitan Area.

2.2 Population

The population of the Study Area is estimated based on the results of Person Trip Survey and data from the population census in 1985 and 1993. As of 1995, the populations of the Study Area and surrounding cities are estimated at 5,995,000 and 816,000, respectively.

2.3 Economic Conditions

From 1990 to 1995, the annual growth rate of the regional economy was 4.56 %. This is slightly higher than the national economic growth of 4.49%. In the Study Area, the primary sector is almost negligible. In the Capital City, the tertiary sector is prominent and occupies about 30 % of the national total. The employment in each economic sector is shown in Table 2-1. Although the secondary sector occupies more than 20%, the tertiary sector is prominent. A total 91,200 persons (3.9% of the total employed persons) go to work in the surrounding towns.

Table 2-1 Employed Population by Sector and Places of Work

Economic sectors	Inside Bogota	Outside Bogota	Study Area Total	
			Persons	%
Primary	16,800	10,900	27,700	1.2
Secondary	549,400	24,000	573,400	24.2
Tertiary	1,708,300	56,300	1,764,600	74.6
Total	2,274,500	91,200	2,365,700	100.0

Source: Person Trip Survey

2.4 Land Use Conditions

The Study Area is limited by the hilly area to the east and Rio Bogota to the west. The urban form of Bogota is longer in north to south direction. The administrative, commercial and business center is located in the traditional Center, but commercial and business activities extend to the north; originally towards Chapinero, then to the area around Calle 72, and most recently to the Santa Barbara and Santa Coloma areas.

Figure 2-1 and Figure 2-2 show land use compositions in the Study area in 1995 and land use regulation in Bogota, respectively. The land use of the Study Area is regulated by the legal standard in accordance with Resolution 6 of 1990. The total land area of the Study Area is about 49,000 hectares. Existing residential areas are about 19,200 hectares which is 40 % of the total area. The area of land which has development potential is 20,100 hectares.

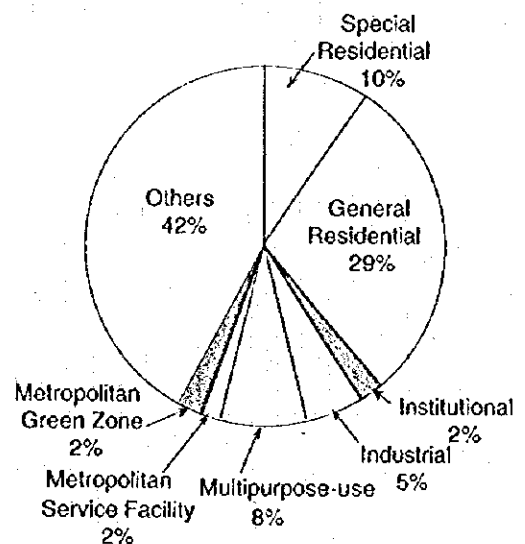


Figure 2-1 Land Use Compositions in the Study Area in 1995

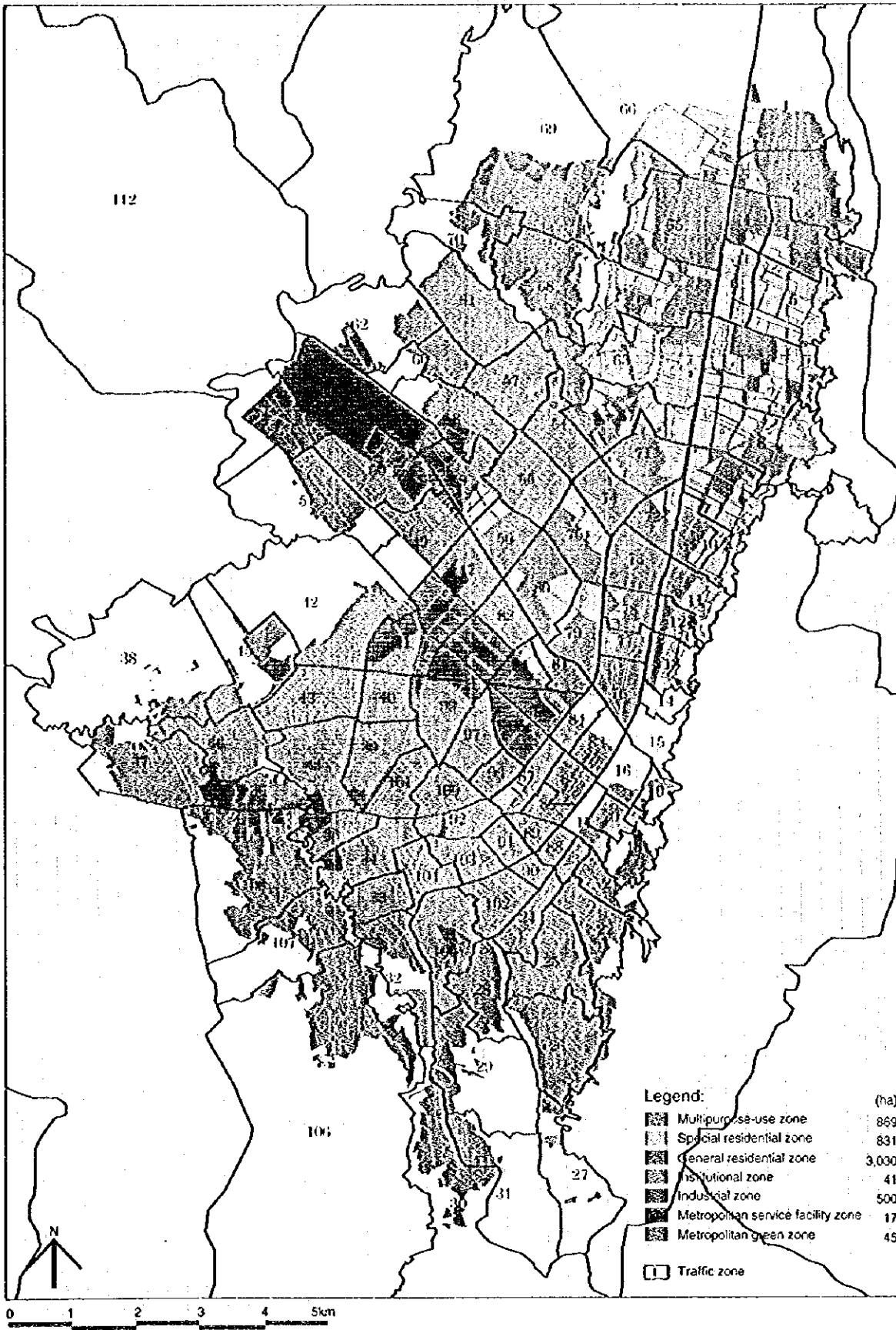


Figure 2-2 Land Use Regulation for Bogota

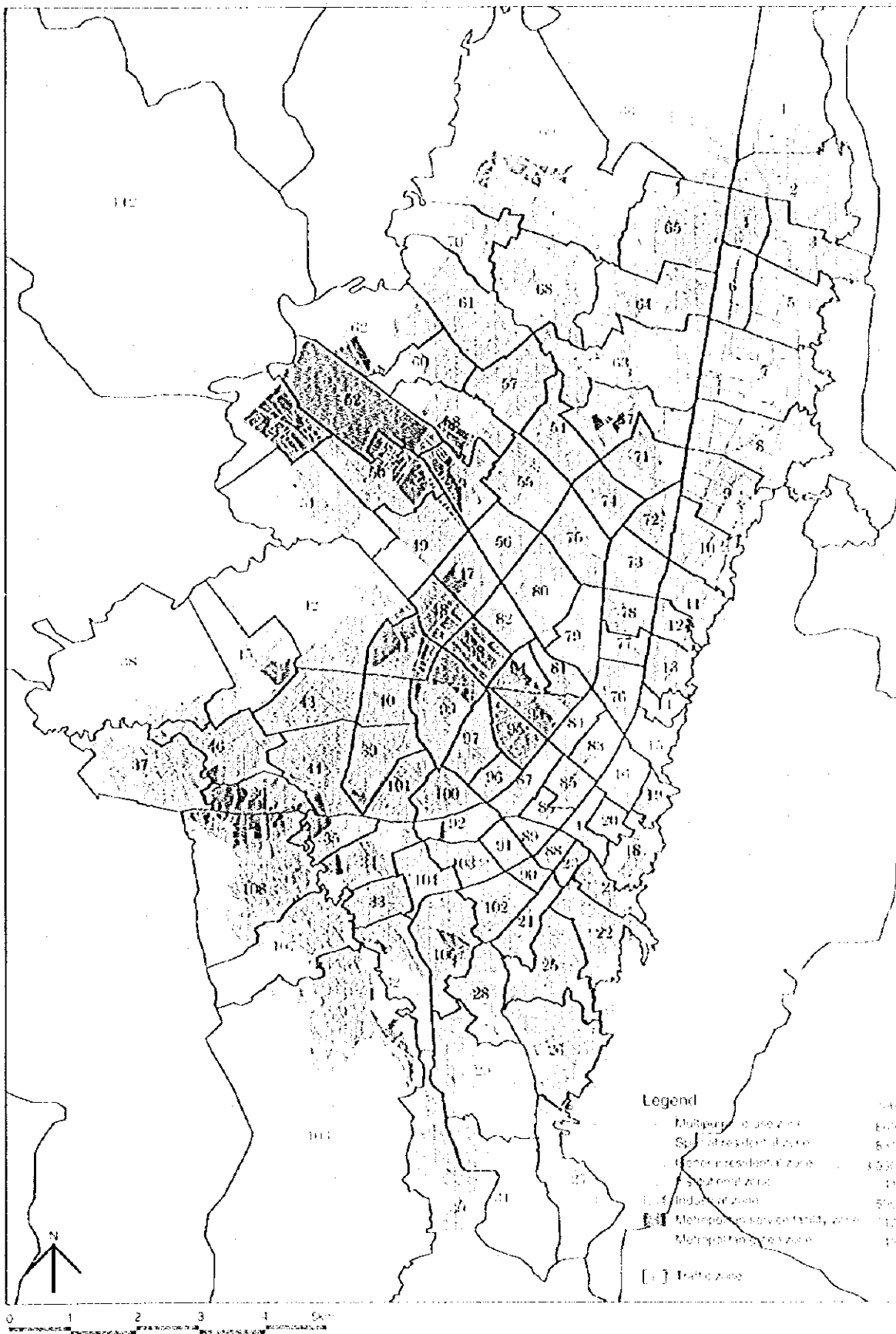


Figure 2-2 Land Use Regulation for Bogotá

3. PERSON TRIP CHARACTERISTICS

3.1 Total Number of Trips

The total number of trips in the Study Area is 14.9 million per day in 1995, of which 14.6 million trips are made by residents in the Study Area, and 298 thousand trips are made by non-residents. Most trips (98%) are made within the Study Area. The trip purpose composition of "to home" is the highest (44%), followed by 24% for "to work", 13% for "to school", 13% for "private", and 6% for "business" (see Figure 3-1). Figure 3-2 shows the composition of trip mode. Approximately 80% of total trips are made by public transportation including bus and taxi, and the remaining 20% are by private.

As for hourly number of trips on trip generation, there are three peak hours in a day; morning, afternoon, and evening. The morning and evening peak hour ratios are approximately 14% and 10%, which occur between 6:00 to 7:00 a.m., and between 5:00 to 6:00 p.m., respectively.

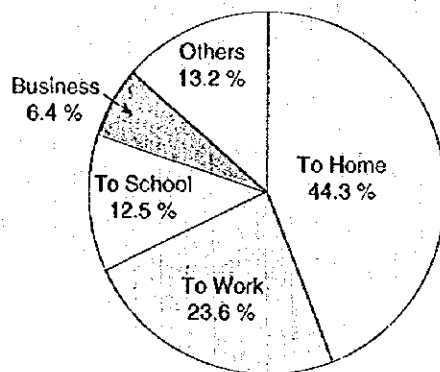


Figure 3-1 Composition of Trip Purpose

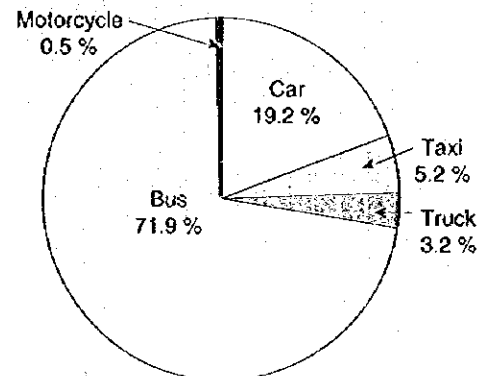


Figure 3-2 Composition of Trip Mode

3.2 Trip Production Rate

The trip production rate by sex is 2.38 for male, and 1.66 for female, and the trip production rate for tertiary sector workers ranges from 3.0 to 4.0 per day. The trip production rate is 2.43 for car owning households, while it is 1.78 for non-motorized households. This shows that the trip production rate is closely related to whether or not a household owns a car.

3.3 Trip Generation and Attraction

Figure 3-3 shows trip generation and attraction by zone and transportation mode; car and bus. The generated and attracted trips in zone No.6 by bus are outstanding at 1.2 million. The zones with higher car generation and attraction are zone No.6, No.4 and No. 21 where are located in central and northern areas.

3.4 Trip Distribution

Judging from the desired line charts shown in Figure 3-4, there are large flows between the central areas which are composed of zones No.5 and No.6 and residential zones in the suburbs. The business trips are also concentrated in zones No.5 and No.6. The travel time of the "to work" trips shows three peaks, around 20-25 minutes, 35 minutes, and 70 minutes.

3.5 Car Ownership

The total number of passenger cars owned in Bogota is about 500,000 in 1995, of which 33% are registered outside Bogota by residents dwelling in Bogota. However, they are actually used in Bogota.

The percentage of motorized households who own a car is approximately 30% of the total. The multiple car owning families who own 2 cars or more are 7% of the total, equivalent to 25% of the motorized households. Zones showing high car ownership are zones No.1, No.2, No.11 which are also high in monthly average income.

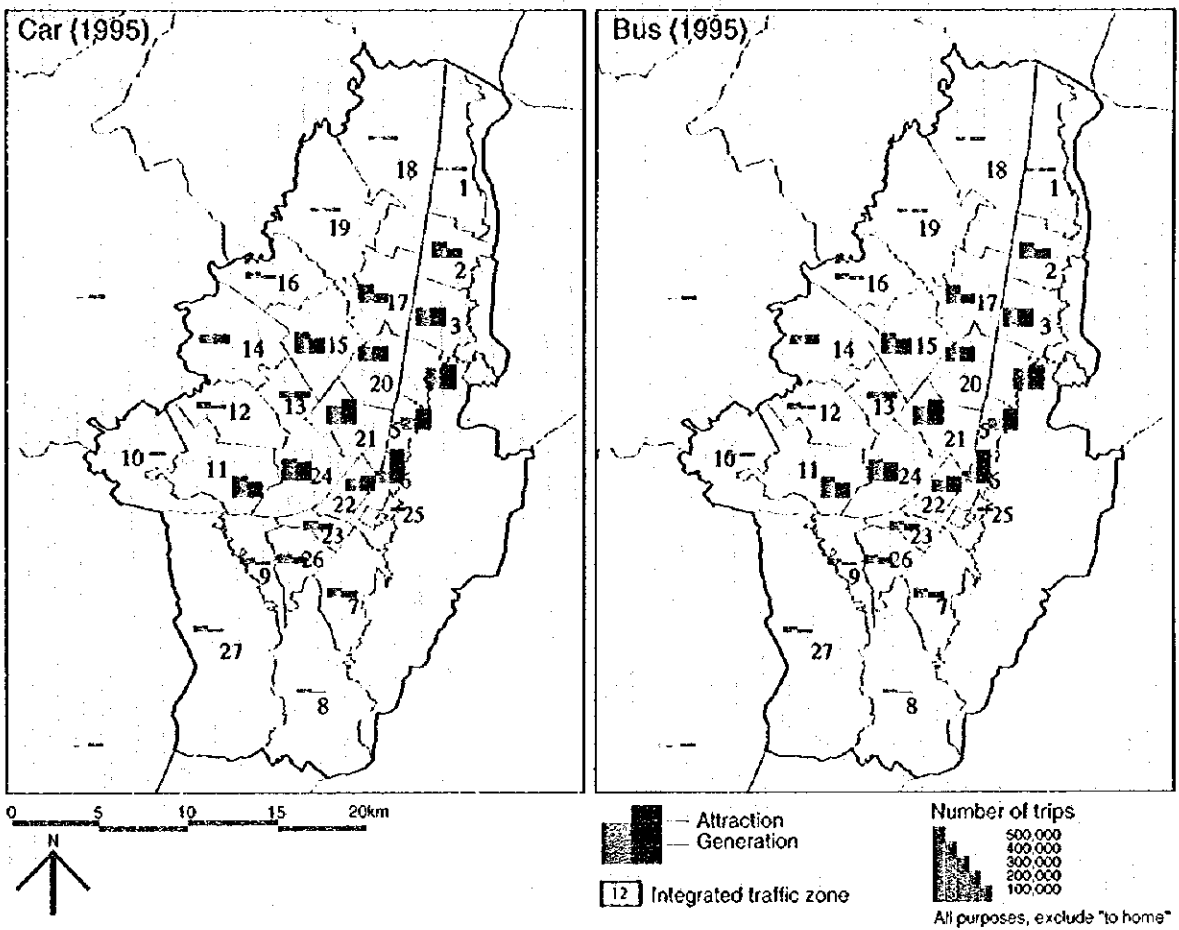


Figure 3-3 Trip Generation and Attraction by Trip Mode

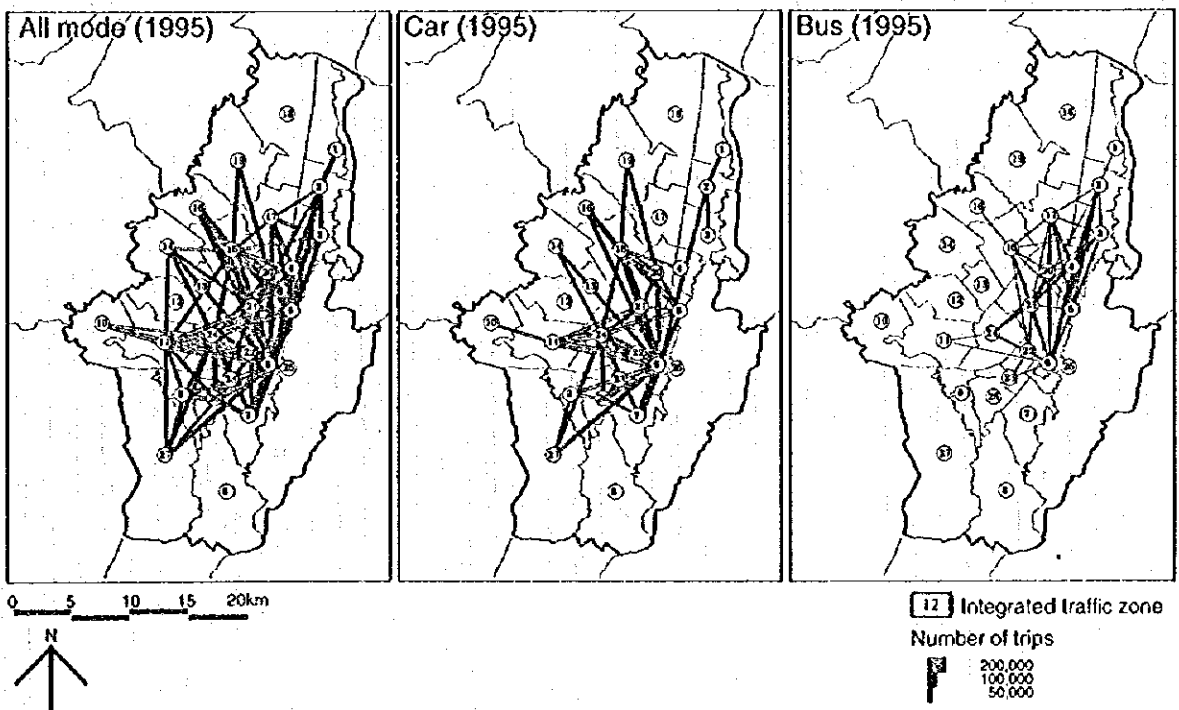


Figure 3-4 Desire Line Chart by Trip Mode

4. THE PROBLEMS IN URBAN TRANSPORT

4.1 Problems of Urban Transport

The following traffic and transport problems and issues are identified through the analysis of present traffic conditions.

(1) From the Viewpoint of Road Facilities.

- 1) Incomplete trunk road network with missing road links.
- 2) Shortage of number of lanes.
- 3) Shortage of roads.
- 4) No shoulder space on either side of the major roads.
- 5) Poor maintenance of pavement on roads and sidewalks.
- 6) Poor maintenance of drainage facilities and system.

(2) From the Viewpoint of Traffic Management

- 1) The traffic flows concentrated in the central area.
- 2) Average travel speed on major roads is lower than 5 km/h.
- 3) Malfunction of the major intersections.
- 4) Many traffic accidents occur at intersections.
- 5) Traffic education for drivers and pedestrians is very weak.
- 6) Malfunction of traffic signals.
- 7) Shortage of the traffic safety facilities.

(3) From the Viewpoint of Public Transport

- 1) Prevailing illegal operation on unauthorized routes and route cutting.
- 2) No respect for laws and regulations.
- 3) Loading and unloading at non bus stop.
- 4) Too many bus routes concentrated on some major roads.
- 5) Lack of safety and security in buses.
- 6) No transport terminal facilities.
- 7) Reckless bus driving with bad manner.

Figure 4-1 shows traffic conditions in Bogota which show long queues at major intersections in the central and suburban areas.

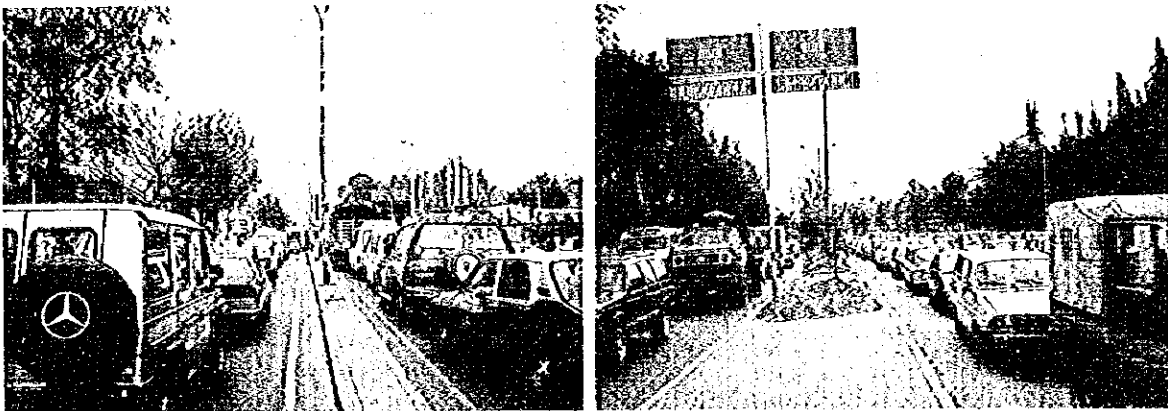
4.2 Issues of Urban Transport

There are many traffic and transport problems in Bogota. As the city grows, with an increase of population and economic activities, the above mentioned problems will become more serious. Considering these conditions, the following issues are mentioned as these to be considered in the planning.

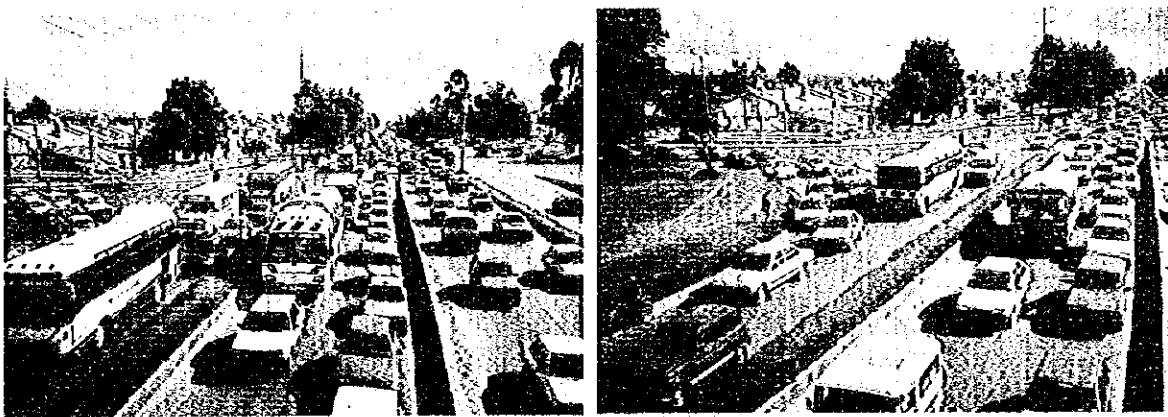
- 1) How to improve the driving courtesy for bus operation.
- 2) How to divert the traffic demand from the private car to public transport.
- 3) How to decrease the traffic congestion in the central area.
- 4) How to mitigate the traffic congestion on the major roads.
- 5) How to create the functional mass transit system.
- 6) How to maintain well-balanced urban development in Bogota.
- 7) How to develop the transport corridors between Bogota and surrounding cities.



(1) Traffic conditions on Av. Caracas in Central Area



(2) Long Queue at Major Intersections in Urban Area



(3) Long Queue at Major Intersections in Suburban Area

Figure 4-1 Photograph of Traffic Conditions in Bogota

5. FUTURE URBAN DEVELOPMENT PLAN

5.1 Socioeconomic Framework

The Colombian economy has been growing at an annual rate of 4.5 % during the 25 year period from 1970 to 1995. The government aims to maintain a growth rate higher than 5 % for the future, based on the discovery of new oil fields in the Departamento de Casanare.

The Study team decided to adopt an average economic growth rate of 5.2 % as the target for the long-term national economic growth of Colombia by 2020, considering that 6 % economic growth rate is required for Colombia to catch up with the Asian tigers. The scale of the Colombian economy will expand to 3.4 times the present one, and the GRDP per capita will rise to 2.5 times the present level; i.e., from about 2,000 to 5,000 US\$.

5.2 Future Population and GRDP in the Study Area

Table 5-1 shows the 2020 population distribution plan for the Study Area. The future population of the Study Area will reach 8.6 million in 2020 and increase by 1.44 times during the 25 -year period since 1995. The net migration into the Study Area will gradually decrease from 300,000 persons per 5 years to almost the balance level (4,000 persons) in 2020. The total population of surrounding cities such as Cajica, Chia, Cota, Funza, Mosquera, and Soacha is forecasted at 2.4 million in 2020, and the population of the Bogota Metropolitan Area will reach at 11.0 million in 2020. Figure 5-1 shows these future population increases in Bogota and surrounding cities.

The future annual economic growth rate of the Study Area is determined to be 5.2 % as the target for the improvement of the total urban environment of the Capital City. The share of the national GDP will rise to 22 %.

Table 5-1 Future Population Distribution in the Study Area

(1) Study Area

Area	1995	2020
Usaquen / Suba	960,000	2,500,000
Fontibon / Engatiba	1,152,000	1,500,000
Bosa / Kennedy / C. Bol	1,289,000	1,850,000
Teusaquillo	166,000	250,000
Others	2,428,000	2,500,000
Total	5,995,000	8,600,000

(2) Surrounding Cities

Area	1995	2020
North	220,000	750,000
Northeast	30,000	70,000
Northwest	39,000	150,000
West	173,000	650,000
Southwest	318,000	700,000
East	36,000	80,000
Total	816,000	2,400,000

(3) Study Area by Wards

Name of Ward	1995	2020
1 Usaquen	415,006	801,958
2 Chapinero	173,473	193,481
3 Santa Fe	147,959	152,991
4 San Cristobal	405,833	411,507
5 Usme	212,080	230,428
6 Tunjuelito	219,585	225,398
7 Bosa	265,706	417,361
8 Kennedy	660,692	876,106
9 Fontibon	317,100	366,798
10 Engatiba	834,563	1,025,427
11 Suba	544,637	1,751,048
12 Barrios Unidos	236,698	245,888
13 Teusaquillo	166,388	277,476
14 Los Mártires	129,800	133,167
15 Antonio Narino	158,016	160,575
16 Puente Aranda	385,188	390,556
17 La Candelaria	29,321	30,930
18 Rafael Uribe	330,567	335,279
19 Ciudad Bolivar	362,424	616,875
Total	5,995,000	8,646,247

5.3 Urban Development Pattern and Land Use

The present urban structures of Bogota can be called a mono-nucleated pattern, although the business/commercial district extends to the north through Chapinero towards Usaquen. For the future urban development pattern of Bogota, the following three (3) patterns could be considered (see Figure 5-2).

a) Mono-nucleated Pattern b) New Town Pattern c) Poly-nucleated Network Pattern

The Mono-nucleated Pattern will worsen the existing traffic problems. On the other hand, the New Town Pattern is very difficult to realize, and it is feared that the economic activities of Bogota will lose their vitality if mobility in the area declines too much. It is considered that the Poly-nucleated Network Pattern is the most realistic and can be developed by making efforts to strengthen the present policies for planning and development.

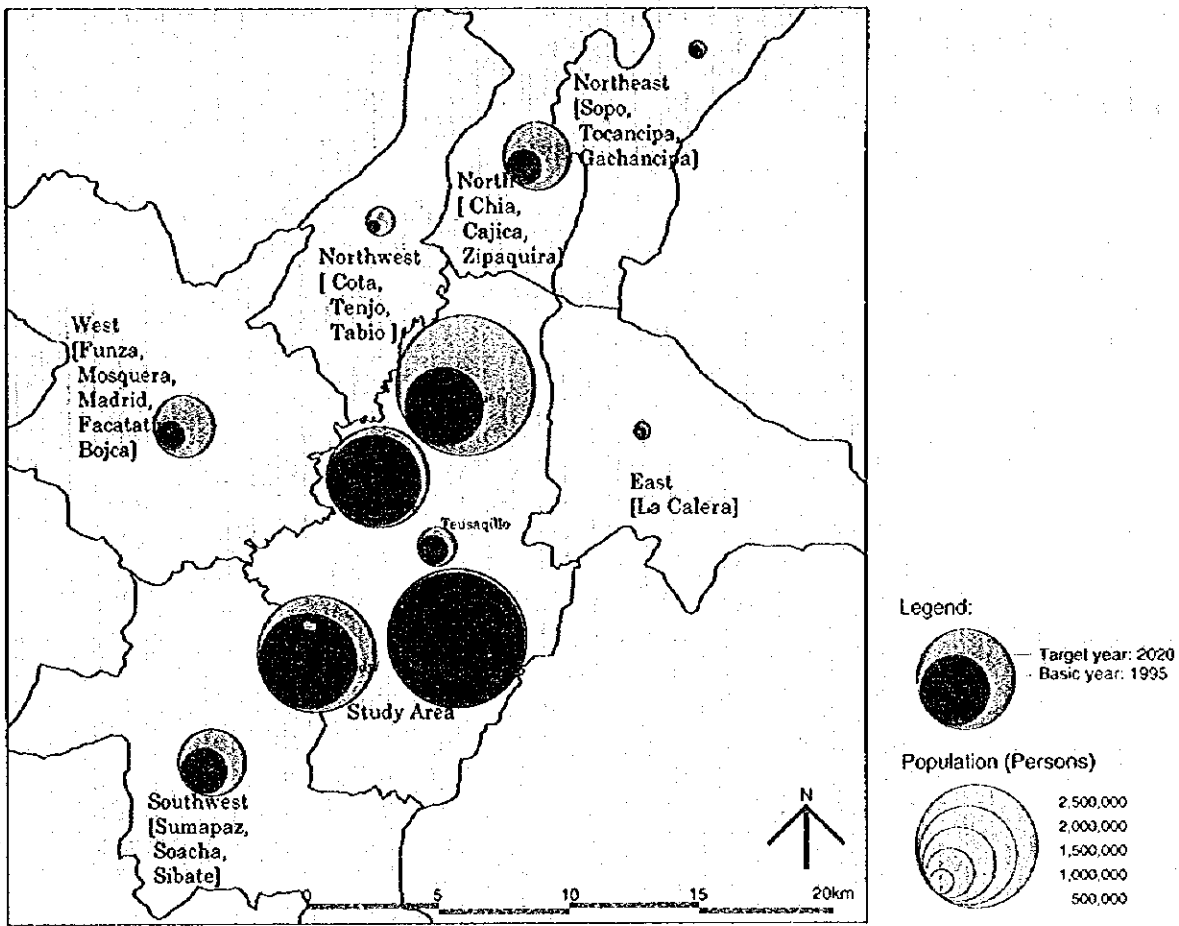


Figure 5-1 Population Increase in Bogotá and Surrounding Cities

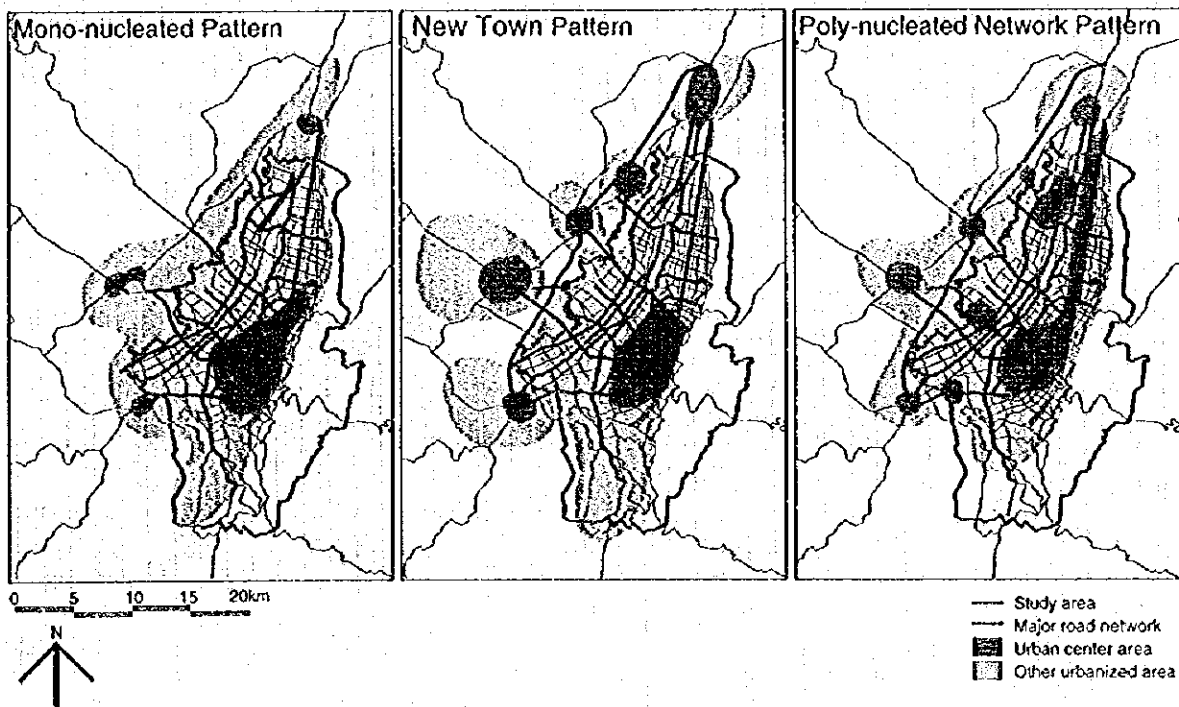


Figure 5-2 Future Urban Development Pattern

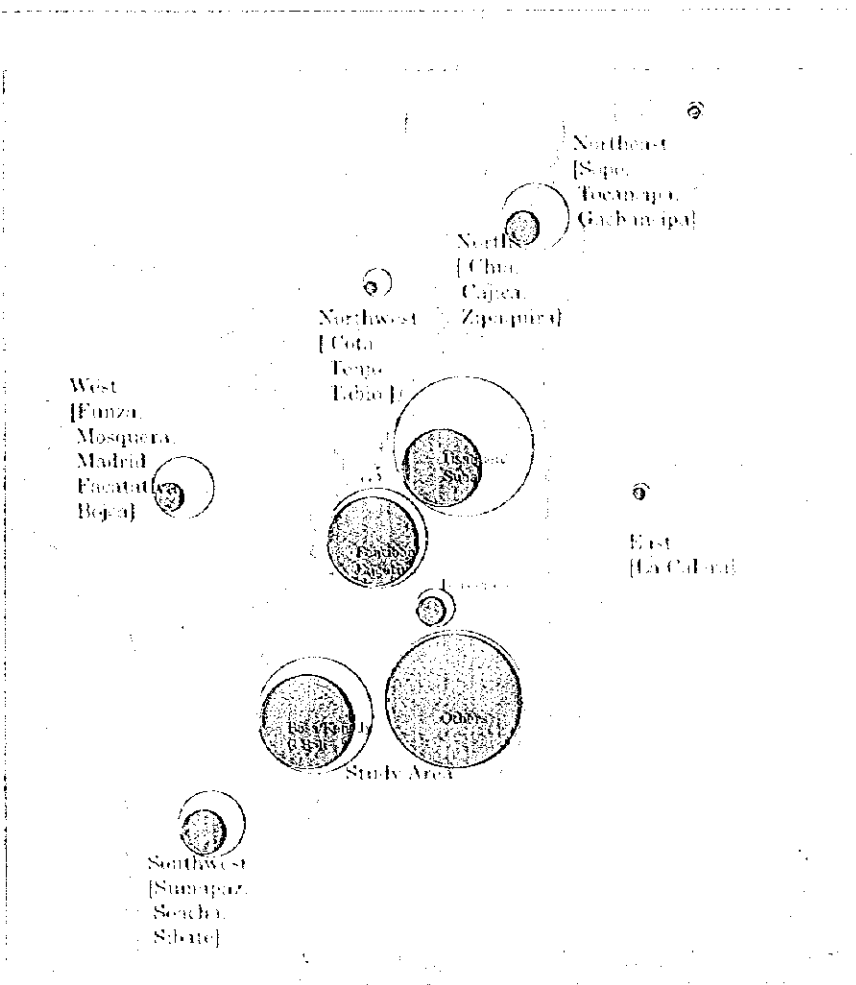


Figure 5-1 Population Increase in Bogotá and Surrounding Cities



Figure 5-2 Future Urban Development Pattern

6. FUTURE TRANSPORT DEMAND

6.1 Increase of Person Trips

The total number of person trips per day in the Study Area in 2020 is forecasted at 17.41 million. The trip increase rate will be 1.55 times from 1995 to 2020, while the population growth rate will be 1.45 times at the same period. Hence, the trip production rate in terms of number of trips per person over 5 years old will rise from 2.01 to 2.15. Summary of travel demand is shown in Table 6-1.

Table 6-1 Summary of Socioeconomic and Travel Demand

Indicators	1995 Year		2020 Year		2020/1995
1 Population (5 years or more)	5,569,633		8,093,524		1.45
2 Number of Cars	497,747		1,350,000		2.71
3 Car Ownership (veh./1,000)	83.0		156.1		1.88
4 Number of Households	1,280,292	1.000	1,830,038	1.000	1.43
1) Non-Motorized	901,232	0.704	959,915	0.525	1.07
2) Motorized Households	379,060	0.296	870,123	0.475	2.30
5 Daily Trips for Residents in Bogota					
1) Number of Trips per Person	2.01		2.15		1.07
2) Total Daily Trips	11,196,830		17,410,563		1.55

6.2 Increase of Motorized Households

The future number of cars is estimated based on the relation between car ownership and GRDP per capita. The estimated number of cars in 2020 is 1.35 million, and car ownership is 156 cars per 1,000 persons (see Table 6-1). The growth rate of cars is about 2.7 times for 25 years from the year 1995 to 2020. The number of motorized households will sharply increase in the northern areas of Bogota between the year 1995 and 2020, in accordance with higher income level of the inhabitants.

6.3 Trip Generation and Attraction

The increase rates of trip generation between 1995 and 2020 in northern and western areas are dramatically higher (2.0- 5.0), while in central areas they are somewhat higher (1.2- 1.8). On the other hand, areas with high growth in trip attraction in 2020 are the existing business/commercial areas and their surrounding areas.

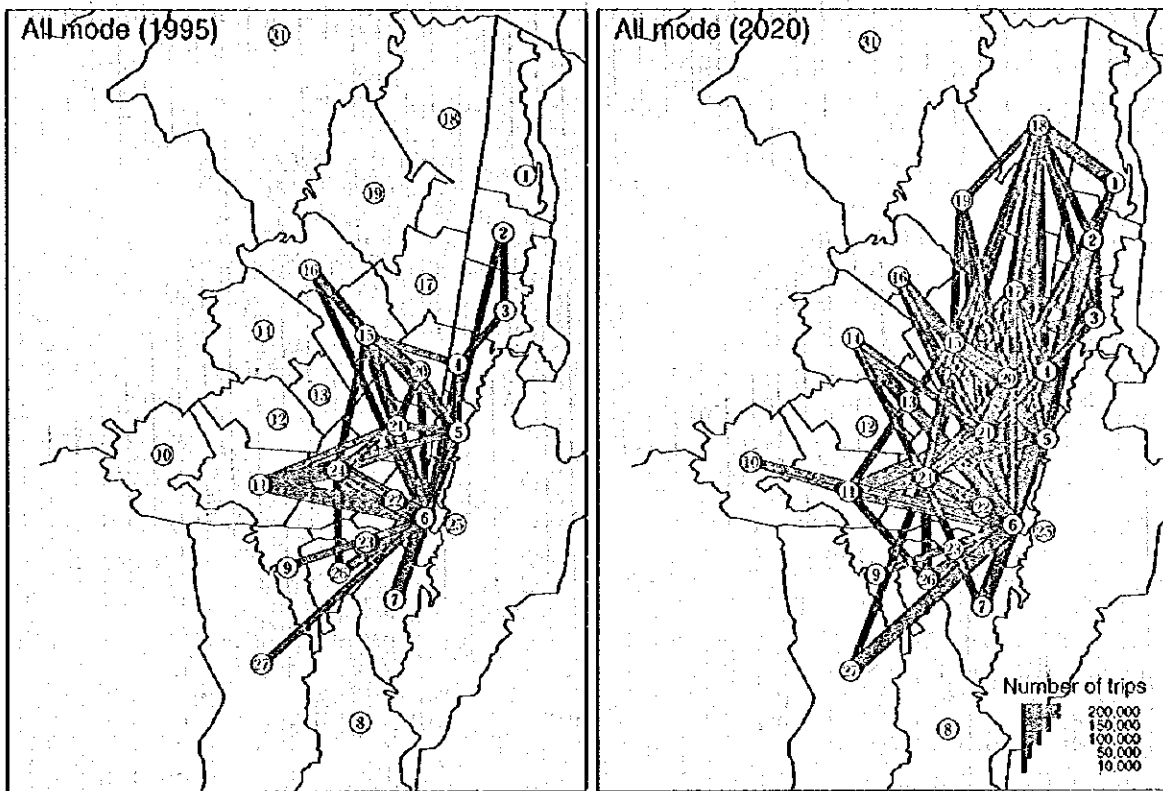
6.4 Trip Distribution

Figure 6-1 illustrates the desire lines by all purposes and modes for interzonal trips in 1995 and 2020. As seen, the heavy trip flows in 2020 will be extended to the whole Study Area, and particularly into the northern areas. Comparing the traffic characteristics between the year 1995 and 2020, strong desire lines are seen within the central area of Bogota both in 1995 and 2020, major OD trips between the central areas and the suburban areas such as Suba, Bosa, and Fontibon are expected to increase considerably. The traffic in the central area will still be heavy.

As for the modal split, trips using public mode increase at approximately 1.31 times of the present while the private mode will increase by 2.19 times. The share of trips by public mode is 60% in 2020, in contrast to 70% in 1995. The private mode increases from 30% in 1995 to 40% in 2020.

6.5 Traffic Assignment on the Existing Road

In order to briefly evaluate the capacity of the existing road network, the 2020 year's future traffic demand is loaded to the existing road network. The traffic demands in 1995 and 2020 are shown in Figure 6-2. As can be seen, the ring and radial trunk roads will be congested with a massive traffic volume. The volume-capacity ratio (V/C) on these roads will obviously exceed 1.0, if no improvements are made to the transport network.



12 Integrated traffic zone

Figure 6-1 Trip Desire Line Chart by All Purposes and Modes in 1995 and 2020

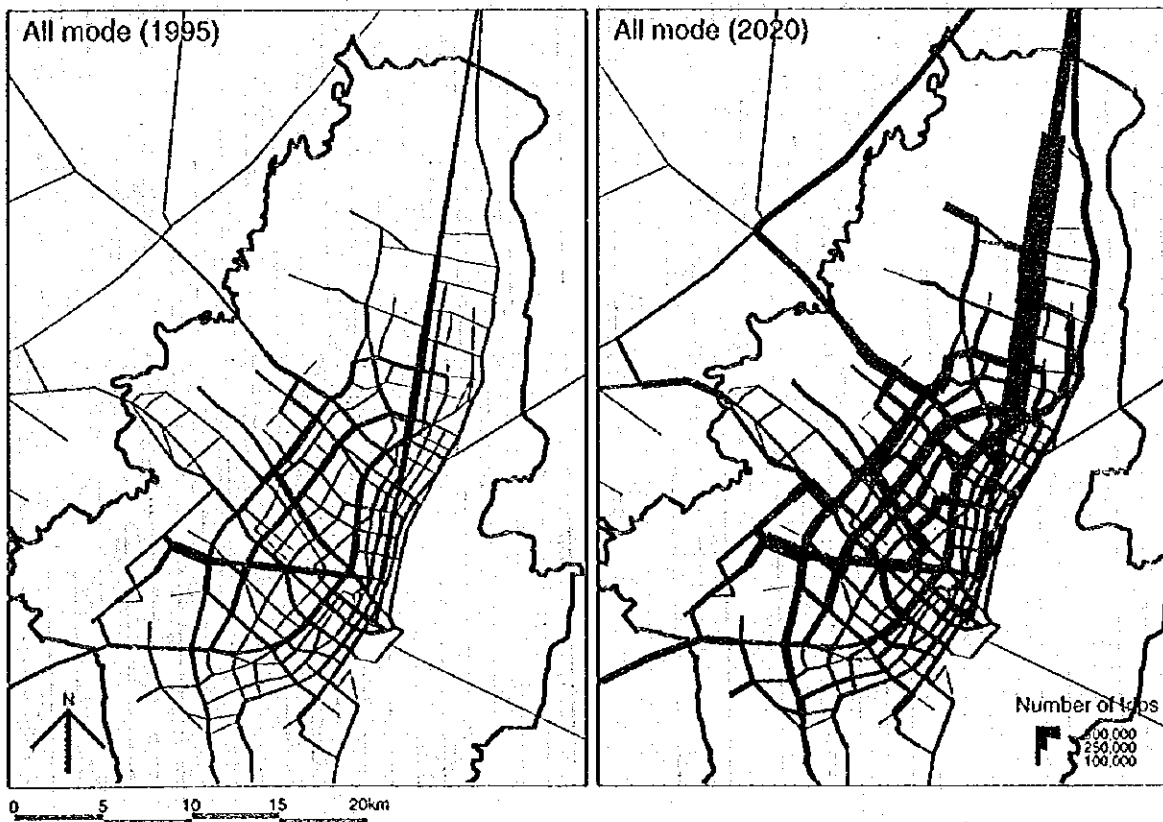


Figure 6-2 Traffic Demand on Existing Road Network in 1995 and 2020

7. BASIC PLANNING CONCEPT

7.1 Urban Transport Direction in Future

The main points of future urban transport issues are followings;

- 1) By the year 2020, the population of the Study Area and surrounding cities will increase to about 11 million, and these areas will form the more integrated Metropolitan Area of Bogota.
- 2) According to the future traffic desire line, the future traffic flows will be concentrated around the Central Business District (CBD) which is surrounded by Av. Quito and Av. 7a. This is a similar pattern to the present one. The traffic flows from northern areas will increase to approximately 3 times the present values. Therefore, in these areas, the traffic congestion will be heavier in the year 2020.
- 3) Approximately 70% of the total trips use the bus transport in 1995, in contrast with about 60% in 2020. The majority of transport modes in the future will still use the public transport. Therefore, it is essential to develop public transport as well as road networks.
- 4) At present, the level of bus transport service is low. It is indispensable therefore to improve the service level of the public transport for the future.

7.2 Basic Planning Concepts

Considering the above discussions, the following planning concepts are identified.

- 1) Future transport axes should be planned based on future land use conditions and population distribution. Figure 7-1 illustrates three important transport axes; 1) within centro, 2) centro and suburban areas, and 3) suburban areas and surrounding municipalities.
- 2) Bogota and surrounding municipalities will form a more integrated Metropolitan Area. Therefore, major transport network should be developed between those municipality areas within the Metropolitan Area. Figure 7-2 shows major traffic flows which must be reinforced between those areas.
- 3) In order to maximize the investment effect of projects, travel demand management (TDM) will be indispensable in future. In the Master Plan, case studies are conducted for several measures to assess their effect.
- 4) The public transport system should be strengthened by improving existing public transport system, introducing bus way system, and introducing mass-transit system.
- 5) The road network system should be improved by strengthening the road network in the central area, strengthening the ring and radial road network, and maintaining the functional road network.
- 6) The traffic management system should be improved by ensuring a smooth and safe traffic flows and improving the traffic regulations and traffic safety education.

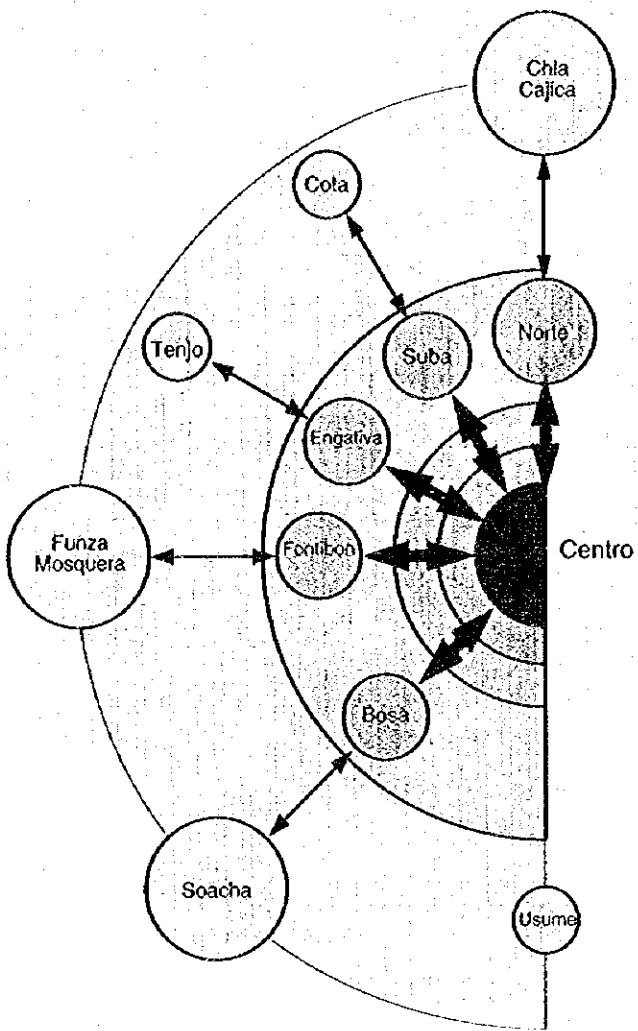


Figure 7-1 Characteristics of Population Distribution and Traffic Flows

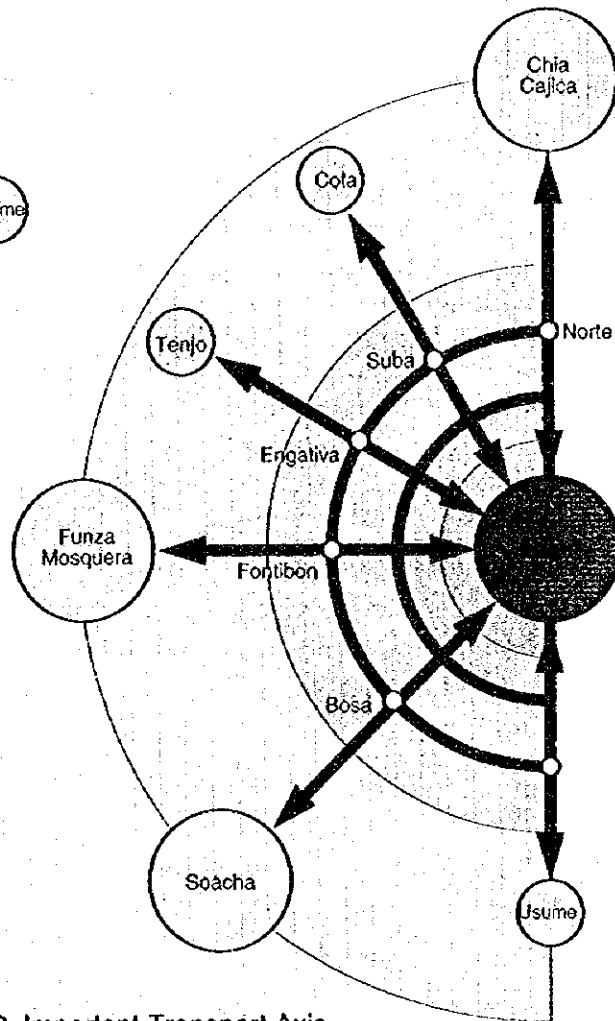
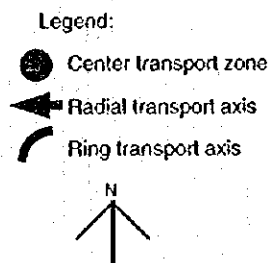


Figure 7-2 Important Transport Axis in Bogotá Metropolitan Area

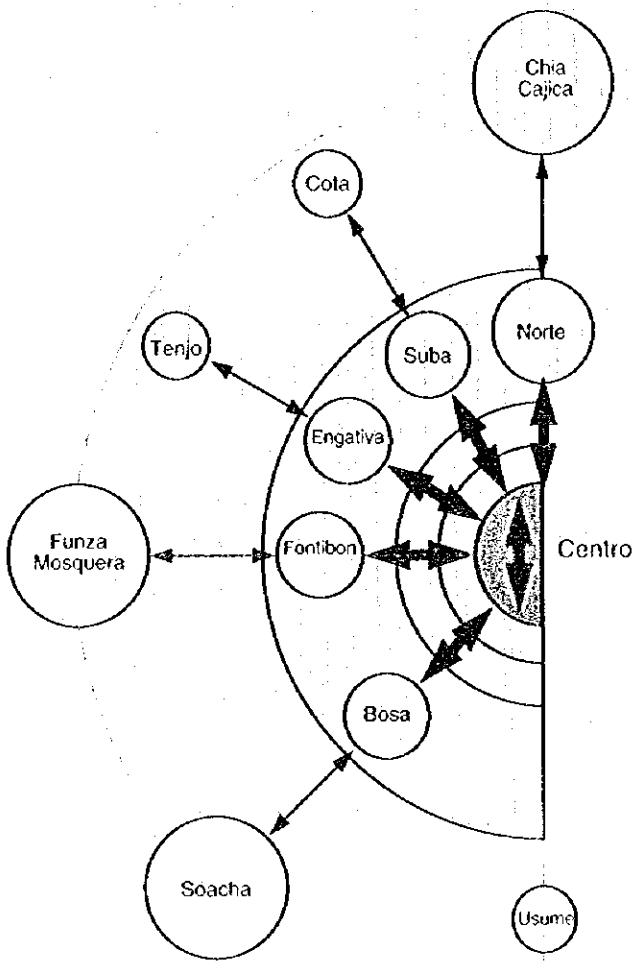


Figure 7-1 Characteristics of Population Distribution and Traffic Flows

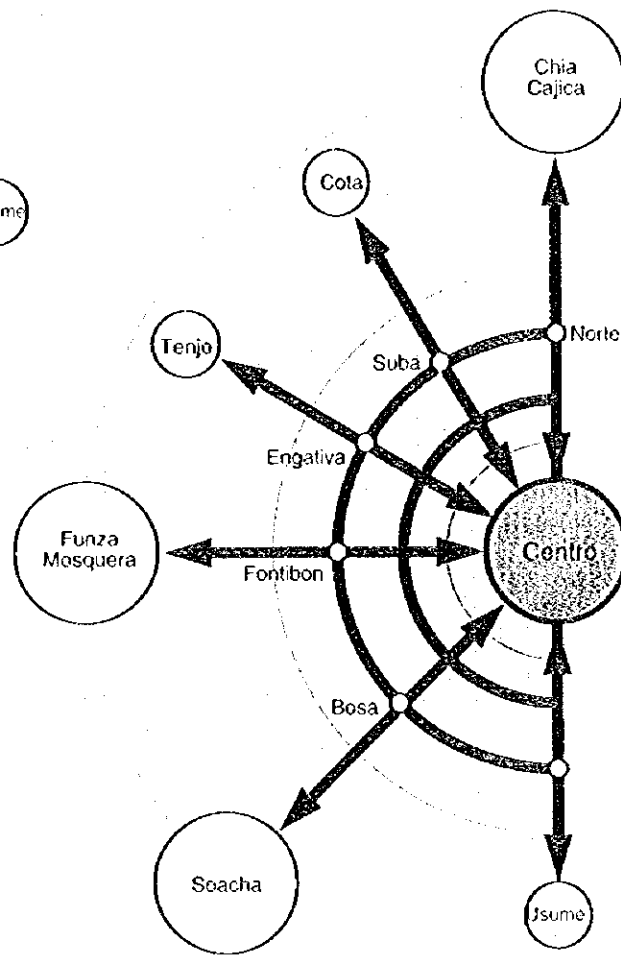


Figure 7-2 Important Transport Axis in Bogota Metropolitan Area

8. ALTERNATIVE TRANSPORT NETWORKS

8.1 Seventeen (17) Alternatives

In order to formulate the Comprehensive Urban Transport Master Plan, the Alternative Transport Networks were prepared by combining the public transport and road network development plans. In this Study, 17 Alternatives were evaluated. The best Alternatives among them were selected for study in the Master Plan.

The alternative transport network plans will consider the following matters.

- 1) to increase the capacity of transport facilities to meet the future traffic demand for public and private transport.
- 2) to enhance the public transport system through introduction of high traffic service level and facilities, and to control transport demand by encouraging traffic diversion from passenger car use to public transport use.

The 17 Alternatives are developed as shown in Table 8-1. Each alternative is composed of at grade roads, urban expressway, segregated busway, and railway system. Alternative A (875 km planning length) is the future road network plan in Bogota formulated by DAPD, is employed as a base case to estimate the effectiveness of alternatives. In Alternative B (933km), several major roads are added to the Alternative A's road network. Alternative C (933km+ 92km: Expressway) adds the urban expressway system to the Alternative B's network.

Alternatives P, D, and E include three segregated busway routes (total 110km) to the base network, while in Alternatives Q, F, and G, three rapid railway routes (total 110km) are planned. Alternatives H to O represent combination plans of busway and railway routes over three routes.

8.2 Selected Transport Network Alternative Plan

The 17 Alternatives were analyzed as shown in Figure 8-1 which shows the relation between service level and project cost. The following relationship can be seen:

- 1) There is a relationship between service level in terms of average travel speed and investment cost up to the point where cost reaches US\$ 8000 million. Beyond the US\$ 8,000 million, the service level is close to reaching its limit (see Figure 8-1).
- 2) Three mode networks: urban expressway, busway and railway networks, are needed from the view points of traffic and transport service level.

Alternative Plan-K, Plan-M, and Plan-O were selected as preliminary candidates for transport networks to be studied in the Comprehensive Urban Transport Master Plan. They include an urban expressway network, two busways and one railway as shown in Figure 8-2.

The reasons for selecting these Alternatives K, M and O are as follows;

- 1) Travel speeds of these Plans are comparatively high among the Alternative Plans.
- 2) Investment efficiencies of these Plans are comparatively high among the Alternative Plans.

Table 8-1 Transport Network Alternative Plans

Public Transport Development Plans	Existing Public Transport	Busway Network Plan (1)+(2)+(3)	Railway Network Plan (1)+(2)+(3)	Combination Plan (1) Busway (2) Railway (1)+(3)	Combination Plan (2) Busway (1)+(2) Railway (3)	Combination Plan (3) Busway (1)+(3) Railway (2)	Combination Plan (4) Busway (2)+(3) Railway (1)
Road Network Development Plans	Do-Nothing						
Existing Road Network	Do-Nothing						
Road Network Plan (1) (DAPD Net)	Plan-A (Base Case)	Plan-P	Plan-Q				
Road Network Plan (2) (DAPD Net + Additional Roads)	Plan-B	Plan-D	Plan-F	Plan-H	Plan-J	Plan-L	Plan-N
Road Network Plan (3) ((2)+Expressway)	Plan-C	Plan-E	Plan-G	Plan-I	Plan-K	Plan-M	Plan-O

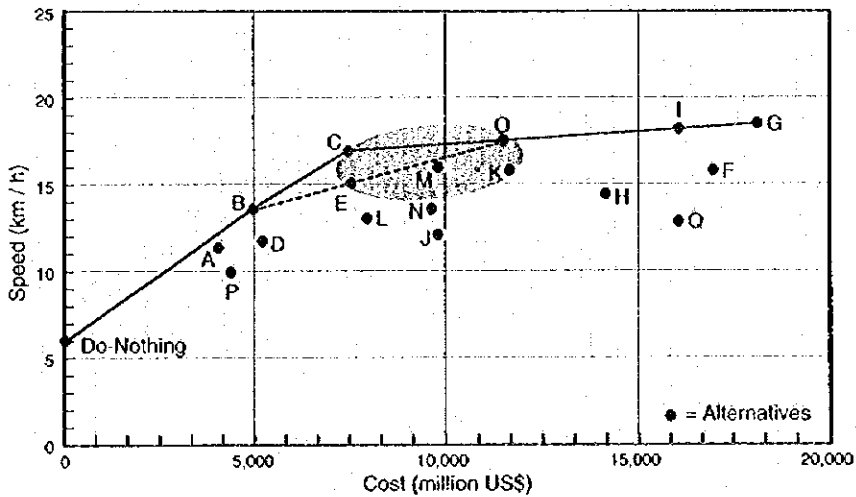


Figure 8-1 Relation Between Service Level and Project Cost

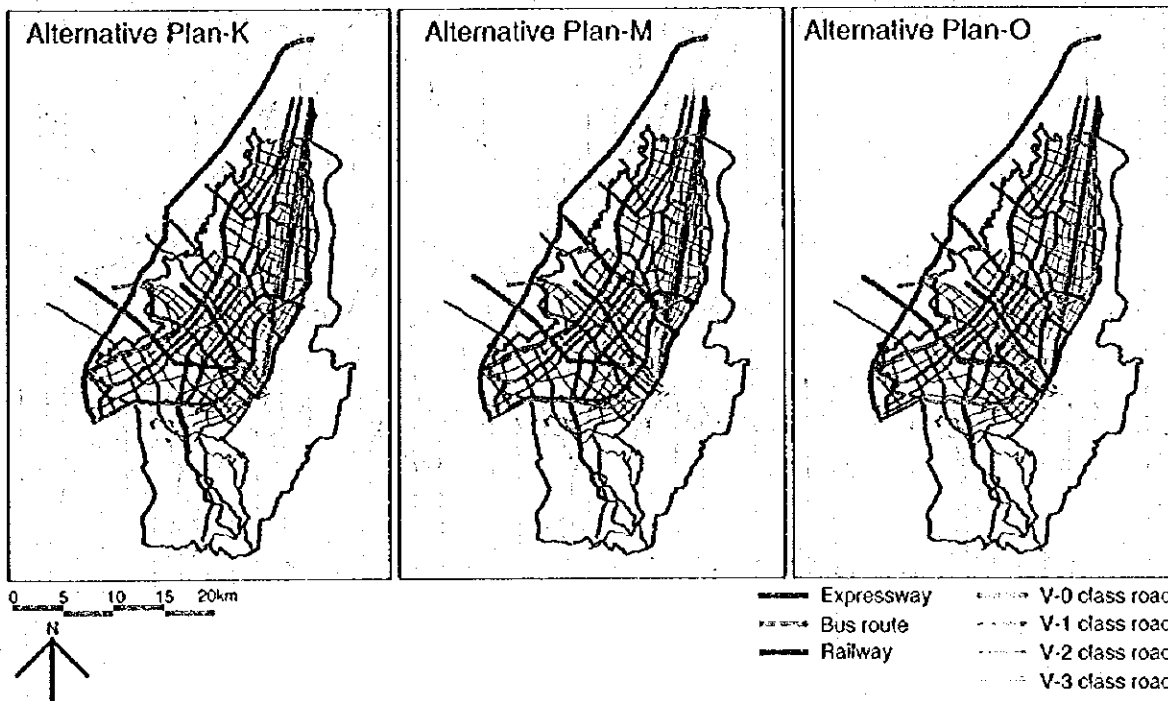


Figure 8-2 Transport Network Alternative Plan-K, Plan-M and Plan-O

9. ROAD SECTOR PLAN

9.1 Road Network Configuration

Future road network was planned basically following the Plan prepared by DAPD in 1993 which formed the ring and radial pattern consisting of five ring roads and nine radial roads, including new construction of Av. Cali, Av. Cundinamarca, Av. Low Murtra (Boyaca Extension) and Av. San Jose. The total length of the future road network is 1,015 km, of which 465 km is newly constructed roads.

9.2 Future Traffic Demand

Considering the future traffic in the year 2020 using the future network, many road sections are observed to have heavy traffic exceeding their capacity (see Table 9-1). The volume to capacity ratios will range from 1.2 to 1.5 and average travel speed will fall down below 5 km/hour.

Table 9-1 Traffic Demand on Major Roads in 2020 (pcu/day)

Road	Daily Traffic	Road	Daily Traffic
Avenida 7a	90,000-120,000	Avenida Boyaca	90,000-120,000
Avenida Quito	120,000-190,000	Autopista Medellin	80,000-100,000
Avenida Caracas	90,000-110,000	Autopista El Dorado	190,000-200,000
Calle 100	140,000-160,000	Autopista Sur	100,000-110,000
Calle 68	130,000-190,000	Autopista Norte	230,000-250,000

In order to alleviate this congestion and maintain the future traffic in an acceptable service level, the following plans of road improvement, grade separation at intersections, new road construction and introduction of urban expressway system are proposed.

9.3 Existing Road Improvement Plan

For existing trunk roads with heavy congestion, 7 improvement projects are proposed as shown in Figure 9-1. Major projects are:

- Grade-separation of 4-lane dual carriageway along Av. Caracas.
- Widening of Autopista Norte, Sur, Medellin and Av. Centenario from 6 lane to 10 lane roads.
- Widening of 2-lane sections of Carrera 11 to 3 lane road.
- Widening of Av. Mariscal from 2 or 3 lanes to 4 lane road.
- Widening of roads in Fontibon Area from 2 lane roads to 4 lane roads.
- Widening of side-walks of Carrera 15 and Av. Jimenez.

9.4 Grade Separation Plan for Selected Intersections

Grade separation at intersections is planned for major congested intersections and for V-0 and V-1 roads crossing with V-2 or higher class roads. The road classification V-0 to V-2 is defined by Acuerdo 2, 1980 of Bogota. In total, 34 intersections are identified for improvement by grade separation. (Figure 9-2)

There are four intersections to be grade-separated along Av. Circumbalar, eight intersections along Av. Caracas, five along Av. Boyaca and also five along Ciudad de Quito.

9.5 New Road (At-grade) Plan

To cope with future traffic increase, the DAPD road plan was strengthened by adding 8 new road projects (three V-2 roads and five V-3 roads) and finally about 400 km of new road construction is needed by 2020 (Figure 9-3). Major ones are constructions of Av. Cundinamarca, Av. Cali and extension of Av. Boyaca. By road class, 47 km of the total length is planned as V-0 road, 50 km as V-1 road, 123 km as V-2 road and 180 km as V-3 road.

All the V-0 road and preferably V-1 road should be designed as full or limited access (controlled) road and on-street parking should be strictly prohibited on all the trunk roads. For some wide arterial construction project, stage development may be recommended from economic viewpoint. Lanes will be increased in number step by step as demand increases. Even in such cases, however, the right of way should be prepared early because future urbanization along the road will make the additional land acquisition more difficult.

9.6 Urban Expressway Plan

In order to relieve the shortage of road capacity in the central part of the City and also to upgrade the quality of road service, development of urban expressway network consisting of two rings and four radials is proposed (Table 9-2 and Figure 9-4).

The 1st ring (inner-ring) is planned on Av. 7a, Av. Chile, Carrera 24 and Av. 28 as a one-way road with four lanes. The 2nd ring (Outer-ring) is planned on Av. 68, Calle 13 and Canal Mollinos passing near Calle 115. Four radial expressways are proposed on Av. 7a, Autopista El Drado, Autopista las Americas and along Rio Amarillo.

Although no design standard is available for the urban expressway, AASHTO standards which are accepted in Bogota will be applied.

As the planned routes are located in the central part of the City, full attention should be paid to the environmental aspect. The design speed are in the range of 60 - 80 km/hour. Noise barriers should be installed where traffic noise is critical. Street trees should be replanted after the expressway is constructed. Thus, urban esthetics and environment must be preserved to the maximum extent.

The urban expressway can be planned as toll way if it offers better service than ordinary street, based on the "beneficiaries-to-pay" principle. Moreover, it can be implemented and managed by the private sector or the third sector, if the project is expected to generate sufficient financial return.

Table 9-2 Outline of Urban Expressway Plan

Segments/Items	Length (km)	No. of lane	Type of Road	Traffic System	No. of IC	Located Area
a) 1st Ring	17.67	4	Viaduct	One-way	6	On Road
b) 2nd Ring	3.89	4	Viaduct	Both way	3	On Road
c) 7a Radial	6.55	4	Viaduct	Both way	1	On Road
d) Medellin Radial	4.03	4	Viaduct	Both way	2	On River
e) El Dorado Radial	4.45	4	Viaduct	Both way	3	On Road
f) Americas Radial	7.93	4	Viaduct	Both way	3	On Road

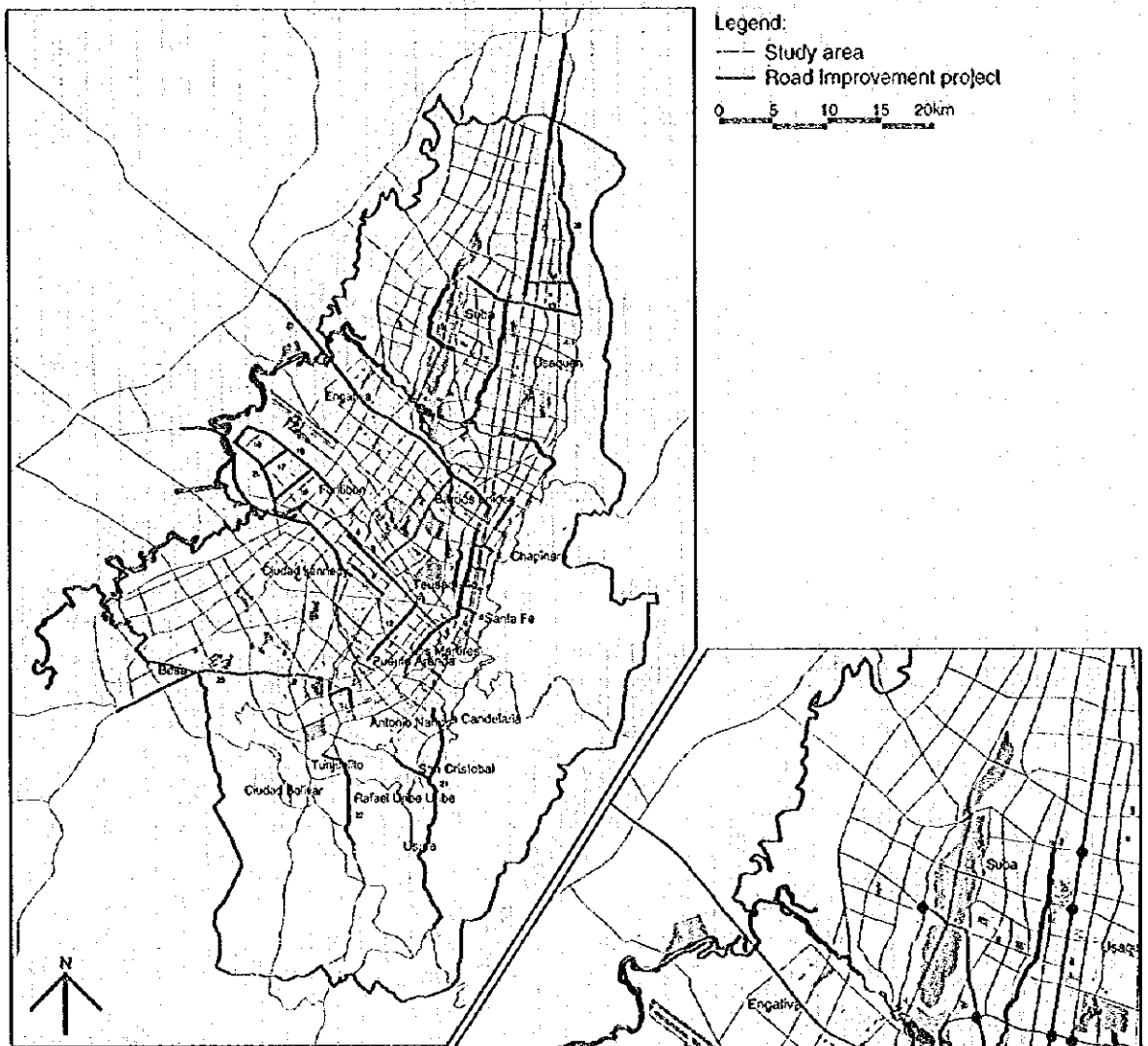


Figure 9-1 Location of Existing Road Improvement Plan

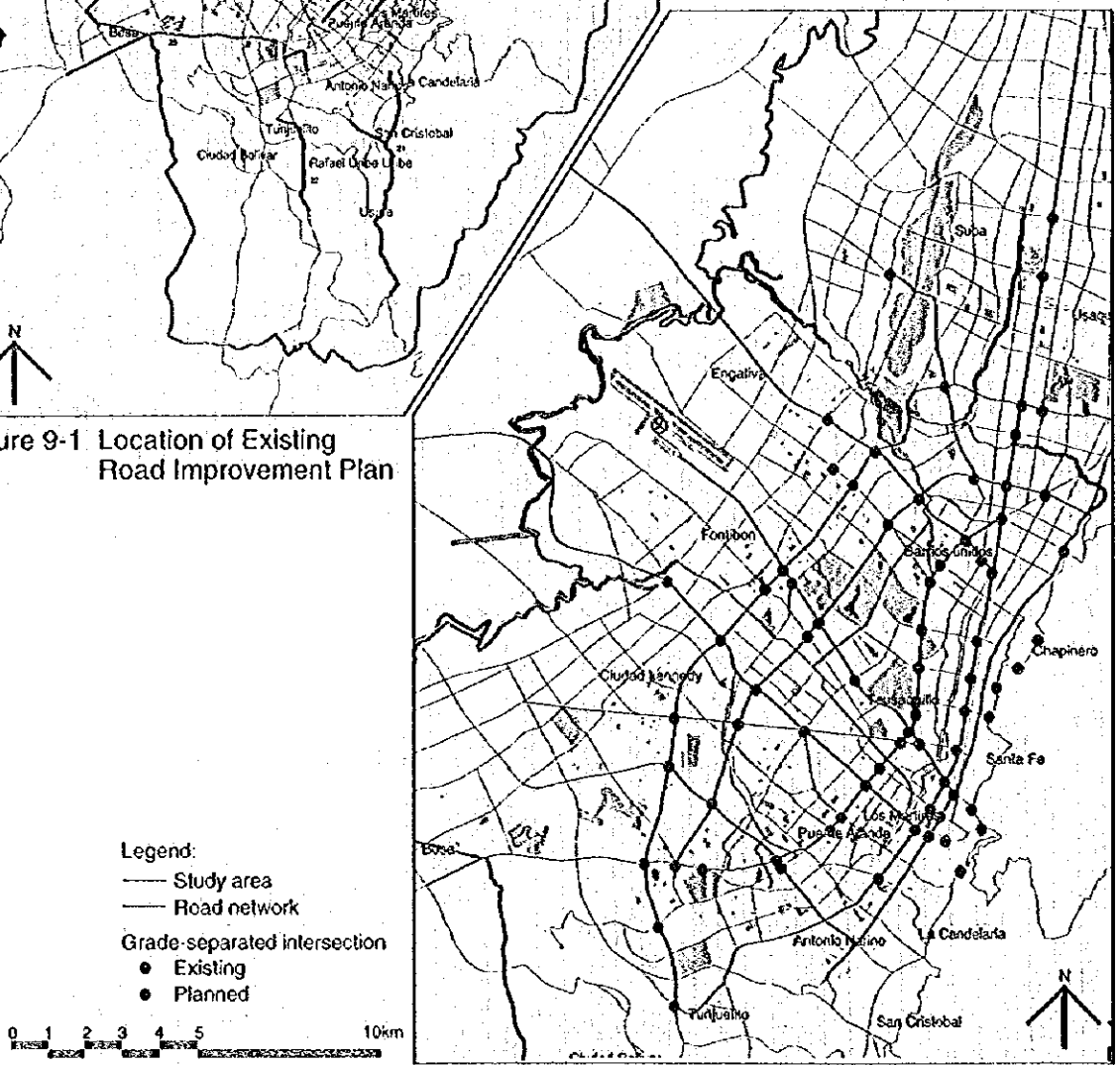


Figure 9-2 Location of Grade Separated Intersection Plan

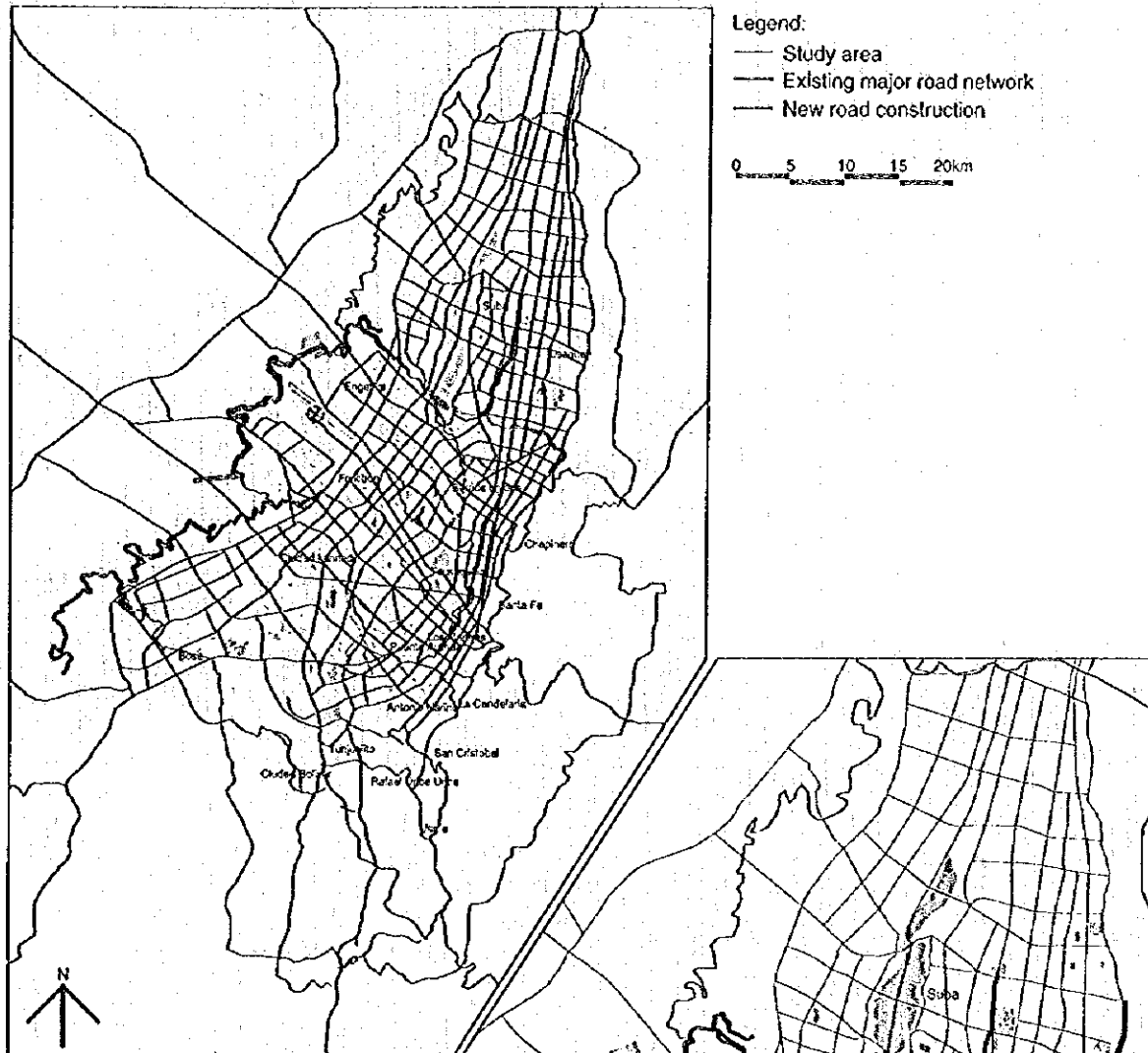


Figure 9-3 Location of New Road Construction Plan

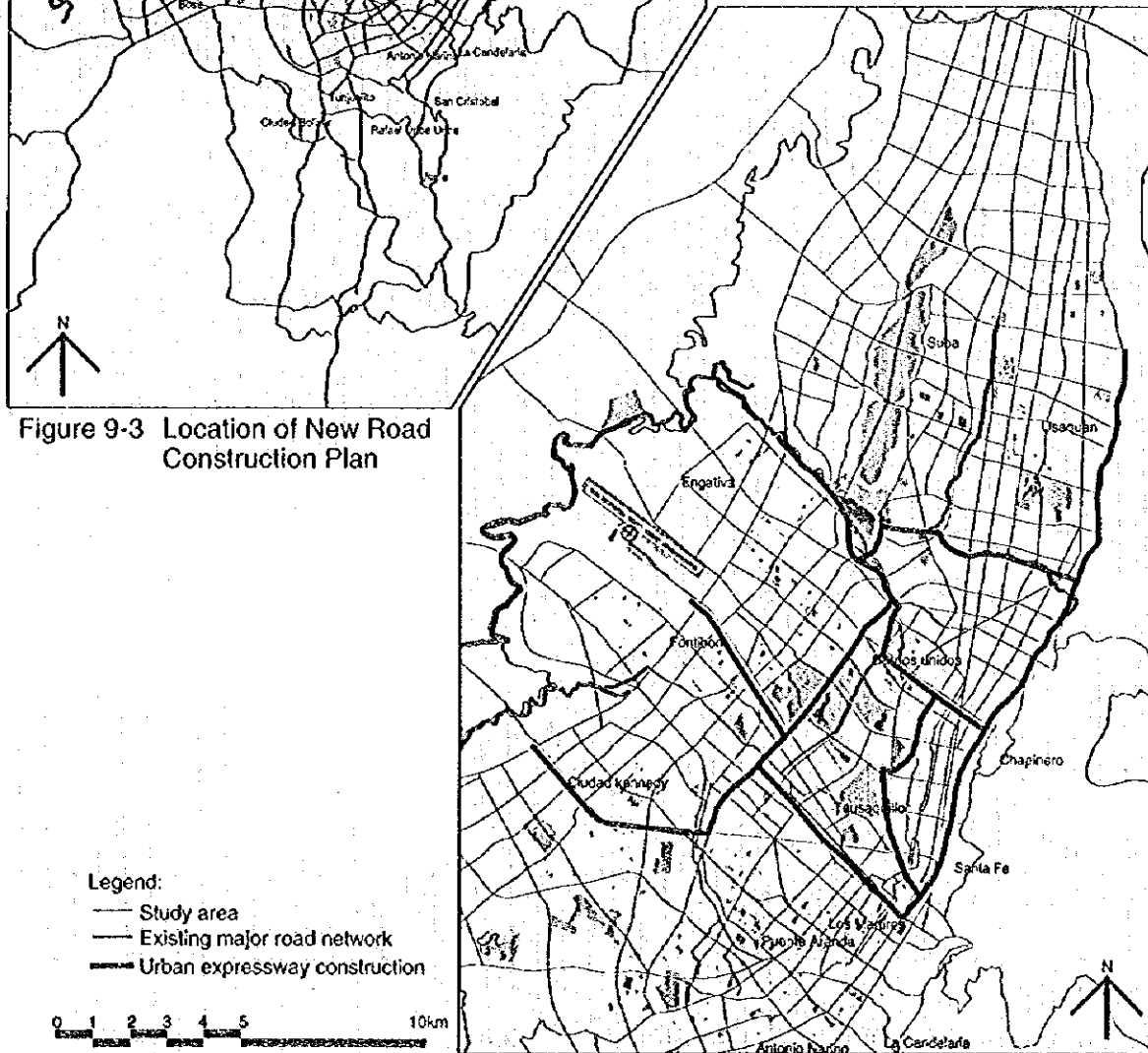


Figure 9-4 Location of Urban Expressway Plan

10. PUBLIC TRANSPORT SECTOR PLAN

10.1 Planning Issues of Short-term Plan

Most of current issues of public transport involve the traditional bus system which can no longer function in a large city like Bogota. In order to modernize the bus system, three fundamental policies are set up: (1) reorganization of bus routes, (2) restructuring of bus operators and (3) revision of tariff system. Those three issues are strongly interrelated and should be treated as one set of planning subjects. In addition, strengthening of STT is a necessary condition to implement the following proposals (Figure 10-1).

10.2 Bus Route Reorganization Plan

The present bus routes should be decreased in number, shortened in distance and simplified by classifying into two service categories of trunk lines and feeder lines. The Metropolitan Area should be divided into 10 to 15 zones. Trunk lines shall connect each zone centroid and shall be operated by large-sized buses with minimum stops. Feeder lines shall serve inside a zone, or shall connect adjacent zones, and should be operated with medium- and small-sized buses.

The trunk bus lines should receive supportive measures such as exclusive bus roads/lanes and grade separation, where necessary to provide better services than other modes. They should create conditions which would encourage private car users to shift their mode to the trunk bus.

Proposed trunk bus network is illustrated in Figure 10-3. There are two types of trunk bus lanes: one is the Av. Caracas type exclusive bus lane (152.1 km) and the other is bus priority lane (62.7 km) which is applicable to trunk roads with less than 8 lanes.

10.3 Restructuring of Bus Operators

Presently, there are 66 bus companies in Bogota, most of which do not own their bus fleet but only possess route franchises and allot them to bus owners. This traditional system causes many problems in current bus service. Two principles are recommended to improve this old-fashioned business structure: (1) Bus companies should be directly responsible to daily bus operation and financial management. (2) Bus owners should equally get returns according to the asset value of their vehicles.

To realize these principles, it is proposed to establish a "Bus Fleet Trust Company" which is a rent-a-bus company being entrusted with vehicles by bus owners and rent them to bus operating companies (Figure 10-2).

10.4 New Tariff Policy

Bus operating cost has been rising year by year due to road congestion and superannuation of bus fleet. Present fare level is not high enough to cover the operating cost, which makes bus replacement difficult. In order to rationalize the tariff system, the zone fare system is recommended, where the fare rises according to trip length. Figure 10-4 presents an example of zoning for the fare system. In the first stage, rather large zones are to be applied, dividing Bogota City into four tariff zones. Suggested tariff rates are also shown, where the minimum fare is 250 pesos, lower than the current flat rate. For intra-zone trips, additional 50 pesos are charged every time when zone boundaries are crossed. Thus, the highest fare is 400 pesos for trips between zone 1 and 4.

10.5 Public Transport Development Scenario

The trunk bus system is recommended as a short-term measure. With two exclusive lanes such as Av. Caracas, the trunk bus system has a capacity of 30,000 passengers per hour at the most. When the demand exceeds this level, a mass-transit system will be needed. However, a huge amount of investment and time will be required to develop a rail-transit network.

It is proposed, therefore, to reform the trunk bus system to a mass transit in a more economical way, by changing the exclusive lanes to exclusive busway capable of transporting 43,000

passengers per hour. Time will come sooner or later, when even a busway service can not cope with the demand. By that time, a railway system should be introduced (Figure 10-5).

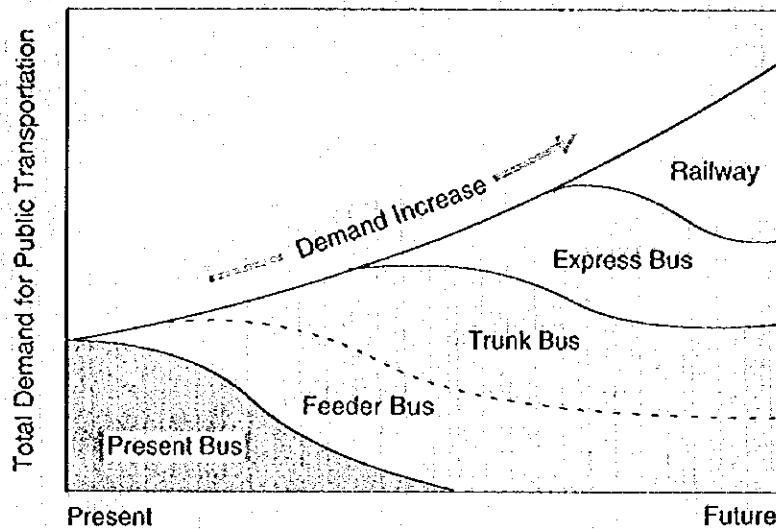


Figure 10-5 Schematic Chart of Public Transport Evolution

10.6 Introduction of Mass-Transit System

Mass-transit is defined in this Master Plan as transit with larger capacity than that of the trunk bus, with its own infrastructure. An express bus operated on the busway and a rail transit meet such conditions.

Based on the demand-supply analysis, eight routes are identified for the configuration of future mass-transit network (Figure 10-6). Most of them are already designated as trunk bus routes in the short-term plan. They should be converted one by one into busways for express bus. The route of Autopista Norte-Av. Quito-Railway Sur-Autopista Sur is evaluated as the most promising route for the first railway construction.

10.7 Express Bus System

Express bus system can be introduced through upgrading "exclusive bus lanes" by completely segregating bus lanes from lanes in common use. It will have railway-like nature, making shuttle service from end to end of a route, and not allowing mixed use such as the current bus lanes on Av. Caracas are now offering. To provide better service by such operation, it is necessary to construct facilities for segregation of passengers, grade separation at intersections, and to expand bus stops and terminals.

10.8 Development Railway Network and Operation Plan

All the mass-transit routes should accommodate rail transit system in the long run, replacing express bus service. However, it would take a long time and huge amount of investment, construction of railway system should be carried out step by step. The following scenario is recommended from the comprehensive viewpoints (Figure 10-7).

- Step 1: Construction of Route No.5 (Autopista del Norte - Av. Ciudad de Quito - Railway South Line - Autopista del Sur).
- Step 2: Construction of Route No.1 & 2, excluding the common section of Route No.5. Operation is switched to the original from Route 1 and 2.
- Step 3: Construction of Route No.4, Circular operation will be started. The sections of Av. Caracas and Av. 27 are used commonly with Route No.1.
- Step 4: Construction of Route No.3, exclusive of the section east of Av. Caracas. Two lines of Av. 81 and the west railway line will be operated individually.

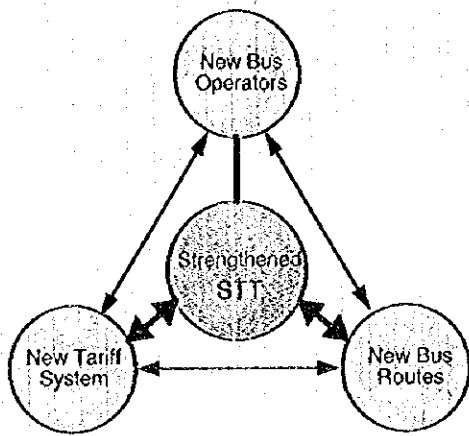


Figure 10-1 Trinity of Short-Term Subjects in Public Transport Plan

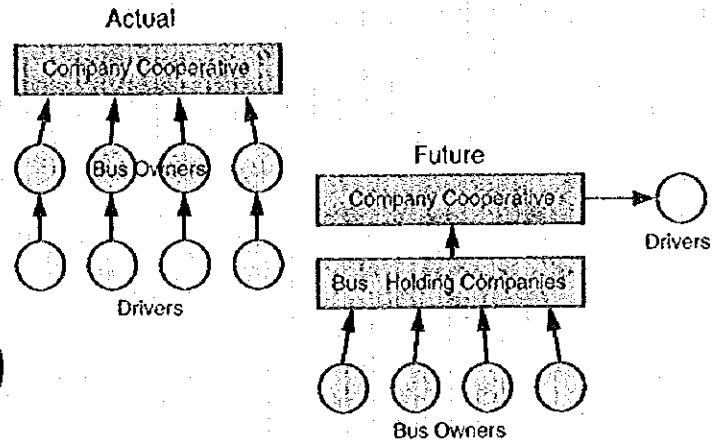
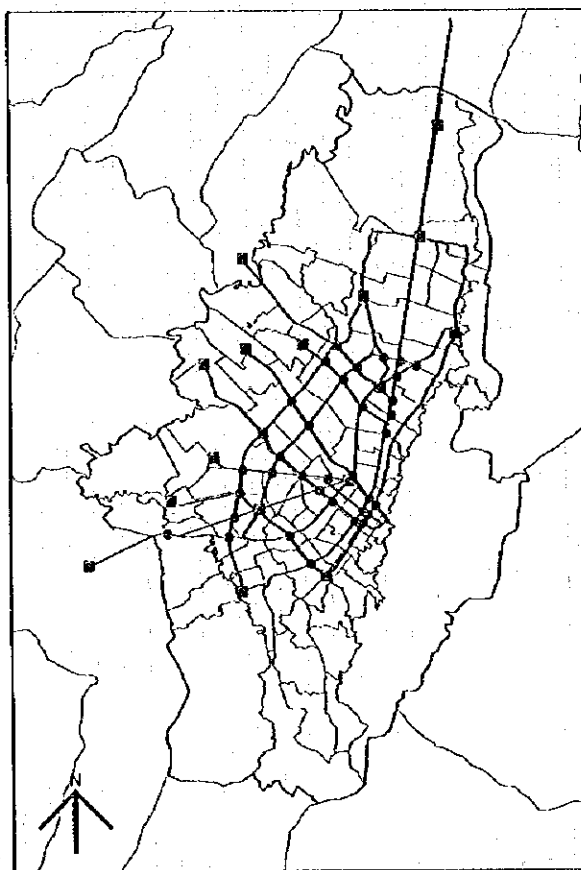
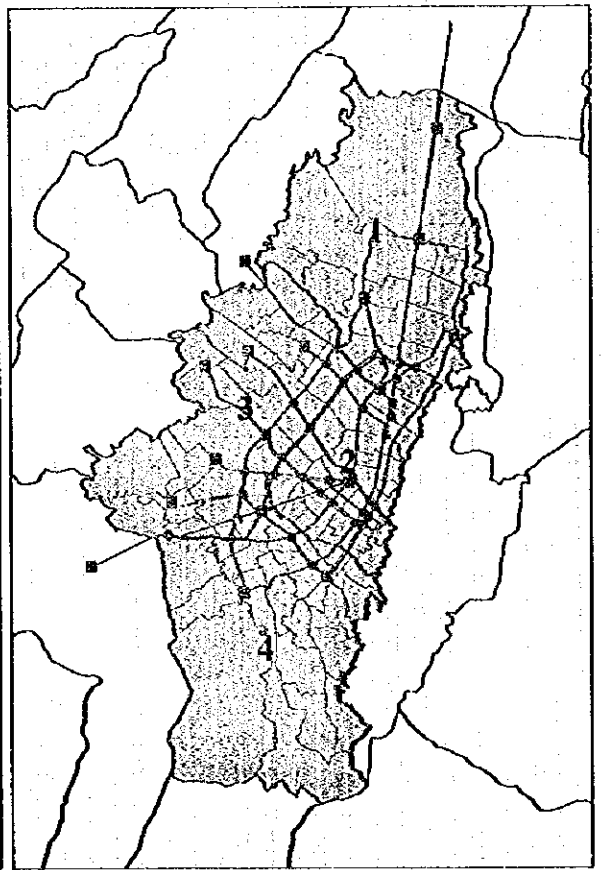


Figure 10-2 Structural Reform of Bus Service Industry



0 5 10 15 20km

- Legend:
- Study area
 - Exclusive bus lane
 - Bus priority lane
 - Bus terminal
 - Major bus stop



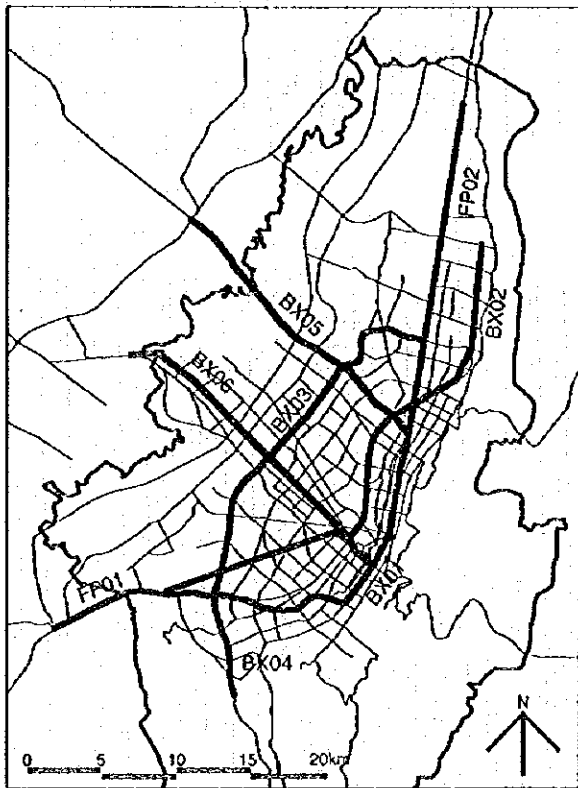
Zone fare system (Peso)

from	to	Zone 1	Zone 2	Zone 3	Zone 4
Zone 1		250	300	350	400
Zone 2		300	250	300	300
Zone 3		250	300	250	300
Zone 4		400	300	300	250

1 Tariff zone and number

Figure 10-3 Trunk Bus Network Plan

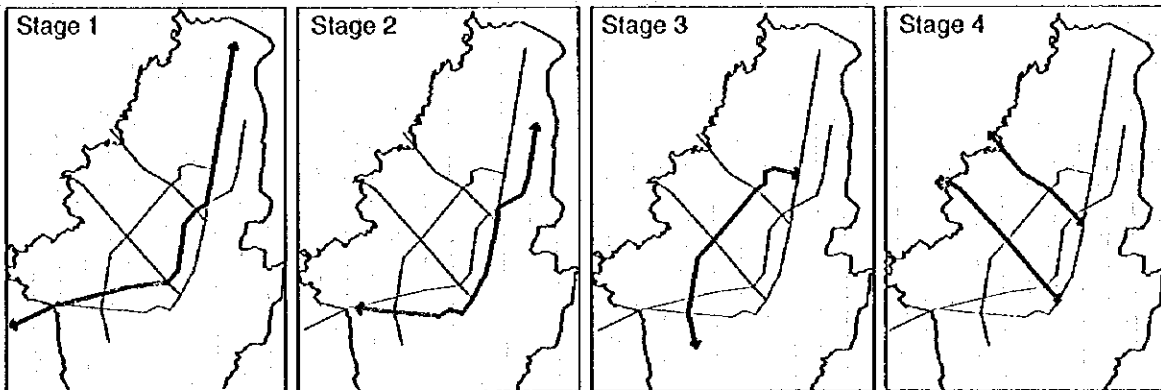
Figure 10-4 Zoning for Zone Fare System



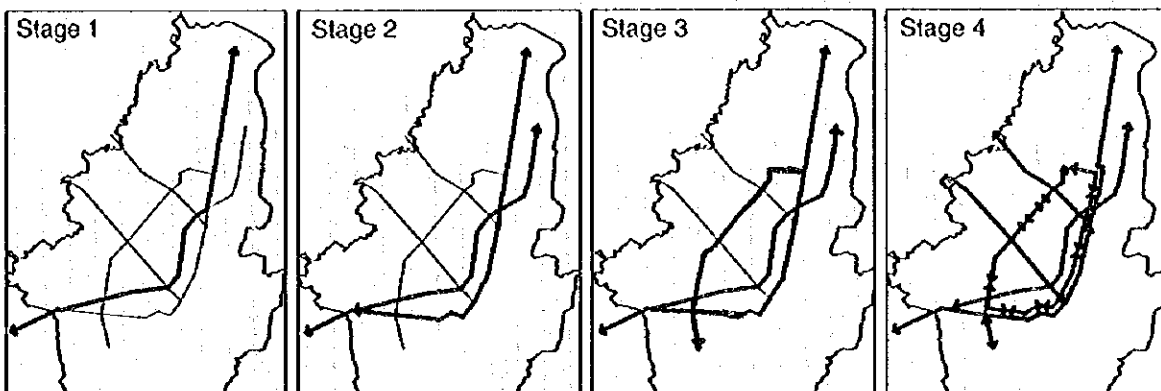
Mass-transit network route

No.	Route	km
BX01	Av. Caracas - Av. 27 - South railway line	19.0
BX02	Av. Caracas - North railway line	9.2
BX03	Av. Boyaca	18.4
BX04	Av. Boyaca - Parque el Tunal	5.0
BX05	Av. 79 / Av. 81	15.0
BX06	Av. Lima - West railway line	15.8
FP01	Line No. 1 (Norte - Quito - Sur)	32.0
FP02	Extension of Line No. 1 to Chia	8.0

Figure 10-6 Mass-Transit Network Plan



Construction



Operation

Figure 10-7 Expansion of Railway Network and Change in Operation System

11. TRAFFIC MANAGEMENT SECTOR PLAN

In the traffic management sector, the following plans and projects are proposed as the short-term measures targeting the year 2001. This would ensure the most effective use of transport facilities and provide smooth, safe and comfortable trips.

11.1 Facility Improvement Plan

In the central part of the City, especially along Carrera 7, 10, 11, 13, 15, 19 and 24, congested or dangerous intersections should be improved by such means as channelization and installation of traffic islands, marking, signs and guard fences. Thirty four intersections are identified for improvement. (Figure 11-1)

11.2 Traffic Control System Improvement Plan

Current traffic signal system linearly coordinated should be expanded and improved by introducing traffic-actuated control system. The new system uses vehicle detectors which enable automatic and real-time collection of traffic information supplied to drivers through message sign board.

11.3 Traffic Safety Education Plan

It is strongly recommended to strengthen the traffic regulations through strict enforcement. In order to promote safety education, traffic safety center should be established together with traffic parks.

11.4 Parking Facility Plan

The short-term plan aims to develop 11 parking facilities for public use with total capacity of 4,450 lots, while increasing on-street parking lots called "Zonas Azules" up to 8,580 lots in total by 2001.

While off-road parking facilities will be highly needed in the central area, parking business is not sufficiently profitable to attract the private sector. Therefore, various incentive policies should be taken. Figure 11-2 shows the concept of underground parking facility.

11.5 Pedestrian Facility Development Plan

The plan proposes to develop road facilities for pedestrians to create urban amenity and beautiful landscape. This may include a pedestrian mall on Calle 85 (Figure 11-3), widening of side-walks on Avenida Jimenez and Carrera 15 (Figure 11-4) and introduction of traffic cell system in Candelaria.

These projects aim at activating commercial and tourism activities in and around the project areas by offering pedestrians comfortable walking conditions.

11.6 Bicycle Road Network Plan

The plan proposes to develop a bicycle road network connecting major parks in the city (Figure 11-5). The network should have its own space segregated from ordinary roads and streets to provide cyclists with safe and comfortable environment. Twelve routes are proposed with a total length of 94.5 km. Along the routes, information boards, traffic signs and signals should be properly installed. Selected parks should provide facilities for a rest area and a workshop.

12. IMPLEMENTATION PLAN

12.1 Project Identification

The following projects are identified in the Master Plan by each sector plan; 1) Road Development Projects including nine (9) existing road improvement projects, one grade separated intersection improvement project, eighteen (18) new road construction projects, and three (3) urban expressway construction projects, 2) Public Transport Projects including fifteen (15) trunk bus development projects, six (6) express bus development projects, two (2) railway development projects, and sixteen (16) transport terminal projects and one (1) truck terminal, and 3) Traffic Management Projects which includes nine (9) traffic management projects.

The above sector plans were incorporated into sixty seven (67) packages. The implementation schedule was made in accordance with project priority.

12.2 Implementation Schedule

Implementation schedule is set up based on the 67 packages considering the following viewpoints of;

- 1) economic effects of the project,
- 2) effects of the project on the traffic service level,
- 3) characteristics of the project,
- 4) balance of annual investment, and
- 5) project size.

The cost-benefit analysis was conducted on the basis of economic effects. The service level was estimated by comparing travel speeds between 2 cases "with" and "without" projects. On-going projects and projects with their budget already allotted were given higher priority. Considering economic growth in future (5% per annum), the annual investment was planned.

The implementation schedule is presented in Table 12-1. However, the detailed construction schedule of the Railway Project is not defined explicitly here, because another mass-transit study named SITM by Colombian side is now on-going.

12.3 Investment Schedule by Phase Plan

The total investment during 25 years from 1997 to 2020 is estimated at US\$ 9,240 million in 1996 price. Yearly investment cost is shown in Figure 12-1. The implementation projects by each phase plan are shown in Figure 12-2. The investment in each planning phase are as follows;

- 1) Short-Term investment (1997 to 2001): US\$ 2,105 million (23%)
- 2) Mid-Term investment (2002 to 2010): US\$ 2,782 million (30%)
- 3) Long-Term investment (2011 to 2020): US\$ 4,353 million (47%)
- Total: US\$ 9,240 million (100%)

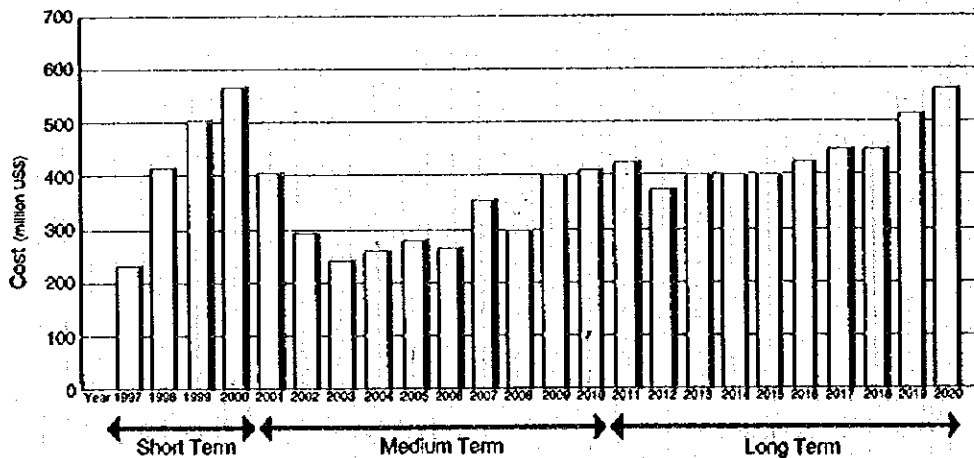
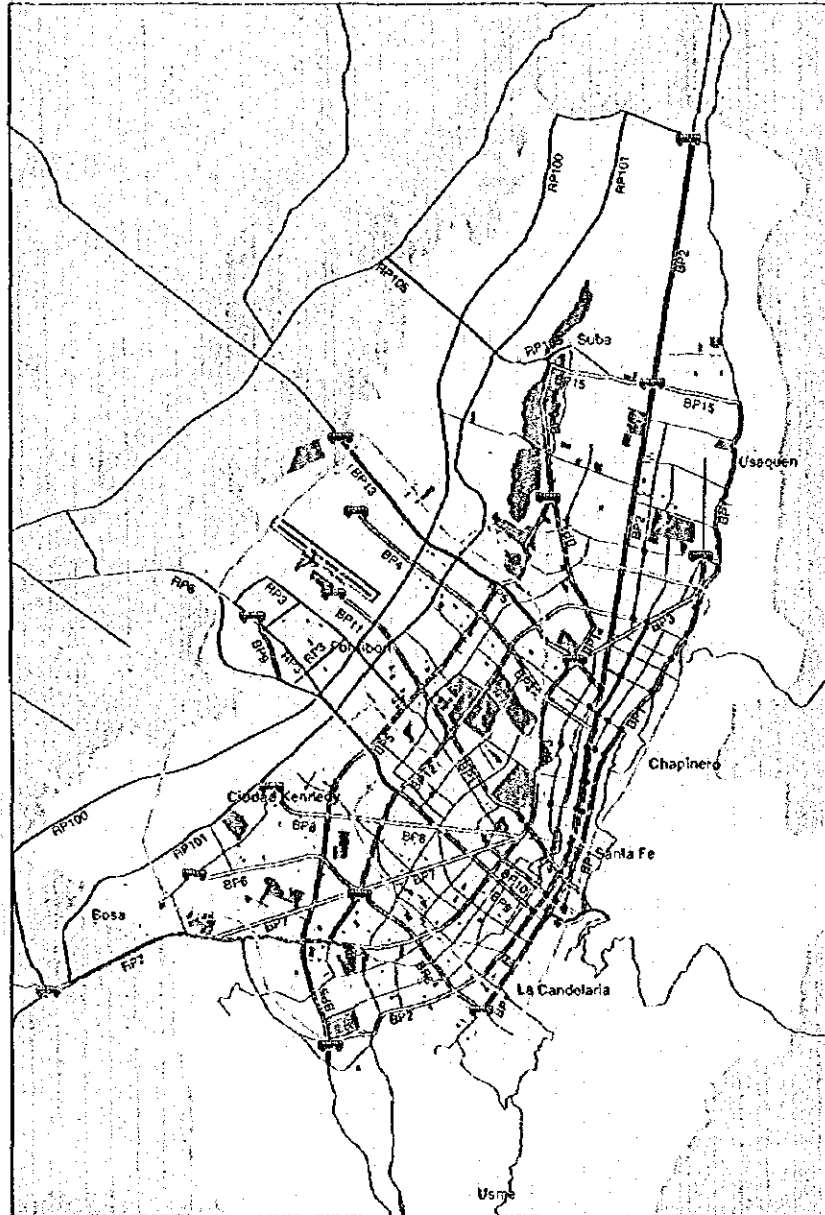


Figure 12-1 Investment Cost by Year

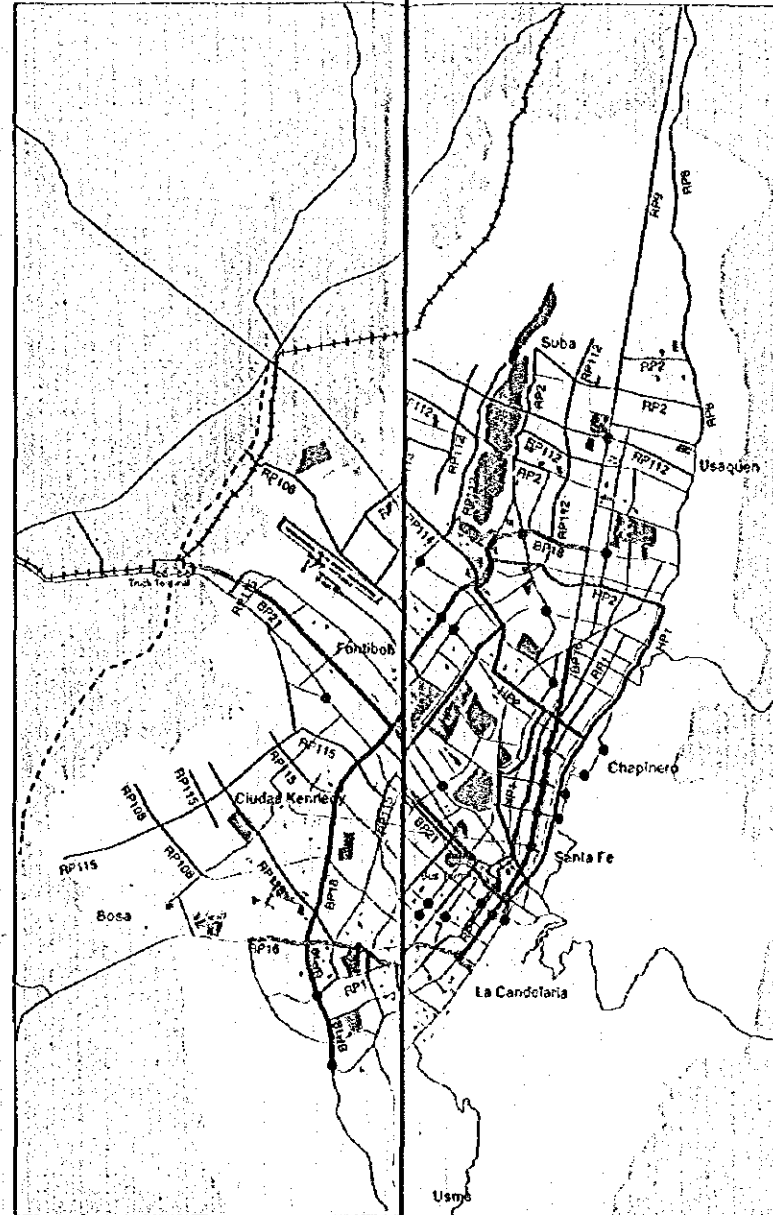
Table 12-1 Implementation Schedule and Corresponding Investment

Project Name	Project Size	Project Cost (1000 US\$)	Short Term		Medium Term					Long Term																	
			1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020		
Traffic Management Projects																											
MP-1	At-Grade Intersection	34 vol	1,474																								
MP-2	Traffic Facilities	13 vol	44,930																								
MP-3	Traffic Education	1 unit	1,572																								
MP-4	Parking Facilities	14 Places	82,366																								
MP-5	Traffic Cell	1 vol	16,155																								
MP-6	Pedestrian Mall (Calle 85)	1 vol	11,620																								
MP-7	Bicycle Road	231 km	23,100																								
MP-8	Carrera 15 Pedestrian Mall	1.50 km	20,000																								
MP-9	Av. Jimenez Ped. Mall	1.50 km	25,000																								
Bus Troncal Projects																											
BP-1	Cra. 7ª	21.40 km	1,700																								
BP-2	Av. Caracas	37.50 km	2,300																								
BP-3	Av. Ciudad de Quito	28.60 km	2,900																								
BP-4	Cra. 68	15.90 km	1,600																								
BP-5	Av. Boyaca	24.50 km	2,500																								
BP-6	Calle 22S/ Av. 1º de May.	11.00 km	900																								
BP-7	Villa del Rio-Cundinamarca	9.50 km	23,800																								
BP-8	Av. de Las Americas	8.20 km	800																								
BP-9	Av. Centenario	13.40 km	1,300																								
BP-10	Av. Ciudad de Lima	4.00 km	400																								
BP-11	Autopista El Dorado	13.40 km	1,100																								
BP-12	Calle 68/ Av. 68	6.60 km	500																								
BP-13	Av. 78 / Av. 81	10.30 km	1,000																								
BP-14	Av. Suba	5.40 km	400																								
BP-15	Calle 170	4.90 km	400																								
Mass Transit Projects																											
BP-16	Av. Caracas - South Line	18.99 km	9,900																								
BP-17	Av. Caracas - North Line	9.24 km	112,800																								
BP-18	Av. Boyaca	18.39 km	5,800																								
BP-19	Av. Boyaca - P. El Tuna	4.98 km	500																								
BP-20	Autopista Medellin	14.95 km	5,500																								
BP-21	Av. Lima - West Line	12.83 km	63,500																								
FP-1	Line No.1 (Ato. Norte - Av. Quito - Alp Sur)	32.00 km	2,275,000																								
FP-2	Extension of Line No.1 (Co Chia)	8.00 km	201,000																								
Terminal Projects																											
BT-1	Main Bus Terminal	1 vol	40,000																								
BT-2	Sub-Bus Terminal	8 vol	48,000																								
BT-3	Feeder Bus Terminal	7 vol	14,000																								
BT-4	Truck Terminal	1 vol	20,000																								
Existing Road Improvement Projects																											
RP-1	Centro Road Imp.	30.00 km	144,955																								
RP-2	Santa Monica Rd. Imp.	17.80 km	70,129																								
RP-3	Fontibon Rd. Imp.	9.40 km	49,128																								
RP-4	Usme Rd. Imp.	37.90 km	155,124																								
RP-5	Medellin Rd. Imp.	12.08 km	47,975																								
RP-6	Centenario Rd. Imp.	10.92 km	43,368																								
RP-7	Sur Rd. Imp.	9.10 km	36,140																								
RP-8	7ª Rd. Imp.	9.54 km	63,410																								
RP-9	Norte Rd. Imp.	9.15 km	36,338																								
RP-10	Grade Separated IC Imp.	34 vol	136,000																								
New Road Construction Projects																											
RP-100	Cundinamarca Rd.	40.62 km	734,230																								
RP-101	Cali Rd.	35.03 km	451,002																								
RP-102	Suba - Kennedy	34.36 km	288,600																								
RP-103	Suba Extension	12.28 km	155,929																								
RP-104	Norte - Estoril	16.36 km	130,392																								
RP-105	San Jose	7.12 km	85,590																								
RP-106	Centenario	10.21 km	106,722																								
RP-107	Americas	5.91 km	105,396																								
RP-108	1º de Mayo	5.95 km	57,258																								
RP-109	Norte	22.00 km	175,370																								
RP-110	Villa Cristina	22.97 km	222,414																								
RP-111	Suba Norte Area	18.02 km	117,029																								
RP-112	Suba Area	29.10 km	182,599																								
RP-113	Barrios Unidos	6.93 km	122,291																								
RP-114	Engativa Area	13.90 km	88,074																								
RP-115	Kennedy Area	24.20 km	174,316																								
RP-116	Besa Area	14.80 km	75,536																								
RP-117	Usme Area	60.20 km	268,753																								
Urban Expressway Projects																											
HP-1	1st Ring	17.65 km	511,329																								
HP-2	2nd Ring	23.89 km	666,939																								
HP-3	Radial	22.97 km	671,307																								
Sub-Total				0,231	411	497	562	403	288	241	259	274	265	352	248	398	406	424	366	399	396	393	422	416	416	508	553
Total of Each Target Years		Million US\$	9,233	2,105					2,782					4,353													

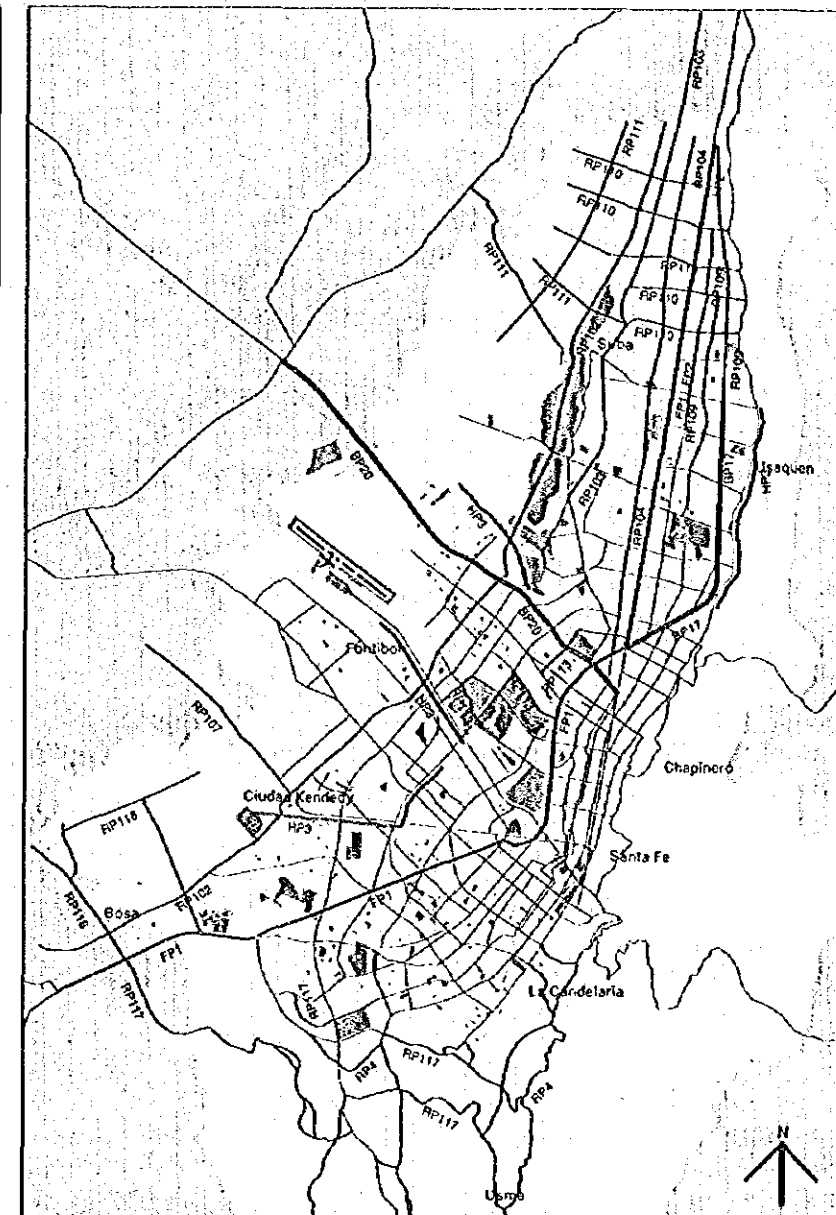
Note: ■ Preparation Work Period
 ■ Construction Work Period
 ■ Possible Construction Work



Short Term (1996 - 2001)



Medium Term (2002 - 2010)



Long Term (2011 - 2020)



- Legend:
- Bus troncal project
 - Express bus project
 - Railway project
 - Existing road improvement project
 - Grade-separated intersection
 - At-grade intersection improvement
 - New road construction project
 - Urban expressway project
 - ☐ Main bus terminal
 - ☐ Sub-bus terminal
 - ☐ Feeder bus terminal
 - ☐ Truck terminal

Figure12-2 Implementation Projects by Each Phase Plan

13. COMPREHENSIVE TRANSPORT MASTER PLAN

The Comprehensive Urban Transport Master Plan for Bogota in 2020 is planned by integrating the three sector plans of road, public transport, and traffic management plans as shown in Figure 13-1.

13.1 Function and Characteristics of the Projects in the Master Plan

- 1) To resolve traffic problems in the central and urbanized areas of Bogota, the following projects are proposed: a) existing road improvement project in central area, b) trunk bus system development projects, c) express bus system development projects, d) urban expressway construction project, e) railway system development project, and f) traffic management projects.
- 2) To support the future traffic demand in suburban areas, the new road construction projects such as Avenida Cundinamarca, Avenida Cali, and others are proposed.
- 3) To service the future traffic demand from the center of Bogota and surrounding cities, the following projects are proposed: a) existing road improvement projects, b) bus express system and Railway system development project, and c) new road construction projects on Auto. Americas extension, Av. 1 Mayo extension, and Av. Cundinamarca.

13.2 Evaluation of the Master Plan

●Economic Aspects

Economic evaluation indicates that the Master Plan is highly feasible, showing EIRR = 42.4 %, B/C = 5.33, NPV = US\$ 12,100 million. Even without TTC savings, Master Plan is still economically feasible; EIRR = 14.3%, B/C = 1.24, NPV = US\$1,738 million.

●Financial Aspects

For execution of the Master Plan, about US\$ 250 to 350 million are required annually. However, the average annual investment budget for the infrastructure in Bogota is between US\$ 100 and 150 million. Therefore, introduction of the toll system, tax increase, and other financial measures should be considered for the implementation of the Master Plan.

●Environmental Aspects

The noise levels of the existing major roads are observed at about 70 (dB) to 80 (dB) during daytime. When the Urban Expressway is constructed, about 70 (dB) will be expected. If certain measures such as noise barriers (5 m) and porous asphalt pavement on the Urban Expressway are taken, the noise level can be decreased by about 10 (dB). When the Urban Expressways are planned, the following matters should be considered for landscaping.

- a) to maintain harmony with the surrounding landscape,
- b) to keep an open space along the Urban Expressway as much as possible, and
- c) to maintain abundant greenery alongside the Urban Expressway.

●Traffic Aspects

The traffic conditions in Bogota will be significantly improved. The average travel speed in the "Do Nothing" case and in the Master Plan case are 6.5 km/h and 18.5 km/h, respectively. However, in spite of construction of the transport network according to the Master Plan, the traffic service level in 2020 will be insufficient. It will be necessary to introduce transport demand management to maximize the investment effect of projects.

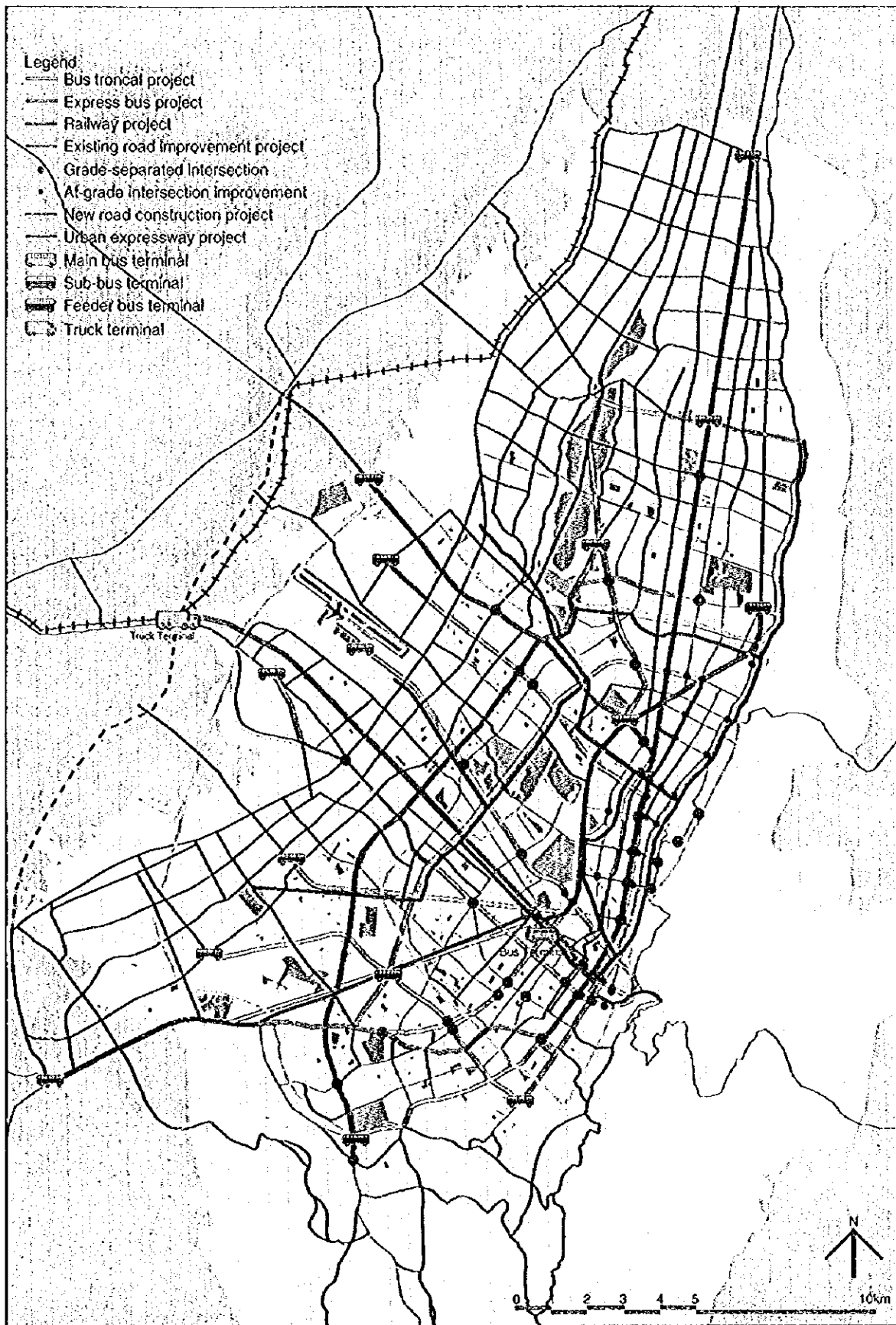


Figure 13-1 Comprehensive Urban Transport Master Plan in 2020

14. TRANSPORT DEMAND MANAGEMENT (TDM)

In order to maximize the investment effect of projects, transport demand management (TDM) will be indispensable in future. In this Master Plan, TDM is treated as a policy option and case studies were conducted for several measures to evaluate their effects. Further studies are necessary prior to the introduction of TDM measures in Bogota.

14.1 Measures of TDM

The major measures of TDM are classified into 3 categories: to discourage car ownership, to discourage car use and to alleviate peak-time demand. These measures have to be introduced under conditions where the public transport is served at a level that makes it possible to shift the car owners to public transport. This is a difficult task because car owners in Bogota have very strong propensity to use a car, i.e., they will use a car whenever and wherever available.

(1) High Taxation

When the purchase tax is raised from 35% (present rate) to 50%, car ownership is expected to be reduced by approximately the same ratio. The total trips in the Study area will be reduced by 1.2% by shifting to the public mode. The tax revenue will be approximately \$ 5,460 billion pesos during 25 years (until the target year 2020).

(2) Area Licensing (Congestion Charging)

The road pricing combines the effecting of alleviating the congested area, while collecting the revenue from toll gate at the same time. Car trips will decrease by 55% as a result of increase in the toll rate of \$ 2000 pesos within the central area. Tax revenue will be approximately \$ 2,750 billion pesos/25 years for the rate when the charge is \$ 2000 pesos.

On the other hand, when this system will be applied, there will be the added problem of costs of the installation of monitoring devices on the road and in the vehicles, and the creation of an administrative/ enforcement structure to collect the revenues.

(3) Car Use Tax (Fuel Tax)

The fuel taxes are effective means of alleviating traffic congestion due to increase operating costs. They also generate revenue for transportation improvements. If tax rate of 20% (currently 13%) is levied on gasoline, 3 % of car trips in the whole Study area are expected to divert to public mode. At the same time, the additional revenue of the fuel tax will be approximately \$ 590 billion pesos during 25 years.

(4) Parking Management

If parking rate of \$1000 pesos is surcharged on car trips within the central area, it is expected that 8.6 % of total trips related to the area will divert from car mode to public mode. At the same time, the revenue from the parking fees will be approximately \$ 480 billion pesos during 25 years.

(5) Summary of TDM

The traffic and financial impacts by implementation of TDM are summarized in Figure 14-1. The application of each measure will likely be difficult. The municipal government of Bogota does not have jurisdiction of car purchase tax. Road Pricing, Parking Control and Fuel Tax are governed by the municipality. The most acceptable measures will be the combination of those. Figure 14-1 shows the summary of Tax Revenue which totals approximately \$ 9,300 billion pesos for 25 years. The amount will be close to the total cost of Master Plan Projects.

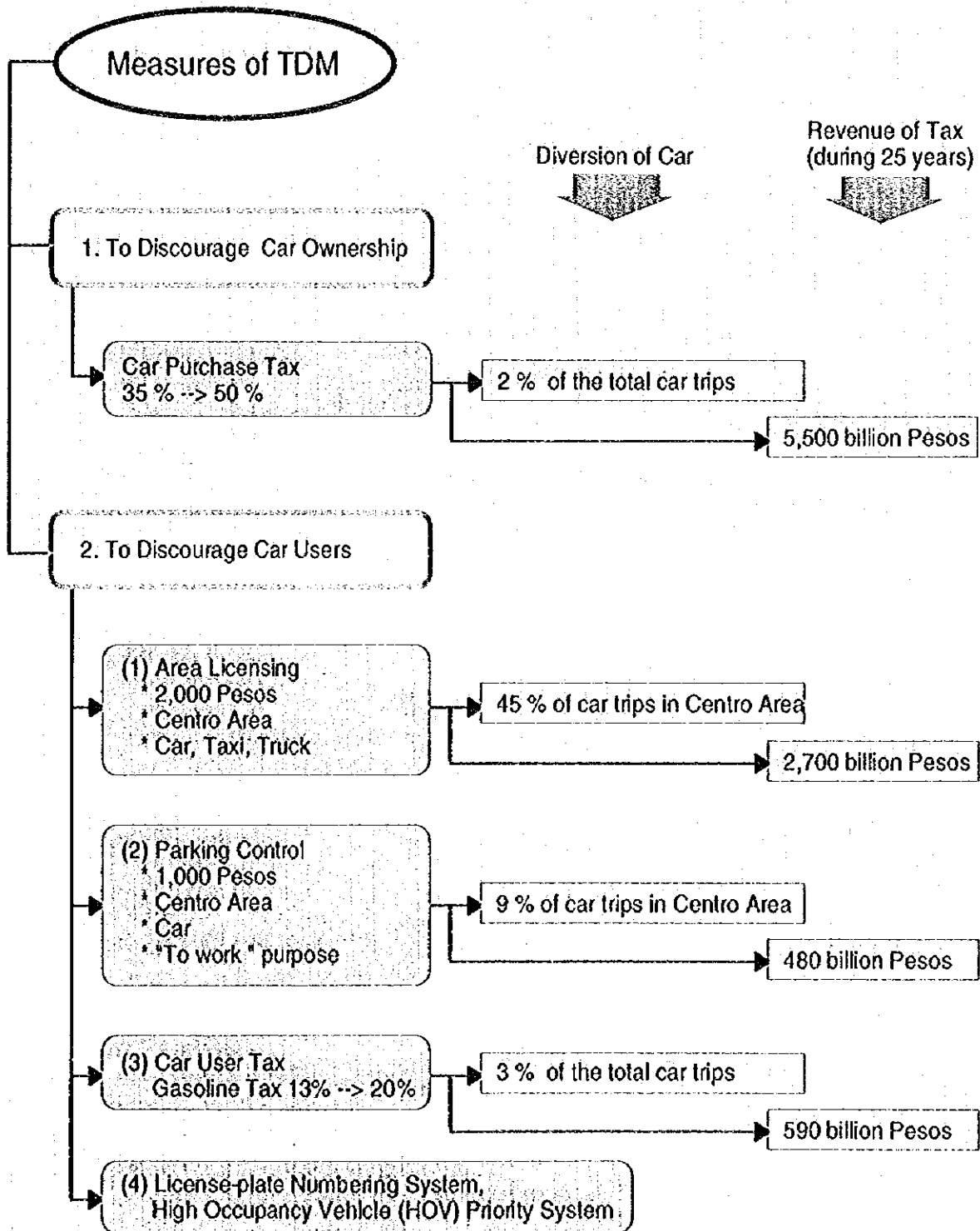


Figure 14-1 Traffic and Financial Impact by TDM

15. RECOMMENDATIONS

15.1 Necessity for Implementing the Master Plan

The urbanization of Bogota will be anticipated to spread into the surrounding cities. The economic growth in 2020 will show an increase in GRDP of 3.5 times the present value. This will contribute to an increase in travel demand which is anticipated to be 1.55 times the present demand in the whole Study Area. The forecast indicates the high rate of increase of private mode of transportation (passenger car), approximately 2.2 times. In order to meet the future transport demand, the comprehensive transport networks should be developed in accordance with the recommended implementation schedule. The Comprehensive Urban Transport Master Plan proposed in the Study will contribute to promote the socioeconomic activities in Bogota and surrounding cities.

15.2 The Projects in the Master Plan

A total of 67 package projects are recommended in the Comprehensive Urban Transport Master Plan of Bogota. All projects in the Master Plan are economically and technically feasible. Total cost is estimated at US\$ 9,239 million (1996 prices). The investment allocation is about 30% of the total amount for public transport projects. The balance involves 20% for urban expressway projects and 50% for road projects.

The Master Plan includes the following projects;

- 1) Trunk Bus System Development Projects,
- 2) Bus Express System Development Projects,
- 3) Railway System Development Projects,
- 4) Existing Road Improvement Projects,
- 5) New Road Construction Projects,
- 6) Urban Expressway Construction Projects, and
- 7) Traffic Management Development Projects.

15.3 Necessity for Transport Demand Management (TDM)

Even if all the projects proposed in the Master Plan are implemented, the recommended transport network and facilities in 2020 would still be insufficient to maintain a good traffic service level in Bogota. To improve the traffic service, traffic demand should be managed to lessen the traffic burden on the network as soon as possible.

15.4 Financial Resources

The total investment to implement the Master Plan is estimated at US\$ 9,239 million. Comparatively, this investment apparently exceeds the historical budget of Bogota Municipality. Other major financial resources which should be considered are as follows;

- 1) Revenue from traffic demand management (TDM),
- 2) Increase of budgets of local and central government,
- 3) Revenue from toll system,
- 4) City development tax, and
- 5) Foreign loan.

Public facilities and infrastructure generate benefits to the users. Therefore, it is strongly recommended that the necessary funds be properly collected from the beneficiaries in proportion to the amount of benefit accruing.

15.5 Institutional Reforms

To secure the financial resources for implementation of the Comprehensive Urban Transport Master Plan, it is necessary to create a revenue system exclusively dedicated for urban transport infrastructure development.

Bogota lacks an organization to coordinate the various official agencies related to urban transport in Bogota. As the population and socioeconomic activities increase, Bogota and surrounding cities will become intertwined. Considering the future socioeconomic situation, it is necessary to create an organization such as Bogota Metropolitan Transport Commission: with representative from the local governments, the central government and the private sector.

Moreover, for continuous execution of the Master Plan and related development projects, a new organization to coordinate transport issues among the existing related agencies should urgently be established. In addition, adequate engineering and professional staff should be recruited. When a new organization is established, it should have the following qualifications:

- 1) be capable to maintain smooth coordination among related authorities,
- 2) have strong authority, and
- 3) maintain adequate technologies; planning, design, construction, and maintenance.

15.6 Further Studies Needed

For advancing the Master Plan, further studies are required in the next stage.

- (1) Feasibility studies should be conducted on large scale road and public transport projects proposed in the Short- and Mid-Term plans.
 - 1) Parking Facilities.
 - 2) Trunk Bus Projects.
 - 3) Main Terminal Projects.
 - 4) Truck Terminal.
 - 5) Grade Separated Interchange Improvement.
 - 6) Cundinamarca Road Construction Project.
 - 7) Cali Road Construction Project.
 - 8) Urban Expressway Construction Projects (total 65 km).
- (2) Considering the importance of strengthening the public transport system in Bogota, a more detailed study of mass transit systems should be conducted to introduce a mass transit system in the Bogota Metropolitan Area.
- (3) As the city grows, the socioeconomic conditions in the Bogota Metropolitan Area will be changed. Taking into account the changes in socioeconomic conditions in the future, the Comprehensive Urban Transport Master Plan should be periodically reviewed and updated.

STUDY ORGANIZATION MEMBERS

(1) JICA Study Team

Mr. Koichi Tsuzuki	Project Manager of the JICA Study Team
Mr. Kenichi Sekine	Highway Planner (Deputy Manager of the JICA Study Team)
Mr. Iwane Mizuno	Urban Development Planner
Mr. Tetsuo Wakui	Public Transport Planner
Mr. Nobuyoshi Sugimoto	Rail Transit Planner
Mr. Masaaki Tsuda	Traffic Management Planner
Mr. Hisayuki Yamaguchi	Traffic Demand Analyst
Mr. Kimio Kaneko	Traffic Management Planner/Traffic Surveyor
Mr. Yoshiaki Nishikatsu	Construction Planner/Cost Estimator
Mr. Osamu Ohtsu	Economist
Mr. Fumiaki Shino	Environment Analyst

(2) JICA Advisory Committee

Dr. Koichi Yamagata	Professor, University of Ibaraki (Chairman of the JICA Advisory Committee)
Mr. Toshio Noguchi	Ministry of Transport
Mr. Eiji Nomura	Metropolitan Expressway Public Cooperation

(3) JICA Project Coordinators

Mr. Tomoyuki Kosawa	Japan International Cooperation Agency (Coordination from March 1996 to December 1996)
Mr. Yuji Ikeda*	Japan International Cooperation Agency (Coordination from July 1995 to March 1996))

(4) Colombia Counterparts

Dr. Fernando Rubiano	Leader of Counterparts
Dra. Piedad Gutierrez	Highway Planner
Dr. Jorge Otaloramero	Highway Engineer
Dra. Ana Luisa Flecha	Urban Development Planner
Dr. William Fabian Escobar	Urban Development Planner
Dr. Rafael Monroy	Public Transport Planner
Dra. Marta Corredor	Traffic and Transport Planner
Dr. Carlos Garcia	Traffic Management Planner
Dr. Henry Tarazona	Traffic and Transport Planner

(5) Steering Committee

Dr. Antanas Mockus	Alcalde Mayor de Santa Fe de Bogota (Chairman of the Steering Committee)
Dr. Efraim A. Becerra	Director of STT (Vice-chairman of the Steering Committee)
Dra. Maria Piedad Mosquera*	Director of STT
Dra. Maria Elisa Bernal	Chief of Special Division of DNP
Dr. Jaime Ortiz Marino	Presidential Council for Santa Fe de Bogota
Dr. Mario Noriega	Mayor's Advisor
Dr. Carlos Hernan Lopez	Ministry of Transport
Dr. Jorge Rodriguez M.	Director of IDU
Dr. Maria Elvira Perez	Director of SOP
Dr. Alberto Villate	Director of DAPD
Dr. Carlos Rodriguez	Council of PNUD

Note; *Predecessor

List of Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
B/C	Benefit/Cost
BMA	Bogota Metropolitan Area
Bogota	Santa Fe de Bogota
CBD	Central Business District
CAR	Corporación Autónoma Regional
C/D	Capacity/Demand
DAMA	Departamento Técnico Administrativo del Medio Ambiente
DANE	Departamento Administrativo Nacional de Estadística
DAPD	Departamento Administrativo de Planeación Distrital
DNP	Departamento Nacional de Planeación
FEDESARROLLO	Fundación para la Educación Superior y el Desarrollo
EIRR	Economical Internal Rate of Return
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GRDP	Gross Regional Domestic Product
HRT	Heavy Rail Transit
IBRD	International Bank for Reconstruction and Development
IDU	Instituto de Desarrollo Urbano
JICA	Japan International Cooperation Agency
LRT	Light Rail Transit
OD	Origin-Destination
PCU	Passenger Car Unit
PT	Person Trip
ROW	Right of Way
SOP	Secretaría de Obras Públicas de Distrito
STT	Secretaría de Transporte y Tránsito
TDM	Transport Demand Management
TTC	Travel Time Cost
UTP	Unidad de Transporte Público
V/C	Vehicle/Capacity
VOC	Vehicle Operating Cost
\$	Colombian Peso
US\$	US Dollar

JICA



LIBI