

### 3. TRAVEL DEMAND ANALYSIS

#### 3.1 General

This manual is made based on the travel demand model prepared on the Study on The Master Plan for Urban Transport of Santa Fe de Bogota in the Republic of Colombia. The travel demand model in the Study employs the "Four-Step Method". The four-step method is used to predict (1) the number of trips made within the Study Area by purpose, (2) zonal origin-destination (OD) pair, (3) the mode of travel used to make these trips, and (4) the routes taken through the transportation network by these trips.

The estimated model was developed based on the Person Trip Survey data conducted by the Study team. The contents of the Person Trip Survey data is shown in the Section 2 in this Manual.

Manual for Travel Demand Model is composed of the following;

- 1) Manual for Travel Demand Model
- 2) User's Manual for the Travel Demand Software (Section: 4)

In the Travel Demand Model, the process of developing the model is shown for understanding the model. Software to implement the procedures contained in this Travel Demand Model developed by JICA Study Team is donated by JICA. The User's Manual is prepared for re-forecasting the future travel demand by using this model according to the variation of socioeconomic conditions.

#### (1) Basic Structure of Model

The flowchart of forecasting model is shown in Figure 3.1-1. The model was embodied by motorized or non-motorized households, by trip purpose and by mode corresponding to each step, as shown in Table 3.1-1. This is because the number of daily trips for motorized household members is considerably higher than the non-motorized, and the zonal origin-destination pair is different by trip purpose and by transportation mode from the analysis of travel demand structure by person trip.

For estimating the traveler demand for non-residents who dwell outside the Study Area, the four-step method was also applied for the residents within the Study Area. In the future, population growth outside Bogota is forecasted at about 2.4 million, in contrast to 0.8 million at present. The future travel demand between Bogota and surrounding areas is forecasted dramatically high, and, the travel pattern of zonal origin-destination will be different. Trip information for non-residents, however, is not available, but the ratio of trips made by them against the total is as low as 2.5 % at present. Even when the simple method is employed for non-residents, influence to the accuracy of whole trips estimated is little. Therefore, travel demand for non-residents was estimated by a simplified estimation method.

The classifications of motorized households, trip purposes and transportation modes are shown below.

#### 1) Zoning System

The total number of zones is 135, of which 108 zones are in the Study area taking account of major roads, city district boundary, and Sector (which means the unit of

integrated Manzana). There are 27 zones outside of the Study area. The zoning maps are shown in Figures 3.1-2 and 3.1-3, which show zoning maps inside and outside the Study area, respectively. Tables 3.1-2 to 3.1-4 also show the zone code tables. The integrated 34 zoning system is also shown to illustrate the zonal indices and desire lines as shown in Figure 3.1-4.

**2) Classification of Motorized Households**

- a) Motorized household : car owned
- b) Non-Motorized Household : motorcycle or bicycle owned

**3) Trip Purposes**

- a) To work
- b) To school
- c) Business
- d) Private/Shopping
- e) To home

**4) Classification of Modes**

- a) Private Mode : Car, Taxi and Truck
- b) Public Mode : Bus

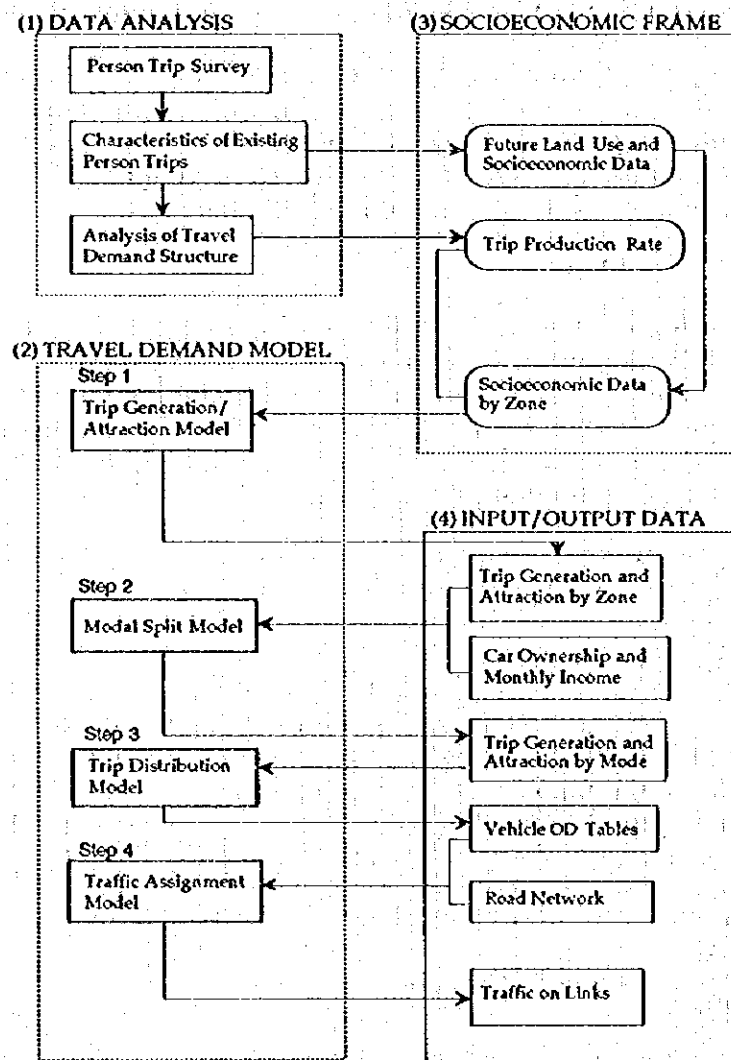


Figure 3.1-1 Flowchart of Forecasting Model

Table 3.1-1 Model Structure

Step	Motorized/ Non-Motorized	By Purpose	By Mode
1) Trip Production	O	-	-
2) Trip Generation/ Attraction	O	O	-
3) Modal Split	O	O	O
4) Trip Distribution	O	O	O
5) Traffic Assignment	-	-	O

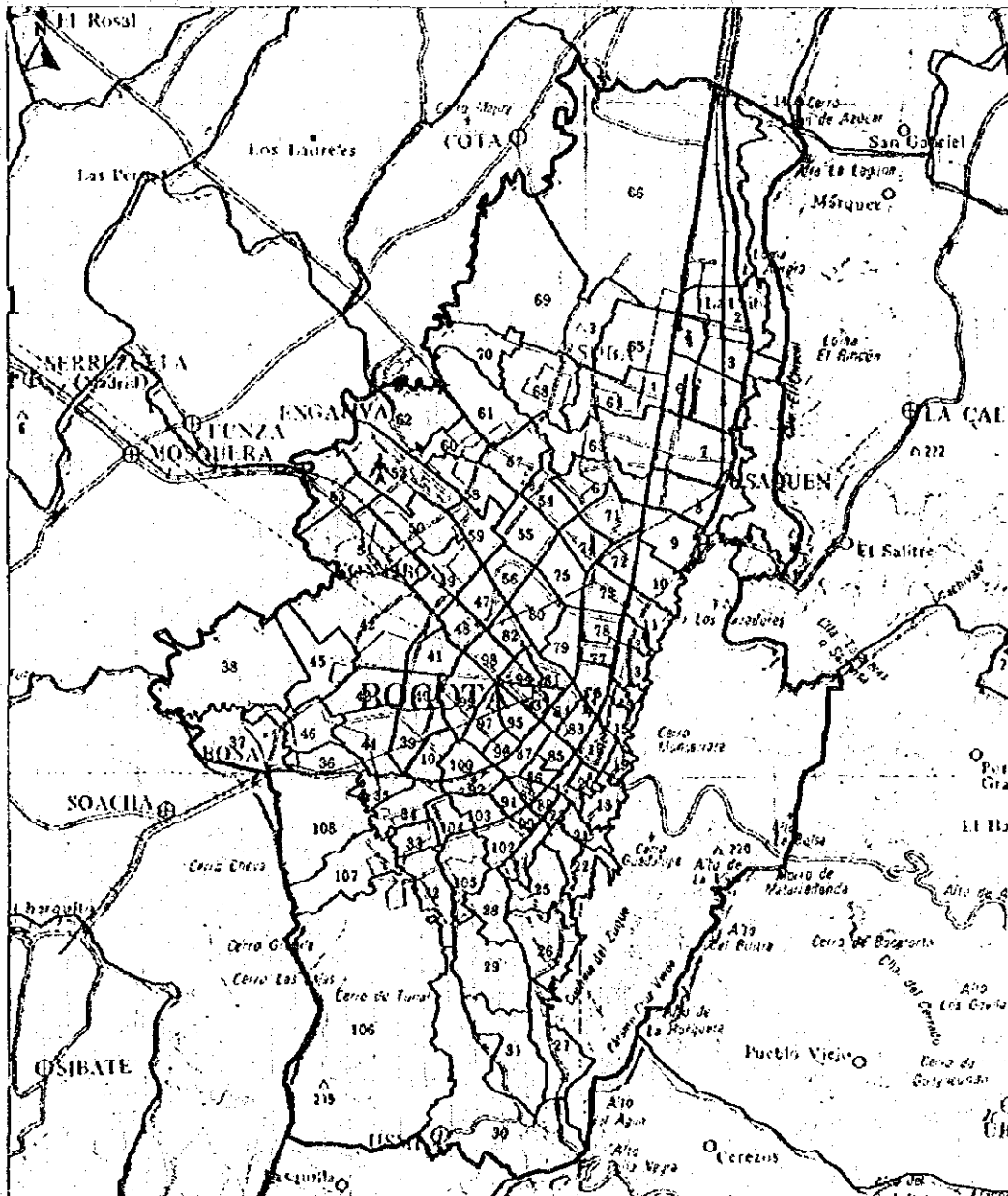


Figure 3.1-2 Zoning Map inside the Study Area

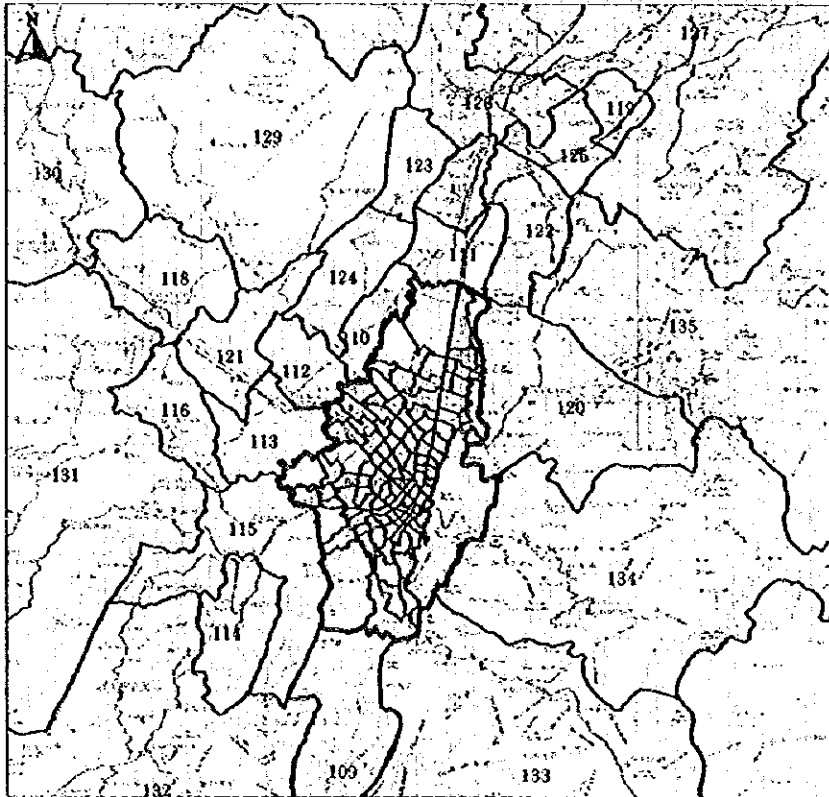


Figure 3.1-3 Zoning Map outside the Study Area

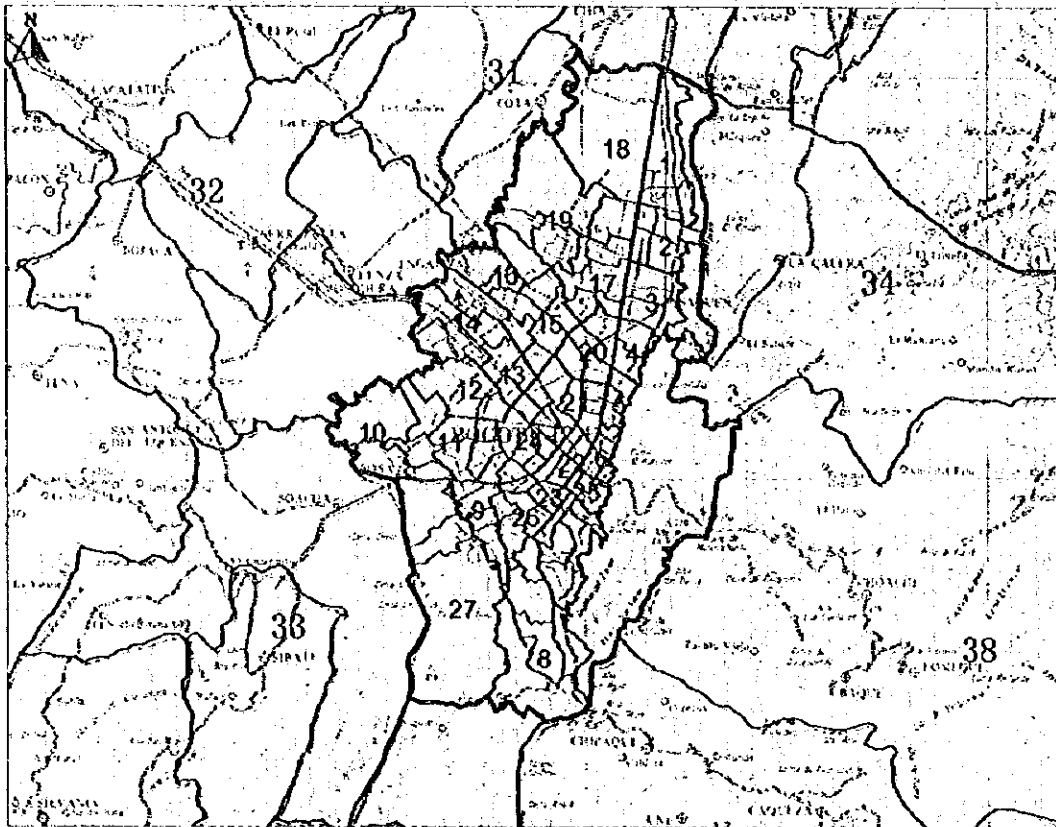


Figure 3.1-4 Integrated Zoning Map

Table 3.1-2 Zone Code Table

Zone No.	District	District Name	Sector Code Number	
1	1	Usaquen	8531	8527
2	1		8532	8528
3	1		8533	8529
4	1		8534	8530
5	1		8535	8531
6	1		8536	8532
7	1		8537	8533
8	1		8538	8534
9	2	Chapinero	8301	8302
10	2		8303	8304
11	2		8305	8306
12	2		8307	8308
13	2		8309	8310
14	3	Santa Fe	8101	8102
15	3		8103	8104
16	3		8105	8106
17	3		8107	8108
18	3		8109	8110
19	17	La Candelaria	3201	3202
20	17		3203	3204
21	4	San Cristobal	1101	1102
22	4		1103	1104
23	4		1105	1106
24	4		1206	1207
25	4		1208	1209
26	4		1210	1211
27	5	Ume	1301	1302
28	5		1303	1304
29	5		1305	1306
30	5		1307	1308
31	5		1309	1310
32	6	Tuyque lito	2501	2502
33	6		2503	2504
34	6		2505	2506
35	6		2507	2508
36	7	Boza	4501	4502
37	7		4503	4504
38	7		4505	4506
39	8	Ciudad Kenne	4401	4402
40	8		4403	4404
41	8		4405	4406
42	8		4407	4408
43	8		4409	4410
44	8		4411	4412
45	8		4413	4414
46	8		4415	4416

Table 3.1-3 Zone Code Table

Zone No.	District	District Name	Sector Code Number	Sector Code Number
47	9	Pontabon	6303	6315
48	9		6306	6307
49	9		6311	6301
50	9		6401	6402
51	9		6406	6410
52	9		5624	
53	9		6414	6418
54	10	Engatva	5404	5405
55	10		5503	5504
56	10		5506	5507
57	10		5613	5612
58	10		5608	5628
59	10		5606	5607
60	10		5623	5627
61	10		5618	5622
62	10		5634	5635
63	11	Suba	9107	9117
64	11		9105	9106
65	11		9104	9110
66	11		9119	9120
67	11		5303	5302
68	11		9202	9203
69	11		9201	9212
70	11		9209	9214
71	12	Barras Unidos	5304	5305
72	12		7401	7402
73	12		7301	7302
74	12		5201	5202
75	12		5101	5102
76	13	Tenasquillo	7101	7102
77	13		7204	7205
78	13		7201	7202
79	13		5107	5108
80	13		5113	5114
81	13		6201	6202
82	13		6318	
83	14	Los Martires	6102	6103
84	14		6101	6106
85	14		4102	4103
86	14		4105	4106
87	14		4101	4107
88	15	Antonio Nari	1208	1201
89	15		2101	2102
90	15		1204	
91	15		2103	2104
92	15		2105	2106
			2107	2301
			2108	2302
			2109	2309
			6308	6308
			6403	6404
			6407	6408
			6415	6417
			6416	6419
			5601	5602
			5502	5501
			5510	5509
			5615	5616
			5625	5626
			5611	5610
			5621	5625
			5614	5614
			5630	5633
			5636	5637
			5631	5632
			9118	9111
			9112	9121
			9108	9112
			9101	9115
			9113	9114
			5301	5401
			9204	9205
			9213	9210
			9215	9219
			5308	5307
			7403	7404
			7303	7304
			5203	5204
			5103	5104
			7103	7104
			7209	7206
			7203	7207
			5105	5106
			5111	5109
			6209	6210
			6104	6105
			6107	6106
			4104	4110
			4111	4109
			4108	4109
			1202	1203

Table 3.1-4 Zone Code Table

Zone No.	District	District Name	Sector Code Number																	
90	16	Puerto Arand	6203	6204	6211	6205	6206													
94	16		6207	6208																
95	16		4201	4207	4208															
96	16		4202	4209	4211	4203														
97	16		4212	4210	4204	4205	4206													
98	16		6304	6305																
99	16		6303	4301	4302	4303	4304	4305	4306	4307	4308	4309								
100	16		4402	4412	4413	4403	4404													
101	16		4401	4407	4406	4405	4408	4409	4416											
102	18	Rafael Uribe	1404	1401	1402	1403	1410													
103	18		2201	2202	2303	2304	2305	2310	2306											
104	18		2203	2204	2205	2207	2208													
105	18		2505	2504	2503	2502	2510	2506	2511	2507	2508									
106	19	Ciudad Bolívar	2422	2520	2516	2514	2521	2517	2558	2559	2560	2561	2562	2519	2523	2524	2525	2530		
107	19		2518	2513	2515	2536	2566	2565	2565											
108	19		2419	2415	2414	2420	2416	2417	2418	2410	2421	2422								
109	20	Suñapez																		
110	23	Cota																		
111	21	Chía																		
112	24	Funza																		
113	24	Mosquera																		
114	25	Sibaté																		
115	25	Soacha																		
116	24	Boyacá																		
117	21	Cajicá																		
118	24	Pacatavita																		
119	22	Cachancipa																		
120	26	La Calera																		
121	24	Madrid																		
122	22	Sopó																		
123	23	Tadó																		
124	23	Tenjo																		
125	22	Tocancipa																		
126	21	Zipacná																		
127	27	Chocontá																		
128	27	Pacho																		
129	28	La Vega																		
130	28	Medellín																		
131	29	Guarandó																		
132	29	Apicalá																		
133	30	Quevené																		
134	30	Chonchi																		
135	30	Cueca																		

BOYACÁ, Northern and North-East Parts of Colombia

Western Part  
TOLIMA, South-West Part  
South-West Part  
METÁ, South-East Part

## (2) Survey Data Processing

Since the Person Trip Survey and Cordon Line Survey data are obtained on the random sampling basis, the collected survey data has to be expanded to change real values based on the present population as a universe. And also, both the survey data have to be adjusted to avoid double counting due to the fact that the person who lives in the inside of the Study Area is included in the interview data from Cordon Line Survey. Those data processing is made in many steps from expansion of survey data to screen line check.

### 1) Person Trip Survey

#### a) Expansion

Expansion of the Person Trip Survey data which is on random sampling basis is made by traffic zone.

#### b) Screen Line Check

The trip data for Person Trip Survey is adjusted by comparing the number of vehicle trips or passengers estimated passing through the screen line from the Person Trip Survey data with the traffic counting data on the screen line. Out of the following two methods of adjustment for the screen check, the former method is generally employed. As for bus, the latter method is also applied in case that the total bus passenger data is obtained from the public transport survey.

#### Adjustment on the Screen Line

The adjustment called "Screen Line Check" is made by comparing number of traffic volume ( $T_p$ ) which passes through the screen line estimated from the Person Trip Survey data with the traffic volume ( $T_s$ ) counted on the screen line. The traffic ( $T_c$ ) which passes through not only the screen line, but also the cordon line, must be erased from the traffic on the screen line. The equation for the screen line check is shown below:

$$T_s - T_c = a * T_p$$

where

a : coefficient of adjustment

The types of car, taxi, truck and bus were adjusted on this method. In the survey, the factors of adjustment for car and taxi are 1.6, respectively, and bus and truck are adjusted with 1.8 and 18.

#### Adjustment of total number of trips

In case that it is possible to obtain the traffic data from other surveys or statistical data, which is the total number of trips for certain transport mode ( $T$ ) traveled within the whole Study Area and which is seemed to be more accurate than that of the Person Trip Survey, the total trips ( $T_u$ ) from the Person Trip Survey are adjusted coinciding with the total number of trips obtained from other sources. The coefficient of adjustment ( $b$ ) is shown below:

$$b = T / T_u$$

As for the screen check for bus, according to the total bus passengers obtained from the public transport survey in which bus passengers by each bus route were



counted, total bus passengers from the Person Trip Survey are also checked on this method. The screen line check for the types of motorcycle, walk and bicycle will be abandoned.

## 2) Expansion Method of Cordon Line Survey Data

Expansion for the interview data of the Cordon Line Survey which is carried out on sampling basis is made according to the following classification:

- Location
- Type of vehicle
- Time range

The factors of expansion are different according to the above classification. The factors for car and taxi are in range of 2 to 15 in the person trip unit, respectively. The truck factor also varies from 2 to 25 according to locations and time. As for buses, the factor (10 to 60) is somewhat large due to that number of interviewed passengers is limited.

## 3) Relation between Cordon Line and Person Trip Surveys

The trip OD table is made from the data of Person Trip Survey and Cordon Line Survey. The Person Trip Survey data is of information for the persons who live inside the Study Area, while the Cordon Line Survey is to purpose collecting the trip information for the travelers who dwell outside the Study Area. In the crude data of Cordon Line Survey, the trip information for passengers who dwell inside the Study Area is collected. It is indispensable that these trip data have to be erased from the crude data of Cordon Line Survey when the trip OD table of the whole Study Area is made.

### 3.2 Estimation of Future Motorized Households

Since the travel demand model is structured by motorized and non-motorized households, as mentioned before, the number of motorized households in future must be estimated. The procedure of estimation is shown below.

- (1) Estimation of total number of motorized households
- (2) Estimation of motorized households by zone

The first step (1) is to estimate the total number of motorized households in the Study Area and then, it is broken down into traffic zones in the second step (2).

#### 3.2.1 Total Number of Motorized Households

There is a close relationship between the car ownership and the household income according to the analysis of the Person Trip Survey data (see Figure 3.2-1). This relationship was used for the estimation of the total number of motorized households, i.e., car-owning households, by inputting both the estimated future income distribution and number of households. In this process, forecasting of two or more vehicle-owning households is indispensable in the estimation of motorized households because they are sizable in number. The multi-car owning was also estimated in the same manner as one-car owning by using the relationship shown in Figure 3.2-2. These estimated motorized households were controlled by the future total number of cars.

The future number of cars was estimated by following steps;

- 1) To forecast the total number of cars according to the relationship between car

ownership and future average income ( see Figure 3.2-1), which is estimated by future growth of GRDP per capita.

- 2) To estimate the future income distribution in proportion to the future growth of GRDP per capita.
- 3) To estimate the ratio of future number of households classified into three categories: non-motorized, one car owning and multi-car owning, according to the relationship between Figures 3.2-2 and 3.2-3.
- 4) To estimate the number of multi-car owning households according to the future average cars by the multi-car owning households.
- 5) To estimate the number of non-motorized and one car owning households controlled by the future total number of cars.

Figure 3.2-3 shows the future income distribution which is estimated in proportion to future growth of GRDP per capita.

The future numbers of cars, and motorized and non-motorized households were estimated as shown in Table 3.3-1 according to the above steps.

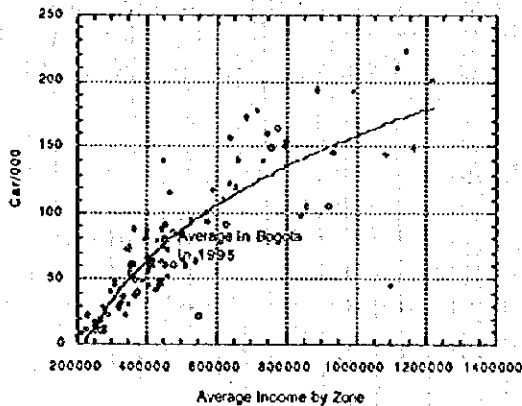


Figure 3.2-1 Relation between Car Ownership and Household Income

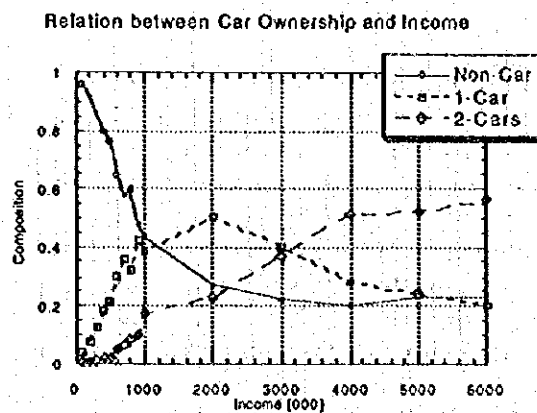


Figure 3.2-2 Relation between One Car and Multi-Car Ownership by Household Income

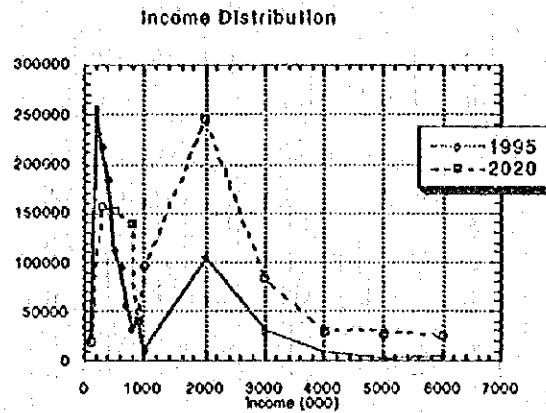


Figure 3.2-3 The Future Income Distribution

### 3.2.2 Motorized Households by Zone

Person trip data analysis found that both average income and car ownership by zone have a close relationship with each other as shown in Figure 3.2-4. There is a high car-ownership rate in high-income zones and a low car-ownership rate in low-income zones. This relationship was used for estimating the motorized households by each zone, i.e., the zonal average household income was employed as an explanatory variable. This variable was adjusted so that the total sum of motorized households of all zones was equivalent to the total number of motorized households.

The future number of cars was estimated by the following steps;

- 1) Estimate the ratio of car owning households by zone according to the future average zonal income based on Figure 3.2-4.
- 2) Estimate the number of car owning households by zone according to the estimated car owning household ratio by multiplying the number of zonal households.
- 3) Adjust the zonal car owning households by the total sum of motorized households of all zones.

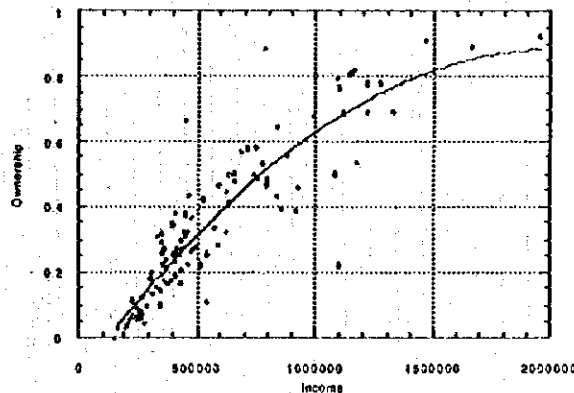


Figure 3.2-4 Relationship between Zonal Car Ownership (cars/1000 persons) and Income

The estimated zonal motorized households are shown in Figure 3.2-5, which shows the comparison between figures in 1995 and 2020.

### 3.3 Trip Generation and Attraction Model

Trip generation model are used to predict the trip ends generated by a household or a zone, usually on a daily or a peak-period basis. Trip ends are classified as being either a production or an attraction. Separate models are used to predict productions and attractions. The variables used as predictors of trip productions include household income, car ownership and size, and the number of workers per household. Trip attraction predictors include zonal employment levels, zonal floor space, etc. Two general classes of trip generation model have traditionally been employed: linear regression models and cross-classification model. In the Study, the regression model was employed.

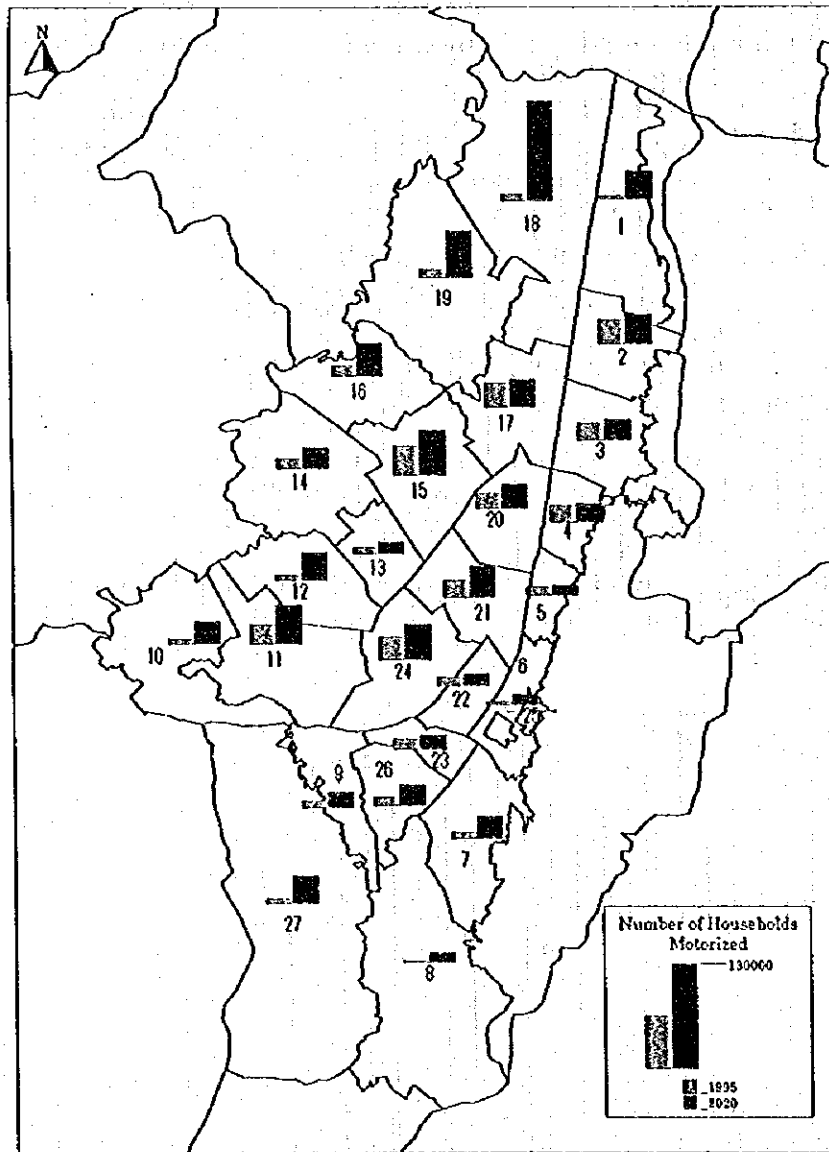


Figure 3.2-5 Estimated Motorized Households by Zone

This model has two steps: the first step estimates the total trip production for an entire zone, and the second are estimate zonal generated and attracted trips which are adjusted into so that they would, agree with the total trip production as control total. At the same time, modal choice is made by zone based on the trip-end model.

### 3.3.1 Total Trip Production

Future total trip production in the Study Area was estimated by using trip production rate (number of trips per person) on the assumption that the rate will be an unchangeable factor in the future. The total trip production was estimated by motorized and non-motorized household members due to the fact that the production rate between car owning and non-car owning is considerably different. The production rate tripped by persons who are 5 years old or above excludes walking and bicycle as shown below;

#### (1) Trip Production Rate

Motorized household: 1- car owning household:	2.43 trips/person/day
Multi-car owning:	2.75
Non-motorized:	1.79

#### (2) Total Trip Production

$$P = PR \times Pop$$

P : Total Trip Production by Motorized/ Non-Motorized Households

PR : Trip Production Rate by Motorized/ Non-Motorized Households

Pop : Population of Motorized/ Non-Motorized Household (5 years old or above)

Table 3.3-1 shows the total trip production which is estimated by substituting the number of persons by categorized households for the above equation. The non-motorized and motorized households are estimated in Section 3.2.

### 3.3.2 Trip Generation And Attraction By Zone

Trip generation and attraction by zone are forecasted by motorized and non-motorized households and by trip purpose (exclusive of "to home") as before-mentioned. As for the "to home" purpose, the trip generation is reflected as the total sum of attracted trips of other purposes exclusive of "business" purpose. On the other hand, the trip attraction is the total sum of generated trips forecasted in the same manner.

Linear type regression models were developed to estimate trip generation and attraction. The equatione are shown below;

$$G_i = a + b_1 \cdot X_{i1} + b_2 \cdot X_{i2}$$

$$A_j = a + b_1 \cdot X_{j1} + b_2 \cdot X_{j2}$$

where;

$G_i$ : Generation trip from zone i

$A_j$ : Attraction trip to zone j

$X_{in}, X_{jn}$ : Socioeconomic data in zone i or j

a,  $b_1$ ,  $b_2$ : model parameters

Table 3.3-1 Summary of Socioeconomics 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/1000)	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

Parameters of variables are shown in Table 3.3-2. The variables for trip generation employed home-based socioeconomic figures which are the numbers of employees and students. As for the attraction, non-home based variables (daytime-based) include the number of tertiary industry workers and students (school-based) employed. These variables are employed because trip generation depends on the home-based socioeconomic figures, while the attraction is for the daytime based variables.

Table 3.3-2 Parameter of Trip Generation and Attraction Model

Y Purpose	$Y=a+b_1*X_1+b_2*X_2+b_3*X_1*X_2$						
	a	b1	b2	b3	X1	X2	r
1) Non-Motorized (1) Generation							
To work	-847.654	1.169			Employee		0.990
To school	2555.253	0.443			Student-Home		0.848
Business	456.503	0.134	2422.675	0.074	Ind-Tertiary	Dummy=1	0.919
Private	945.576	0.243	0.168		Employee	Student-	0.865
(2) Attraction							
To work	-631.425	1.055			Ind-Tertiary		0.979
To school	1138.708	0.202	-5769.45	0.731	Student-School	Dummy=1	0.950
Business	-717.852	0.267			Ind-Tertiary		0.942
Private	-870.891	0.508			Ind-Tertiary		0.915
2) Motorized household (1) Generation							
To work	513.969	0.964			Employee		0.971
To school	-343.141	1.204			Student-Home		0.950
Business	426.337	0.103	1804.757	0.073	Ind-Tertiary	Dummy=1	0.921
Private	161.182	0.677	7069.032	0.016	Employee	Dummy=1	0.944
(2) Attraction							
To work	-1930.922	0.576			Ind-Tertiary		0.982
To school	908.976	0.079	-2199.677	0.699	Student-School	Dummy=1	0.959
Business	143.591	0.167			Ind-Tertiary		0.924
Private	-379.046	0.408			Ind-Tertiary		0.915

### 3.3.3 Modal Split Model

#### (1) General

Modal split models are used to predict the percentage of trips using each of the models available to the given trip makers. Modal split occurring after trip distribution is known as a *trip-interchange* modal split model, while the model in which modal split is performed prior to distribution is known as a *trip-end* model.

**Trip-end models** Trip-end modal split modeling is based on the assumption that transit ridership is primarily a function of socioeconomic variables; that is, virtually all transit riders are assumed to be "captive" riders - people who have no other choice but to ride transit. This assumption is most valid in areas which possess relatively low transit service levels.

The major advantage of such models is that they are simple to apply and require relatively little data for calibration or prediction. In particular, since the trips have not yet been distributed, the only variables that can be used in these models are those that were used in the trip generation stage: car ownership, income, household size, zonal population density, etc.

**Trip-interchange models** Since trip-interchange models are used after trip distribution, they can utilize the service characteristics (travel time, costs, etc.) of the alternative modes available for a given trip to determine the modal splits. Typically this has been accomplished through the use of diversion curves, which express the percentage of transit trips as a function of one or more service ratios and socioeconomic categories.

#### (2) Outline of Modal Split Procedure

In Bogota, it was disclosed from the data analysis that car ownership influences the determination of modal choice between private car and public bus. The modal choice is less frequently made on the basis of the travel time or the travel cost on the route to destination.

The modal split model employed was the "trip-end" model as mentioned above. This model is made based on the assumption that modal choice is primarily explained by socioeconomic characteristics on generated or attracted zone. The variables used in this model are car ownership and income, etc. This model, however, can not utilize the service characteristics (travel times, costs, etc.) of the alternative modes to determine the modal splits. In Bogota, as mentioned above, the modal choice between private car and public bus is primarily determined by whether a car is owned or not, and not by the travel time or the cost.

The estimation of each transport mode was made using the binary choice method shown in Figure 3.3-1. As the first step, the transportation modes were classified into 2 modes: private transport (car, taxi and truck) and public transport (bus). The estimation of each transport mode was made by the trip-end model. In this classification, taxi is classified into private mode since it serves privately as passenger cars.

The second step in which the private modes are divided into Car, Taxi and Truck, was conducted after forecasting the trip OD table for the private and public transport.

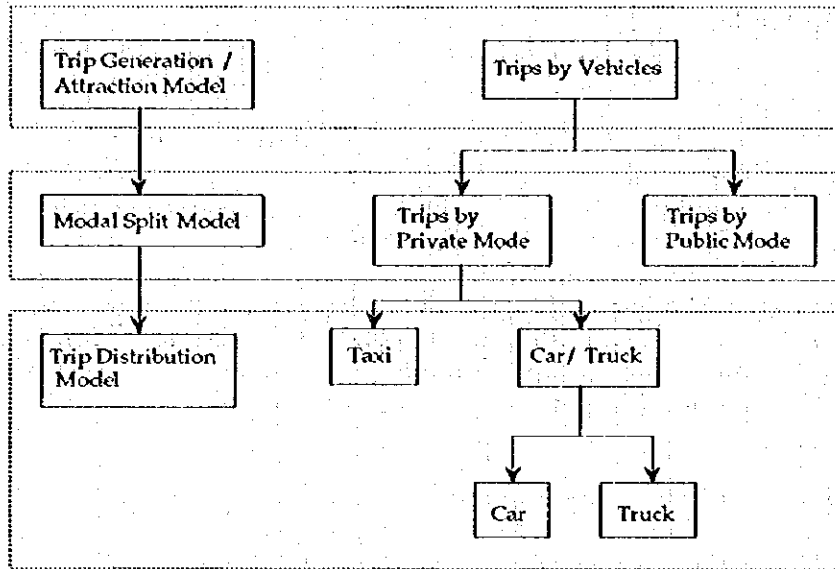


Figure 3.3-1 Procedure of Modal Split Model

**(3) Modal Split Ratio of Private and Public Transport**

The model was made for the motorized and non-motorized households. The model variable for motorized households used the average zonal car ownership (veh/1000 pop), while the one for non-motorized took the average zonal income from the Person Trip data analysis.

Figure 3.3-2 shows the diversion curve for the "To Work" purpose in the motorized households. As can be seen, the ratio of modal choice of private vehicles to the public transport is related to the average zonal car ownership. The future zonal modal choice is estimated by the equations which are made on the relationship shown in Figure 3.3-2. The parameters of equations are shown in Table 3.3-3.

On the other hand, the travel distance, the travel time, and the cost are not to related to the determination of the modal choice of the public transport to the private vehicles as shown in Figure 3.3-3. The present traffic characteristics show that it is difficult to make the trip-interchange model.

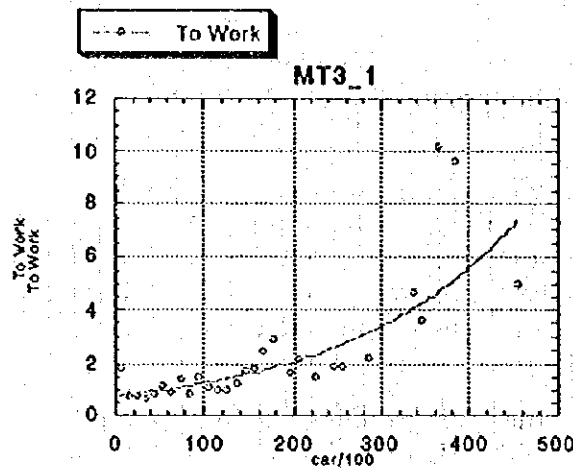


Figure 3.3-2 Diversion Curve for "To Work" Purpose of Motorized Household



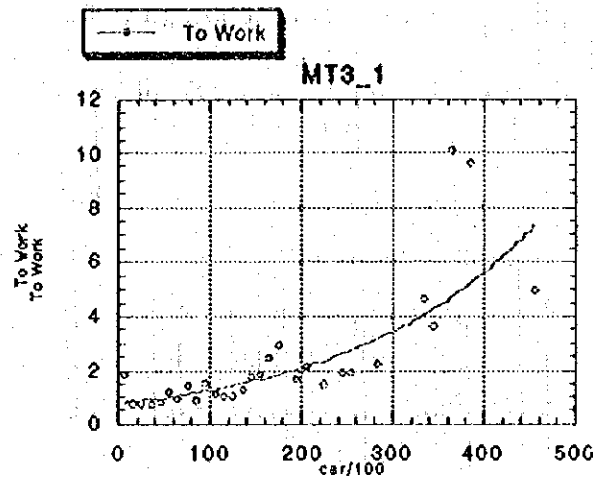


Figure 3.3-3 Relationship Between Travel Distance and the Ratio of Modal Choice of Public Mode

Table 3.3-3 Equations and Parameters of Modal Choice Model

Y = a * exp ( b X )		
Motorized Household	a	b
To Work	0.767	0.00496
To School	0.310	0.00078
Business	3.670	0.00280
Private	1.439	0.00440
Y = a + b <sup>x</sup>		
Non-Motorized Household	a	b
To Work	0.128	8.455e-9
To School	0.065	7.789e-9
Business	0.599	7.048e-9
Private	0.225	2.461e-7

Note: Y is ratio of modal choice of the zonal private vehicle

(4) Other Split Ratios

The split ratio of taxi and car (including truck) applied the present ratio of trips used taxi by each zone from the Person Trip Survey data. As for the ratio of car and truck, future split ratio for an entire zone was estimated based on the future trip ratio of truck to car, which was estimated from future car and truck ownership.

The truck demand was estimated by a simple estimation method based on trend analysis. The method has two steps; the first step is to estimate the traffic demand corresponding to the future growth of truck volume, and the second one is to estimate the generated and attracted volumes from/to zone in the future. A trip OD table of truck was estimated by the present pattern method.

The future number of trucks in 2020 is estimated by the regression analysis in which the variable employs the GRDP whose figure is in close relationships with the registered trucks. The future ratio of trucks to cars and trucks in number will be 0.14, in contrast to 0.16 at present. As for the ratio of trips, the future ratio of trucks is estimated about 0.12 as shown in Table 3.3-4. The truck OD trip table was estimated by using the truck trip ratio from the car and truck OD trip tables.

**Table 3.3-4 Trip Ratio of Car and Truck**

Year	Registered Vehicles			No. of Trips		
	Car	Truck	Truck/C+T	Car	Truck	Truck/C+T
1995	497,747	92,850	0.157	2,175,369	348,289	0.138
2020	1,350,000	210,468	0.135	5,900,081	789,485	0.118

**3.3.4 Projection of Trips by Mode in 2020**

Numbers of trips by mode (private and public) and by motorized and non-motorized households in the years 1995 and 2020 are shown in Table 3.3-5.

**Table 3.3-5 Trip Comparison by Mode in 1995 and 2020**

	1995			2020			2020/1995		
	Private	Public	Total	Private	Public	Total	Private	Public	Total
1) Non-Motorized Households	828,412	6,094,477	6,922,889	1,105,252	6,299,600	7,404,852	1.33	1.03	1.07
2) Motorized Households	2,285,982	1,987,959	4,273,941	5,711,661	4,294,050	10,005,711	2.50	2.16	2.34
3) Total	3,114,394	8,082,436	11,196,830	6,816,913	10,593,650	17,410,563	2.19	1.31	1.55

**3.3.5 Projection of Trip Generation and Attraction in 2020**

Estimated trip generation and attraction in 2020 according to the integrated zone are shown in Tables 3.3-6 and 3.3-7. Figure 3.3-4 shows a comparison between the figures in 1995 and 2020 in which "to home" trips are excluded to clearly show the characteristics of generation and attraction.

Trip generation and attraction by the motorized and non-motorized households are shown in Figures 3.3-5 and 3.3-6.

Figures 3.3-7 and 3.3-8 show the public mode trip generation and attraction by purpose in 1995 and 2020 in which "to home" trips are excluded to clearly show the characteristics of generation and attraction. Figures 3.3-9 and 3.3-10 also show the generation and attraction of the private mode.

Table 3.3-6 Trip Generation and Attraction in 2020

zone	Generation									
	To Work		To School		Business		Private		To Home	
	car	bus	car	bus	car	bus	car	bus	car	bus
1	29,261	43,128	7,364	40,242	9,408	8,729	35,853	17,251	102,651	218,994
2	77,283	66,207	19,420	82,277	26,686	8,650	73,515	31,810	109,129	104,807
3	71,447	32,458	16,138	48,776	30,336	7,166	75,916	21,787	168,819	159,285
4	66,080	11,317	15,912	40,771	52,153	7,492	83,732	17,409	236,402	187,619
5	24,834	24,352	10,751	39,297	31,331	12,017	58,224	24,840	186,513	393,696
6	18,337	55,348	10,806	42,413	53,777	28,442	60,044	46,823	219,212	831,662
7	42,128	183,588	8,468	80,475	24,072	13,894	27,255	54,872	42,849	90,467
8	15,671	93,846	2,858	39,392	9,359	5,451	6,642	27,875	9,361	42,469
9	29,396	105,621	4,349	60,895	22,550	8,759	24,585	39,689	39,809	93,980
10	33,493	108,134	3,876	54,259	8,108	7,969	20,497	36,553	45,180	75,432
11	94,619	242,506	12,941	144,256	66,779	19,108	61,631	81,191	120,707	197,490
12	46,327	37,532	13,058	49,617	8,471	3,326	36,927	14,437	47,061	33,773
13	30,298	24,188	8,236	41,960	12,141	5,126	26,201	12,489	39,157	65,442
14	41,492	93,375	6,782	59,449	20,263	10,112	33,155	36,124	80,231	138,997
15	107,119	226,004	23,378	163,538	41,171	21,330	97,262	88,151	142,746	221,144
16	50,203	141,508	12,600	84,710	13,714	10,112	34,438	51,636	45,652	60,644
17	87,662	51,094	18,022	71,229	23,741	9,953	75,696	22,185	96,591	82,656
18	124,271	84,007	36,651	117,131	16,120	6,024	103,961	45,614	180,145	135,326
19	58,603	131,557	11,205	83,089	18,209	12,335	39,976	52,519	53,104	89,209
20	55,834	87,464	14,578	68,269	28,580	10,134	70,081	35,847	137,588	200,017
21	68,148	61,040	18,784	84,044	45,999	14,691	102,085	45,756	239,689	360,818
22	30,964	40,718	6,417	41,663	31,253	13,794	53,902	27,669	124,590	234,911
23	50,865	53,542	10,659	44,221	14,722	7,171	30,429	19,762	53,352	101,108
24	83,989	154,296	31,421	108,185	43,873	34,206	88,131	67,114	135,578	313,123
25	2,557	11,186	1,770	6,115	4,027	2,031	6,951	6,758	21,632	106,566
26	47,056	142,904	7,535	70,255	26,164	12,457	36,951	49,681	58,686	144,657
27	33,426	172,356	12,730	69,995	20,326	12,961	25,873	57,233	54,679	91,398
28	0	0	0	0	0	0	0	0	0	0
29	467	219	261	995	6,781	1,058	5,410	1,025	26,984	56,471
30	6	128	8	129	3,378	168	767	133	1,285	2,610
31	0	0	373	213	755	249	1,075	409	12,779	9,468
32	17	505	57	1,002	10,898	580	10,911	832	22,520	26,638
33	258	935	285	332	17,395	1,773	11,394	1,220	13,121	41,663
34	7	210	189	311	3,795	182	111	261	2,283	7,179
35	186	525	14	302	0	0	987	348	2,302	1,558
36	10	288	0	0	0	0	0	0	801	313
37	139	394	146	0	0	0	724	0	4,334	1,303
38	0	0	0	0	669	157	188	447	412	3,224
Total	1,422,453	2,482,480	348,042	1,829,807	747,004	317,496	1,421,480	1,037,750	2,877,934	4,926,117

Table 3.3-7 Trip Generation and Attraction in 2020

zone	Attraction									
	To Work		To School		Business		Private		To Home	
	car	bus	car	bus	car	bus	car	bus	car	bus
1	53,641	51,741	12,595	164,490	15,622	8,104	46,317	23,473	65,261	93,214
2	44,945	49,433	17,924	44,359	19,613	7,967	55,430	21,543	152,589	164,547
3	76,447	112,353	15,150	39,999	35,951	12,400	90,793	30,237	146,929	93,372
4	114,743	145,325	42,144	42,326	55,354	13,273	96,325	27,311	148,737	64,339
5	65,633	171,446	44,057	204,086	39,862	19,323	98,040	66,576	84,617	81,678
6	93,577	468,770	46,098	253,134	94,361	54,452	144,361	173,605	80,901	135,962
7	24,441	32,458	2,236	34,928	14,548	8,951	15,637	28,997	71,550	296,784
8	6,513	14,982	22	15,235	5,395	3,102	1,971	15,421	24,074	148,656
9	20,096	34,943	2,606	44,316	12,376	7,079	20,010	26,607	51,896	179,475
10	28,175	29,399	1,544	23,803	7,376	9,493	19,316	24,869	52,656	181,712
11	84,991	91,675	3,141	63,401	43,968	15,658	43,547	57,219	156,178	435,378
12	28,279	19,700	1,195	6,933	6,971	3,871	19,685	8,932	86,468	92,774
13	24,701	44,781	2,374	8,071	10,812	5,260	22,338	14,769	57,988	71,739
14	54,999	94,573	2,717	30,094	23,355	9,371	36,717	25,134	73,276	171,488
15	65,068	93,126	20,687	95,559	29,984	18,194	68,949	53,240	204,266	440,866
16	28,899	24,760	1,767	21,310	8,301	6,312	16,591	20,621	88,426	253,672
17	39,482	47,688	8,772	21,463	16,419	7,382	54,709	22,577	162,825	130,140
18	88,722	20,206	35,248	109,375	20,574	5,599	68,345	13,216	238,518	229,202
19	36,364	28,650	2,299	32,716	11,750	9,078	18,368	32,685	98,450	246,835
20	66,045	115,171	7,829	67,322	28,984	12,354	78,231	40,284	126,158	173,657
21	107,134	176,812	31,105	144,547	51,621	15,735	124,094	73,648	169,491	175,695
22	68,084	146,269	6,638	64,254	33,247	11,509	65,297	50,479	82,016	100,274
23	25,464	43,963	4,050	45,090	14,618	7,457	24,222	23,994	82,632	108,429
24	81,197	227,035	7,713	54,652	36,507	18,676	60,856	63,196	181,103	308,822
25	9,995	41,117	7,892	66,623	5,443	3,960	14,003	12,013	10,465	22,677
26	25,951	43,821	10,836	76,601	14,940	9,264	28,682	35,863	84,960	240,528
27	39,482	42,397	252	20,506	15,053	7,940	13,921	34,431	64,396	272,476
28	0	0	0	0	0	0	0	0	0	70
29	3,903	13,085	2,026	17,373	19,870	1,232	24,651	2,805	5,493	2,180
30	818	2,630	0	90	2,445	178	293	60	690	428
31	1,082	3,345	6,335	6,081	2,600	404	5,556	76	1,337	613
32	6,432	13,447	376	7,230	18,526	1,499	22,195	3,296	10,434	2,398
33	4,165	29,814	414	932	19,110	1,744	13,135	5,521	10,707	2,750
34	1,045	3,871	0	818	4,328	50	1,601	542	285	800
35	210	1,693	0	0	1,245	32	2,251	284	1,059	1,086
36	877	439	0	0	1,675	0	594	530	12	396
37	602	1,325	0	0	4,711	225	2,922	276	914	461
38	231	237	0	90	589	388	1,527	1,420	177	544
Total	1,422,453	2,482,480	348,042	1,829,807	747,004	317,496	1,421,460	1,037,750	2,877,934	4,926,117

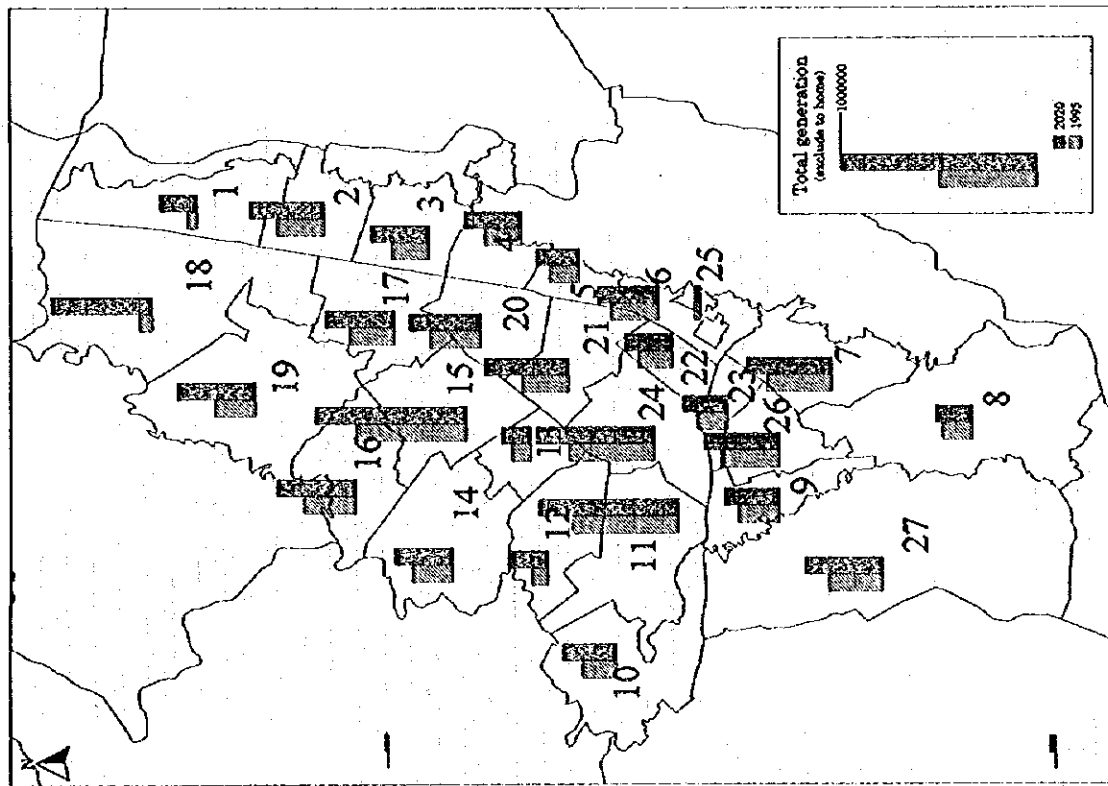
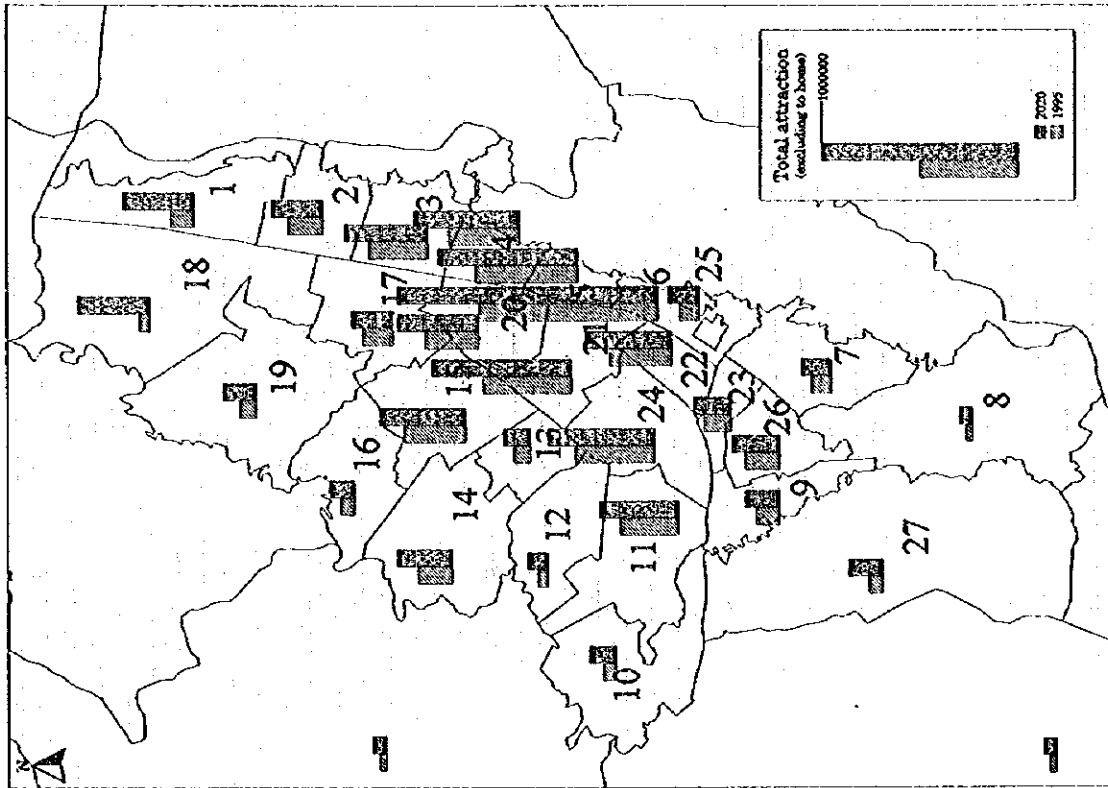


Figure 3.3-4 Trip Generation and Attraction in 1995 and 2020

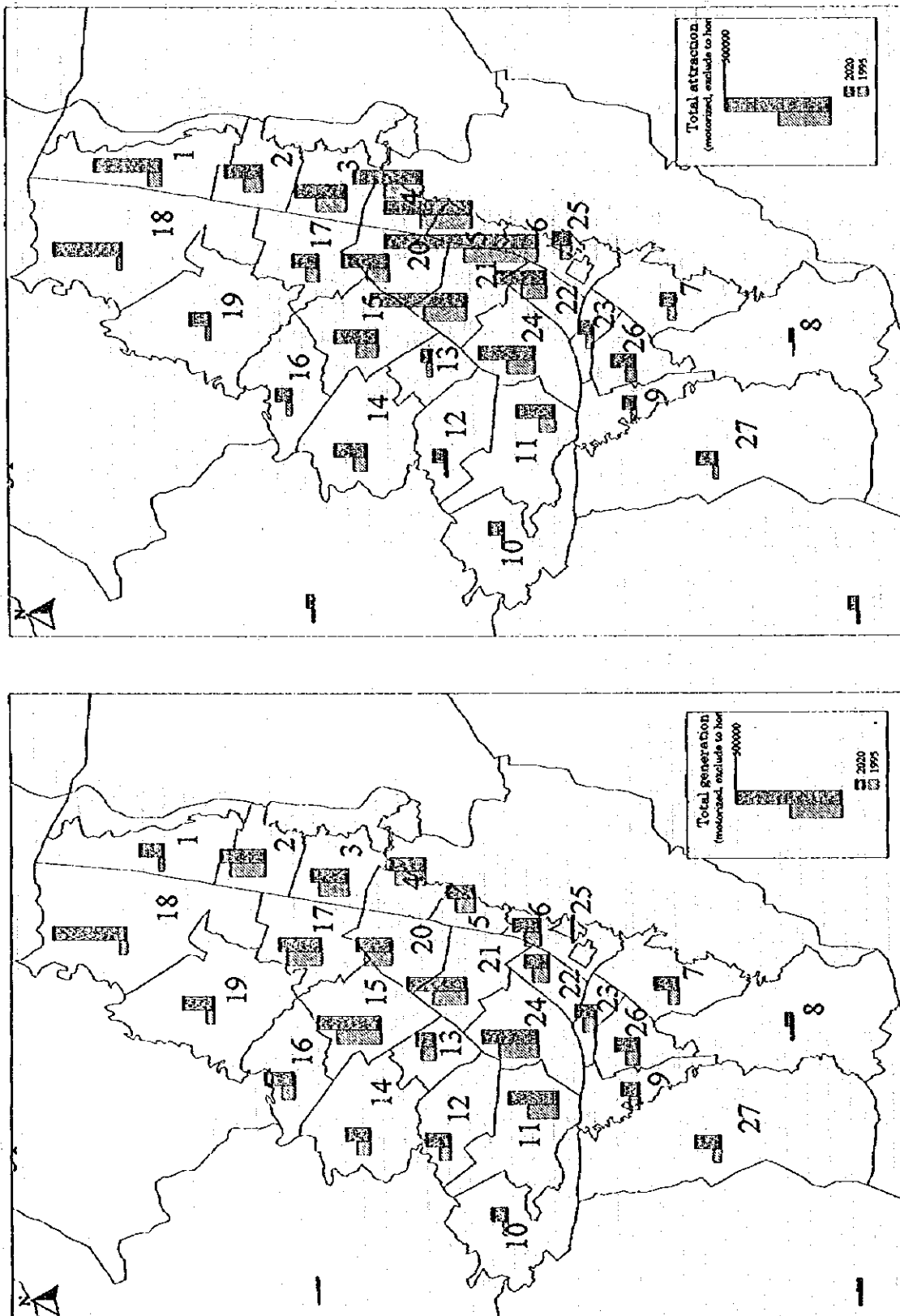


Figure 3.3-5 Trip Generation and Attraction in Motorized Households (1995/2020)

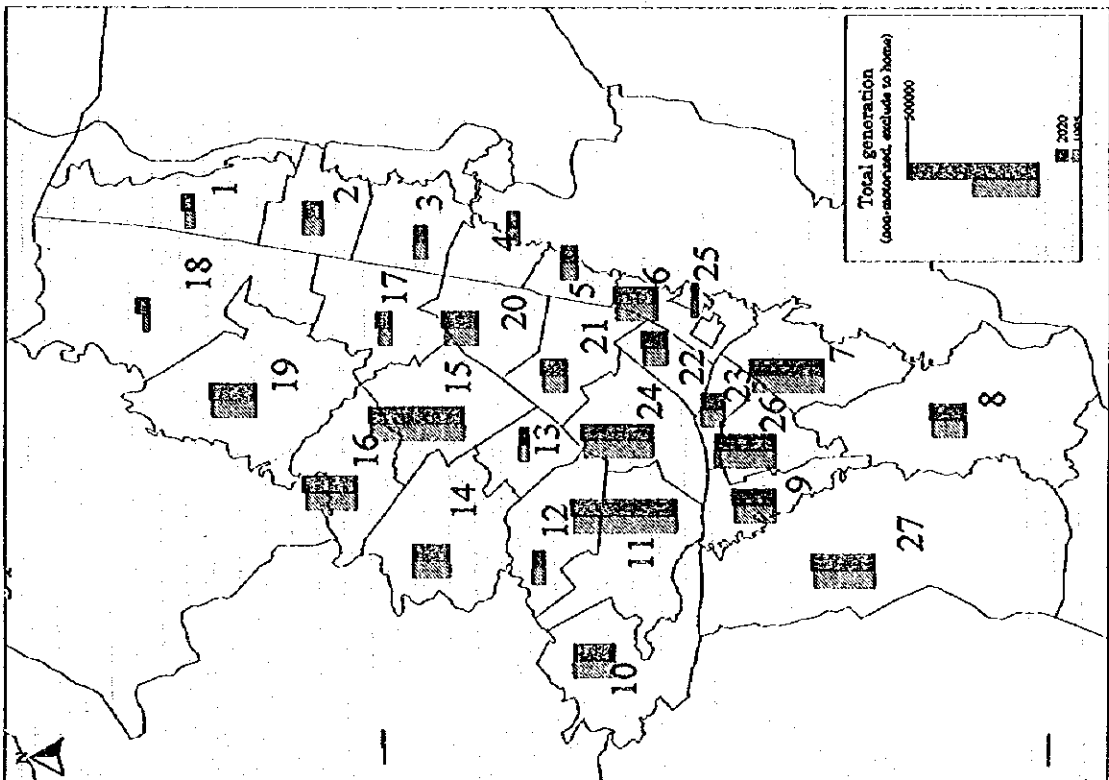
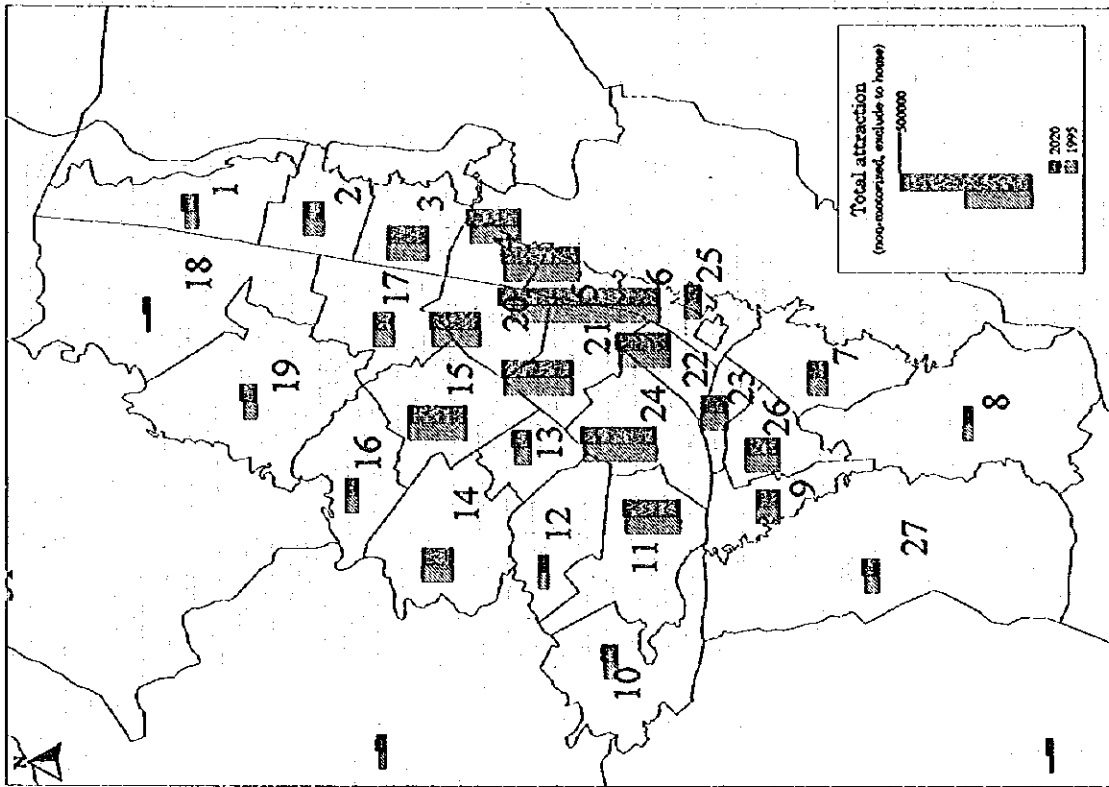


Figure 3.3-6 Trip Generation and Attraction in Non-Motorized Households (1995/2020)

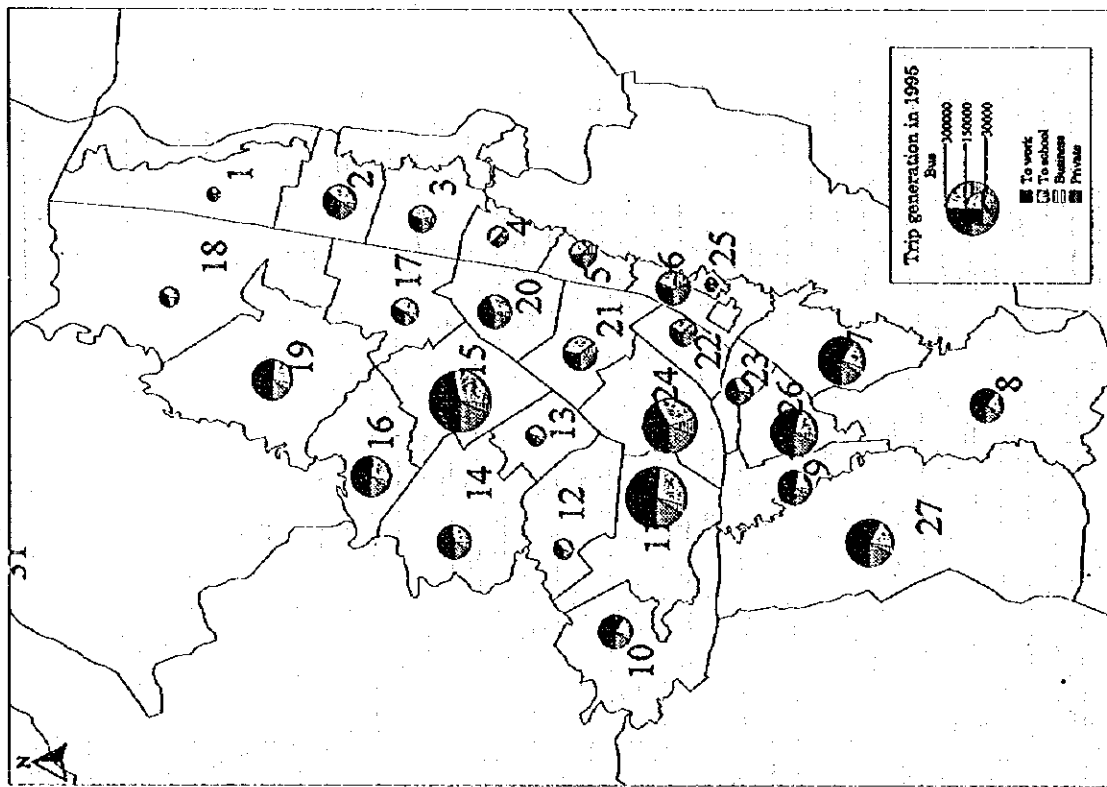
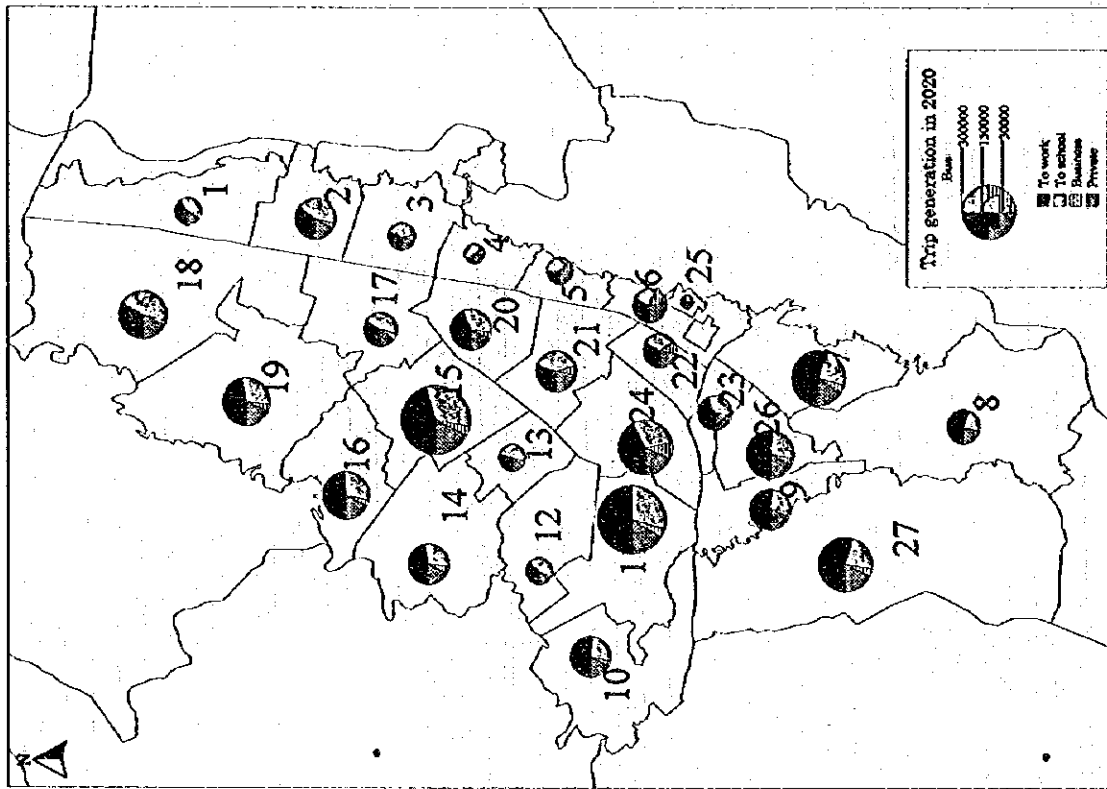


Figure 3.3-7 Trip Generation by Public Mode (1995/2020)



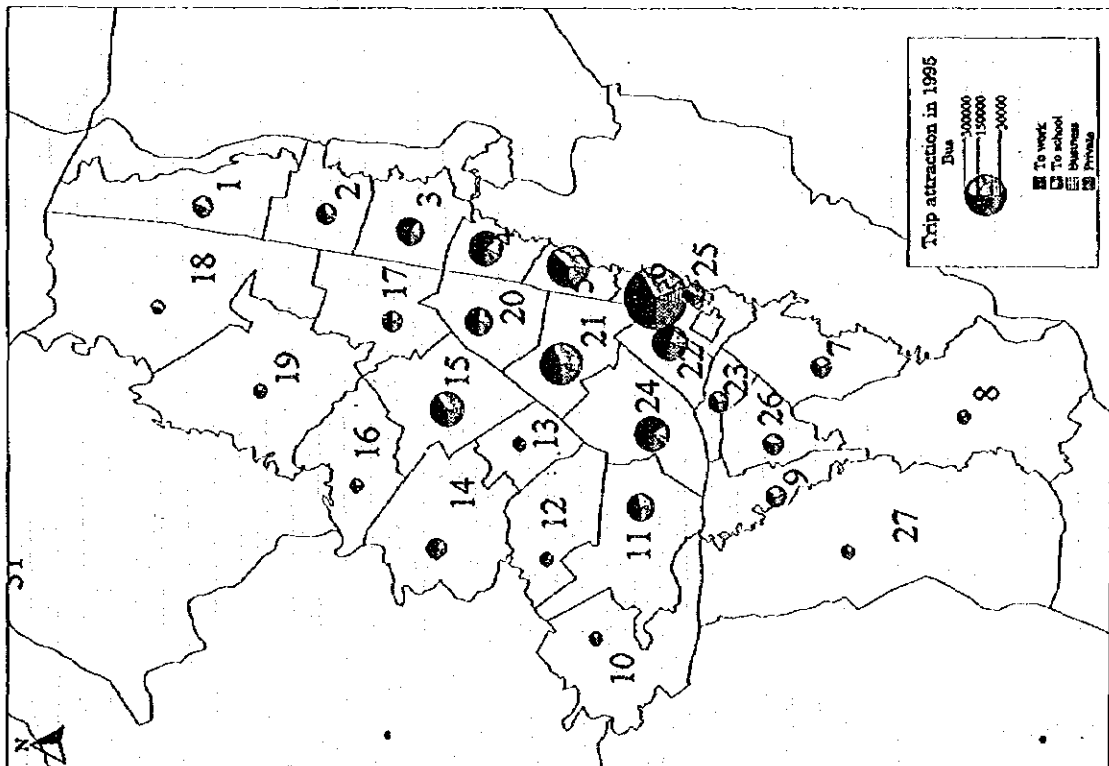
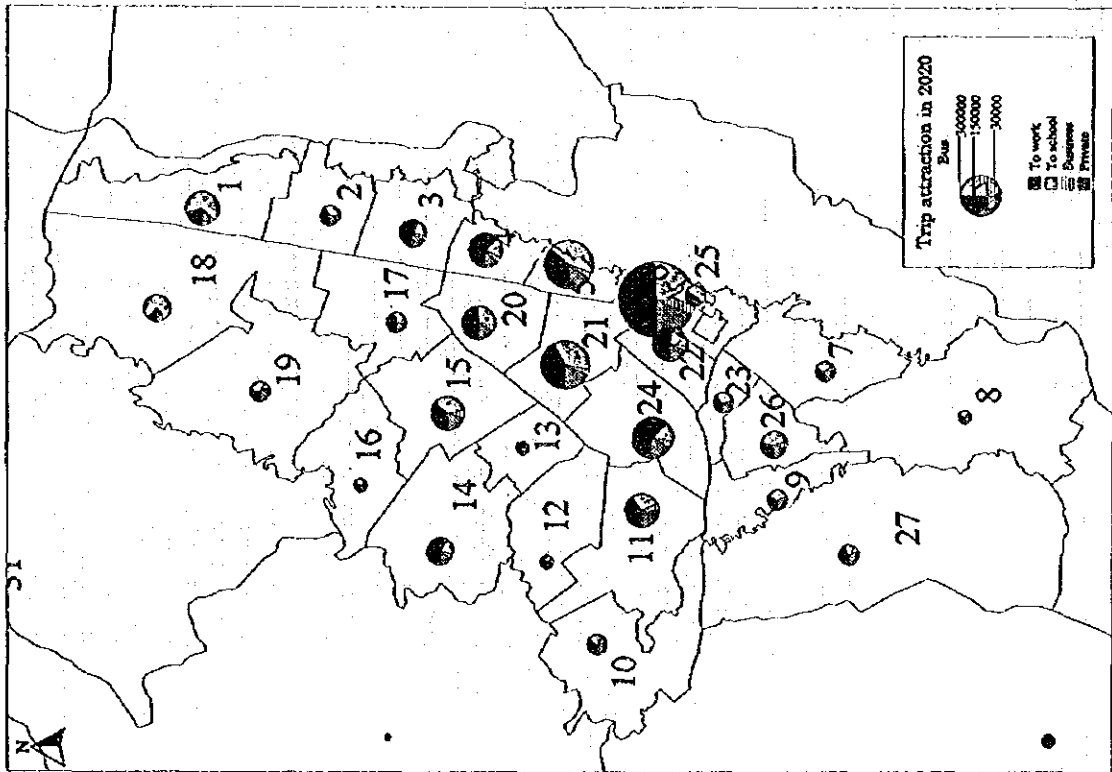


Figure 3.3-8 Trip Attraction by Public Mode (1995/2020)

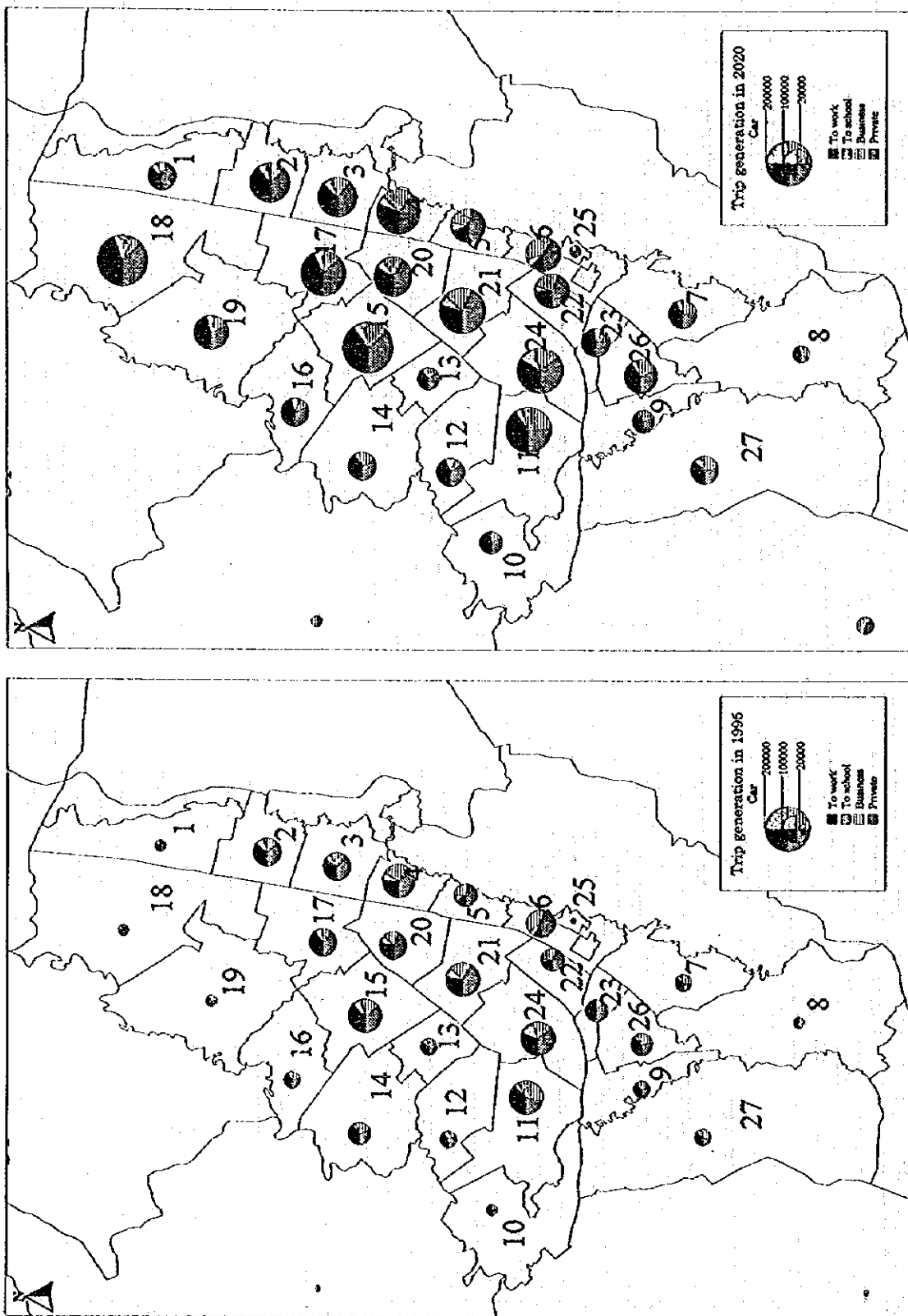


Figure 3.3-9 Trip Generation by Private Mode (1995/2020)

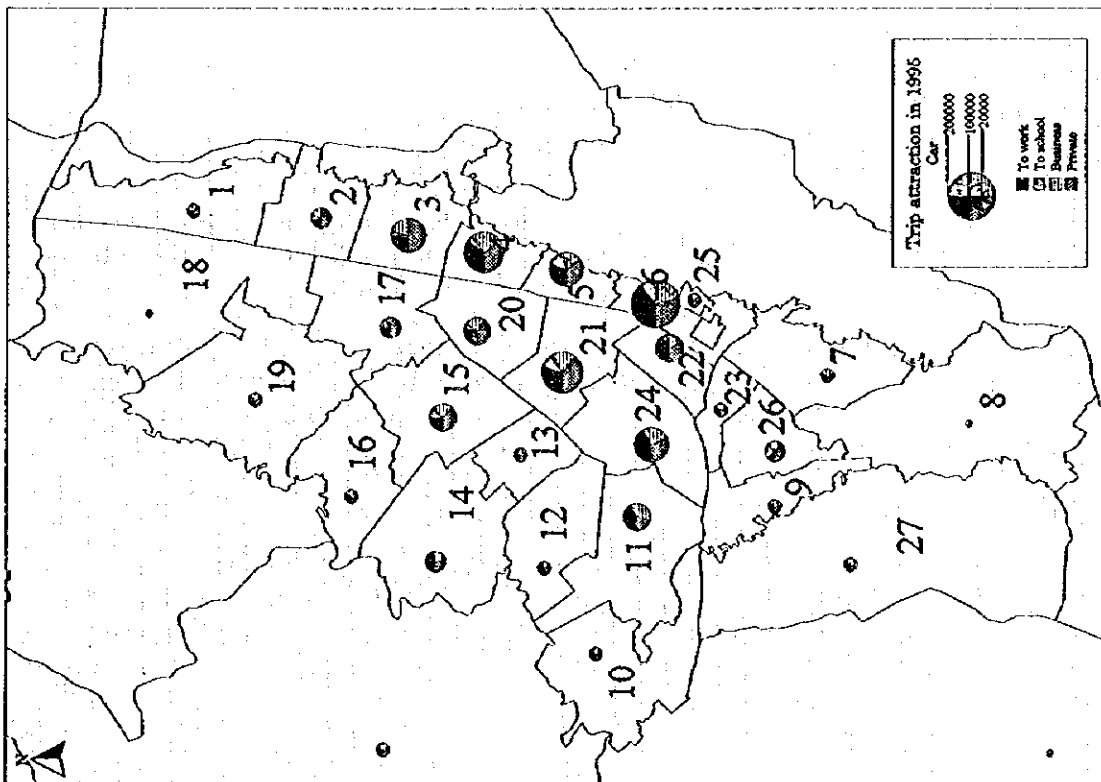
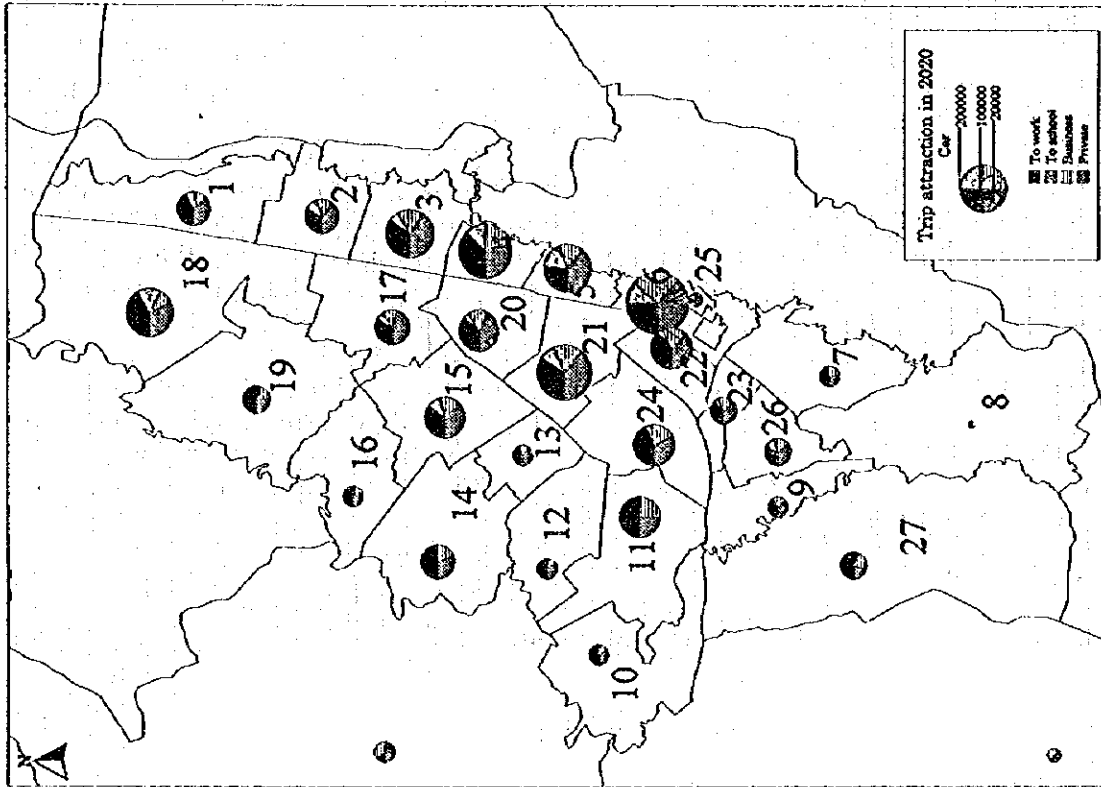


Figure 3.3-10 Trip Attraction by Private Mode (1995/2020)

### 3.4 Trip Distribution Model

#### 3.4.1 General

Trip distribution models are used to estimate the number of trips made between pairs of zones after the total number of trips starting from and ending in each zone is known. There are many types of trip distribution models exist. Including *growth factor* techniques such as the Fratar method, which were used in early transportation studies but are now used mostly for short-term updating of trip tables, *intervening opportunities* models, which have been used in limited occasions over the years, are cumbersome to calibrate, *disaggregate destination choice* models, and finally, the virtually universally used *gravity model*.

The gravity model, in one form or another, is the most typical model used in transportation planning applications. In the Study, Voorhees-type gravity model was developed to estimate interzonal trips by motorized/non-motorized household and by the purpose. The "to home" trip was estimated in the same manner as the generated and attracted "to home" trip.

#### 3.4.2 Interzonal Trips

Voorhees-type gravity model is expressed as follows:

$$T_{ij} = G_i \frac{A_j * D_{ij}^a}{\sum_{j=1}^n (A_j * D_{ij}^a)} K_{ij}$$

where;

- $T_{ij}$  : OD trips between zones  $i$  and  $j$
- $G_i$  : Generated trips from zone  $i$
- $A_j$  : Attracted trips to zone  $j$
- $D_{ij}$  : Road distance between zones  $i$  and  $j$  (km)
- $a$  : Parameter

The friction factor  $D_{ij}$  is an inverse function of the "cost" of travel (travel time, distance, monetary out-of-pocket cost, "generalized cost," etc.) between zones  $i$  and  $j$ . In the Study,  $D_{ij}$  shows road distance between zones  $i$  and  $j$ . The model parameters are shown in Table 3.4-1.

Figure 3.4-1 shows comparison to present actual OD trips and estimated one for the car using trips of the "To Work" purpose in the non-motorized households to examine the precision of the Gravity model. As can be seen, the model parameters of Gravity model are well developed.

#### 3.4.3 Intrazonal Trip Model

It is difficult to estimate intrazonal trips by the gravity model since it is very hard to choose the friction factor such as travel time and distance within zones  $i$ . Therefore, it is necessary to make another model for estimating the intrazonal trips. In the Study, the model with the variable related size of zone was developed. The intrazonal trip model is expressed as follows;

$$T_{ii} = K \cdot G_i^a \cdot A_i^b \cdot L_i^c \cdot D_i^d$$

where;

- T<sub>ii</sub> : OD trips inside zone i
- G<sub>i</sub> : Generated trips from zone i
- A<sub>i</sub> : Attracted trips to zone i
- L<sub>i</sub> : Area of zone i (km<sup>2</sup>)
- D<sub>i</sub> : Dummy variable
- K,a,b,c,d : Parameters

The model parameters are shown in Table 3.4-2.

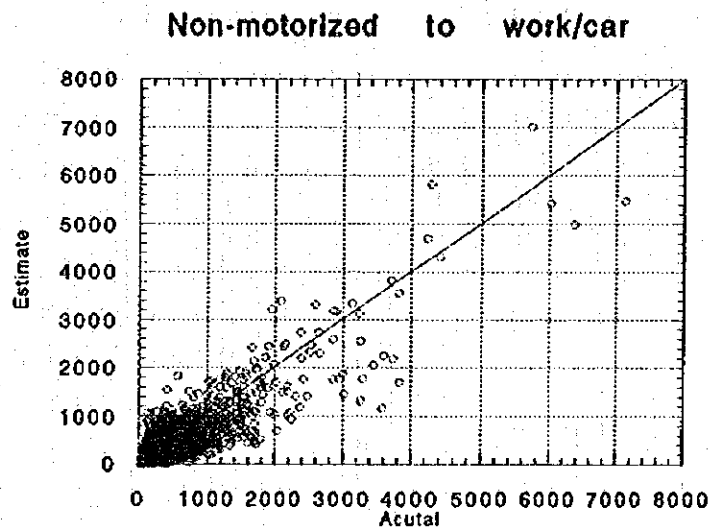


Figure 3.4-1 Comparison of Present Actual and Estimated OD Trips

Table 3.4-1 Parameters of Trip Distribution Model

	Purpose	Car		Bus	
		Parameter	R	Parameter	R
Motorized	To Work	-0.414	0.807	-0.374	0.877
	To School	-0.730	0.907	-0.429	0.837
	Business	-0.574	0.775	-0.281	0.927
	Private	-0.471	0.828	-0.558	0.869
Non-Motorized	To Work	-0.247	0.860	-0.568	0.888
	To School	-0.837	0.957	-0.864	0.804
	Business	-0.535	0.792	-0.491	0.861
	Private	-0.581	0.764	-0.678	0.838

Table 3.4-2 Parameters of Intrazonal Model

$T_{ij} = K * G_i^{\alpha} * A_j^{\beta} * L_i^{\gamma} * D^{\delta}$						
	k	$\alpha$	$\beta$	$\gamma$	$\delta$	R
Motorized household						
Mode:Car						
To work	5.1810099	0.429	0.155	-0.135	1.441	0.841
To school	93.316785	0.067	0.026	0.039	0.791	0.814
Business	103.54435	0.259	-0.051	-0.157	1.412	0.803
Private	0.2039256	0.889	-0.046	0.111	0.676	0.811
Mode:Bus						
To work	14.296289	0.316	0.100	-0.122	0.862	0.806
To school	9.2998661	0.225	0.020	0.227	0.860	0.805
Business	2206.1407	-0.376	0.039	-0.057	1.565	0.831
Private	25.380978	0.412	0.035	-0.209	0.920	0.806
Non-motorized household						
Mode:Car						
To work	70.105412	0.079	0.073	-0.035	1.144	0.912
To school	0.4936147	0.560	0.324	0.135		0.905
Business	38.744934	0.331	-0.026	-0.116	1.288	0.838
Private	54.217298	0.314	0.022	-0.173	1.201	0.815
Mode:Bus						
To work	0.001399	0.885	0.387	0.178		0.874
To school	0.0287821	0.759	0.194	0.241	0.957	0.800
Business	19.511421	0.310	0.014	-0.037	1.041	0.896
Private	0.0750951	0.747	0.185	0.108	0.667	0.821

### 3.4.4 Projection of Trip Distribution

In the above steps, 20 OD tables in the unit of person which are composed of 2 classified households (motorized and non-motorized), 5 trip purposes, and 2 types of vehicles (private and public) are made.

Figure 3.4-2 illustrates the desire lines by all purposes and modes for interzonal trips in 1995 and 2020. The desire lines by the private and public mode are shown in Figure 3.4-3, which also compares the desire lines in 1995 and 2020. In 2020, the strong desire lines in the private mode cover the whole Study area, while in 1995 they only cover the area within the central area. On the other hand, the public mode links the central business/commercial area (zone Nos. 5, 6 and 22) and surrounding residential areas with strong desire lines.

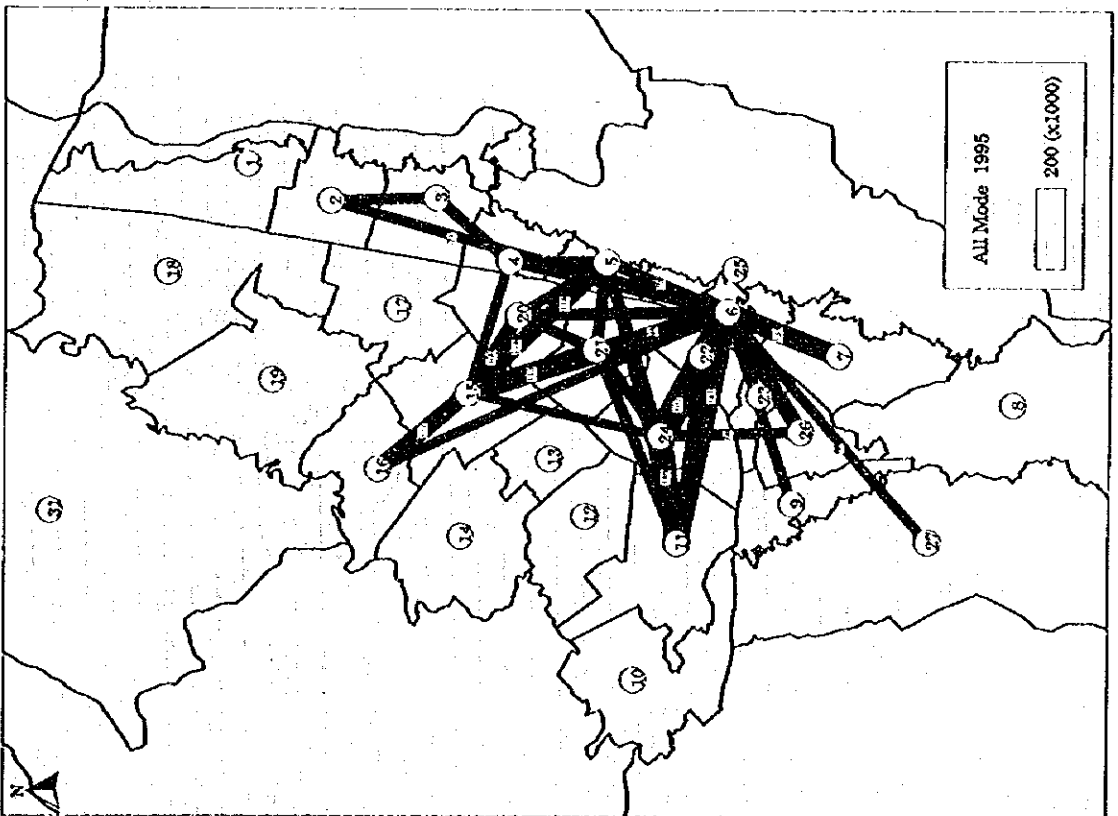
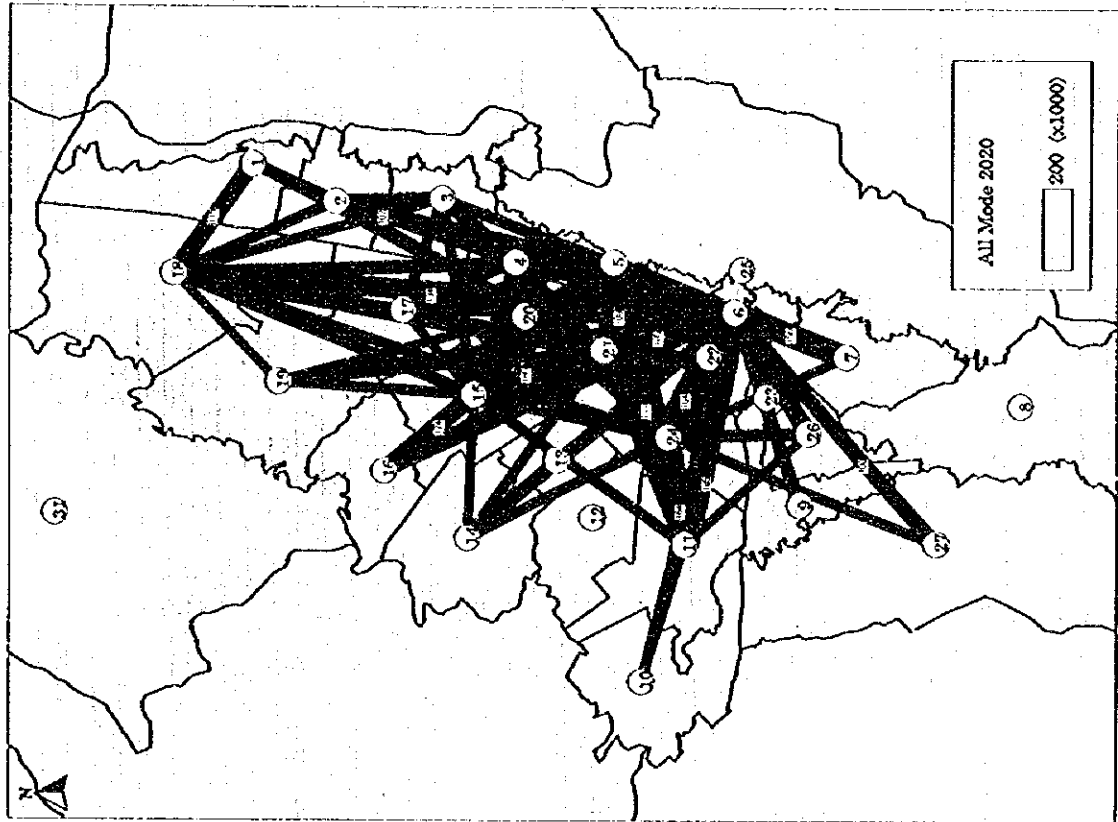


Figure 3.4-2 Trip Desire Lines by All Purposes and Modes (1995 /2020)

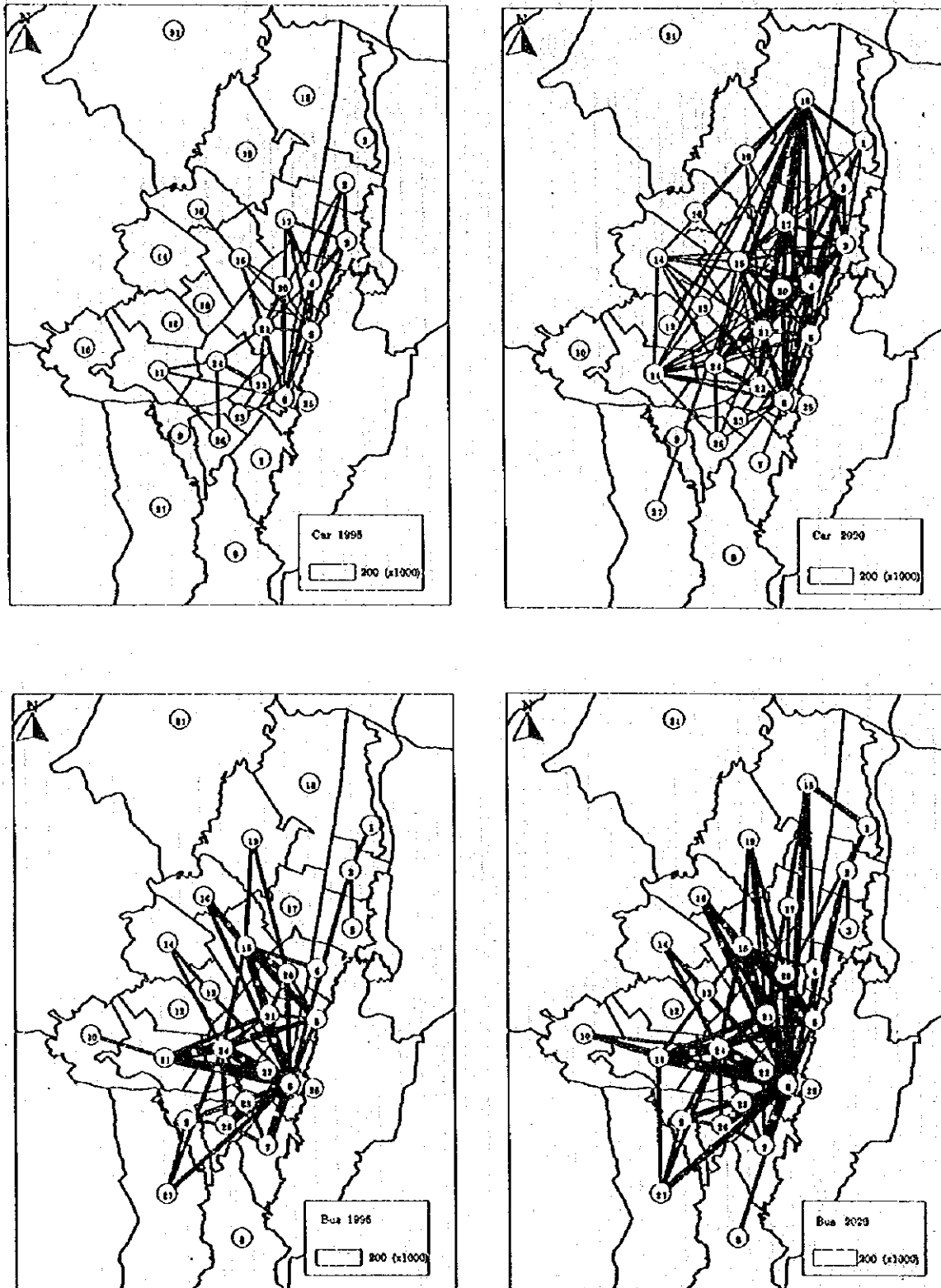


Figure 3.4-3 Trip Desire Lines by Public and Private Modes ( 1995/ 2020)



### 3.4.5 Travel Demand for Non-Residents Who Dwell outside the Study Area

The travel demand in the future between Bogota and surrounding areas will be forecasted dramatically high, and also, the travel pattern of zonal origin-destination will be different. Trip information for non-residents, however, is not available but the ratio of trips made by them to the total is as low as 2.5 % at present. Even when the simple method is employed for non-residents, the influence in accuracy of whole trips estimated is little. Therefore, travel demand for non-residents was estimated by a simplified estimation method.

The trips of non-residents from/to Bogota are approximately 283 thousand trips per day, and it is estimated that 100 thousand peoples who dwell outside Bogota come/go from/to Bogota in a day from the Cordon Line Survey. According to these information, the trip production rate is about 3 trips per person.

Future trip production between Bogota and surrounding areas was forecasted on the assumption that the travel characteristics for the non-residents will be unchangeable factors in the future. It is forecasted that approximately 340 thousand peoples in 2020 will come in Bogota from the surrounding areas for working, shopping, etc. based on the future estimated population. The trips to flow into Bogota will be forecasted at approximately 1 million trips per day according to the trip production rate mentioned above. Its figures rise about 3 times in 2020, comparing to that at the present.

## 3.5 Traffic Assignment

### 3.5.1 Traffic Assignment Model

The last step in the four-step method is the assignment of the predicted modal flows between each origin-destination pair to actual routes through a given mode's network. Assignment procedures are based on the assumption that each individual chooses the route which he/she perceives as the best for himself/herself, that is, each individual minimizes or "optimizes" his/her own travel time or cost.

Traffic assignment techniques include:

1. Minimum path (all-or-nothing) assignment
2. Equilibrium assignment
3. Stochastic assignment

#### 1) Minimum path (all-or-nothing) assignment

In this approach, "ideal" (i.e., uncongested) minimum travel time paths (routes) are computed for each O-D pair, and all flows between these pairs are loaded onto these routes. A given route receives "all or nothing" of a given O-D pair's flow. Advantages of this approach are that it is simple and inexpensive to use, it depicts the routes most travelers would be expected to use in the absence of capacity and/or congestion effects, and the results are easy to understand and interpret.

#### 2) Equilibrium assignment

Equilibrium assignment techniques explicitly recognize that transportation network link costs generally depend on link flow levels. Hence, these techniques search for a user-equilibrium solution in which link flows and costs are simultaneously resolved. Approaches to this problems involve the use of approximate *capacity restraint* methods in which the flow is incrementally loaded onto the network, thus allowing congestion to gradually "build up" and travel-time estimates to adjust in response to

this. Advantages of the capacity restraint approach relative to all-nothing assignment are that it more realistically approximates peak-hour flow characteristics than all-or-nothing assignment, it achieves a distribution of trips over a number of routes for any given origin-destination pair, and it is guaranteed to converge to a solution. One example is shown in Figure 3.5-1.

### 3) Stochastic assignment

Stochastic procedures recognize that several routes between an origin and a destination might be perceived to have equal travel time or otherwise be equally attractive to a traveler and, as a result, might be equally likely to be used by that traveler.

In this Study, the capacity restraint method in the equilibrium assignment was employed. The traffic assignment model have two systems. One is for private vehicle such as cars and trucks inclusive of taxis on roads. The private vehicle passes on minimum distance/time route chosen in this model. The other is for public transport (bus) on fixed routes. The buses are assigned on fixed routes prepared in the model. Both assigned traffic volumes were combined together on the same road network after conducting traffic assignment separately.

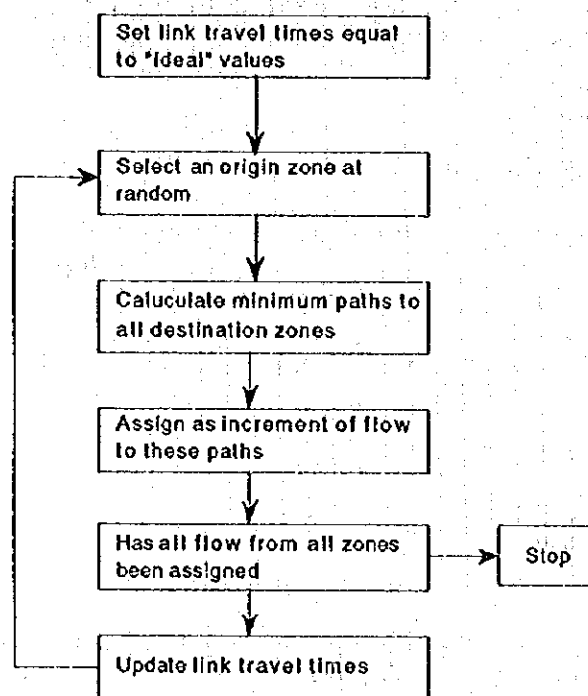


Figure 3.5-1 Capacity Restraint Trip Assignment

#### 3.5.2 Average Occupancy and Passenger Car Unit (PCU)

The person base trip OD tables (Unit: person-trips) by mode have to be modified into passenger car unit (trip/PCU). These OD tables were first modified into vehicle base unit divided by average number of passengers (occupancy) and then multiplied by PCU factor. The PCU is the number of passenger cars that are displaced by a single heavy vehicle of a particular type under prevailing roadway, traffic, and control conditions. The average occupancy and PCU factor used for the conversion are shown in Table 3.5-1. The average occupancy and PCU factors for truck and bus respectively are calculated by the weighted average procedure between light truck and truck, and bus,

busesta, colectivos, and intermunicipal bus.

Table 3.5-1 Average Occupancy and PCU

Vehicle Type	Average Occupancy	PCU Factor
Car	1.66	1.0
Taxi	1.40	1.0
Truck	1.73	1.72
Bus	21.46	1.78

### 3.5.3 Modal Split

The number of trips by two modes, Public and Private Transport, is shown in Table 3.5-2. The table shows the number of vehicles calculated from the PT data using vehicle occupancy rate. The rate of increase per unit between 1995 and 2020 is 2.05, while the growth rate of person trips is 1.55. The ratios of public and private modes increase at approximately 1.31 and 2.19, respectively. The modal share of public in vehicle trip unit is 10% (494 thousand trips) in 2020, in contrast to 16% (377 thousands) in 1995. The private mode increases from 84% (1.93 million trips) in 1995 to 90% (4.23 millions) in 2020.

Table 3.5-2 Modal Share of Vehicle Trips

	1995		2020		2020/1995
	No. of Trips	Composition	No. of Trips	Composition	
Private	1,931,032	0.837	4,229,016	0.895	2.19
Public	376,575	0.163	493,577	0.105	1.31
Total	2,307,608	1.000	4,722,593	1.000	2.05

### 3.5.4 Traffic Assignment Model for Private Mode

Traffic assignment predicts the traffic volume on roads chosen by minimum distance / time route. The speed of vehicle to select minimum-time route is governed by the relationship between traffic volume and the capacity. Hence, the speed of vehicle is determined by the speed-flow curves which are governed by the number of lanes, one-way and dual-way traffic flows, and land-use conditions along roads are classified into urban area, rural area and unpaved roads (see Figure 3.5-2).

The traffic assignment model for private mode uses "capacity restraint" method. The basic iteration loop is shown below and Figure 3.5-3:

- OD matrices are divided into the following 5 lots to make the phased assignment of the traffic : 1st 30%, 2nd 20%, 3rd 20%, 4th 20% and 5th 10%.
- Minimum time-route is selected on roads.
- The 1st lot of trips is assigned to the selected route, and the number of trips passing over each link of network is counted.
- Travel speed on each road is modified according to speed-flow curves.
- The above four steps are iterated.

As mentioned before, cars, taxis and trucks are assigned to this model. On the other hand, buses are assigned to the bus assignment models. Finally, after assigned to roads separately, both modes, public and private transportation, are combined together to estimate transport facilities.

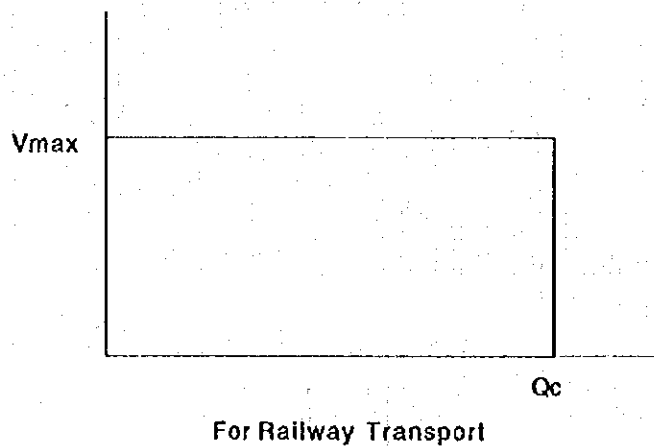
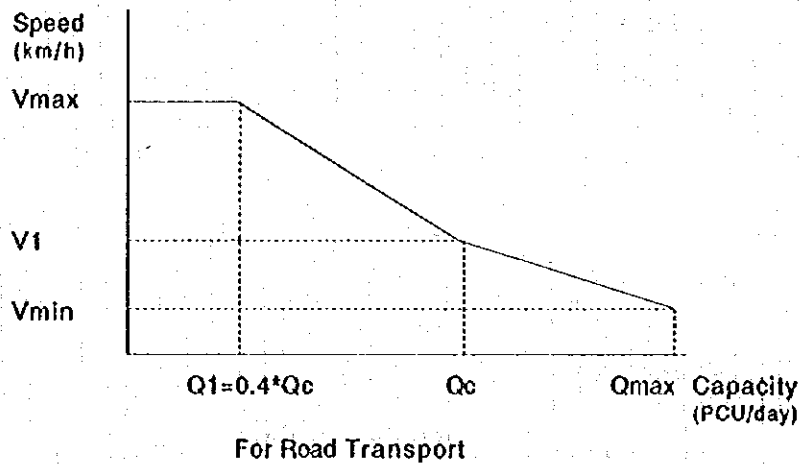


Figure 3.5-2 Speed-Flow Curves

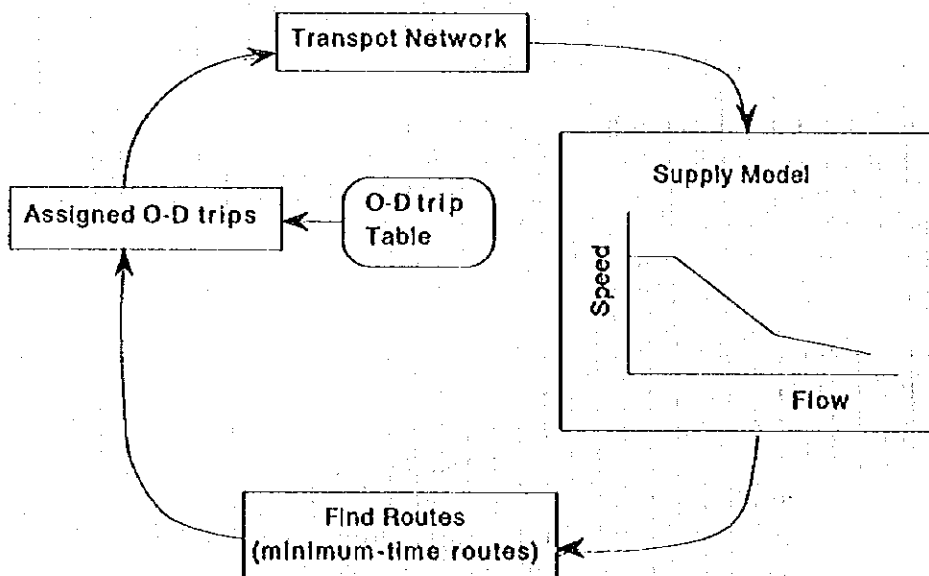


Figure 3.5-3 Basic Iteration Loop

Table 3.5-3 Speed-Flow Curves

QV No.	Place	Class	Direction	Lanes	V-max	V-1	V-min	Q-min	Q-max	Q-over
1	Inside the Study Area	V-0	Dual-way	14	70	35	8	95,200	238,000	297,500
2			Dual-way	12	70	35	8	81,600	204,000	255,000
3			Dual-way	10	70	35	8	68,000	170,000	212,500
4			Dual-way	8	70	35	8	54,400	136,000	170,000
5			Dual-way	6	70	35	8	40,800	102,000	127,500
6		V-0	Dual-way	4	70	35	6	27,200	68,000	85,000
7			One-way	6	70	35	6	40,800	102,000	127,500
8		V-0	One-way	4	70	35	6	27,200	68,000	85,000
9			One-way	2	70	35	6	13,600	34,000	42,500
10		V-1	Dual-way	12	60	30	6	72,000	180,000	225,000
11				10	60	30	6	60,000	150,000	187,500
12				8	60	30	6	48,000	120,000	150,000
13		V-1	Dual-way	6	60	30	6	36,000	90,000	112,500
14				4	60	30	6	24,000	60,000	75,000
15				6	60	30	6	36,000	90,000	112,500
16				4	60	30	6	24,000	60,000	75,000
17		V-2	Dual-way	2	60	30	6	12,000	30,000	37,500
18				10	55	27.5	5	52,000	130,000	162,500
19		V-2	Dual-way	8	55	27.5	5	41,600	104,000	130,000
20				6	55	27.5	5	31,200	78,000	97,500
21				4	55	27.5	5	20,800	52,000	65,000
22		V-2	Dual-way	2	55	27.5	5	10,400	26,000	32,500
23				6	55	27.5	5	31,200	78,000	97,500
24				4	55	27.5	5	20,800	52,000	65,000
25				2	55	27.5	5	10,400	26,000	32,500
26		V-3	One-way	1	55	27.5	5	5,200	13,000	16,250
27				10	50	25	5	48,000	120,000	150,000
28				8	50	25	5	38,400	96,000	120,000
29		V-3	Dual-way	6	50	25	5	28,800	72,000	90,000
30				4	50	25	5	19,200	48,000	60,000
31				3	50	25	5	14,400	36,000	45,000
32				2	50	25	5	9,600	24,000	30,000
33		V-3	Dual-way	1	50	25	5	4,800	12,000	15,000
34				6	50	25	5	28,800	72,000	90,000
35				4	50	25	5	19,200	48,000	60,000
36				3	50	25	5	14,400	36,000	45,000
37				2	50	25	5	9,600	24,000	30,000
38		V-3E	One-way	1	50	25	5	4,800	12,000	15,000
39				10	50	25	5	48,000	120,000	150,000
40		V-3E	Dual-way	8	50	25	5	38,400	96,000	120,000
41				8	50	25	5	28,800	72,000	90,000
42				4	50	25	5	19,200	48,000	60,000
43				3	50	25	5	14,400	36,000	45,000
44				2	50	25	5	9,600	24,000	30,000
45				1	50	25	5	4,800	12,000	15,000
46				6	50	25	5	28,800	72,000	90,000
47				4	50	25	5	19,200	48,000	60,000
48				3	50	25	5	14,400	36,000	45,000
49				2	50	25	5	9,600	24,000	30,000
50		V-3E	One-way	1	50	25	5	4,800	12,000	15,000
51	4			40	40	40	100,000	100,000	100,000	
	Outside the Study Area									

### 3.5.5 Traffic Assignment Model for Public Mode (Bus Transportation)

Minimum bus route from several alternative routes by OD pair is chosen taking account of the waiting time at bus stops when passengers transfer buses and bus passengers are assigned to this route. This assignment system introduced the concept of private traffic assignment model. In this model, the assigned bus route is determined by each lot according to the frequency of service instead of the speed-flow curve. When the frequency is exceeded by the assigned number of buses, this bus is not chosen in the following lot.

Method of the model is outlined as follows:

- a) OD matrices are divided into the following 5 lots to make the phased assignment of the traffic: 1st 30%, 2nd 20%, 3rd 20%, 4th 20% and 10%.

- b) Minimum-distance route is selected on the assumption that minimum-time bus route is selected from the alternative routes. When the minimum pass is selected, waiting time or transfer time at bus stops is taken into account.
- c) The 1st lot of trips is assigned to the selected bus route, and the number of trips incrementally loaded onto bus network is counted.
- d) Frequency of service by each bus route (input data) is compared to assigned number of buses derived from the assigned number of passengers. When the number of buses exceeds the frequency, this bus route is not chosen in the next lot.
- e) The above 4 steps are iterated.

### 3.5.6 Traffic Demand on Road Network

Traffic assignment was made under the conditions on which the OD trips in 2020 loads on the present network to disclose traffic demand on major corridors. The traffic demands in 1995 and 2020 are shown in Figure 3.5-4. This assignment was conducted under the all-or-nothing assignment to easily understand the corridor of major trip flows in the estimated future OD trip pattern.

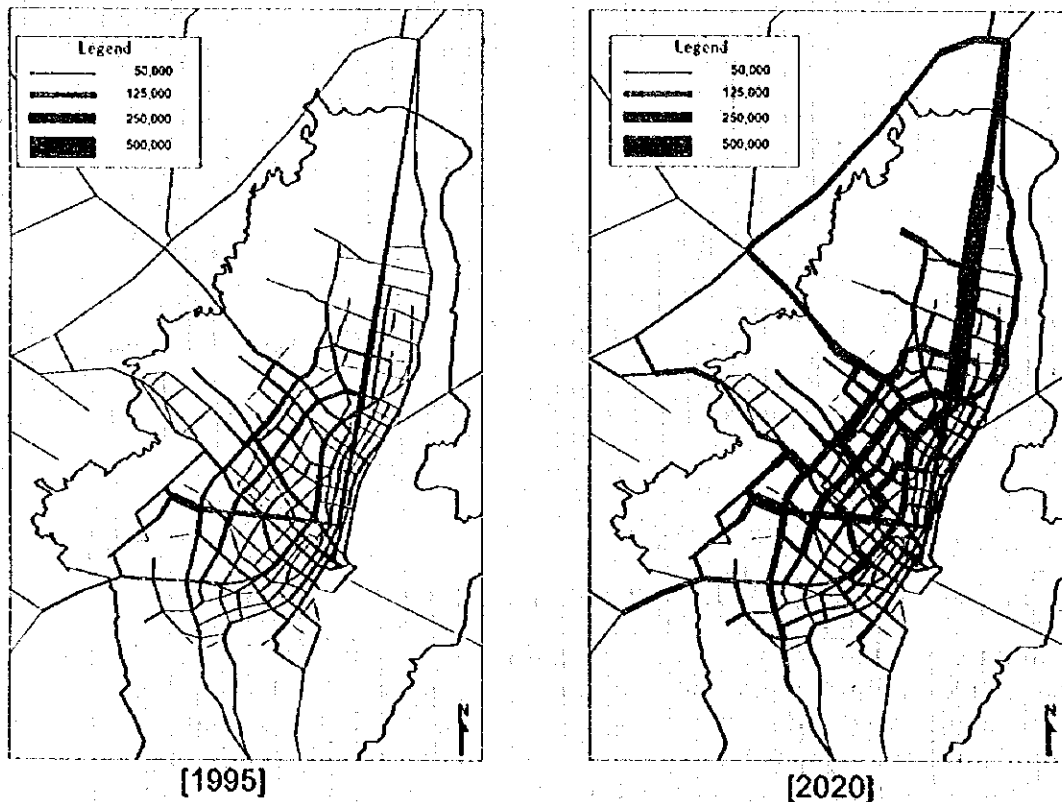


Figure 3.5-4 Traffic Demand on Present Road Network in 1995 and 2020

## 4. USER'S MANUAL FOR THE TRAVEL DEMAND MODEL

### 4.1 Introduction

This user's manual on the travel demand model is a comprehensive manual containing all the procedures you need to work with JICA model named "MastPlan Bogota", which is a software developed by JICA Study Team for estimating the travel demand in Bogota. This software is prepared for users who review and re-estimate the future travel demand by using this model according to the variation of socioeconomic conditions.

The software is classified into two parts:

- 1) Part I module (composed of programs named SOCIO-FRAME, TRF-OD and GENATT) for estimating the travel demand, and
- 2) Part II Module (program named TRF-ASSIGN) for simulating the traffic volume on transport network.

The Part I module is for estimating trip OD tables corresponding to socioeconomic frame work, and the Part II is for estimating traffic volume on prepared transport network by traffic assignment model. The Master Plan projects in each target year are prepared in the Part II module and it is easy for adding and erasing each project to review the projects in the Part II.

In the software "MastPlan Bogota", the data at present and in the future used for forecasting the travel demand is prepared in each module. The available data is mainly collected from Person Trip Survey and estimated in the course of the Study.

The modules have a modern and user-friendly interface. The program modules are entirely menu-driven. Users operate in the graphical user-interface system depending on Microsoft Windows 95.

The "MastPlan Bogota" has been designed to run on all IBM PC or compatible microcomputers with at least 16 MB of internal memory (RAM). The program files occupy up to approximately 60 MB of disk space per module, so a hard disk is required to store them. The "MastPlan Bogota" is operated under Microsoft Windows 95.

Screens are displayed in color so a color monitor is required. The modules are fully mouse-aware. All menu options, data fields, and dialog box options can be accessed using the left mouse key.

The outline of Part I and Part II modules is shown in Figure 4.1-1.

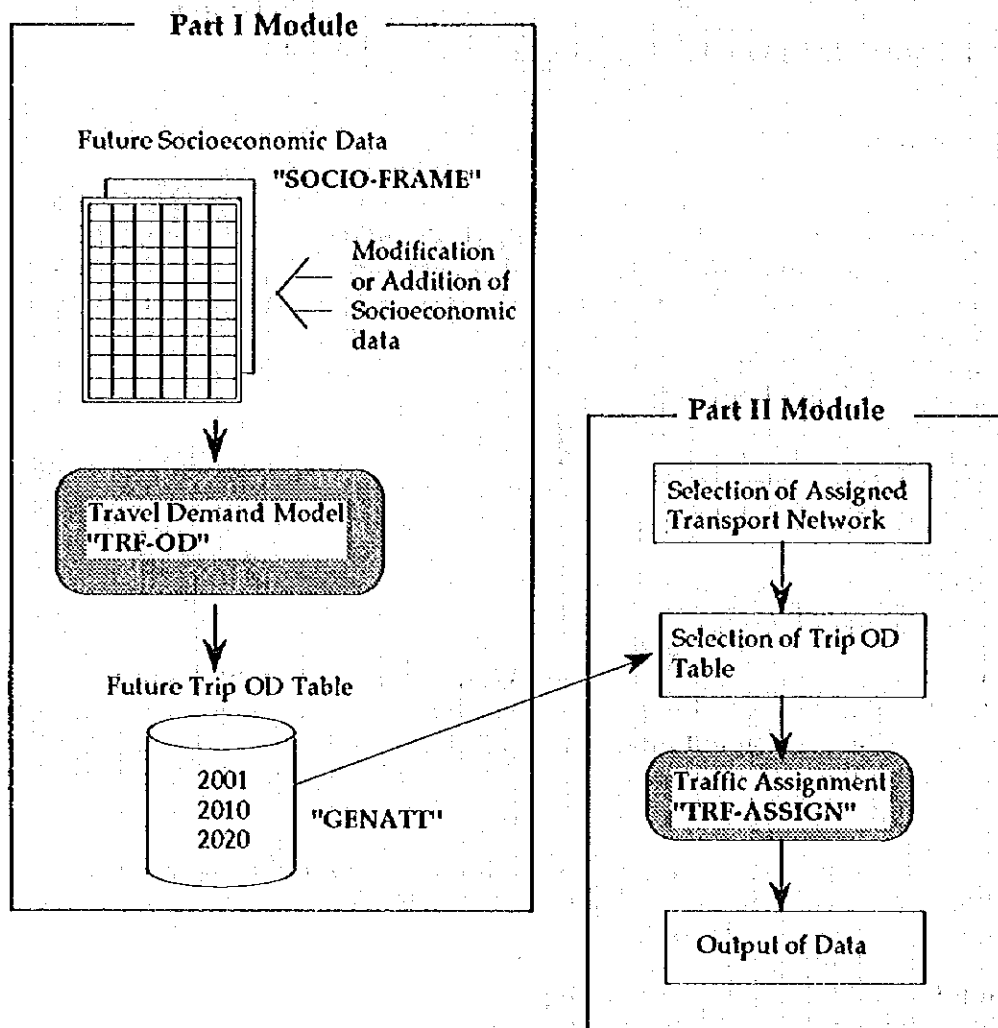


Figure 4.1-1 Outline of Part I and Part II Modules

## 4.2 Part I Module

In the Part I module, the future OD tables are estimated by inputting the socioeconomic data. The OD tables for the target year of 2020 are output. At the same time the OD tables for the short and medium terms are also outputted automatically. The socioeconomic data in the target year of 2020 is preserved in advance in the manner of data files in hard disk in the module.

The socioeconomic data is able to modify in the menu-driven manner on the screen.

### 4.2.1 Modification of Input data

The following data is preserved in advance in the manner of files and is also shown in Appendix Tables:

- 1) Total Population in 1995 and 2020
- 2) Population (5 years old or over) in 1995 and 2020
- 3) Number of Households in 1995 and 2020
- 4) Working Population (Living Place) in 1995 and 2020
- 5) Number of Students (Living Place) in 1995 and 2020
- 6) Working Population (Working Place): Primary Industry in 1995 and 2020



- 7) Working Population (Working Place): Secondary Industry in 1995 and 2020
- 8) Working Population (Working Place): Tertiary Industry in 1995 and 2020
- 9) Number of Students (School Place) in 1995 and 2020
- 10) Average Monthly Household Income in 1995 and 2020
- 11) Car Ownership in 1995
- 12) GRDP per capita in 2020
- 13) Peoples to Flow into Bogota in 2020

The modification of the data is operated in the following steps.

**(1) Selection of Data Files to be Modified (File Name : \bog\_tdas\base\_dat.xls)**

The program is executed by moving the menu highlight bar as shown in Figure 4.2-1. The submenu is chosen in the next stream; "start" > "Programs" > "MastPlan Bogota" > "SOCIO-FRAME" on the operating system Windows 95. And then, the work sheet of Excel appears on the screen. The 4 work sheets as shown in Figure 4.2-2 appear on the screen.

- 1) Socioeconomic data in 1995: unchangeable data
- 2) Socioeconomic data in 2020: changeable data
- 3) GRDP value in 2020: changeable data
- 4) Work sheet prepared for output data

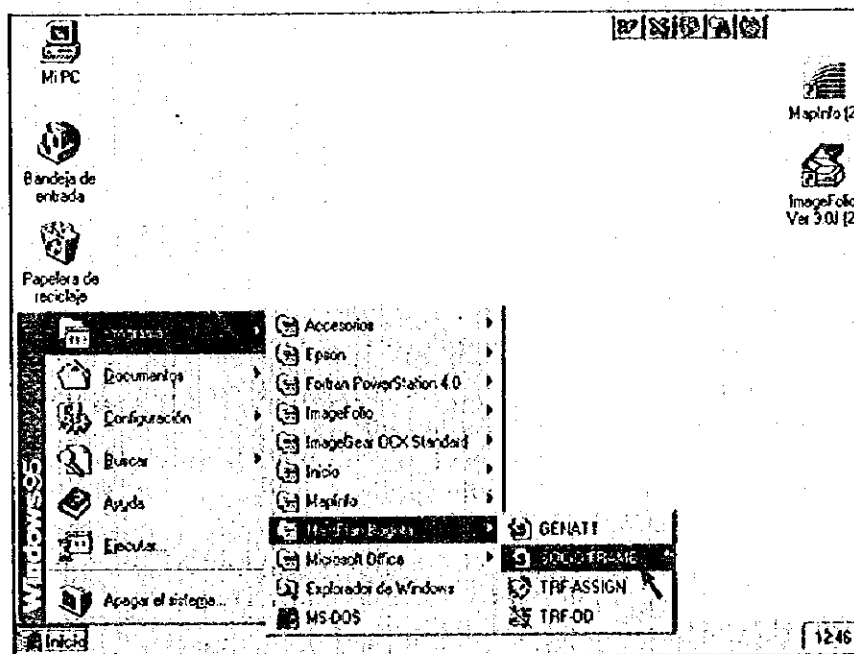


Figure 4.2-1 Selection of Data Files to be Modified

The screenshot shows a Microsoft Excel spreadsheet titled 'BASE.DAT.XLS'. The spreadsheet contains a table with columns labeled A through L and rows numbered 1 through 31. The data includes various numerical values across the columns, with some cells highlighted in yellow. The status bar at the bottom shows 'Ready' and 'NUM'.

Row	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													
26													
27													
28													
29													
30													
31													

Figure 4.2-2 Work Sheet on Microsoft Excel

(2) Modification of Data

The data on the work sheets named Tab "2020" and "GRDP" is changeable on the screen. You move the mouse cursor on the cell with data to be corrected and click the mouse key. Then the data is inputted in the highlighted cell. It should be noted that it is not permitted to input numerical data on the character format data, and vice visa.

(3) Saving the Data to be Modified

The modified data must be saved on the hard disk in the following procedure.

- 1) Save the data corrected on the work sheet by depressing Key "Ctrl" plus "S" key simultaneously on the computer key board.
- 2) Move the data to another work sheet named "output" by clicking on the work sheet tab named "output" by the mouse key.
- 3) Choose "File>Save As". Save as dialog displays.
- 4) Select the "CSV (Comma Delimited)" in the "Save File As Type" list box. Confirm the directory to be "Y:bog\_tdas" as shown in Figure 4.2-3. The file name saved must be "base\_dat.csv".
- 5) Click the "OK" button (using the mouse). The data saving is completed in this process. Then the following message appears on the screen as shown in Figure 4.2-4.

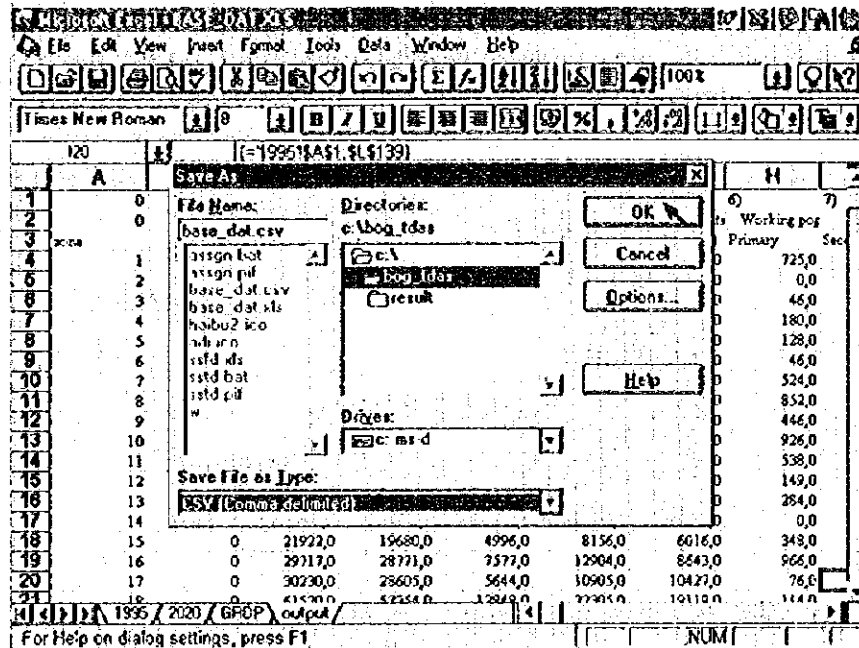


Figure 4.2-3 Dialog Box for Saving Data

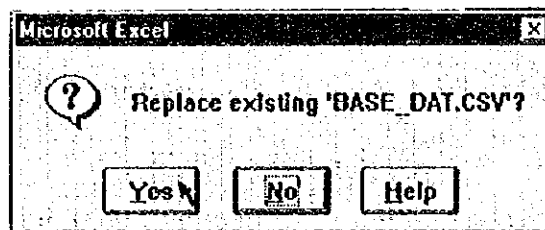


Figure 4.2-4 Warning Message for Data Save

- 6) Click the "Yes" button. Then the following message appears as shown in Figure 4.2-5.

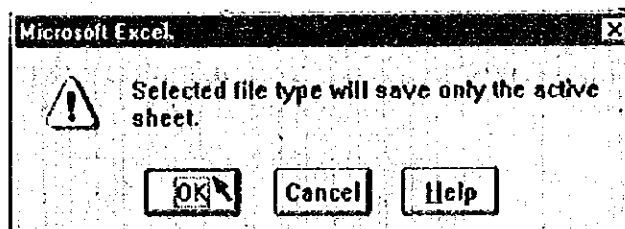


Figure 4.2-5 Warning Message for Reconfirmation

- 7) Click the "OK" button. The data saving procedure is completed by quitting Excel in this final step.

## 4.2.2 Future Travel Demand

### (1) Execution of Program

The program is executed by moving the menu highlight bar as shown in Figure 4.2-6. The submenu is chosen in the next stream; "start" > "Programs" > "MastPlan Bogota" > "TRF-OD" on the operating system Windows 95. Running time is about 1.5 hours with Pentium processing machine.

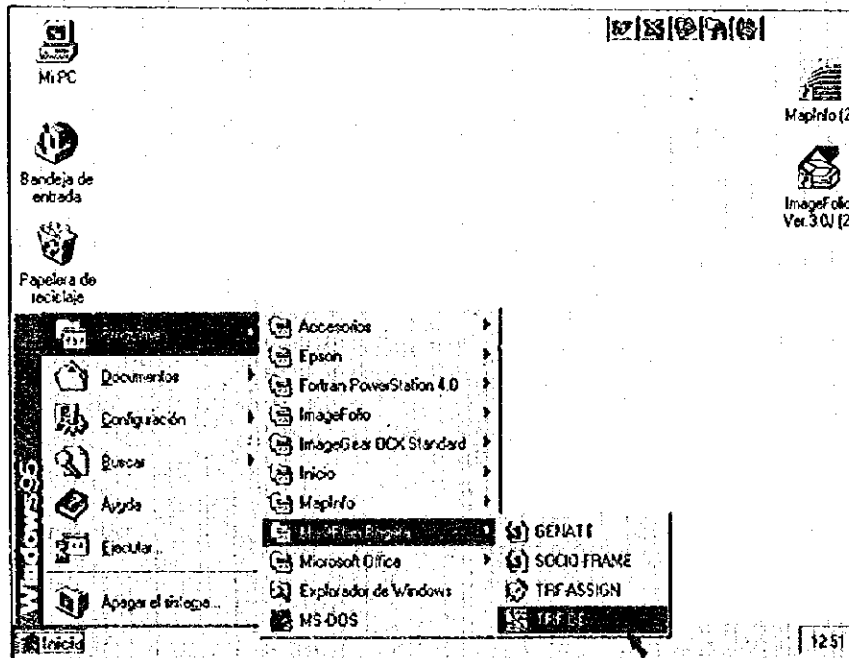


Figure 4.2-6 Showing Submenu Tree

The execution of program which is composed of Step 1 to Step 20 is monitored on the screen as shown in Figure 4.2-7.

### (2) Output Lists

The output lists as a result of the execution of program are stored in the manner of files in the hard disk. The lists are shown on the Excel work sheet on the screen. The output lists are shown by moving the menu highlight bar as shown in Figure 4.2-8. The submenu is chosen in the next stream; "start" > "Programs" > "MastPlan Bogota" > "GENATT" on the operating system Windows 95. Table 4.2-1 and Table 4.2-2 show the samples of output lists.

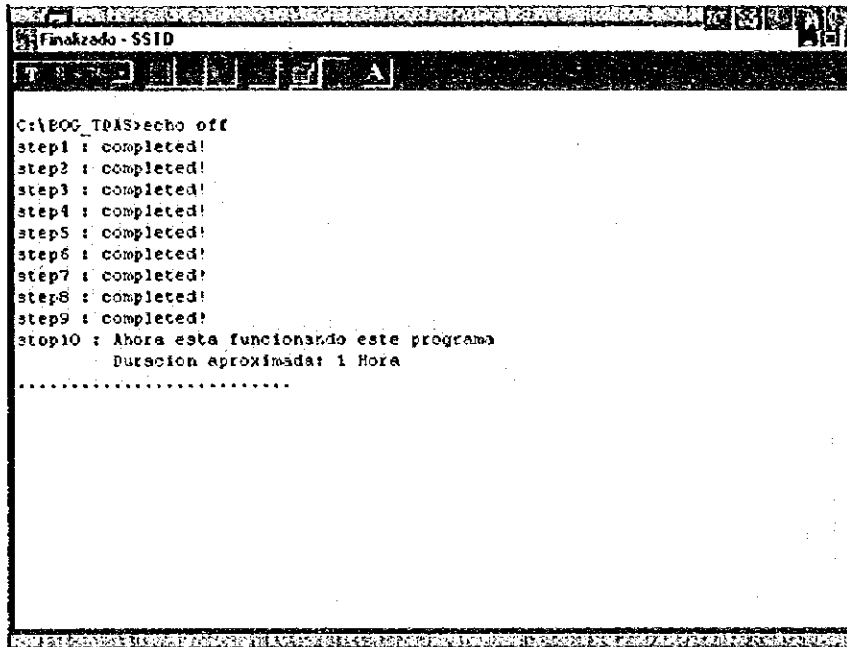


Figure 4.2-7 Conditions of Execution of Program

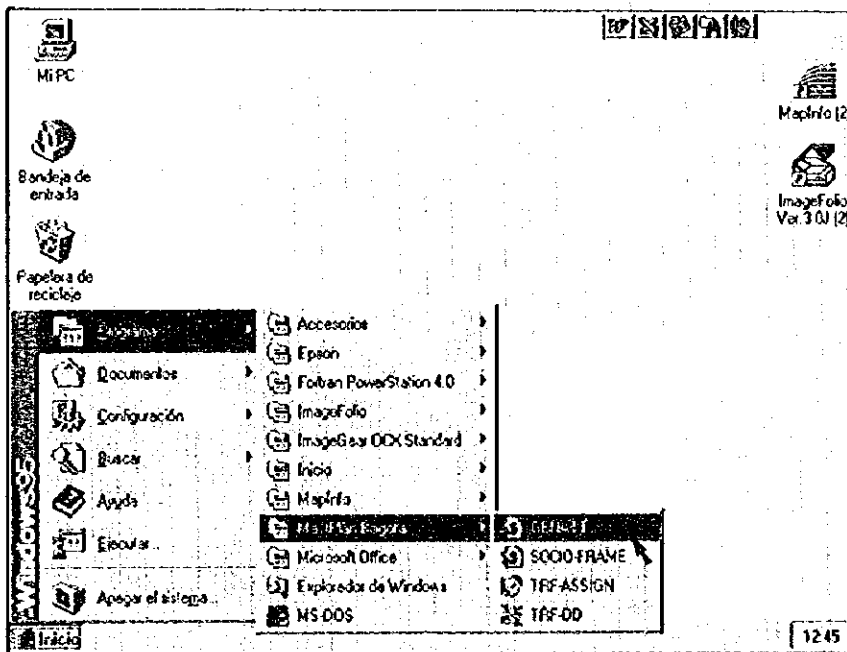


Figure 4.2-8 Showing Submenu Tree for Output Lists (GETATT)

Table 4.2-1 Sample of Output List

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		1,350,097		2.71
3.Car Ownership(veh./1000)	83.0		156.1		1.88
4.Number of Households	1,280,292	1.000	1,830,039	1.000	1.429
1)Non-Motorized	901,232	0.704	960,167	0.525	1.065
2)Motorized Households	379,060	0.296	869,872	0.475	2.295
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		17,410,178		1.55

### (3) Estimated Trip OD Tables

The following estimated trip OD tables are stored in the directory of "Ybog\_tdas Yresult" in the final step. The short and medium term OD tables (in 2001 and 2010) are estimated automatically by the interpolation method without socioeconomic data.

- 1) PCU OD Table in 2001: file name "pcu2001.txt"
- 2) PCU OD Table in 2010: file name "pcu2010.txt"
- 3) PCU OD Table in 2020: file name "pcu2020.txt"
- 4) Vehicle OD Table in 2020: file name "aut2020.txt"
- 5) Person OD Table in 2020: file name "per2020.txt"

The data format for the OD tables which is common for every OD table is shown in Table 4.2-3.

Table 4.2-2 (1) Trip Generation and Attraction by Modes

zone	GENERATION				ATTRACTION			
	car	taxi	truck	bus	car	taxi	truck	bus
1	118,306	17,246	13,715	209,933	112,189	16,392	12,203	207,770
2	41,999	5,851	3,030	147,473	39,643	5,924	3,229	135,527
3	43,724	9,173	7,928	81,174	49,238	9,028	8,811	84,837
4	34,091	6,221	2,165	53,486	34,855	6,008	1,905	53,529
5	106,400	18,419	5,579	103,905	110,456	17,620	6,005	104,924
6	47,867	9,143	3,838	53,708	49,722	9,717	4,202	54,275
7	174,333	33,023	9,392	188,023	170,093	32,288	9,083	173,569
8	121,156	25,398	4,837	107,503	121,250	24,271	3,544	102,318
9	169,587	30,412	13,324	129,991	169,990	32,872	9,302	122,057
10	189,968	46,397	4,863	176,028	181,091	47,842	5,791	154,056
11	102,413	29,667	4,278	196,447	94,178	25,192	3,199	178,948
12	71,310	21,300	634	135,922	69,210	19,306	260	122,431
13	74,350	21,274	1,391	227,059	68,702	22,879	1,192	205,924
14	25,505	8,076	1,321	81,446	18,688	6,972	1,403	73,855
15	50,817	18,420	2,281	141,122	45,147	15,023	2,530	129,800
16	215,330	78,800	28,314	730,560	151,805	64,482	26,960	652,180
17	19,287	6,905	144	109,789	17,356	6,505	202	106,394
18	16,152	4,356	2,502	61,722	13,720	5,031	1,979	76,478
19	13,328	4,182	112	48,158	10,754	2,777	49	42,397
20	21,617	8,828	711	102,300	16,950	6,908	202	93,932
21	6,543	2,429	1,681	20,108	7,365	2,456	3,625	20,918
22	11,893	5,156	4,168	51,323	12,990	6,272	2,239	34,930
23	12,476	2,805	4,672	21,087	13,384	2,826	4,537	21,720
24	25,751	9,005	2,377	97,512	23,298	10,136	10,760	99,359
25	14,260	5,483	17,234	128,043	23,071	6,893	9,019	136,152
26	12,471	2,957	1,407	89,901	14,528	2,743	1,330	95,529
27	539	97	0	12,687	737	74	0	13,644
28	6,753	1,399	273	49,678	7,701	1,687	77	52,698
29	1,756	709	2,119	25,418	2,473	554	1,086	27,067
30	11,191	2,283	816	71,188	13,240	2,868	1,298	74,615
31	4,491	1,317	11,437	40,522	4,997	1,424	12,595	42,937
32	15,128	4,183	2,722	71,023	16,646	5,207	2,445	75,186
33	9,787	4,233	650	47,758	11,313	4,819	114	46,455
34	23,064	7,004	7,037	94,412	24,536	7,774	7,369	97,623
35	23,860	8,107	9,395	96,645	27,524	9,085	11,466	95,178
36	17,583	5,998	2,571	48,284	17,678	6,051	2,706	50,290
37	30,693	7,319	8,147	171,219	30,134	7,633	7,542	176,424
38	33,769	4,253	1,535	63,955	35,523	4,912	1,647	68,245
39	42,202	15,277	18,038	89,424	50,194	15,600	18,516	90,927
40	18,821	4,754	33	47,903	19,641	5,399	0	47,705
41	14,741	3,876	2,395	25,575	16,374	3,435	1,875	25,694
42	85,197	22,034	32,432	111,267	94,536	23,181	23,657	115,297
43	53,347	20,386	31,922	170,230	59,295	18,788	38,382	175,592
44	31,169	13,108	16,922	103,073	35,901	15,022	11,053	104,312
45	26,123	8,562	27,842	126,806	22,037	8,559	33,190	132,623
46	28,242	9,430	11,121	141,958	30,497	10,694	13,482	147,830
47	23,490	14,576	13,410	61,241	24,933	9,545	788	62,643
48	3,923	1,135	2,954	24,098	4,110	895	964	22,360
49	53,721	12,031	2,112	71,284	59,237	14,187	1,069	74,077
50	52,125	11,235	9,818	104,616	53,575	12,591	16,616	105,858
51	51,422	14,435	12,897	148,584	52,407	13,638	7,473	147,399
52	26,400	20,058	8,191	54,744	25,769	37,238	714	59,540
53	9,508	1,937	152	34,663	11,395	1,498	0	37,865
54	42,870	13,603	3,273	129,074	49,065	14,808	2,295	129,238
55	71,287	29,344	7,866	170,231	78,572	27,638	9,239	174,702
56	30,786	9,681	2,681	48,434	29,920	9,184	2,541	46,905
57	60,245	15,368	10,347	167,933	62,828	16,518	9,299	172,846
58	37,643	10,865	542	137,152	42,506	11,803	1,963	143,305
59	27,185	12,996	218	60,326	28,812	13,265	1,334	63,380
60	30,049	9,769	4,190	87,688	33,470	8,730	4,218	92,608
61	48,385	14,421	4,572	169,682	53,897	13,109	5,617	181,059
62	29,014	5,208	2,816	76,426	31,556	5,525	3,455	81,291
63	108,991	17,789	2,044	105,216	112,667	21,835	584	106,695
64	44,451	8,166	4,095	65,083	49,596	9,054	4,365	70,084
65	51,789	11,421	2,367	73,104	55,251	11,265	636	73,298
66	323,595	48,696	18,488	318,231	323,525	46,414	30,661	326,824
67	77,057	13,679	1,058	62,131	79,799	15,286	2,149	63,148
68	27,848	6,598	3,987	157,650	33,678	7,316	3,848	163,147
69	90,789	13,214	22,464	135,124	93,354	14,854	21,883	142,559
70	12,040	2,395	557	69,193	13,189	2,396	664	73,204

Table 4.2-2 (2) Trip Generation and Attraction by Modes

zone	GENERATION				ATTRACTION			
	car	taxi	truck	bus	car	taxi	truck	bus
71	44,805	10,561	1,936	69,200	46,759	9,989	124	68,273
72	44,857	10,790	2,734	52,520	47,725	11,164	2,319	52,986
73	75,900	20,639	17,869	144,529	68,227	21,052	14,993	138,186
74	28,893	9,678	3,890	101,012	30,366	9,695	1,545	102,652
75	32,258	9,126	770	56,283	34,870	8,434	787	52,767
76	74,276	25,132	6,330	128,933	70,484	23,304	4,555	121,004
77	55,340	16,020	750	113,620	53,389	15,031	4,382	109,200
78	54,085	17,299	839	86,954	55,338	17,460	149	83,324
79	44,614	13,672	5,479	59,690	43,635	14,660	4,825	55,652
80	69,688	18,536	1,728	88,366	69,847	16,814	1,034	83,500
81	26,992	9,179	2,110	39,440	28,156	8,212	2,065	39,473
82	32,227	6,242	13	101,327	28,895	5,971	629	102,979
83	26,198	10,887	3,974	88,524	26,320	9,688	3,536	85,114
84	60,044	18,136	4,860	119,687	55,314	16,418	6,889	109,701
85	26,422	7,281	1,531	58,589	25,062	6,569	2,443	55,175
86	15,789	3,689	2,220	38,316	14,991	3,220	2,045	39,480
87	54,566	15,327	6,313	99,236	54,750	14,758	9,450	97,105
88	18,361	5,382	2,401	29,068	14,790	6,491	11,345	28,448
89	16,022	5,550	269	36,920	18,325	4,730	7	38,761
90	15,554	5,779	92	28,197	15,121	8,248	2,109	27,464
91	18,487	7,221	1,172	71,207	18,007	7,161	1,110	68,553
92	36,938	7,008	15,995	70,057	41,104	7,728	11,155	68,337
93	17,407	6,185	362	59,604	14,335	3,866	2,052	55,564
94	19,488	5,886	1,217	20,789	19,668	6,265	1,219	20,444
95	18,224	6,385	3,757	69,601	11,966	5,115	1,559	63,735
96	20,608	7,783	92	51,783	23,834	9,567	392	53,239
97	42,162	14,454	451	69,767	47,639	16,356	156	75,349
98	18,396	4,825	2,992	74,512	15,669	3,891	2,738	69,550
99	63,520	24,944	4,244	171,429	66,685	27,156	3,808	172,339
100	31,863	13,442	13,457	64,681	40,689	14,421	12,658	68,425
101	26,703	10,124	1,791	104,143	28,106	9,727	2,027	110,247
102	31,751	11,006	8,961	101,916	32,395	10,935	8,574	104,870
103	30,276	10,182	6,559	80,025	31,067	11,427	7,034	79,492
104	20,524	9,116	20,151	101,860	21,589	9,609	22,222	104,296
105	25,387	6,965	7,791	125,387	28,099	8,226	6,883	133,684
106	30,547	6,837	4,199	155,598	31,816	7,116	4,901	165,773
107	17,949	5,942	460	88,530	19,574	6,421	700	94,765
108	47,155	12,596	16,331	146,160	53,120	13,410	19,494	153,393
109	5,061	96	0	70	5,901	120	0	6
110	21,791	1,820	1,283	17,236	19,577	2,020	5,542	16,540
111	62,041	7,063	22,615	80,780	57,451	4,967	24,259	110,928
112	24,693	2,333	13,672	38,084	20,688	2,123	20,157	41,483
113	26,197	3,295	26,690	30,455	21,564	3,204	27,681	31,563
114	5,434	497	774	12,911	5,906	467	403	12,492
115	40,814	6,758	19,354	125,856	34,496	6,933	24,502	137,961
116	2,142	60	18	466	2,235	64	48	627
117	10,622	647	1,996	10,497	12,700	498	1,206	11,839
118	10,241	1,024	452	14,795	8,804	681	496	15,673
119	2,145	269	1,720	1,924	2,949	404	2,631	2,009
120	10,168	993	3,430	12,332	8,958	908	5,830	13,240
121	8,485	1,140	3,667	15,263	6,775	734	1,223	20,566
122	2,283	207	320	3,727	2,584	179	313	3,795
123	2,619	209	1,852	2,686	2,128	161	2,314	3,023
124	4,904	159	260	3,089	4,946	203	392	3,542
125	2,621	124	582	5,191	3,176	135	330	5,483
126	17,477	1,496	2,290	18,420	17,455	1,113	936	19,427
127	9,373	857	3,569	18,133	11,141	695	1,457	23,179
128	478	16	0	1,596	589	18	0	2,366
129	2,875	141	55	5,364	3,238	140	28	6,186
130	2,654	503	1,447	1,058	2,238	66	0	1,602
131	8,188	1,989	7,395	8,314	6,721	1,025	7,405	10,469
132	153	3	0	58	142	3	0	6
133	3,742	710	3,039	4,569	4,626	722	0	6,965
134	2,341	109	48	2,757	3,430	155	453	3,883
135	1,027	41	0	2,158	1,464	122	55	2,750
Total	5,183,248	1,337,784	765,439	11,240,718	5,183,248	1,337,784	765,439	11,240,718



Table 4.2-3 Data Format for OD Tables

Column	Data Type	Item(English)	Item(Espanol)	Minimum	Maximum
1	INT(5)	Zone Code of Origin	Codigo de Zona Origen	1	135
2					
3					
4					
5					
6	INT(5)	Zone code of Distination	Codigo de Zona Destino	1	135
7					
8					
9					
10					
11	INT(7)	Car	Vehiculo	0	-
12					
13					
14					
15					
16					
17					
18	INT(7)	Taxi	Taxi	0	-
19					
20					
21					
22					
23					
24					
25	INT(7)	Truck	Camion	0	-
26					
27					
28					
29					
30					
31					
32	INT(7)	Bus	Bus	0	-
33					
34					
35					
36					
37					
38					

### 4.3 Part II Module

In the Part II module, the traffic volume is predicted on the transport chosen by minimum distance / time route. The Master Plan project data of three target years of 2001, 2010 and 2020 is prepared in advance in the manner of data files in hard disk in the module. The traffic and passenger volumes for three target years are output in the manner of output lists and graphics on the computer screen.

Every project data prepared in Master Plan is stored in hard disk. The project network data for the three target years also prepared in the hard disk. Those data were used for the evaluation of Master Plan network.

The purposes of the Part II module are to predict traffic volume corresponding to the review of Master Plan projects. This module has a function which it is possible to add and erase some projects from the project list prepared in the target years.

The parameters in the assignment such as Speed-Flow Curves, number of iterations, etc., described in Section 3 are fixed in the module.

### 4.3.1 Traffic Assignment

#### (1) Execution of Program

The traffic assignment program is executed by moving the menu highlight bar as shown in Figure 4.3-1. The submenu is chosen in the next stream; "start" > "Programs" > "MastPlan Bogota" > "TRF-ASSIGN" on the operating system Windows 95.

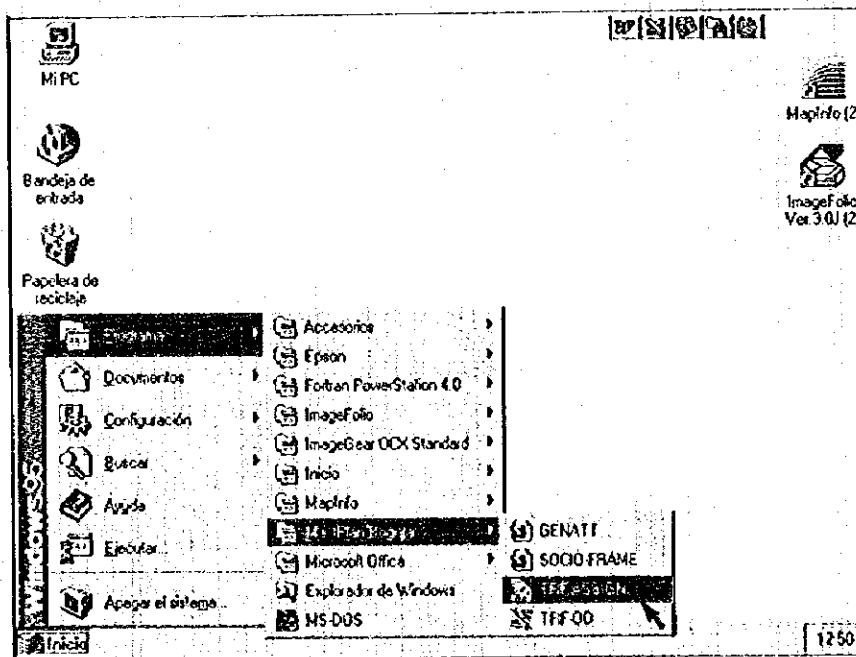


Figure 4.3-1 Execution of Program

#### (2) Choice of the Project Year

In the process of the execution, the following dialog box for inquiring the target year of the project appears on the screen (see Figure 4.3-2). Choose the target year of Mater Plan from among the prepared box for the target years; 1996, 2001, 2010, and 2020. Then, select the following button in the dialog box;

- 1) Click on the button of "Especificaciones", then go to Section (3) for explanation.
- 2) Click on "Siguiente", then jump to Section (4).
- 3) Click on "Salida" and the program terminates.

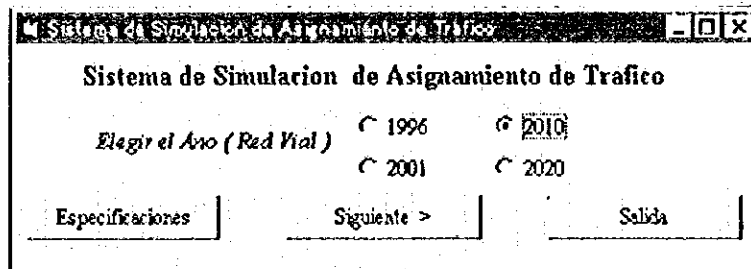


Figure 4.3-2 Dialog Box for Inquiring the Target Year

### (3) Execution of "Especificaciones"

In this step, the module has a function of adding and erasing certain projects on the preserved project list in accordance with the selected target year in the previous Section (2). When you would like to add and/ or erase certain projects, click the circle button of the certain projects then the color in circled button changes to black if operation succeeds. If you click the same button again, the color returns to the previous state. Figure 4.3-3 shows the optional project list.

Click on the button of "default", then the project list returns to the initial conditions of the target year.

To complete this process, click on the button "OK".

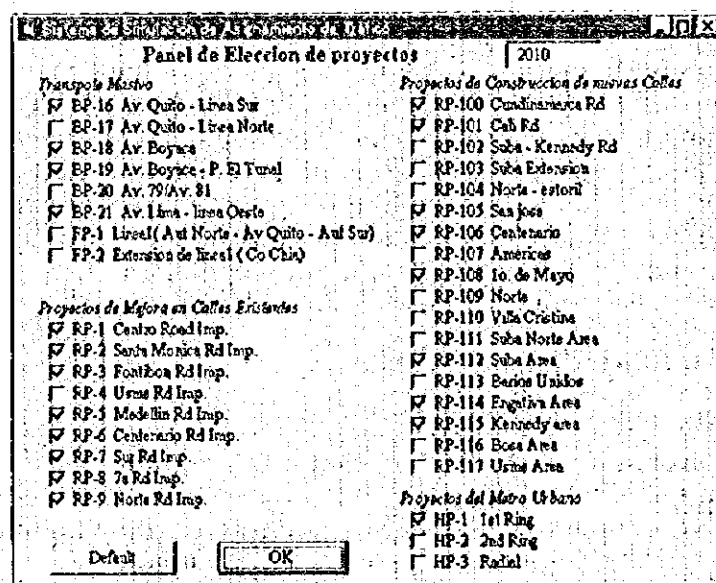


Figure 4.3-3 Optional Project List

### (4) Choice of Trip OD Table

Click the button of "Siguiente", then the following dialog box appears as shown in Figure 4.3-4. Choose the trip OD table for the assignment from the prepared OD table lists in the dialog box. To use the trip OD table estimated by JICA Study Team, choose from the following preserved OD table lists;

- 1) PCU OD Table in 1995: file name "JICA1995"
- 2) PCU OD Table in 2001: file name "JICA2001"
- 3) PCU OD Table in 2010: file name "JICA2010"
- 4) PCU OD Table in 2020: file name "JICA2020"

To use the trip OD table estimated by yourself under the procedure of the Part I module, choose this OD table from the preserved OD table lists for 2001, 2010 and 2020.

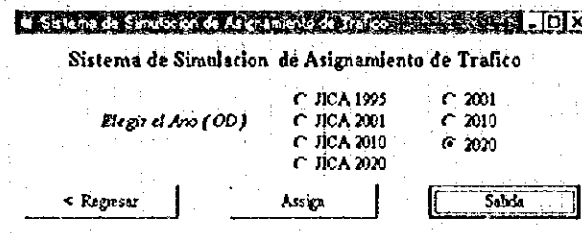


Figure 4.3-4 Dialog Box for Choice of Trip OD Table

Then select the following button in the dialog box;

- 1) Click the button of "<Regresar", then the screen return to Section (2) for explanation.
- 2) Clicking "Assign", the assignment program is executed.
- 3) Click "Salida", then the program terminates.

Running time for the traffic assignment is about 1 -2 minutes with Pentium processing machine. The program automatically terminates.

#### 4.3.2 Output of Graphical Network

The output data is stored in the manner of file named "asgres.mif" in the hard disk. The data is composed of assigned traffic volume and link conditions such as capacity, link length, number of lanes, etc. The graphical network data is also preserved in advance in the module. The assigned text data "asgres.mif" is combined with the graphical data and shown in graphics by using the application program named MapInfo which is illustrated on the transport network and map for network link data and zone data such as socioeconomic and traffic volume data on population, trip generation and attraction, etc. For detailed MapInfo, refer to manual.

##### (1) Execution of MapInfo for Importing Data

MapInfo is executed by the following procedure.

- 1) Click on Icon of MapInfo to start the MapInfo program.
- 2) Click the button of "Cancel" then Dialog Box appears on the screen.
- 3) Incorporate the output file of traffic assignment into the MapInfo. At first, click on "Table>Imprt....." on the menu bar. Then the following dialog box appears as shown in Figure 4.3-5. In the second step, select the directory to "\bog\_tdas \result" in the Directories List box and move the menu highlight bar on the file "asgres.mif" in the File Name box, and click the button of "Import".

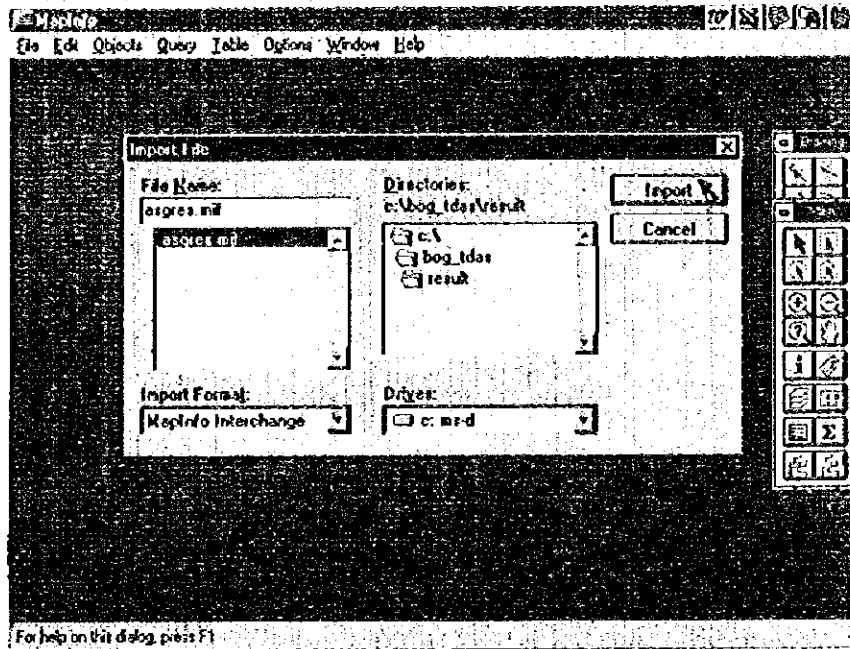


Figure 4.3-5 Dialog Box for Importing the Output File for Traffic Assignment

- 4) In the previous step 3), as long as you complete the clicking the "Import", the following dialog box appears as shown in Figure 4.3-6. Click the button of "Save". If the same file name exists in the same directory, the message box appears on the screen. Click the button of "OK".

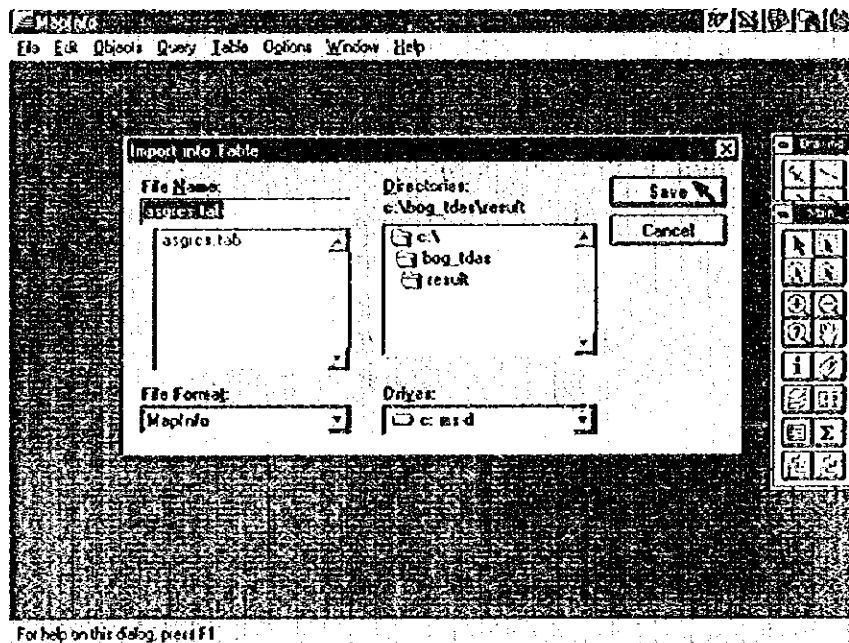


Figure 4.3-6 Dialog Box for Save of the Imported File

## (2) Displaying the Transport Network Data

The transport network data is displayed on the screen by using MapInfo. Move the mouse cursor on the pull down menu bar of "Window" and move the highlight bar on

the submenu of "New Map Window". Then the following graphics appear on the screen as show in Figure 4.3-7.

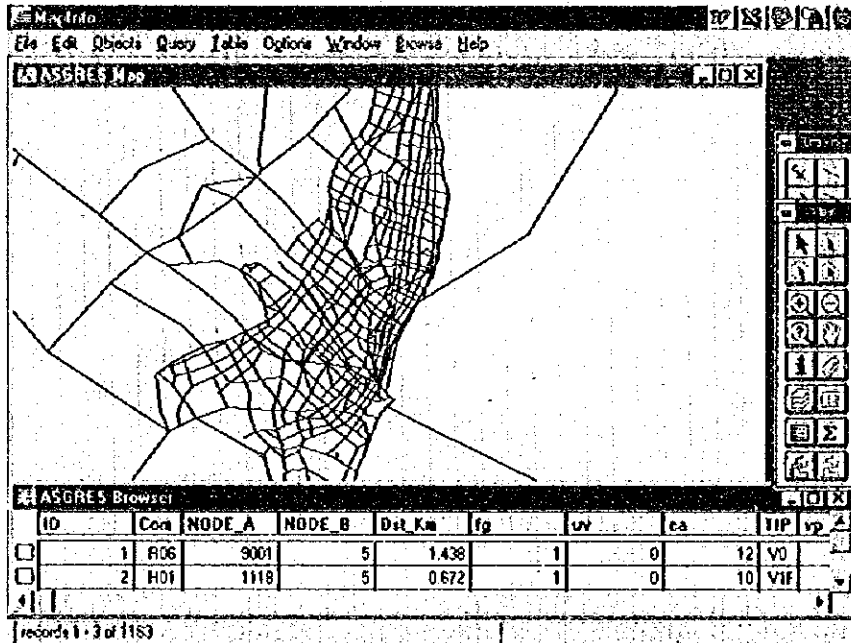


Figure 4.3-7 Displaying the Transport Network Data

When you want to modify an element in the picture window; for example, to move, scale, or change its lines, refer to the manual of MapInfo. The JICA manual does not show the procedures of the graphics.

The contents of transport network data to browse on the screen are shown in Table 4.3-1. They are composed of transport facility and traffic volume assigned. These data are browsed for traffic volume in the manner of lines colored by ranks and figures beside the links by using the functions of MapInfo. The samples of browser are shown in Figure 4.3-8 and Figure 4.3-9.

Table 4.3-1 Contents of Transport Network Data

	Column	Contents	Remarks
1)	ID	Link Number	
2)	Com	Project Component Number	
3)	Node A	Node Number	
4)	Node B	Node Number	
5)	Dst km	Distance (km)	
6)	fg	Transport ID Number	1: Ordinary Roads 2: Urban Expressways 3: Express Busway 4: Railway 5: Rampway 6: Transfer Links with Busway 7: Transfer Links with Railway 8: Dummy 9: Dummy
7)	uv	Don't Use	
8)	ca	Number of Lanes	
9)	TIP	Road Classification	V0, V1, V2, V3
10)	Vp	Don't Use	
11)	act	Don't Use	
12)	ktv	Assigned Traffic Volume	
13)	inout	Don't Use	
14)	BVT	Road Improvement	1: Existing Roads 2: Improved Roads with widening 3: Planning Roads
15)	QV	QV Equation No. (Speed-Flow Curve)	
16)	Direction	Oneway ID	0: Dualway Road 1: Oneway from Node A to Node B
17)	Via rapida	Don't Use	
18)	Via Pagar	Don't Use	
19)	Ocpn	Don't Use	

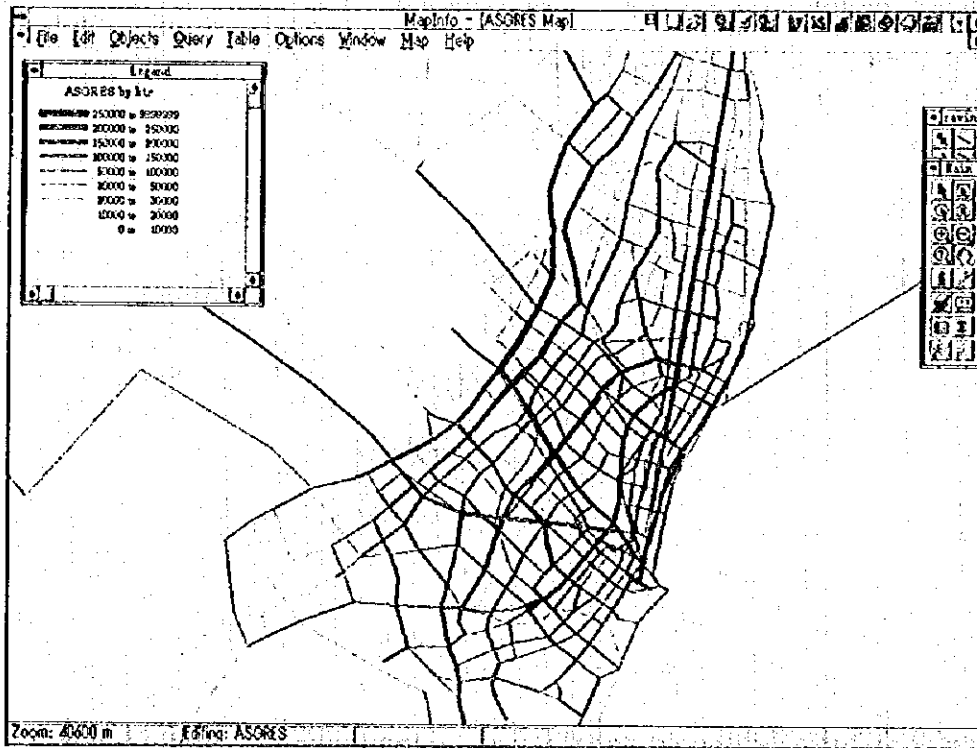


Figure 4.3-8 Sample for Browser of Traffic Volume (Lines by Traffic Volume Ranks)

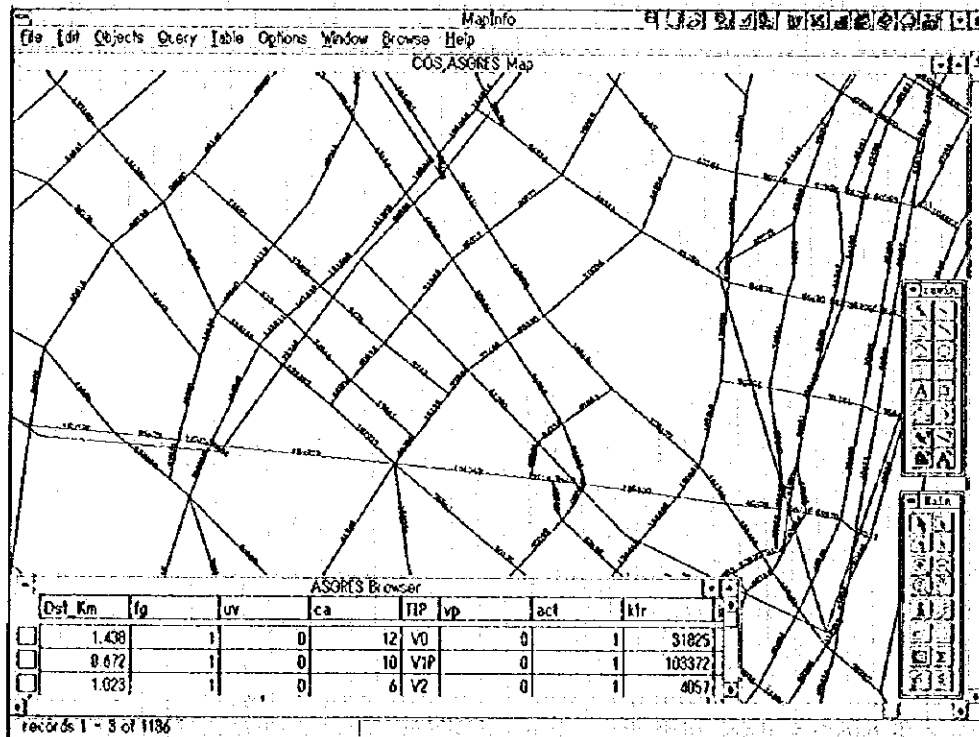


Figure 4.3-9 Sample for Browser of Traffic Volume (Figures beside Lines)



Appendix Table

Socioeconomic Data in 1995

zone	(1) Total population	(2) Population 5 years-	(3) No. of household	(4) Working population (living place)	(5) No. of students (living place)	(6) Working population (working place)	(7) Primary	(8) Secondary	(9) Tertiary	(10) No. of students (studying place)	(11) Av. household income	(12) No. of Car
1	41,961	37,154	8,339	16,568	13,625	725	3,553	9,456	27,842	585,056	3,453	
2	21,985	20,190	4,583	7,121	8,422	0	5,268	10,488	27,388	357,497	1,181	
3	69,223	64,046	16,011	29,434	21,476	46	2,993	13,377	17,599	629,919	6,327	
4	34,115	32,033	7,285	16,232	10,069	160	3,544	5,401	8,511	747,424	5,469	
5	83,647	80,670	19,154	36,365	26,673	125	6,206	19,765	17,173	1,097,069	20,364	
6	33,413	32,270	6,699	14,133	11,682	46	5,102	11,477	6,071	1,156,410	8,578	
7	54,628	50,551	17,853	38,664	22,882	524	15,221	51,341	20,219	1,328,192	20,812	
8	45,034	43,534	10,210	21,662	12,059	852	12,407	34,455	11,173	1,461,905	16,900	
9	47,727	46,051	12,015	26,935	10,827	446	15,753	56,966	6,746	1,090,780	18,233	
10	43,073	40,972	13,132	20,455	11,556	926	14,197	64,380	26,518	1,952,632	19,436	
11	34,356	33,075	7,949	15,258	9,777	536	11,176	49,401	30,362	715,041	6,121	
12	20,570	20,036	4,185	7,667	7,926	149	6,922	33,504	21,047	773,409	3,364	
13	27,641	26,557	7,057	10,793	10,096	284	5,722	33,707	56,508	934,091	4,019	
14	4,520	3,904	925	2,670	719	0	4,798	17,650	12,539	1,100,000	205	
15	21,922	19,680	4,996	8,156	6,156	349	5,179	36,355	25,639	361,856	1,326	
16	29,717	28,771	7,577	12,904	8,643	966	23,581	158,995	74,675	511,452	1,790	
17	30,230	29,605	5,644	10,905	10,427	76	4,112	22,444	16,742	329,289	957	
18	64,570	57,254	12,848	22,305	19,119	114	15,415	3,017	20,850	280,202	616	
19	11,402	10,328	2,313	4,626	3,358	217	884	5,090	17,516	548,577	249	
20	17,919	17,636	3,696	7,070	5,946	51	2,987	22,954	22,496	232,476	402	
21	18,291	17,085	3,900	7,055	5,564	92	893	1,672	2,282	355,476	1,114	
22	50,309	45,532	10,641	13,531	15,998	0	1,647	4,290	9,636	294,631	1,158	
23	13,935	12,950	2,787	6,893	3,771	0	1,647	2,957	4,189	432,333	1,095	
24	59,345	55,816	12,802	22,933	19,249	0	2,834	13,247	24,605	392,604	2,855	
25	149,554	137,251	30,785	52,591	44,638	91	3,237	6,005	27,029	264,922	2,737	
26	114,419	104,599	22,517	40,002	34,174	79	3,765	5,308	28,172	229,445	1,437	
27	10,748	9,409	2,140	3,037	2,939	0	284	586	3,394	161,448	0	
28	50,867	45,544	10,676	19,153	15,752	0	773	3,286	6,478	342,286	1,162	
29	29,929	28,924	5,797	9,579	9,184	161	609	1,525	8,269	203,611	497	
30	74,738	70,265	14,299	24,850	22,614	217	2,511	5,704	23,050	277,150	953	
31	65,806	62,668	9,222	15,324	14,701	0	1,667	3,156	15,347	220,709	508	
32	60,268	55,344	12,806	23,462	16,120	0	4,159	7,347	14,438	259,779	2,453	
33	26,157	23,707	5,999	10,933	8,321	0	524	4,899	14,506	504,410	1,620	
34	83,548	76,727	16,966	31,314	23,719	0	2,228	7,572	20,768	318,373	2,438	
35	50,512	47,206	11,805	21,573	12,870	96	5,472	11,715	12,560	543,408	3,193	
36	38,458	35,562	8,319	13,783	12,724	114	2,342	3,549	6,059	443,529	2,771	
37	158,990	143,538	33,322	54,077	45,904	290	7,400	15,065	47,675	262,290	3,212	
38	60,218	59,124	13,354	20,255	18,661	105	2,276	2,300	14,000	214,596	634	
39	73,375	69,258	16,238	30,017	21,415	87	8,253	13,106	11,504	479,616	6,300	
40	32,143	30,283	7,021	11,672	10,151	0	3,509	6,575	9,032	356,158	2,369	
41	14,777	14,190	2,745	6,015	5,034	0	3,268	4,610	2,818	840,000	1,438	
42	64,720	59,854	13,640	24,612	21,703	65	3,503	10,518	8,625	602,745	2,111	
43	110,291	109,858	24,194	47,049	32,705	185	5,149	27,317	37,452	458,492	7,092	
44	93,304	85,907	19,435	37,782	27,363	46	4,607	11,306	16,910	370,344	4,614	
45	116,322	104,663	22,895	41,571	37,661	256	5,492	15,589	27,393	267,829	1,255	
46	147,707	140,963	29,511	54,115	47,830	0	2,356	10,910	24,131	323,379	3,986	
47	16,551	14,970	3,795	7,273	5,061	0	2,449	8,497	905	919,032	1,736	
48	0	0	0	0	0	0	5,380	5,292	459	0	0	
49	58,108	55,339	11,538	24,417	21,739	411	4,671	13,920	6,512	1,116,396	12,162	
50	104,253	97,401	22,538	42,043	29,524	131	4,109	15,090	18,560	403,293	6,854	
51	104,220	94,060	22,717	37,950	31,669	366	12,540	22,959	36,426	367,368	6,414	
52	0	0	0	0	0	530	1,549	18,594	919	0	0	
53	33,961	31,645	7,641	13,047	10,643	0	1,822	3,262	3,300	312,679	1,513	
54	87,474	82,461	15,455	35,527	24,322	636	7,779	16,906	24,443	441,836	5,428	
55	139,439	130,173	31,581	58,356	40,596	46	10,164	20,572	34,453	444,584	12,285	
56	11,055	10,779	2,395	4,882	3,571	172	2,321	9,008	16,507	1,143,462	2,456	
57	142,641	136,048	29,091	58,762	44,984	0	4,574	18,891	34,116	400,983	8,612	
58	106,554	99,118	23,719	42,980	34,883	246	7,925	16,703	14,724	409,266	6,563	
59	56,073	53,530	11,805	21,472	17,402	101	3,356	9,891	7,504	636,303	6,919	
60	88,490	79,530	20,069	33,375	25,560	9	2,945	7,542	11,871	408,000	5,095	
61	152,169	140,126	32,989	63,565	42,520	140	4,988	14,624	26,777	430,482	6,301	
62	50,636	46,261	10,549	19,470	15,745	0	1,150	4,682	9,908	440,152	2,287	
63	54,750	51,593	15,526	37,950	24,439	750	6,958	22,703	10,185	1,271,376	23,833	
64	65,749	61,720	14,363	29,315	19,600	81	2,664	10,043	9,759	796,960	9,958	
65	43,892	40,755	10,407	17,055	15,068	62	2,532	6,923	9,875	739,051	6,067	
66	27,215	25,552	5,425	11,373	10,091	159	1,887	5,707	13,661	840,656	6,058	
67	41,758	39,662	9,505	19,469	11,079	65	4,700	16,064	7,078	1,660,664	14,552	
68	139,970	128,193	30,198	53,224	45,826	152	7,602	14,483	28,645	361,382	4,363	
69	75,062	64,413	16,077	28,775	20,838	367	4,100	8,065	21,815	422,600	4,655	
70	66,068	59,291	14,197	25,579	19,638	0	2,810	5,875	12,545	273,912	1,885	

Appendix Table

Section 4 : User's Manual for the Travel Demand Model

Socioeconomic Data in 1995 (continued)

zone	1) Total population	2) Population 5 years -	3) No. of household	4) Working population (living place)	5) No. of students (living place)	6) Working population (working place) Primary	7) Secondary	8) Tertiary	9) No. of students (studying place)	10) Av. household income	11) No. of Car
71	50,660	49,628	10,715	21,522	13,441	90	5,507	17,589	7,707	1,166,736	7,613
72	38,362	37,293	9,092	15,456	9,236	207	4,319	13,564	5,822	889,064	7,367
73	50,711	45,542	11,934	18,682	13,487	65	11,780	25,679	20,356	575,224	4,754
74	73,218	69,743	15,644	30,166	29,555	102	6,288	16,993	17,306	409,277	3,291
75	23,777	23,399	5,115	11,177	7,105	0	3,547	8,595	12,202	1,081,887	3,449
76	32,578	30,231	7,780	13,711	8,074	195	6,076	32,399	23,765	662,361	4,571
77	30,501	29,355	6,850	11,907	10,663	194	3,554	18,253	24,729	760,345	4,587
78	26,291	25,012	5,908	12,603	7,185	0	4,313	19,263	14,370	799,310	4,037
79	26,327	25,290	5,756	10,562	9,721	94	1,205	11,053	17,258	1,215,833	5,284
80	26,668	26,294	5,476	10,815	8,578	0	5,008	30,216	7,578	1,217,370	4,619
81	23,953	23,321	4,971	9,942	6,508	0	3,295	8,952	2,841	991,887	4,609
82	72	72	15	31	31	197	1,681	3,751	856	450,000	10
83	30,139	27,667	7,182	11,536	8,241	178	5,622	21,223	12,540	376,852	1,178
84	14,995	15,405	3,901	6,301	5,802	387	11,164	36,993	6,806	687,051	2,901
85	20,318	17,844	3,719	8,038	4,916	0	3,298	15,858	7,438	405,953	1,766
86	25,623	23,990	5,471	12,415	7,261	0	3,395	5,459	7,210	419,200	1,637
87	36,565	34,277	7,976	15,947	9,734	40	7,227	24,375	15,197	640,790	5,799
88	25,912	23,589	5,226	9,759	8,715	0	1,389	5,717	8,418	340,000	1,894
89	34,433	28,595	6,856	12,696	9,555	102	1,931	4,603	6,467	590,889	3,685
90	14,797	17,430	3,837	7,365	5,588	76	1,314	4,205	7,527	527,391	1,778
91	34,194	32,987	7,005	12,686	11,450	0	5,047	12,805	12,240	400,217	2,749
92	47,680	44,723	9,583	19,876	14,185	95	5,805	8,535	14,735	471,217	5,654
93	3,197	3,059	576	1,230	854	262	10,258	14,116	5,550	369,280	119
94	10,274	9,808	2,335	4,669	2,896	60	2,894	5,619	889	783,510	3,656
95	3,513	3,227	783	1,679	974	0	8,592	20,578	2,871	313,325	171
96	39,094	36,251	8,435	15,730	10,943	110	2,094	7,869	6,183	857,644	4,104
97	68,564	66,799	14,353	32,128	20,536	110	2,058	11,418	7,282	659,291	8,120
98	4,958	4,456	1,502	3,395	980	0	13,545	20,016	1,445	365,217	611
99	110,911	104,380	25,990	45,726	27,191	0	20,921	34,644	22,093	408,880	7,273
100	64,456	60,551	14,132	25,276	18,154	0	1,424	6,495	7,165	658,261	5,859
101	78,185	72,075	15,785	34,675	16,534	478	8,014	12,812	17,444	461,502	4,936
102	65,461	61,098	13,756	25,738	19,355	0	3,232	12,101	25,838	450,199	4,911
103	61,564	58,790	14,492	24,974	15,006	279	3,670	9,410	18,890	410,732	2,971
104	69,834	64,912	14,997	24,542	22,668	181	3,145	8,213	26,582	333,600	2,633
105	132,708	119,956	26,523	49,662	35,691	0	4,498	9,414	22,501	243,716	2,300
106	155,938	140,237	29,492	54,041	44,902	92	5,197	11,065	37,801	255,215	1,640
107	74,135	67,797	15,912	28,954	20,753	0	1,552	5,222	14,667	254,175	1,927
108	132,360	119,789	27,370	45,553	44,136	211	8,245	13,868	28,710	324,347	4,112
109	Sumaza					0	0	0	51		
110	Cela					1,035	2,35	3,038	7,422		
111	Chía					891	3,794	9,399	19,226		
112	Funza					1,056	1,502	3,601	953		
113	Mosquera					567	2,433	2,905	5,534		
114	Sibaté					165	1,200	1,737	219		
115	Soacha					538	4,719	8,944	2,014		
116	Bojaca					76	41	29	119		
117	Cajía					0	659	1,056	51		
118	Facatativa					655	934	2,136	355		
119	Cachandía					0	62	265	0		
120	La Calera					166	794	2,574	1,044		
121	Madrid					1,593	1,230	3,365	1,406		
122	Sopó					510	520	1,734	191		
123	Talibó					131	205	76	0		
124	Terjé					328	72	521	155		
125	Tocancía					117	665	644	84		
126	Zapquí					347	721	3,379	85		
127	Sabana Norte					367	283	2,414	274		
128	Rimboquí					0	0	81	0		
129	Subachoque/La Vega					742	448	855	0		
130	Villeta/Quadas					93	512	1,539	182		
131	Tequendama					735	1,565	2,730	224		
132	Fusagasugá					0	197	185	0		
133	Caqueza/Medina					746	726	3,394	234		
134	Florencia					0	299	125	81		
135	Guzatá/Gacheta					80	106	437	0		
total	5,965,000	5,569,633	1,280,292	2,365,757	1,785,785	27,750	573,360	1,764,647	1,785,785	514,769	497,747

Appendix Table

Socioeconomic Data in 2020

zone	1) Total population	2) Population 5 years	3) No. of household	4) Working population (living place)	5) No. of students (living place)	6) Working population (working place)	7) Primary	8) Secondary	9) Tertiary	10) No. of students (studying place)	11) Av household income
1	264,825	237,456	52,892	124,945	27,863	469	14,315	168,542	143,959	1,294,681	
2	113,345	105,374	23,628	43,865	41,297		9,411	27,806	124,106	741,536	
3	83,560	78,264	19,327	42,455	24,386		4,008	33,802	19,942	1,408,324	
4	42,525	40,422	8,951	24,177	12,406		4,671	12,552	10,024	1,378,297	
5	87,062	84,999	19,946	45,251	27,778		6,853	26,784	17,291	2,001,804	
6	65,460	44,444	9,114	22,926	16,137		5,886	16,064	7,436	1,225,473	
7	111,937	108,300	23,614	61,108	29,662		17,762	63,458	25,615	2,569,613	
8	56,194	54,168	12,463	31,582	14,833		13,877	39,946	13,452	2,454,991	
9	63,507	61,582	13,964	42,763	14,296		17,741	64,272	8,969	2,467,773	
10	44,868	43,206	13,679	25,495	12,126		15,496	70,394	29,245	3,359,474	
11	35,578	34,674	8,232	19,880	9,582		11,647	53,242	32,151	1,391,361	
12	20,720	20,433	4,216	9,216	8,108		7,415	35,569	22,879	1,679,081	
13	28,868	28,336	7,355	13,479	10,647		6,334	37,138	63,611	1,935,663	
14	5,352	4,680	1,095	3,278	720		5,543	24,024	15,335	2,550,932	
15	23,307	21,181	5,312	10,361	5,349		5,902	38,968	28,151	822,053	
16	30,623	30,014	7,808	15,880	8,552		27,045	247,681	60,369	1,159,317	
17	30,883	29,581	5,766	13,312	9,752		4,495	34,441	15,613	763,639	
18	62,824	59,144	13,110	27,196	19,099		1,904	7,937	21,237	644,603	
19	12,744	11,227	2,454	5,926	3,468		1,025	6,386	20,135	1,191,307	
20	15,686	17,354	3,854	8,810	5,631		3,297	25,299	23,172	492,241	
21	19,027	17,992	4,057	8,769	5,579		1,058	3,149	2,103	824,365	
22	51,179	46,894	10,823	22,525	15,376		1,932	8,192	9,242	676,302	
23	14,215	13,376	2,843	6,292	3,860		1,187	6,995	4,002	844,789	
24	60,285	57,424	13,011	27,852	18,314		3,270	18,152	22,831	827,361	
25	152,192	141,365	31,326	63,945	41,452		4,133	17,688	24,193	612,634	
26	114,609	106,064	22,554	47,828	31,603		4,244	13,814	25,191	530,206	
27	12,257	10,862	2,440	4,138	2,950		498	1,639	3,427	374,494	
28	52,513	47,911	11,621	23,622	14,864		1,066	7,466	5,632	710,856	
29	36,298	31,825	7,031	13,592	9,335		1,176	4,806	8,449	467,251	
30	79,787	75,945	15,267	31,830	27,239	130	3,120	12,145	22,258	591,162	
31	49,573	46,680	9,980	20,463	14,341		2,153	7,258	15,017	500,129	
32	62,158	57,811	13,214	28,829	15,406		4,651	12,538	12,979	637,245	
33	26,618	25,393	6,347	13,822	8,107		691	7,630	15,222	1,133,361	
34	85,317	79,223	17,305	58,164	22,622		2,785	14,278	19,236	713,409	
35	51,276	49,024	11,983	26,123	12,322		8,244	20,442	11,714	1,239,523	
36	49,021	37,424	8,543	17,121	12,972		3,349	8,116	5,750	1,074,933	
37	160,300	146,847	33,597	66,113	43,423		9,916	30,445	43,750	616,905	
38	217,940	196,426	42,519	77,003	51,923	62	13,953	50,492	36,908	493,127	
39	75,323	70,964	16,669	36,813	20,787		9,229	19,195	10,523	1,076,174	
40	33,633	32,077	7,346	14,593	10,063		3,829	9,325	8,894	756,268	
41	15,125	14,751	2,820	7,381	5,041		3,470	5,952	2,563	1,855,221	
42	270,140	252,909	56,971	122,751	85,314	39	22,209	55,774	31,693	1,218,674	
43	118,612	111,515	24,260	36,370	30,740		6,015	37,231	35,766	928,186	
44	95,064	88,607	19,775	45,998	26,157		5,187	18,666	15,422	799,809	
45	118,260	107,136	23,258	50,518	35,158	166	8,051	29,521	24,874	558,491	
46	149,807	144,729	29,931	65,581	46,030		2,970	22,521	21,143	634,426	
47	47,523	43,513	10,897	24,954	14,358		5,542	13,766	7,692	1,728,602	
48	0	0	0	0	0		5,593	7,564	0	0	
49	62,064	60,374	12,325	31,164	23,004		11,682	18,850	6,411	2,472,113	
50	111,060	105,069	24,014	53,527	29,295		8,309	25,761	18,266	826,967	
51	109,957	102,609	23,965	47,839	31,657	219	28,941	46,569	35,703	814,561	
52	0	0	0	0	0		1,686	31,300	0	0	
53	36,171	34,123	8,151	16,604	10,766		5,235	6,217	2,899	723,368	
54	89,593	85,503	18,903	43,476	21,678		8,995	23,341	23,715	1,004,412	
55	142,124	134,315	32,495	71,073	38,838		11,335	31,455	32,504	981,720	
56	12,013	11,857	2,602	6,339	4,156		2,624	10,243	17,863	2,719,817	
57	143,345	138,405	29,234	70,561	43,207		7,457	29,682	31,164	1,055,043	
58	110,690	104,206	24,114	53,311	34,161		8,826	25,717	13,655	828,827	
59	56,472	54,576	11,889	25,810	16,835		4,326	14,125	6,340	1,259,401	
60	90,904	83,051	20,617	40,922	24,547		3,396	14,605	10,802	916,753	
61	213,240	198,755	46,229	106,442	55,933	85	9,641	36,431	33,981	950,163	
62	167,040	154,483	35,776	76,744	47,454		10,183	28,302	25,323	940,766	
63	69,093	66,803	19,463	47,655	26,272		7,825	29,958	9,986	2,344,193	
64	80,344	76,354	17,577	42,811	22,924		3,255	17,433	11,062	1,523,223	
65	124,430	121,871	30,731	60,255	41,335		8,978	24,517	26,151	1,496,461	
66	725,152	701,196	145,415	304,223	259,136	101	50,293	259,087	271,970	2,192,473	
67	68,030	57,723	13,664	33,443	18,212		6,079	22,304	9,544	3,027,833	
68	158,095	146,576	34,108	71,833	47,647		9,293	28,153	29,373	820,100	
69	429,585	373,445	92,074	196,916	108,324	239	41,297	74,022	55,354	885,516	
70	75,390	67,934	16,069	24,524	20,333		3,653	12,290	12,652	576,355	

Section 4 : User's Manual for the Travel Demand Model

Socioeconomic Data in 2020 (continued)

zone	1) Total population	2) Population 5 years -	3) No. of household	4) Working population (living place)	5) No. of students (living place)	6) Working population (working place) Primary	7) Secondary	8) Tertiary	9) No. of students (studying place)	10) Av household income
71	52,799	52,360	11,167	26,602	14,094		6,203	21,993	7,607	2,064,883
72	39,912	39,445	9,474	19,245	9,523		4,959	17,307	5,937	1,907,123
73	52,551	49,797	12,265	23,120	13,643		13,160	64,539	20,056	1,521,613
74	75,033	72,356	16,035	36,942	20,377		7,526	23,409	17,179	877,445
75	25,589	25,492	5,505	14,373	7,603		4,246	10,739	12,856	2,423,851
76	34,196	32,655	8,160	17,197	8,330		6,752	61,682	25,343	1,209,674
77	31,220	30,417	7,043	13,462	10,495		4,553	31,857	26,543	1,704,483
78	26,525	25,546	5,961	15,193	7,193		4,795	39,465	14,674	1,291,843
79	26,731	25,995	5,344	12,937	9,797		1,429	13,276	18,160	2,679,573
80	32,900	32,841	6,872	15,944	10,699		6,077	34,143	9,138	2,665,644
81	24,128	23,781	5,007	11,967	6,554		3,859	11,047	2,957	2,216,572
82	101,775	95,715	21,201	52,360	45,095		9,525	99,474	33,162	693,647
83	30,643	28,474	7,301	14,014	7,604		6,673	26,002	12,043	773,643
84	16,950	15,729	3,935	7,594	5,467		12,601	41,368	7,156	1,593,294
85	21,267	19,908	3,883	10,053	4,870		4,453	22,326	7,714	941,423
86	26,307	24,836	5,606	15,201	7,055		3,705	10,276	7,131	908,467
87	38,003	35,771	8,220	19,643	9,838		8,022	28,295	14,574	1,466,717
88	26,402	24,332	5,328	11,882	7,928		1,436	8,950	7,999	761,364
89	32,191	29,645	6,816	15,536	9,900		2,136	10,703	6,423	1,370,294
90	19,095	17,894	3,999	8,940	5,482		1,424	7,801	7,303	907,419
91	34,927	34,110	7,158	15,494	11,428		5,359	18,523	12,278	725,786
92	48,439	46,043	9,745	24,153	13,759		6,420	12,383	14,210	1,005,853
93	3,236	3,134	583	1,485	906		11,010	16,423	5,762	738,245
94	10,650	10,292	2,420	5,763	2,961		3,307	10,033	837	1,526,863
95	3,557	3,308	793	2,031	889		9,349	23,381	2,749	708,903
96	39,272	36,860	8,472	18,879	10,724		2,220	10,809	5,501	1,982,031
97	70,125	69,162	14,680	39,261	20,495		2,470	16,800	6,649	1,493,634
98	7,255	6,796	1,359	4,212	299		14,506	24,144	1,412	880,145
99	112,317	107,006	26,314	55,331	26,449		22,211	43,402	20,456	933,777
100	65,456	62,256	14,353	30,676	17,256		1,791	11,541	6,627	959,045
101	78,679	73,428	15,888	41,695	16,180		9,050	18,819	16,660	1,029,657
102	65,891	62,256	13,845	30,929	18,087		3,704	17,297	24,599	910,450
103	61,858	59,826	14,568	29,988	14,791		3,859	21,050	18,243	989,719
104	71,354	67,143	15,324	30,330	21,937		3,835	13,813	25,336	738,195
105	136,146	123,649	27,007	60,423	33,382		5,272	19,748	20,030	550,110
106	283,756	262,878	54,592	119,571	75,328	56	14,965	61,423	62,305	494,004
107	144,375	133,579	30,558	67,399	37,606		7,828	30,846	26,147	532,407
108	183,750	166,956	38,000	75,571	56,252	135	13,409	43,788	32,130	710,656
109	Sumapaz					0	0	0	0	0
110	Cota					345	1,853	11,277	10,483	
111	Chía					297	18,974	51,667	28,055	
112	Funza					529	6,759	16,205	1,275	
113	Mosquera					284	10,949	13,073	8,131	
114	Sibaté					110	2,400	4,343	206	
115	Soacha					201	14,157	24,132	2,781	
116	Bojaca					51	82	243	135	
117	Cajica					0	1,310	3,696	58	
118	Facatativa					437	1,868	5,340	565	
119	Gachancipa					0	620	795	0	
120	La Calera					111	1,588	9,009	1,550	
121	Madrid					1,195	2,460	8,470	2,017	
122	Sopó					340	1,040	4,335	256	
123	Talibá					87	410	190	0	
124	Tenjo					219	144	1,303	242	
125	Tocancipá					76	1,995	1,944	131	
126	Zapaguirá					174	1,442	8,448	133	
127	Sabana Norte					26	566	4,828	428	
128	Rosneige					0	0	162	0	
129	Subachoque/La Vega					495	806	1,710	0	
130	Villota/Quindas					62	1,024	3,066	254	
131	Tequendama					400	3,130	5,460	323	
132	Eusaganga					0	304	390	0	
133	Cajagüta/Molina					497	1,452	6,766	306	
134	Fomeque					0	575	259	92	
135	Guasca/Gacheta					74	212	874	0	
total	8,646,163	8,093,524	1,830,039	4,067,898	2,505,100	8,100	908,799	3,492,600	2,515,800	1,172,768

## Appendix Table

## Socioeconomic Data in 2020 (continued)

## 11) GRDP (million \$)

	1995	2020	2020/1995
GRDP	32,152	79,177	2.463

## 12) Peoples to flow into Bogotá in 2020

341,600

[The page contains extremely faint and illegible text, likely bleed-through from the reverse side of the document. No specific content can be transcribed.]



ALCADIÁ MAYOR  
DE SANTA FE DE BOGOTÁ



SECRETARÍA DE TRANSITO Y TRANSPORTE

I - VI

HABITOS DE DESPLAZAMIENTO Y TRANSPORTE					
ZONA:					
SECTOR:					
SECCION:					
MANZANA:					
No. DE ENTREVISTA:					

DIRECCION Y BARRIO

ENTREVISTADO PRINCIPAL			TELEFONO:
FAMILIA (APELLIDOS):			
OBSERVACIONES:			
ENTREVISTADOR:	NUMERO:	FECHA:	FIRMA:
OBSERVACIONES:			
JEFE DE GRUPO:	NUMERO:	FECHA:	FIRMA:
OBSERVACIONES:			
SUPERVISOR:	NUMERO:	FECHA:	FIRMA:
OBSERVACIONES:			
COORDINADOR:	NUMERO:	FECHA:	FIRMA:
OBSERVACIONES:			

I					
No. FAMILIAS RESIDENTES		No. PERSONAS RESIDENTES		No. PERSONAS ENTREVIST.	
17	18	19	20	21	22

II	
ESTRATO SOCIO-ECONOMICO	
	CODIGO
1	23
2	
3	
4	
5	
6	
7	
8 NO CONTESTA	
9 NO SABE	

III						
INGRESOS FAMILIARES MENSUALES						
- En pesos -						
24	25	26	27	28	29	30
31						

IV		V		VI	
TIPO DE VEHICULOS DE USO FAMILIAR		PROPIEDAD DEL VEHICULO		LUGAR DE MATRICULA	
1. CARRO/AUTOMOVIL	32	1. PROPIO / PRIVADO	33	1. BOGOTA	34
2. VAN / PICK UP		2. DE EMPRESA O GOBIERNO		2. FUERA DE BOGOTA	
3. TAXI					
4. MOTO					
5. BICICLETA					
9. NINGUNO					









EL ESTUDIO SOBRE EL PLAN MAESTRO TRANSPORTE DE SANTA FE DE BOGOTA		CORDON LINE SURVEY ORIGIN AND DESTINATION INTERVIEW SURVEY		NO.												
a) ESTACION NO.		b) FECHA		c) HORA												
1. 2.		3. 4. 5. 6.		7. 8. 9. 10.												
d) SENTIDO		1. ENTRANDO		2. SALIENDO												
11.		11.		11.												
LOCALIZACION																
Nº	e) TIPO DE VEHICULO	1) NIVEL DE OCUPACION	g) DATO RESIDENCIA	h) ORIGEN	i) DESTINO	j) PROPOSITO DEL VIAJE	k) TIPO DE CARGA	l) PESO								
	1. AUTOMOVILES 2. TAXIS 3. CAMIONES 4. BUSES 5. BUSSETAS 6. COLECTIVOS 7. BUS INTERMUNICIP 8. COLECTIVO INTERN	NUMERO DE PASAJEROS INCLUSIVE EL CONDUCTOR	NOMBRE DE LA CIUDAD DONDE RESIDE DIRECCION COMPLETA SI ESTA DENTRO DE LA CIUDADO DE BOGOTA	ORIGEN DE ESTE VIAJE DIRECCION COMPLETA SI ESTA DENTRO DE LA CIUDADO DE BOGOTA	DESTINO DE ESTE VIAJE DIRECCION COMPLETA SI ESTA DENTRO DE LA CIUDADO DE BOGOTA	1. RESIDENCIA 2. TRABAJO 3. ESTUDIO 4. NEGOCIOS 5. RETORNO TRABAJO/OFICINA 6. COMPRAS 7. ASUNOS PERSONALES/OTRO	1. AGROPECUARIO PESQUERA 2. MADERA/PRODD MADERA 3. MINERALES 4. PROD. METAL/MAGUIPARRIA 5. MERCANCIAS 6. PRODUCTOS QUIMICOS 7. OTRO	EN TONELADAS								
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
ENCUESTADOR		SUPERVISOR		CODIFICADOR		REVISOR										

EL ESTUDIO SOBRE EL PLAN MAESTRO TRANSPORTE DE SANTA FE DE BOGOTA	CORDON LINE SURVEY TRAFFIC VOLUME COUNT SURVEY	NO.
--	---	-----

ESTACION	NO. FECHA	HORA	SENTIDO	LOCALIZACION																						
<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="width:50%; height: 20px;"> </td><td style="width:50%; height: 20px;"> </td></tr> <tr><td style="text-align: center;">1</td><td style="text-align: center;">2</td></tr> </table>			1	2	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td></tr> <tr><td style="text-align: center;">3</td><td style="text-align: center;">4</td><td style="text-align: center;">5</td><td style="text-align: center;">6</td></tr> </table>					3	4	5	6	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td></tr> <tr><td style="text-align: center;">7</td><td style="text-align: center;">8</td><td style="text-align: center;">9</td><td style="text-align: center;">10</td></tr> </table>					7	8	9	10	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="width:100%; height: 20px;"> </td></tr> <tr><td style="text-align: center;">11</td></tr> </table> 1. ENTRANDO 2. SALIENDO		11	
1	2																									
3	4	5	6																							
7	8	9	10																							
11																										

HORA	1) AUTO-MOVILE	2) TAXI	3) CAMIONES	4) BUS	5) BUSETAS	6) COLECTIVOS	7) BUS INTER-MUNICIPAL	8) COLECTIVO INTERMUNICIPAL
:15								
:30								
:45								
:00								
:15								
:30								
:45								
:00								
:15								
:30								
:45								
:00								
:15								
:30								
:45								
:00								
:15								
:30								
:45								
:00								
:15								
:30								
:45								
:00								

ENCUESTADOR	SUPERVISOR
-------------	------------


EL ESTUDIO SOBRE EL PLAN MAESTRO TRANSPORTE DE SANTA FE DE BOGOTA	OCUPACION DE VEHICULOS CORDON LINE SURVEY	NO.
--	--	-----

ESTACION	NO. FECHA	HORA	SENTIDO	LOCALIZACION																						
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 50%; height: 20px;"> </td><td style="width: 50%; height: 20px;"> </td></tr> <tr><td style="text-align: center;">1</td><td style="text-align: center;">2</td></tr> </table>			1	2	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 25%; height: 20px;"> </td><td style="width: 25%; height: 20px;"> </td><td style="width: 25%; height: 20px;"> </td><td style="width: 25%; height: 20px;"> </td></tr> <tr><td style="text-align: center;">3</td><td style="text-align: center;">4</td><td style="text-align: center;">5</td><td style="text-align: center;">6</td></tr> </table>					3	4	5	6	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 25%; height: 20px;"> </td><td style="width: 25%; height: 20px;"> </td><td style="width: 25%; height: 20px;"> </td><td style="width: 25%; height: 20px;"> </td></tr> <tr><td style="text-align: center;">7</td><td style="text-align: center;">8</td><td style="text-align: center;">9</td><td style="text-align: center;">10</td></tr> </table>					7	8	9	10	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="width: 100%; height: 20px;"> </td></tr> <tr><td style="text-align: center;">11</td></tr> </table> 1. ENTRANDO 2. SALIENDO		11	
1	2																									
3	4	5	6																							
7	8	9	10																							
11																										

NO	AUTOMOVILE	TAXI	CAMIONES	NO	AUTOMOVILE	TAXI	CAMIONES
1				26			
2				27			
3				28			
4				29			
5				30			
6				31			
7				32			
8				33			
9				34			
10				35			
11				36			
12				37			
13				38			
14				39			
15				40			
16				41			
17				42			
18				43			
19				44			
20				45			
21				46			
22				47			
23				48			
24				49			
25				50			

EMCUESTADOR	SUPERVISOR
-------------	------------

EL ESTUDIO SOBRE EL PLAN MAESTRO TRANSPORTE DE SANTA FE DE BOGOTA	CONTEO DE VEHICULOS SOBRE INTERSECCION	NO.
--	---	-----

ESTACION	FECHA	HORA	SENTIDO	LOCALIZACION																						
<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="width:50%; height: 20px;"> </td><td style="width:50%; height: 20px;"> </td></tr> <tr><td style="text-align:center;">1</td><td style="text-align:center;">2</td></tr> </table>			1	2	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td></tr> <tr><td style="text-align:center;">3</td><td style="text-align:center;">4</td><td style="text-align:center;">5</td><td style="text-align:center;">6</td></tr> </table>					3	4	5	6	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td><td style="width:25%; height: 20px;"> </td></tr> <tr><td style="text-align:center;">7</td><td style="text-align:center;">8</td><td style="text-align:center;">9</td><td style="text-align:center;">10</td></tr> </table>					7	8	9	10	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><td style="width:100%; height: 20px;"> </td></tr> <tr><td style="text-align:center;">11</td></tr> </table>		11	
1	2																									
3	4	5	6																							
7	8	9	10																							
11																										

HORA	IZQUIERDA			RECTO			DERECHA		
	AUTO-MOVILES	BUSES	CAMIONES	AUTO-MOVILES	BUSES	CAMIONES	AUTO-MOVILES	BUSES	CAMIONES
:15									
:30									
:45									
:00									
:15									
:30									
:45									
:00									
:15									
:30									
:45									
:00									
:15									
:30									
:45									
:00									
:15									
:30									
:45									
:00									
:15									
:30									
:45									
:00									
:15									
:30									
:45									
:00									

ENCUESTADOR	SUPERVISOR
-------------	------------









JICA

LIE