INTERIM REPORT (Volume II)
FUTURE TRANSPORTATION DEMAND FORECAST AND PLAN FORMULATION

DAVAO CITY URBAN TRANSPORT CUM LAND USE STUDY

(March, 1981)

REPUBLIC OF THE PHILIPPINES
MINISTRY OF PUBLIC HIGHWAYS

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INTERIM REPORT (Volume II)

FUTURE TRANSPORTATION DEMAND FORECAST
AND
PLAN FORMULATION

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I. SOCIO-ECONOMIC FRAMEWORK AND LAND USE PLAN

CHAPTER 1

SOCIO-ECONOMIC FRAMEWORK

1.1 NATIONAL AND REGIONAL FRAMEWORK

Population, Gross Domestic Products (GDP), and other major socio-economic indicators have been forecast for the entire Philippines and for Region XI as presented in Tables 1.1 and 1.2, based on the following materials, as updated using the information contained in the 1979 Philippine Statistical Yearbook:

1) Long-Term Philippine Development Plan up to the Year 2000 (hereinafter referred to as "Long-Term Plan 2000")
2) Southern Mindanao 5-Year Development Plan, 1978-1982

The forecast shown in Tables 1.1 and 1.2 in terms of constant prices can be converted into current prices by applying the inflation factor stipulated for each indicator. For instance, such factors for GNP and GDP for 1975 were 1.667 and 1.676, respectively, and average per capita GNP and GDP in current prices in 1975 are calculated to have been ₱2,716 and ₱2,724, respectively, for the entire Philippines. Likewise, average per capita GDP for Region XI was ₱2,854 in 1975 in current prices.

For Region XI, a growth rate comparable to average in the past 7 years has been assumed for the future of the primary industry, while, for the secondary and tertiary industry, substantially higher growth rate is expected than in the past. Particularly, planned growth rate of the secondary industry is a high 13.9% per annum in the assumption of concentrated investments in the industrial sector. Average per capita GDP growth rate is to jump from the 1.3% per annum of the past 7 years to 5.5% in the future under the plan.

NOTE: All data presented in the tables and figures in this Report for which source is not indicated have been either estimated or compiled by the DCUICLUS Team.

TABLE 1.1 BASIC FRAMEWORK FOR NATIONAL ECONOMY

	ACTUAL		OR ESTIMATE					Average Annual Growth Rate	PROJECTION					Average Annual Growth Rate
	72	73	74	75	76	77	78	79	72 - 79	80	85	90	95	00	80 - 00
POPULATION 1/ (Thousands as of July 1)	38,751	39,827	40,934	42,071	43,398	44,766	46,178	47,635	3.0%	49,137	56,742	65,041	73,867	83,444	2.7%
GROSS NATIONAL PRODUCT 2/ (Million pesos at 1972 prices)	55,526	60,881	64,739	68,530	73,341	77,958	82,477	92,201	7.5%	96,206	143,333	213,546	318,152	474,001	8.3%
PER CAPITA GNP (pesos at 1972 prices)	1,433	1,529	1,582	1,629	1,690	1,741	1,786	1,936	4.4%	1,958	2,526	3,283	4,307	5,680	5.5%
GROSS DOMESTIC PRODUCT 2/ (million pesos at 1972 prices)	56,075	60,931	64,139	68,361	73,585	78,161	82,681	92,902	7.5%	96,937	144,422	215,168	320,570	477,605	8.3%
PER CAPITA GDP (pesos at 1972 prices)	1,447	1,530	1,567	1,625	1,696	1,746	1,790	1,950	4.4%	1,973	2,545	3,308	4,340	5,724	5.5%
NATIONAL INCOME 2/ (million pesos at 1972 prices)	45,791	49,864	52,263	55,063	59,458	63,280	66,129	75,659	7.4%	79,055	118,803	178,536	268,303	403,203	8.5%
PER CAPITA INCOME (pesos at 1972 prices)	1,182	1,252	1,277	1,309	1,370	1,414	1,432	1,588	4.3%	1,609	2,094	2,745	3,632	4,832	5.7%

SOURCE: 1/ 1975 NCSO, Projection by NEDA and other years estimated by exponential interpolation.

2/ 1972 - 1978 NEDA, 1979 Central Bank and projection made based on Long-Term Philippine Development Plan

TABLE 1.2 BASIC FRAMEWORK FOR REGIONAL ECONOMY

ITEMS	ACTUAL OR ESTIMATE								Average Annual Growth Rate 72 - 79	PROJECTION					Average Annual Growth Rate 80-00
	72	73	74	75	76	77	78	79		80	'85	90	95	00	
POPULATION 1/ (thousands as of July 1)	2,394	2,496	2,603	2,715	2,879	3,033	3,237	3,393	5.1%	3,556	4,344	5,158	6,126	7,274	3.6%
GROSS REGIONAL DOMESTIC PRODUCT 2/ (million pesos at 1972 prices	4,182	4,454	4,363	4,623	4,937	5,286	6,021	6,497	6.5%	7,059	10,816	17,004	26,733	42,029	9.3%
GRDP BY SECTOR 2/ (million pesos at 1972 prices															
Agriculture, Forestry & Fishery	1,934	2,060	1,981	2,119	2,265	2,422	2,806	2,960	6.3%	3,142	4,175	5,917	8,287	11,264	6.3%
Industry	690	735	767	789	842	907	1,024	1,166	7.8%	1,320	2,736	5,237	9,758	17,904	13.9%
Manufacturing	587	625	617	625	664	712	777	881	6.0%	1,003	2,001	3,724	6,844	12,399	13.4%
Mining & Quarrying	2	2	4	5	6	5	8	9	24.0%	11	22	51	80	126	13.0%
Construction	92	98	134	146	160	175	223	253	15.5%	282	660	1,326	2,566	4,875	15.3%
Electricity, Gas & Water	9	10	12	12	13	14	18	19	11.3%	21	54	136	267	504	17.2%
Service	1,557	1,658	1,615	1,716	1,829	1,957	2,192	2,371	6.2%	2,598	3,905	5,849	8,688	12,861	8.3%
Transport, Communication & Storage	92	98	99	107	116	126	175	220	13.3%	261	454	782	1,283	2,186	11.2%
Commerce	1,199	1,277	1,230	1,305	1,389	1,481	1,535	1,632	4.5%	1,744	2,542	3,673	5,266	7,439	7.5%
Other Services	266	283	286	304	325	350	482	499	9.4%	593	909	1,394	2,139	3,286	8.9%

Note: Totals may not sum due to rounding.

Source: 1/ Estimated based on 1970 and 1975 Census data, Long-Term Philippine Development Plan and Southern Mindanao 5- Year Development Plan

2/ Estimated based on Long-Term Philippine Development Plan and Southern Mindanao 5- Year Development Plan

1.2 SOCIO-ECONOMIC FRAMEWORK FOR DAVAO CITY

1.2.1 Demographic Framework

1) Population Prediction for the Year 2000

The population of Davao City in the year 2000, as estimated by a number of government agencies, ranges from about 1.3 million to 1.4 million. Due, however, to the recent topping out of population increase rate in Davao City, NEDA has effected a downward adjustment in the future population and estimates 1990 population at about 780,000. On the same trend (after this downward adjustment), the City's population in the year 2000 will be just under 1.0 million, a substantial reduction from the previous estimates.

It is believed, however, that this recent projection by NEDA is quite conservative because it was made based on the data for the 1970s, when economic activities were stagnant in Davao due to the oil crisis and other reasons and, moreover, did not taken into consideration any population increase due to various large scale development projects which are in plan for the future of the City.

For this reason, the year 2000 population of 1.3 million (although it deviates from the past trend) is adopted as policy target for this Report, assuming substantial social increases of population as a consequence of various development projects. The City authority of Davao also uses the year 2000 population of 1.3 million for all of its future plans and programs.

Table 1.3 Population Projection

	1975	2000	Average Annual Growth Rate (%)
Davao City Population (000)	485	1,300	4.0

The population increase rate estimated for Davao City for the period of 1975 to the year 2000 which is somewhat higher than such rates estimated for the Philippines and for Region XI, is believed reasonable in view that Davao will be positioned as the cultural, administrative, and economic center for not only Region XI but also the entire Mindanao.

2) Population Distribution

The Study Area (which is Davao City) is divided into the Project Area and Non-Project Area for the purpose of population estimates here. The City population increased by an increment of 167,527 from 1970 to 1979, under the contribution of natural increase of 114,054 (68.1%) and social increase of 53,473 (31.9%). This increment is divided between the Project Area and Non-Project Area as presented in Table 1.4.

Table 1.4 Population Increase, Davao City, 1970-1979

	Project Area	Non-Project Area	Davao City
1970 Population	264,242	128,231	392,473
1979 Population	371,740	188,260	560,000
Total Increase	107,498	60,029	167,527
Natural	76,790	37,264	114,054
Social	30,708	22,765	53,473

Now, for the purpose of estimating population increases in the Project Area and Non-Project Area from 1979 to the year 2000, natural increases during this period is estimated at 273,260 for the Project Area and 138,740 for Non-Project Area at the average annual natural increase rate of about 2.6% based on such rate of NEDA.

Social increases have been predicted as follows in the absence of data to support estimates:

i) Population inflow into Davao City due to the implementation of various development projects (social increase) will be absorbed into the Project Area, where majority of such projects will be sited.

ii) In this view, social increase in Non-Project Area, where relatively few such projects will be implemented, is estimated for the period of 1979 to the year 2000 at the same rate as in the period of 1970 to 1979. Then, social increase thus estimated for Non-Project Area is deducted from the social increase for the entire Davao City in arriving at social increase for the Project Area.

iii) This calculation so far can result in an underestimation of social population increase in Non-Project Area, in view of some development projects to be implemented in this area such as Calinan, and, therefore, the above estimated social increase is adjusted to some degree in consideration of such development projects.

Thus, social increase in Non-Project Area from 1979 to the year 2000 is estimated at 73,000 as the total of 53,000 calculated at the same rate as in 1970 to 1979 and an additional 20,000 as developmental increase.

Social increase in the Project Area from 1979 to 2000 is estimated at 255,000, which is about 3.5 times that in Non-Project Area, a ratio which is believed reasonable in view of the differences in the present level of economic activities and future land use intensity between the Project Area and Non-Project Area.

Table 1.5 Population Increase, Davao City, 1979~2000

	Project Area	Non-Project Area	Davao City
1979 Population	371,740	188,260	560,000
2000 Population	900,000	400,000	1,300,000
Total Increase	528,260	211,740	740,000
Natural	273,260	138,740	412,000
Social	255,000	73,000	328,000

3) 1990 Population

Average population increase rate estimated for the period of 1979 to 2000 is used in predicting population for 1990. Table below presents population in 1979, 1990, and 2000.

Table 1.6 Population, Davao City, 1979, 1990 & 2000

	Project Area	Non-Project Area	Davao City
1979	371,740	188,260	560,000
1990	590,000	280,000	870,000
2000	900,000	400,000	1,300,000

1.2.2 Economic Framework

1) Employment

(1) Project Area

The labor force is expected to swell by the year 2000 as a result of changes in population age structure and the increase of working females, and the total employment in Davao City to nearly triple in the twenty years and reach 468,000, if the same employment to population ratio, 36%,/1 can be assumed for the City as in Region XI.

Table 1.7 Employment, Davao City, 1979, 1990 & 2000

	Project Area		Non-Project Area		Davao City	
	Population	Employment	Population	Employment	Population	Employment
1979	371,740	115,000	188,260	67,000	560,000	182,000
1990 1/	590,000	198,000	280,000	100,000	870,000	298,000
2000	900,000	324,000	400,000	144,000	1,300,000	468,000

Note : 1/ Estimated by interpolation

/1 The ratio is assumed in Long-Term Plan 2000.

The current share of the secondary industry in the total number of workers is not much higher than the national average (of 15% in 1975) and, in view of the future land use concept, should be much enlarged in the future.

The share of the tertiary industry in the total number of workers, which is already high at 60% in 1979, will rise further, in view that the average rate of growth in the gross products of the tertiary industry in Region XI as a whole is estimated at a high 8.3% for the period of 1980 to the year 2000 (see Table 1.2).

In view of the above, it is estimated that the secondary and tertiary industry will represent 27% and 70%, respectively (3% being that of the primary industry), of the total number of workers in the Project Area in the year 2000. Thus, the number of workers in these two industrial sectors of the Project Area is estimated at 88,000 and 227,000, respectively, for that year.

The sectoral shares of total workers and the number of workers per 1,000 population in the Project Area are shown for 1979 and 2000 in the following table.

Table 1.8 Sectoral in Employment and No. of Employment per 1,000 Population, Project Area, 1979 and 2000

Sector	Sectoral Share (%)		No. of Employment/1000 Population	
	1979	2000	1979	2000
Primary	21	3	65	10
Secondary	19	27	59	98
Tertiary	60	70	186	252
Total	100	100	310	360

(2) Non-Project Area

At present, the non-project area is mostly characterized as a rural area except Calinan. Although several urban development projects are to be implemented here in the future, the non-project area will basically remain as the rural area.

2) Employment by Sector

(1) Project Area

a) Primary Industry

Primary industry workers in the Project Area are classified into agricultural workers and fishery workers.

It is accepted that agricultural area will shrink in the future as downtown areas will be expanded, and the number of agricultural workers will decrease substantially. The Land Use Concept for the Year 2000 plans to retain approximately 6,000 hectares of land for agricultural purposes, which will accommodate 6,000 agricultural workers at the rate of one hectare of cultivated land per farmer. This average size of cultivated land per farmer is believed reasonable because, in the Project Area, where only few large plantations exist, average size of farm should be smaller than the average for the entire Davao City of 1.5 hectares per farmer, and also because decrease in the number of farmers will be slower than reduction in agricultural land. The number of agricultural workers is predicted to drop from the estimated 20,000 in 1979 to 6,000 by the year 2000.

Fishery workers, estimated for the Project Area at 4,000 in 1979, is predicted to decline to 3,000 by the year 2,000 due to the encroachment of fishing grounds also by industrial and commercial development.

Therefore, the number of primary industry workers in the Project Area is estimated for the year 2000 at 9,000, which is three-eight of the number in 1979.

b) Secondary and Tertiary Industries

As of 1979, the secondary and tertiary industries represented 19% and 60% respectively, of the total number of workers.

It is desirable that industry and commerce will be developed in a well balanced manner in Davao City, which is positioned as cultural, administrative, and economic center of Mindanao.

(2) Non-Project Area

We assume the composition of employment by industry in the non-project area as follows, referring to those of rural Non-Project Area./1

Primary industry	70%	- 101,000
Secondary industry	10%	- 14,000
Tertiary industry	20%	- 29,000

(3) Summary

Table 1.9 Employment by Sector, Davao City, 1979, 1990 & 2000

	Project Area			Non-Project Area			Davao City		
	1979	1990 1/	2000	1979	1990 1/	2000	1979	1990	2000
Primary	24,000	18,000	9,000	51,000	73,000	101,000	75,000	91,000	110,000
Secondary	22,000	48,000	88,000	5,000	9,000	14,000	27,000	57,000	102,000
Tertiary	69,000	132,000	227,000	11,000	18,000	29,000	80,000	150,000	256,000
Total	115,000	198,000	324,000	67,000	100,000	144,000	182,000	298,000	468,000

Note : 1/ Estimated by interpolation.

/1 Composition of employment by industry in the rural area, 1975

(percent)

	Primary	Secondary	Tertiary
Davao del Sur	76	7	17
Cebu	74	10	15
Isabela	80	6	14
Leyte	81	6	13
Davao del Norte	89	3	8

SOURCE: 1975 Census

3) Gross Products of Davao City

(1) Productivity

No data is available on the present level of the labor productivity of Davao City, not to speak of a future level, and, therefore, must be estimated. The national average of sectoral labor productivity is estimated as presented in Table 1.10.

Table 1.10 Labour Productivity by Sector, Philippines, 1975 & 2000

(pesos/year/employemnt at 1972 prices)

	1975[1/]	2000[2/]	Average Annual Growth Rate (%)
Primary	2,700	7,200	4.0
Secondary	12,400	30,300	3.6
Tertiary	7,100	11,600	2.0
Total	5,500	14,800	4.0

Source: 1/ Estimated based on 1979 Philippine Statistical Yearbook

2/ Estimated based on Long-Term Plan 2000

It is expected that labor productivity in Davao City, which is the center of not only Region XI but also of the entire Mindanao, is believed to be substantially higher than averages for Region XI and entire Mindanao. For this reason, a reasonable ratio of labor productivity of Davao to the national average was saught for through the comparison of average per capita regional gross products as shown in Table 1.11, which, incidentally, reflects the gradual elimination of regional gaps in the Philippines as designed by the Long-Term Plan 2000.

Table 1.11 Comparison of Per Capita GDP

		Philippines	Luzon	Metro Manila	Mindanao	Region XI
1975[1/]	Per capita GDP (pesos at 1972 prices)	1,625	1,936	4,577	1,158	1,703
	Indicator (national ave. = 100)	100	119	282	71	105
	Population (000)	42,071	22,790	4,790	9,147	2,715
2000[2/]	Per capita GDP (pesos at 1972 prices)	5,724	6,354	9,000	4,698	5,778
	Indicator (national ave.=100)	100	111	157	82	101
	Population (000)	83,444	44,485	11,905	23,480	7,274

Source: 1/ Estimated mainly based on 1979 Philippine Statistical Yearbook

2/ Estimated based on Long-Term Plan 2000

Assuming that the position of Davao City in Mindanao is comparable to that of Metro Manila in the Philippines, average per capita gross products in Davao can be calculated as 2.0 times the average GDP in 1975 and 1.3 times in the year 2000. Further assuming no sectoral variation in these ratios, labor productivity in Davao City can be estimated as presented in Table 1.12.

Table 1.12 Labour Productivity by Sector, Davao City, 1975, 1979 & 2000

(pesos/year/employment at 1972 prices)

	1975	1979[1/]	2000	Average Annual Growth Rate (%)
Primary	5,400	5,900	9,400	2.2
Secondary	24,800	26,700	39,400	1.9
Tertiary	14,200	14,300	15,100	0.2
Average	11,000	12,000	19,200	2.3

Note: 1/ Estimated by interpolation

(2) Gross Products

Multiplication of sectoral labor productivity by the number of workers in each industrial sector gives sectoral distribution of gross product, as presented in Table 1.13.

Table 1.13 GDP by Sector, Davao City, 1979, 1990 &2000

(million pesos at 1972 prices)

Sector	Project Area			NonProject Area			Davao City		
	1979	1990	2000	1979	1990	2000	1979	1990	2000
Primary	142	109	85	301	549	949	443	690	1,034
Secondary	587	1,488	3,467	134	281	552	721	1,773	4,019
Tertiary	987	1,895	3,428	157	269	438	1,144	2,165	3,866
Total GDP	1,762	3,492	6,980	592	1,099	1,939	2,308	4,628	8,919
Per Capita GDP (pesos at 1972 prices)	4,616	5,919	7,756	3,145	3,925	4,848	4,121	5,320	6,861

Note: 1/ Estimated by interpolation

CHAPTER 2

DEVELOPMENT PATTERN OF THE PROJECT AREA

2.1 Comparison of three Alternatives

There are three alternatives for the future urban development of the Project Area, prepared mainly from the view of population concentration. Those are:

Type A One Center Development Pattern
Type B Ribbon-Type Development Pattern
Type C Multi-Center Development Pattern

which are shown in the next page.

Among these three patterns, Type A could be easiest to realize because the population increase in the past had been concentrated to the Poblacion and its adjacent areas, and this trend would be continued without any strong policy measures.

If the most people of 900,000 population concentrates to one part of the Project Area, various public nuisance will be inevitable because of the over-congestion, especially in the field of transportation.

From this point of view, decentralization of population distribution and economic activities might be preferable such as Type B or Type C pattern.

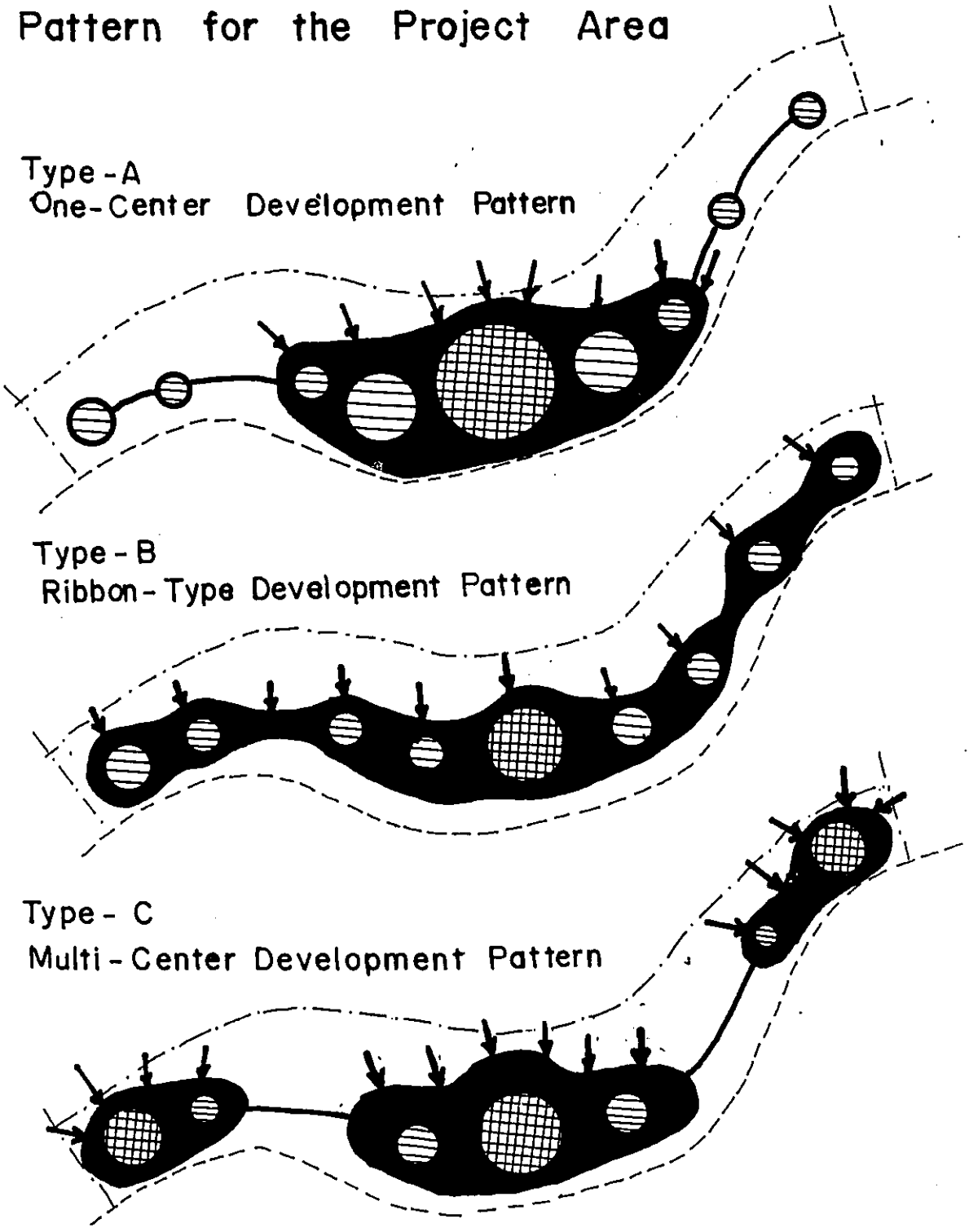
The basic idea of Type B is uniform development all over the Project Area, where no big urban centers have been developed yet except the poblacion.

In such areas, it is discouraged to scatter the development resources widely because it may decrease the investment efficiency.

By this reason, Type C is to be recommended. For the first step, several development centers should be developed in order to lessen the pressure of population concentration to the Poblacion area. This pattern may be transformed into Type B in the future beyond 2000.

FIG. 1.1

Alternatives of Urban Development Pattern for the Project Area



2.2 Introduction of Block System

Considering that great change will arise in the future Project Area concerning to land use and urbanization, the current zoning by administrative boundaries may not necessarily be suitable for planning work, although it has been used in the person trip survey. As for Toril district, for example, its socio-economic influence will become to go beyond the present administrative boundary as the Toril urban area expands. Thus new zoning system should be required for the planning stage. Each new zone must be characterized as an area in which most of social and economic daily activities could be completed, in other words, each zone must be independent of other zones to some extent.

Based on the results of various analysis, the Project Area should be divided into four zones (hereinafter called "Blocks"), which is shown in the following figure.

Block I	:	Lasang, Bunawan, Mahayag, Tibungco, San Isidro, Gatungan, Acasia (3,932 ha)
Block II	:	Ilang, Panacan, Sasa, Mudiang, Indangan, Communal (2,950 ha.)
Block III	:	Poblacion district, Pampanga, Buhangin, Agdao, Cabantian, Tigatto, Ma-a,Bucana, Matina Pangi, Matina Crossing, Matina Aplaya, Talomo, Magtuod, Langub, Catalunan Grande, Catalunan Pequeno (8,386 ha.)
Block IV	:	Bago Gallera, Dumoy, Baliok, Bago Oshiro, Bankas Heights, Lubogan, Crossing Bayabas, Toril, Daliao, Sirawan, Fagel Lizada, Bato, Marapangi (3,542 ha.)

Total Area 18,810 ha.

The following factors are taken into account in order to formulate this Block division.

a) Present population distribution (Fig. 1.2)
b) O-D pattern of shopping activities (Fig. 1.3)
c) O-D pattern of trips attending school. (Fig. 1.4)
d) Current land-use pattern
e) Image for the future land-use and development projects

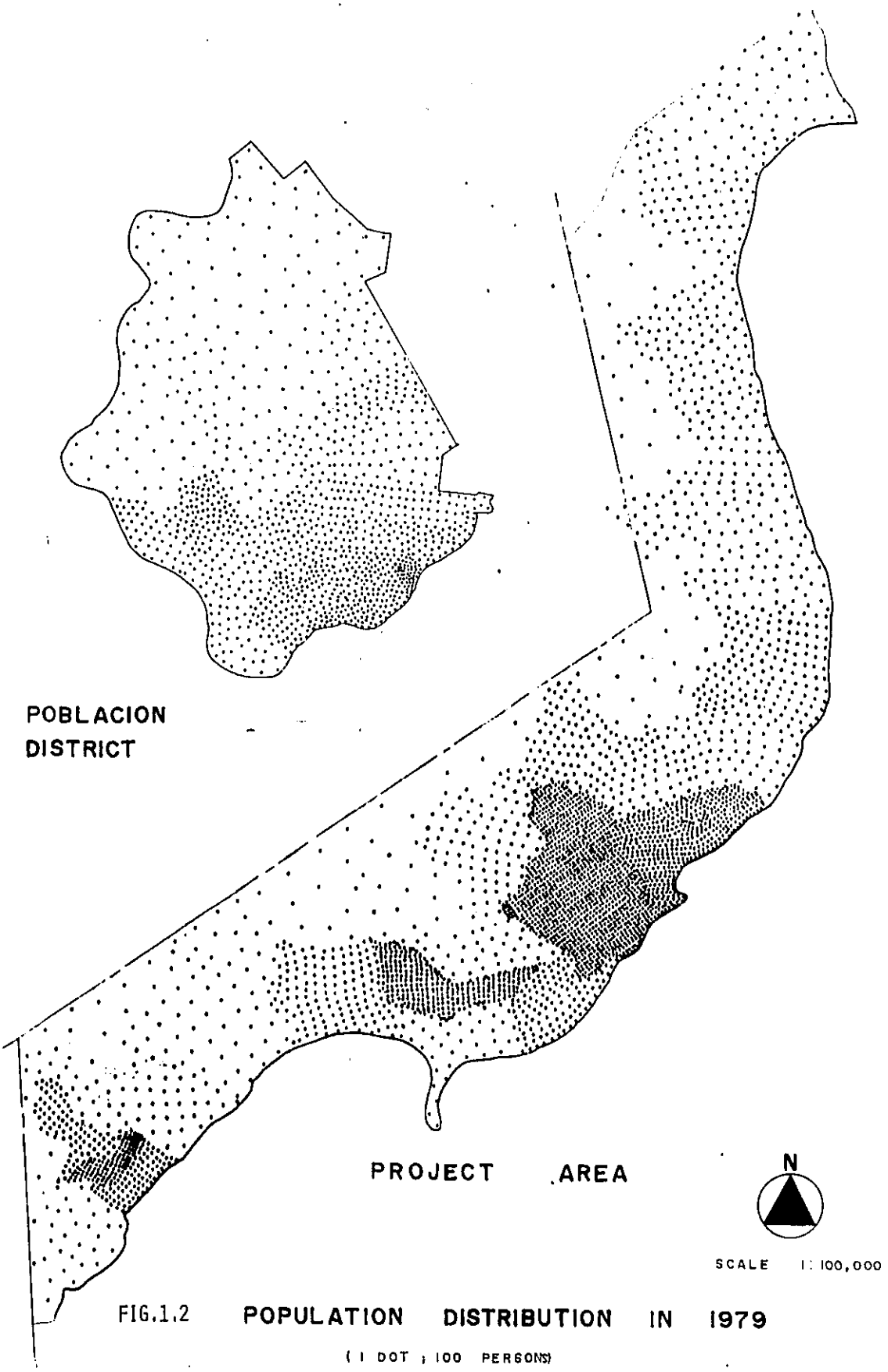


FIG.1.2 POPULATION DISTRIBUTION IN 1979

(1 DOT : 100 PERSONS)

THE RESULT OF PT SURVEY IN 1979

Origin	Destination
Lasang	Lasang (66.7), Poblacion (33.3)
Bunawan	Lasang (47.6),Poblacion (27.5) Bunawan (26.7)
Mahayag	Panakan (100.0)
Tibungco	Tibungco (68.2),Poblacion (27.4)Panakan (2.1)
Ilang	Panakan (52.2), Tibungco (28.9) Poblacion(18.9
Panacan	Panakan (62.0), Poblacion (38.0)
Sasa	Poblacion (67.4),Panakan (19.2) Sasa (11.5)
Pampanga	Poblacion (65.2),Agdao (17.0),Panakan (16.7)
Buhangin	Poblacion (69.2), Agdao (19.4)
Agdao	Agdao (63.8), Poblacion (36?2)
Ma-a	Poblacion (98.8)
Matina Pangi	Poblacion (70.9), Matina Crossing (15.2)
Bucana	Poblacion (96.6)
Matina Crossing	Poblacion (93.0), Matina Crossing (3.7)
Matina Aplaya	Poblacion (93.8), Toril (6.2)
Talomo	Poblacion (68.4), Toril (19.4),Talomo (12.2)
Bago Gallera	Toril (89.3), Poblacion (10.7)
Baliok	Toril (62.6), Poblacion (37.4)
Dumoy	Toril (72.6), Poblacion (27.4)
Crossing Bayabas	Toril (50.8), Poblacion (37.2)
Daliao	Toril(89.4), Poblacion (10.6)
Lizada	Toril (74.5), Lizada (25.5)

FIGURES IN PARENTHESIS SHOW SHARE.

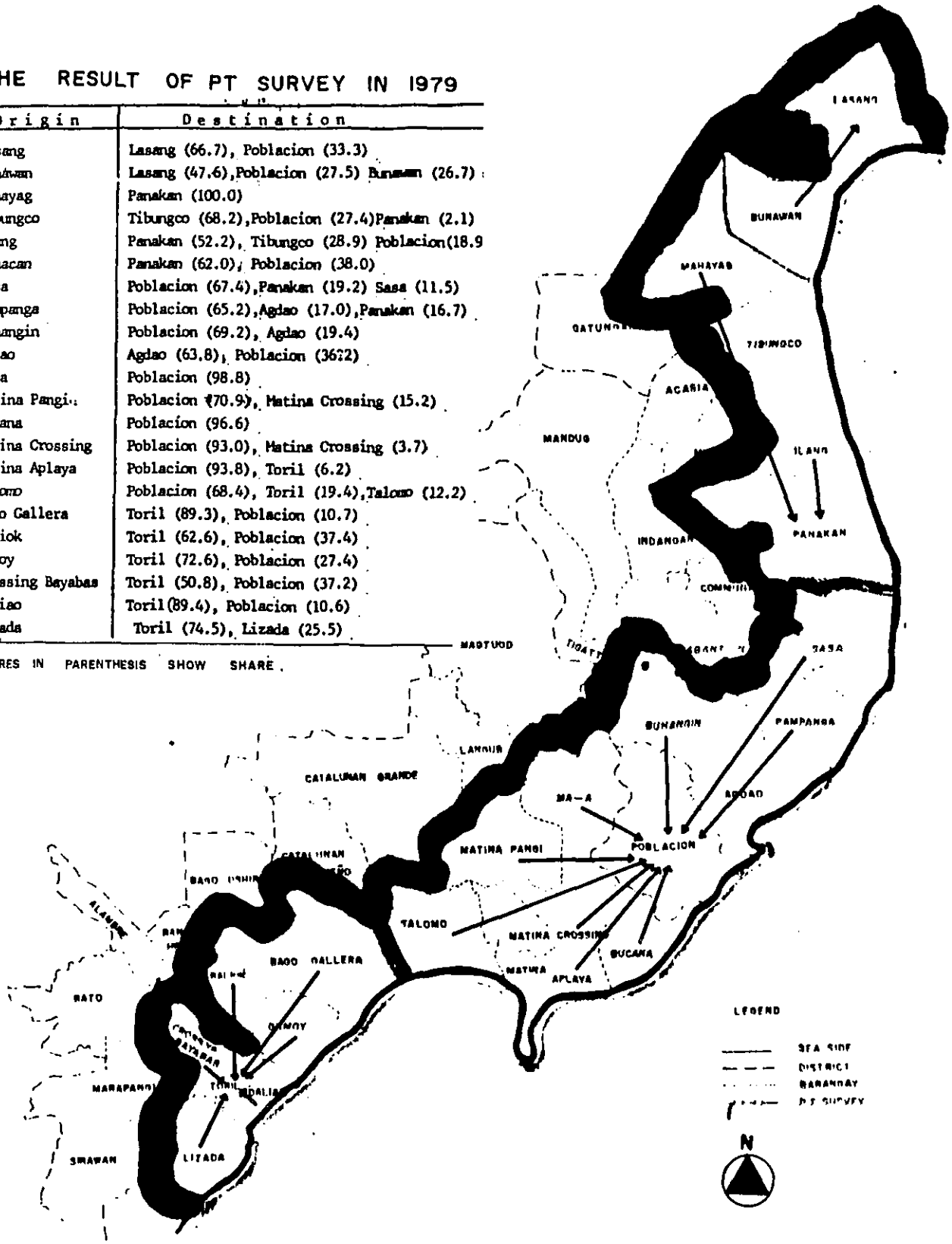


FIG. 1.3 ORIGIN - DESTINATION PATTERN OF SHOPPING ACTIVITY

0 5,000 10,000

SCALE 1 : 100,000

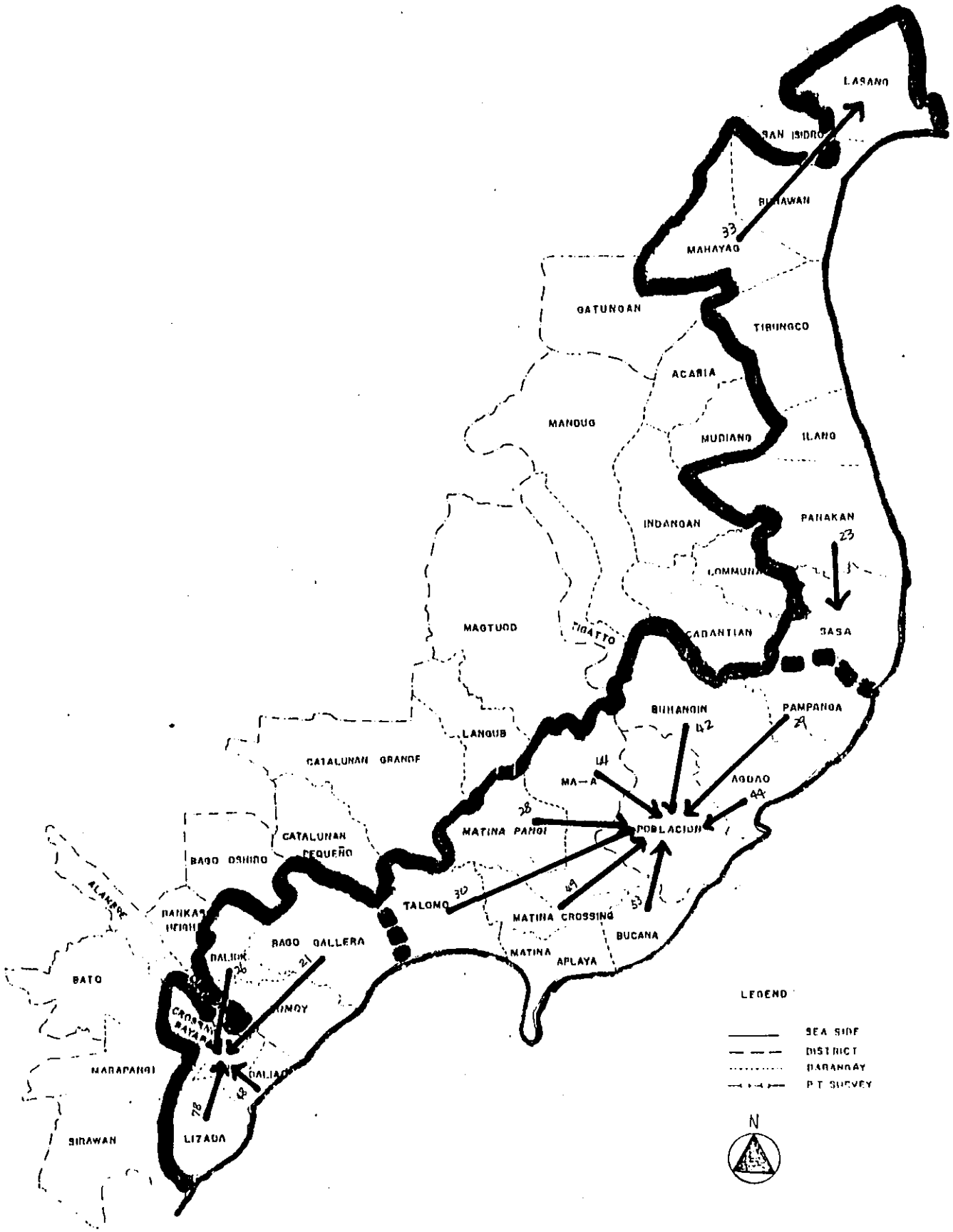


FIG1.4 ORIGIN-DESTINATION PATTERN OF TRIPS ATTENDING SCHOOL

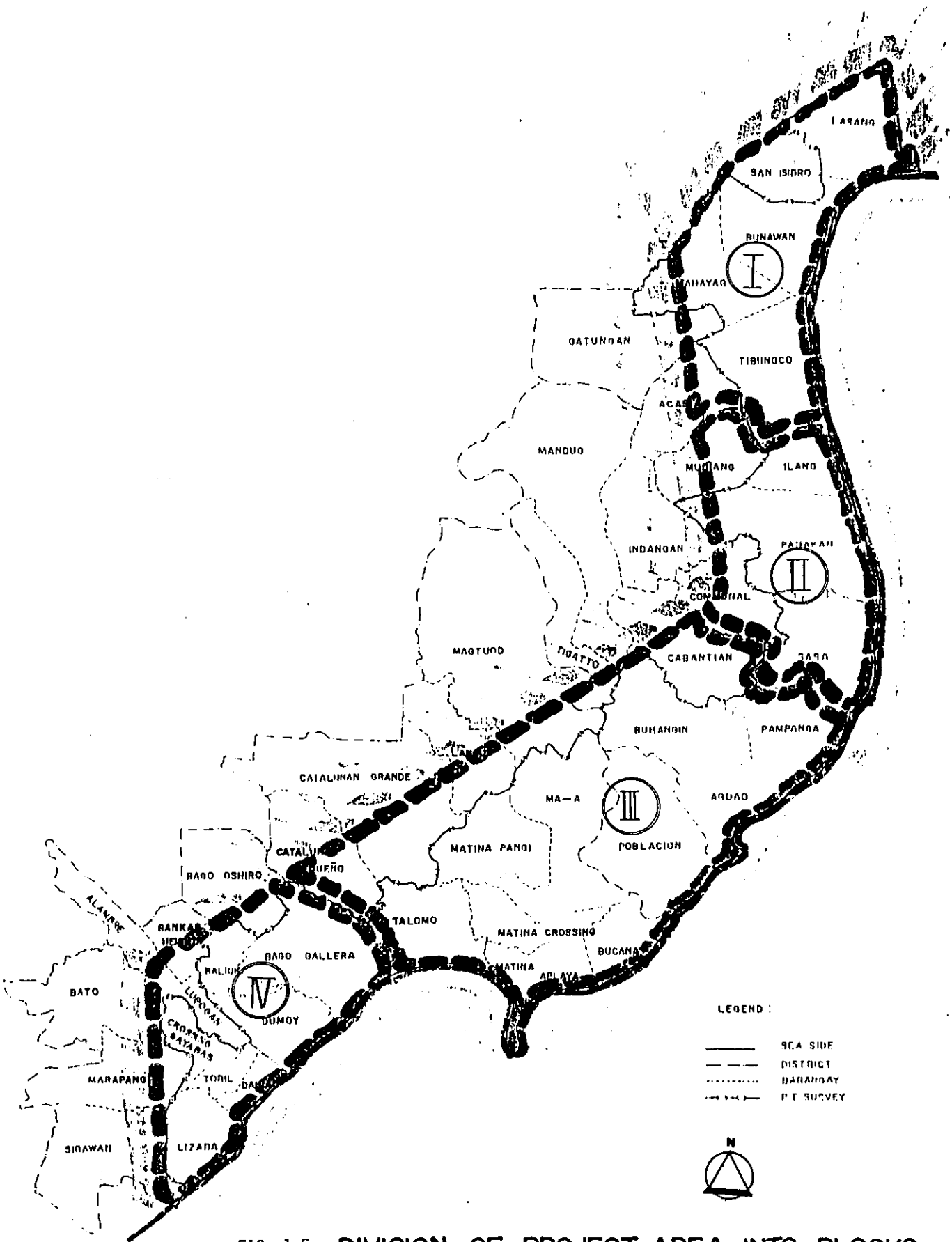
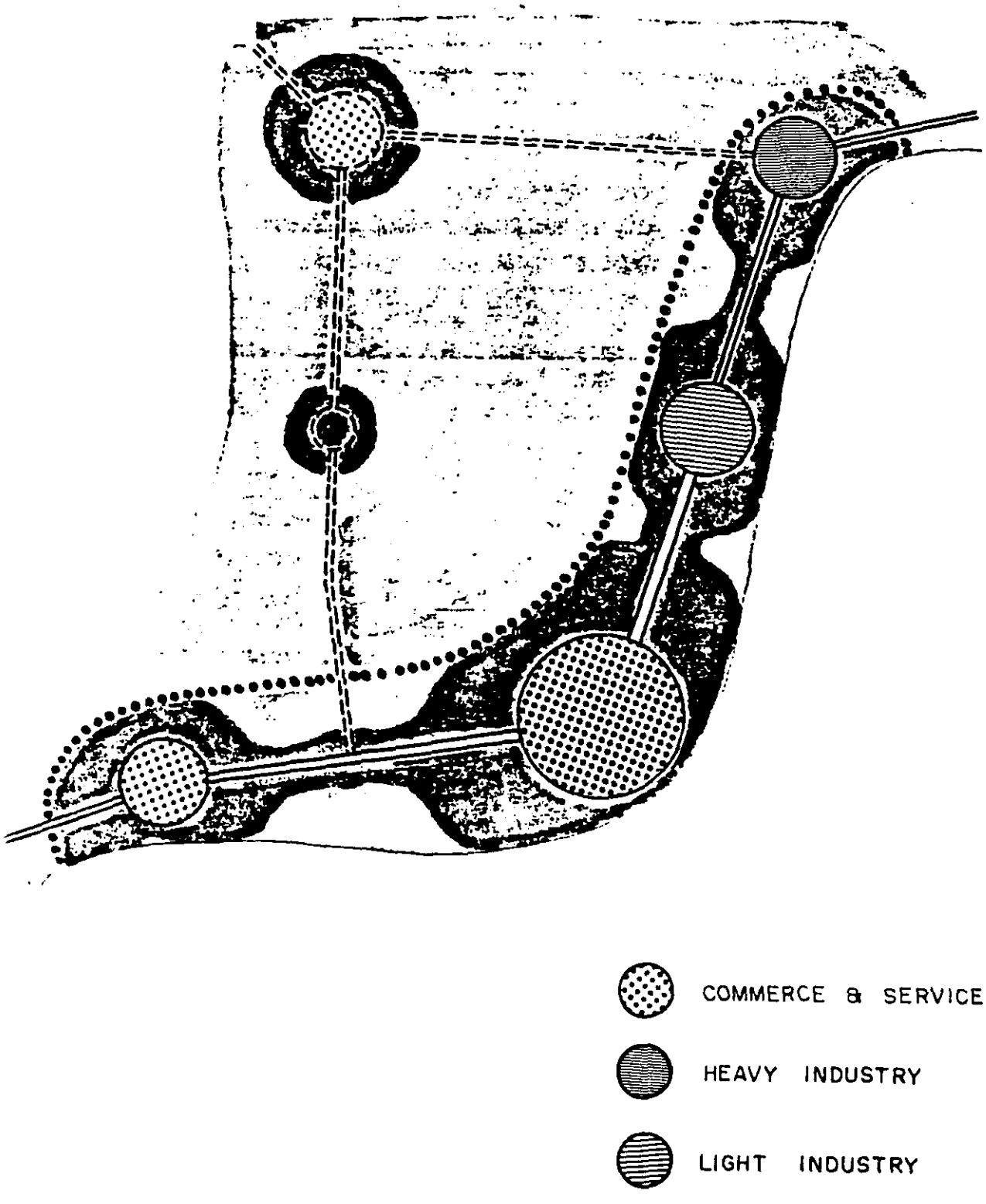


FIG. 1.5 **DIVISION OF PROJECT AREA INTO BLOCKS**

FIG. 1.6 DEVELOPMENT PATTERN



CHAPTER 3

LAND USE

3.1 Basic Idea

Davao City is the largest city in Mindanao Island, and is expected to be one of the biggest growth center in this country. From this point of view, the Project Area must be the regional center of all fields such as production, distribution, administration, culture, education, and so on. In order to realize this end, it is essential that all these fields of activity be arranged in a well-balanced manner. In this way, this area can become an attractive city, safe, orderly, and complete with all amenities. The Project Area extends long and narrow from North to South for 40 kilometers and the western part of this area is lined by long stretches of hills. Thus, the possible place for urbanization is limited to a zone 1 to 2 kilometers wide, running along the stretch of the seashore.

Herewith, we would like to suggest the formation of a multi-center development pattern so as to avoid as much as possible the problems of overcrowding, traffic, and industrial pollution caused by the process of urbanization.

3.2 Land Use Plan

i) Residential District

By the year 2000, twice as much residential areas will be required as in the present.

The ideal distribution of residential areas is for them to surround the centers of blocks such as Commercial District or Industrial District and at this point we must be flexible, taking into consideration various aspects such as convenience, amenities and environmental condition, so that we can divide the planned residential zones into two parts: the low-density area (65 or 100 persons/ha) and the high-density area (200 persons/ha.)

ii) Commercial District

Poblacion will still be the biggest commercial center of the Project Area in the future. We have designed to establish the Central Business District (C.B.D.) in the Poblacion. The one area especially along

Roxas Blvd. and the southern portion of Ecoland will be formed as commercial districts and business districts which will have closely-related functions to the Poblacion. In the other centers of each block too, depending on its capacity, a commercial center will be established.

iii) Industrial District

New industrial zones/districts will be developed, covering an area of 400 hectares. Most of the new Industrial Zones will be planned as an integrated industrial estate system in principle so that they will not affect the environment and save the investment for infrastructure development for its industrialization. Each industrial district will be located separately in seven places within the Project Area. Among them, the biggest and the most important one will be Panacan Industrial District

iv) Port Area

In order to keep consistency with the Davao Gulf masterplan study which has been studied in pace with our investigation, the expansion of Sasa and Sta. Ana Ports will be planned. Also, the development of industrial harbors might be necessary in Panacan and Toril, depending firstly, on the progress of the Industrial District project and secondly, on the type of industries located within the area.

v) Airport Area

Here, our major premise is the use of Bangoy Airport by the year 2000. In preparation for the future introduction of larger types of aircrafts, we have planned to expand the runway to more than 3,000 meters. In this case it is necessary to pay careful attention to the noise pollution which might affect the surrounding residential areas.

vi) Others

Comprehensive development of the Bucana district located in the Northern part of Davao River will also be planned in order to fulfill the facility needs of education, culture, sports, recreation and parks. The Academic town is designed to be constructed in Block II and III-B (See figures) and in this town, all kinds of research institutes and university buildings will cluster together.

Fig. 1.7 Illustrates the present Land Use, and Fig. 1.8 Illustrates the Land Use in the year 2,000. Presently, about 20% of the Project Area (18,100ha) is used as residential, commercial, industrial and Institutional areas. By the year 2,000, however, this percentage will increase to about 44% (See Table 1.15).

Table 1.14 Proposed Industrial Estates/Zones

Industrial Estates/zones	Characteristic
Bunawan	o Heavy and/or Obnoxious Industry o Utilization of Local Materials o Export and Domestic Market Oriented Industry
Panacan	o Utilization of Sasa Port o Non-Pollutive Industry o Wide Range Industrial Development
Sasa	o Utilization of Sasa Port o Non-Pollutive Heavy Industry using Imported Materials
Agdao	o Local Market Oriented Industry o Labor-Intensive Light/Medium Industry
Ma-a	o Local Market Oriented Industry o Medium Industry using local materials o Abattoir (Proposed) Related Industry
Daliao	o Local and Domestic market Oriented Industry o Medium Industry using Marine Products o Service Industry for Vessels
Fagel/Lizada	o Light Non-offensive and Service-Oriented Industry o Establishment of an Export Processing Zone

Source: DCUTCLUS Team

Table 1.15 Current and Future Land Use

	1979		2000	
	Area (ha.)	%	Area (ha.)	%
Residential	2,549	(14)	5,720	(32)
Commercial	283	(1)	900	(5)
Industrial	322	(2)	730	(4)
Institutional	202	(1)	510	(3)
Open Space	160	(1)	1,840	(10)
Others	14,584	(81)	8,400	(46)
Total	18,100	(100)	18,100	(100)

Source: DCUTCLUS Team

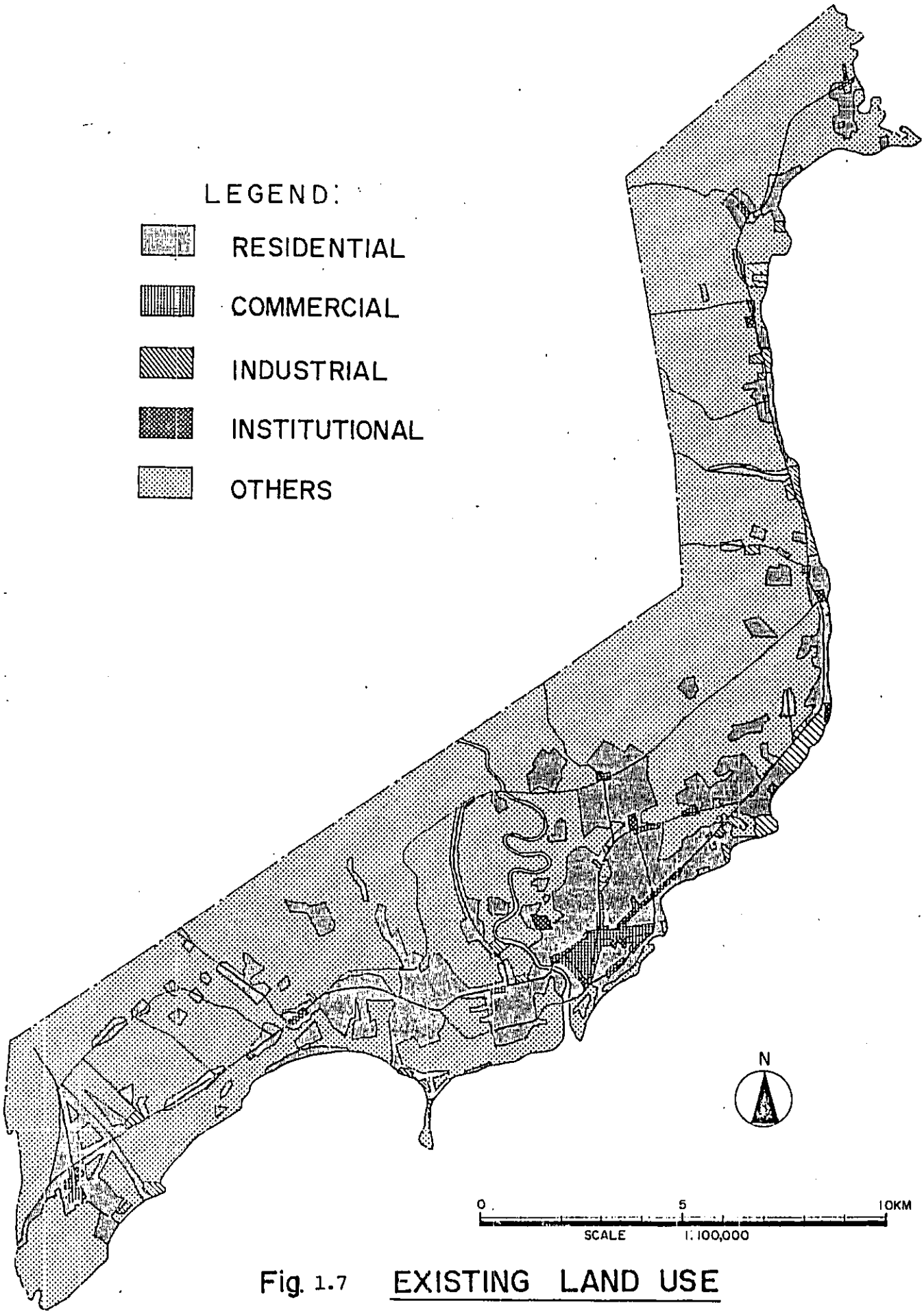


Fig. 1.7 EXISTING LAND USE

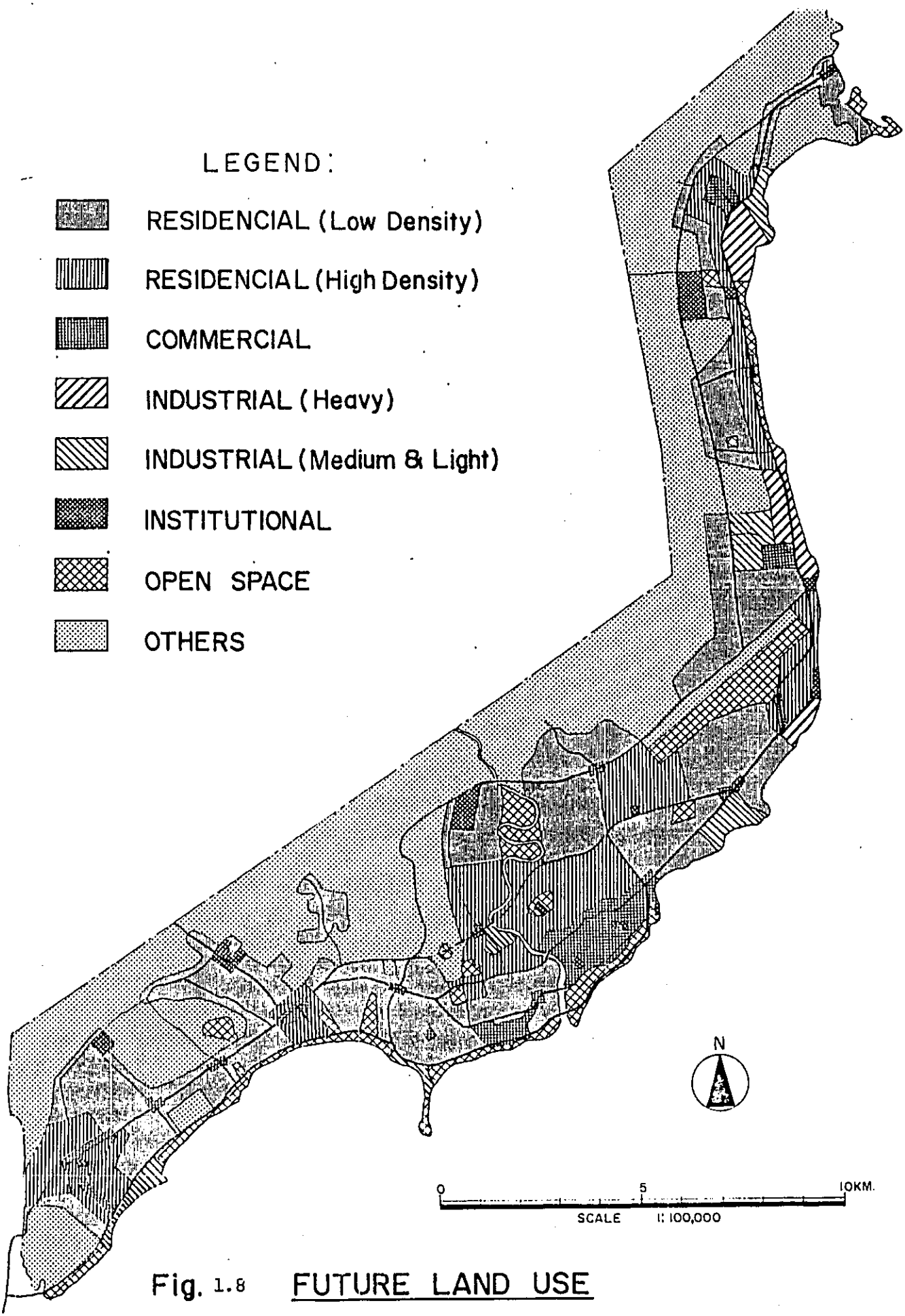


Fig. 1.8 FUTURE LAND USE

CHAPTER 4

ZONAL BREAKDOWN OF FUTURE POPULATION FRAMEWORK

Future population framework is inter-related with future land use concept and with various urban activities, and, therefore, they are reviewed together, and the result of this review provides an important data input for the formulation of a comprehensive transport system for Davao City.

Here, land use in the years 1990 and 2000 will be first conceived of, and forecast based on this concept will be the totals and breakdowns (workers, students) of day population and night population. This forecast will be accomplished in two steps:

i) Population Framework by Block

ii) Population Framework by C Zone (Barangay)

4.1 Future Population Framework (Year 2000)

4.1.1 Night Population

(1) Night Population by Block

Night population by block was presented at the last Steering Committee. However, Block III is large in area size and, therefore, the population of this Block is divided into two; Poblacion, Agdao, and Bucana are made Block III-A and the remainder, Block III-B. The population of each of these blocks is to be forecast taking into consideration the future land use concept and population density.

Table 1.16 Night Population by Block

Block	Night Population
I	110,000
II	130,000
III-A	250,000
III-B	290,000
IV	120,000
TOTAL	900,000

Source: DCUTCLUS Team

(2) Night Population by C zone

Night population by C zone is to be forecast taking into consideration the future land-use concept and population density, with the block's night population as the control total. The result of this forecast is presented in Fig. 1.9.

4.1.2 Night Population of Workers

(1) Night Population of Workers by Block

Night Population of workers by block is forecast by applying the participation ratio to the total night population of each block. The result of this forecast is given in the table below.

FIG. 1.9 NIGHT POPULATION

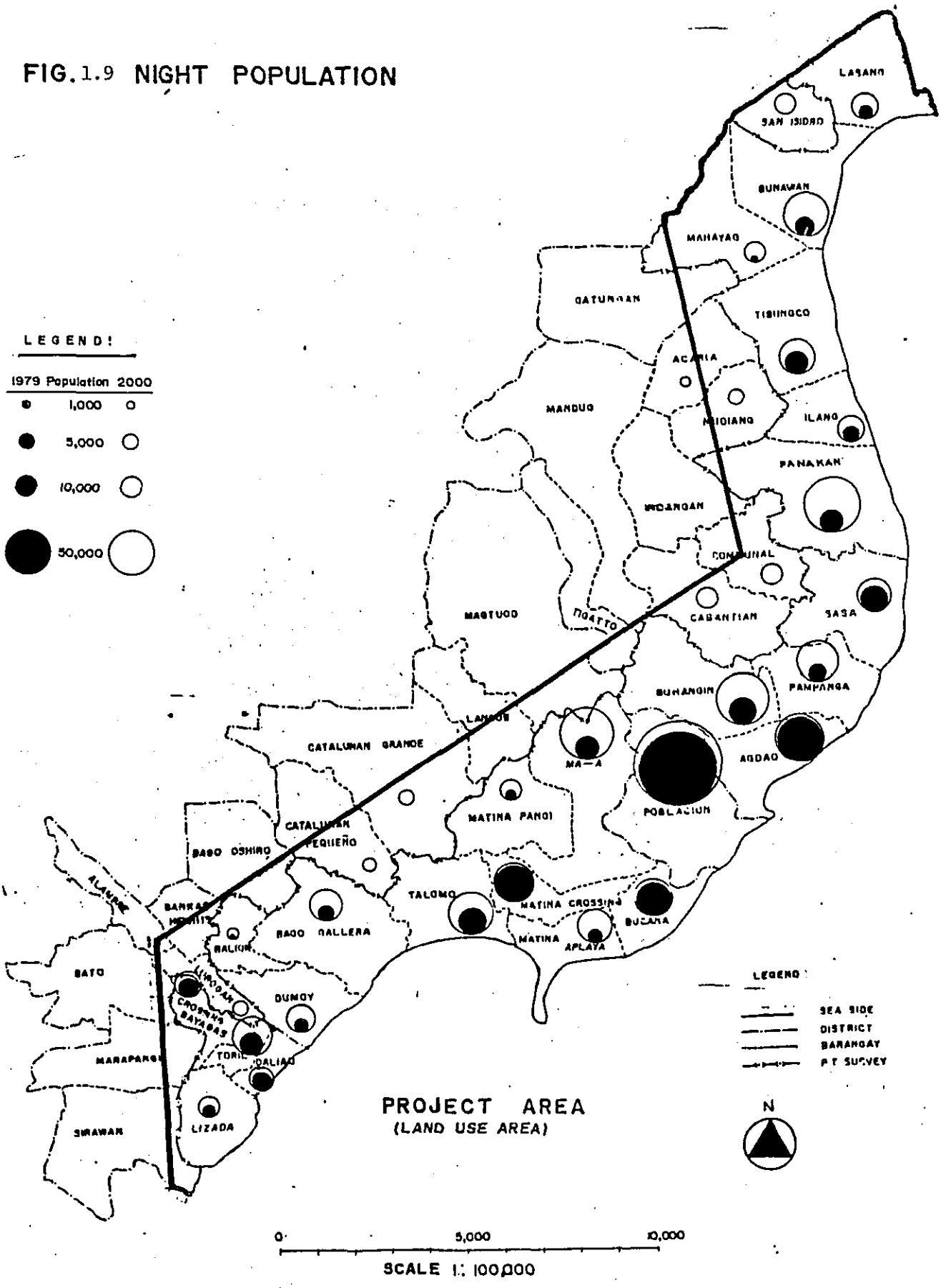


Table 1.17 Night Population of Workers by Block

Block	Workers
I	39,500
II	47,000
III-A	90,000
III-B	104,500
IV	43,000
TOTAL	324,000

Source: DCUTCLUS Team

(2) Night Population of Wrokers by C-Zone

Night population of workers by C Zone is forecast through the application fo workers to population ratio to the total night population of each C zone.

(3) Night Population of Workers by Industry

Primary Industry: Night population of workers in the primary industry is forecast, taking into account the area of agricultural land as according to the future land use concept and fishery base development. The result of forecast is shown in Table 1.18.

Secondary and Tertiary Industry: Night population of workers in the secondary and tertiary industry are forecast, taking into consideration the present ratios of workers in the secondary and tertiary industry. The result of this forecast is shown in Table 1.18.

The industrial structure of the night population of workers by C-zone is estimated in similar manner and adjusted, with the number of workers for each block as the control total.

Table 1.18 Workers by Residence and by Block

Block	Primary	Secondary	Tertiary	Total
I	2,000	15,600	21,900	39,500
II	1,000	14,800	31,200	47,000
III-A	0	20,600	69,400	90,000
III-B	2,000	28,300	74,200	104,500
IV	4,000	8,700	30,300	43,000
TOTAL	9,000	88,000	227,000	324,000

Source: DCUTCLUS Team

4.1.3 Day Population of Workers

(1) Day Population of Workers in the Project Area

In forecasting the day population of workers in the Project Area, the number of those who come from Non-Project Area into the Project Area must be taken into consideration. According to the Person Trip Survey result, the ratio of the day population of workers to the night population of workers was 1.043. Assuming, based on this, that the ratio of day to night population of workers will be 1.05 in the year 2000, the day population of workers is estimated at 340,000.

The day population of workers is, then, broken down into industries. Workers who flow into the Project Area from Non-Project Area are considered to be workers in the secondary and tertiary industry, because the day population and night population of primary industry workers are about the same by their nature. Therefore, workers flowing in are distributed at the rates of the night population of secondary and tertiary workers. The result of this forecast is as follows:

Table 1.19 Day Population of Workers at Industry

Workers	Primary	Secondary	Tertiary	Total
Day Population	9,000	88,000	227,000	324,000
Increment	*0*	*5,000*	*11,000*	*16,000*
Night Population	9,000	93,000	238,000	340,000

Source: DCUTCLUS Team

(2) Day Population of Workers by Block

As for the primary industry, the day population of workers is assumed the same as the night population of workers.

The secondary industry is broken into manufacturing and non-manufacturing for the purpose of forecast. Workers in construction, utilities, mining, and other non-manufacturing industries presently account for about one-third of the total number of workers in the secondary industry. Assuming that this ratio will remain constant in the future, the future day population of workers in non-manufacturing industries are estimated at 31,000. This total is then distributed to each block at the composition ratios of block population. Workers in manufacturing are distributed taking into consideration the area size of industrial development and the kind of industry. The result is shown in Table 1.20.

For the tertiary industry, the forecast is based on the number of tertiary industry workers per 1,000 of night population and taking into consideration the future land-use concept. The number of tertiary industry workers per 1,000 of night population is estimated for each block as follows:

The number for Block I, which will become an industrial center, is estimated at 150, which is the same as the national average.

The number for Block II, which will also become an industrial center but is close to Poblacion and, therefore, will have a high level of commercial activities, is estimated at 200, which is between the national average and the planning value for the Project Area.

Block III-A is not only the center of the Project Area but will also be the center of Davao City, Region XI, and of Mindanao Island, and, therefore, the number for this Block is assumed to be double the average for the entire Project Area, or 500.

The number for Block III-B, which will be characterized as a residential area, is estimated at 150, same as the national average.

The Project Area average of 250 is used for Block IV, in view of its characteristics as a satellite town of Poblacion.

The number of workers in the tertiary industry is estimated for each block based on the above estimates. The resultant discrepancy between the total of such workers in different blocks and the known total of tertiary industry workers in the Project Area is absorbed by Block III-A (or the number for this block is adjusted so as that the totals jibe with each other). The result is presented in Table 1.20.

Table 1.20 Day Population of Workers by Industry and by Block

Block	Primary	Secondary	Tertiary	Total
I	2,000	17,000	17,000	36,000
II	1,000	29,000	26,000	56,000
III-A	0	19,000	121,000	140,000
III-B	2,000	14,000	44,000	60,000
IV	4,000	14,000	30,000	48,000
TOTAL	9,000	93,000	238,000	340,000

Source: DCUTCLUS Team

(3) Day Population of Workers by C Zone

The day population of primary industry workers is assumed the same as the night population of such segment.

With the number of secondary industry workers of each block as the control total, the number of non-manufacturing workers (which is assumed to be one-third of workers in the entire secondary industry) is distributed to C zones at the zonal composition ratios of population, while the number of manufacturing workers is distributed taking into consideration the area size of industrial development and the kind of industry.

With the number of tertiary industry workers of each block as the control total, the number of tertiary industry workers is forecast for zones which will become the core of a block taking into consideration the urban scale and population, while that for other zones at the rate of 100 per population of 1,000.

4.1.4 Night Population of Students

The night population of students is broken into elementary school children, secondary school pupils, and college students. The rates of enrollment of elementary school children and secondary school pupils, according to the Person Trip Survey result, are 17% and 10%,respectively. Likewise, that of college students is 3.5%, but 5% is assumed in the expectation of future improvement in this rate. Thus, the night population of students is forecast by applying the total enrollment rate of 32% to total night population. The result is as shown in Table 1.21.

4.1.5 Day Population of Students

The night population of elementary school children, secondary school pupils, and college students is converted into day population as follows:

i) Elementary school children are assumed to go to the elementary school within their barangay.

ii) Using the secondary school pupils' enrollment rate of 10% and assuming that the average number of pupils per school is 1,500, it is judged that the distribution of secondary schools is one per population 10,000 to 20,0000. Therefore, it is assumed that secondary school pupils living in a barangay with a population of less than 10,000 commute to the closest barangay with a population of over 10,000 for school.

iii) It is expected that college students will commute to the academic town to be developed outside Poblacion.

iv) The number of students flowing from Non-Project Area to the Project Area is set at 2,000 in consideration

of the Person Trip Survey result, and it is assumed that all of the 2,000 flow into Poblacion.

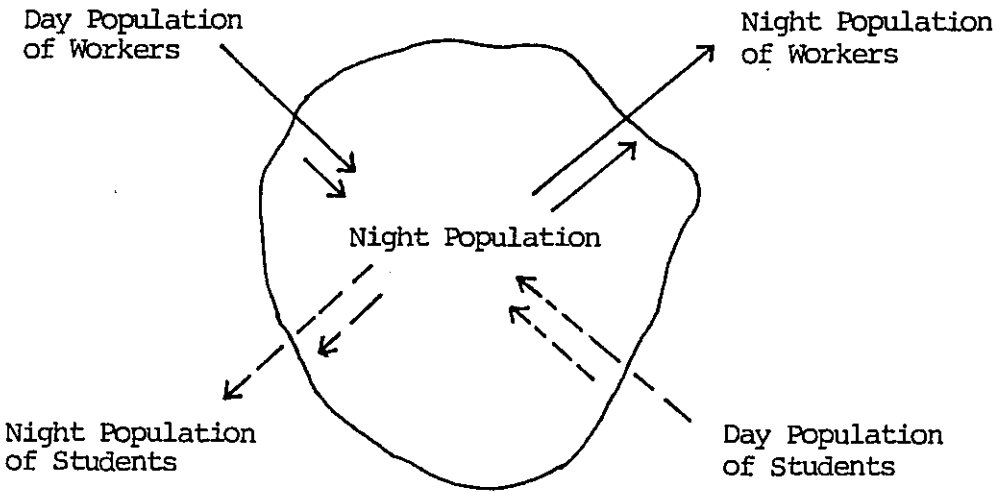
The result is presented in Table 1.21.

4.1.6 Day Population

Day population can be forecast by the following equation:

Day Population = Night Population - Night Population of Workers + Day Population of Workers - Night Population of Students + Day Population of Students

The result is as shown in Table 1.21.



Day Population

Table 1.21 Future Population Framework (Year 2000)

Block	(A) Night Population	(B) Day Population	Workers		Students		(B)/(A)
			Night Population	Day population	Night Population	Day Population	
I	110,000	109,300	39,500	36,000	35,200	38,000	0.99
II	130,000	136,200	47,000	56,000	41,600	38,800	1.05
III-A	250,000	310,500	90,000	140,000	80,000	90,500	1.24
III-B	290,000	238,100	104,500	60,000	92,800	85,400	0.82
IV	120,000	123,900	43,000	48,000	38,400	37,300	1.03
TOTAL	900,000	918,000	324,000	340,000	288,000	290,000	1.02

SOURCE: DCUTCLUS Team

4.2 Future Population Framework (Year 1990)

Population framework for the year 1990, which is a mid-point between the present (1979) and the target year (2000), is conceived of as explained hereunder.

It would be ideal if the process of development progressed with a smooth continuity, because urban development necessitates huge sums of fund and a long period of time and, therefore, an excessively rapid progress would not only entail an unbearable burden on public finance but also bring about diverse distortions through rapid change in urban structure. Therefore, the population framework for the year 1990 is estimated based on the average annual population increase rate for the period of 1979 to 2000, with minor adjustment as indicated by the review of development program under the land-use concept.

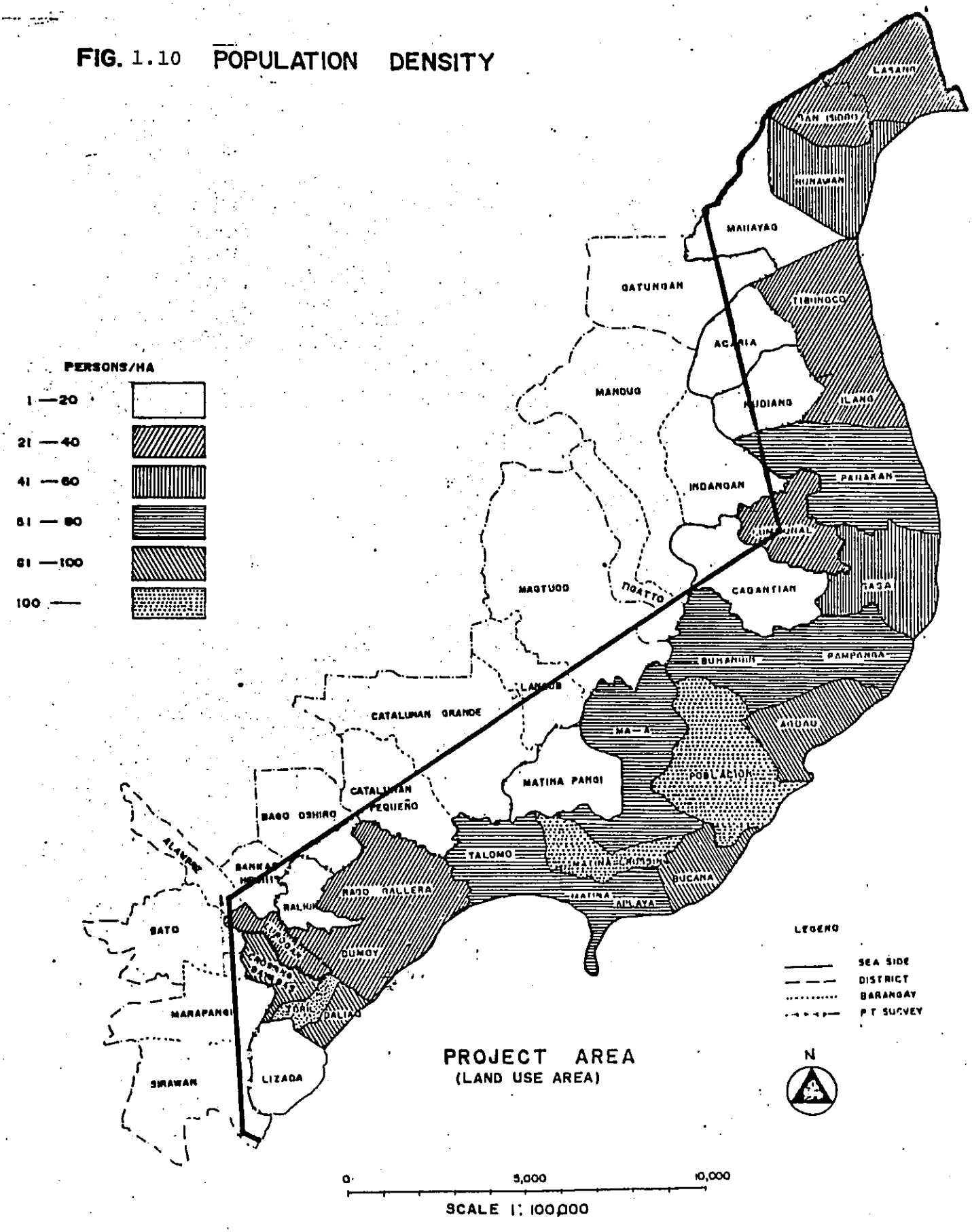
The result is as presented in Table 1.22.

Table 1.22 Future Population Framework (Year 1990)

Block	(A) Night Population	(B) Day Population	Workers		Students		(B)/(A)
			Night Population	Day Population	Night Population	Day Population	
I	45,000	43,300	15,100	12,000	14,200	15,600	0.95
II	60,000	64,000	20,200	25,600	18,900	17,500	1.07
III-A	225,000	263,200	75,500	107,300	70,900	77,300	1.17
III-B	190,000	159,800	63,700	37,000	59,800	56,300	0.84
IV	70,000	71,600	23,500	26,000	22,000	21,100	1.02
TOTAL	590,000	601,900	198,000	207,900	185,800	187,800	1.02

Source: DCUTCLUS Team

FIG. 1.10 POPULATION DENSITY



CHAPTER 5

POSSIBLE PUBLIC INVESTMENT FOR THE TRANSPORT SECTOR

This section deals with the estimate of the amount of possible public investment for the transport sector in the Project Area, based on the past trends of public investment, planned economic growth in the future and the Philippine Government's policy. The results, however, should not be considered as the planned amount of public investment nor investment target, while it provides useful information and guidelines in formulating the masterplan of urban transport.

5.1 Past Trends of Public Investment (Philippines)

Table 1.23 Past Trends of Public Investment (Philippines)

	Investment at 1972 const. prices							Average Growth Rate (% p.a.)
	1972	1973	1974	1975	1976	1977	1978	
Public Investment (₱ million)	1,034	1,183	1,508	2,294	3,128	3,565	3,905	24.8
Share in GNP (%)	1.9	1.9	2.3	3.3	4.3	4.6	4.7	-
Other Investment (₱ million)	10,539	11,357	14,143	16,690	17,503	16,798	18,218	9.6
Total Investment (₱ million)	11, 573	12,540	15,651	18,984	20,631	20,363	22,123	11.4
Share in GNP (%)	20.8	20.6	24.2	27.7	28.1	26.1	26.8	-

Source: 1979 Philippine Statistics Year Book

5.2 Estimating Process

i) According to the Long-Term Plan 2000, the shares of Luzon, Visayas and Mindanao in public investment are 50%, 25% and 25% respectively, which are considered to be constant up to the year 2000.

ii) The proportion of public investment to GNP was 3% in 1975, and is estimated at 5% in 1980 and 6% in 2000 in the Long-Term Plan 2000. This target is reflected in the recent rapid increase in the share of public investment in GNP, as revealed in Table 1.23. The Government of the Philippines is considered to be faithfully pursuing this goal.

iii) Since the total GNP of the country in 2000 is estimated at 474,001 million pesos at 1972 constant prices, the total public investment in Mindanao in 2000 is calculated as follows:

474,001 x 0.25 x 0.06 = 7,110 (₱ million at 1972 prices)

iv) By multiplying 0.517, which is the proportion of Region XI to Mindanao in public investment assumed in the Long-Term Plan 2000, by the figure above, public investment of Region XI in 2000 can be calculated:

7,110 x 0.517 = 3,680 (₱ million at 1972 constant prices)

This corresponds to 8.8% of the projected GRDP of 42,029 (₱ million at 1972 constant prices) of Region XI in 2000, which is considerably high compared to the national average of 6.0%.

v) Since the population of Region XI in 2000 is 7,274,000 as projected, per capita public investment of Region XI can be calculated at ₱ 506.

vi) For per capita public investment of Davao City, the following two (2) cases are considered:

I. ₱ 506 - same as the regional average
II. ₱ 607 - 20% higher than the regional average considering the fact that the City will service whole Mindanao and Region XI as a center of administration, economy, culture, education, etc.

vii) Since the projected population of the City is 1.3 million in 2000, the possible public investment for the year 2000 is calculated at ₱658 million, and ₱789 million for the cases I and II respectively.

viii) With regard to the actual public investment of the country in 1979, the share of transport sector was 38% with 30% for land transport. Holding these shares as constant, public investment of the City can be calculated as presented in Table 1.24 and Table 1.25.

Table 1.24 Public Investment at 1972 Constant Prices, Davao City, 1979 & 2000

		₱ Million		Average Growth Rate (%p.a.)
		1979	2000	
Case I	Public Investment	N.A.	658	-
	Transport Sector	6.7	250	18.8
	Land Transport	3.0	197	22.1
	Other	3.7	53	13.5
CaseII	Public Investment	N.A.	789	-
	Transport Sector	6.7	300	19.8
	Land Transport	3.0	237	23.1
	Other	3.7	63	14.5

SOURCE: DCUTCLUS Team

Table 1.25 Accumulated Public Investment at 1972 constant prices, Davao City

(₱ million)

		1981 - 1990	1991 - 2000	Total
Case I	Public Investment	-	-	-
	Transport Sector	232	1,297	1,529
	Land Transport	137	970	1,107
	Other	95	327	422
Case II	Public Investment			
	Transport Sector	247	1,506	1,753
	Land Transport	144	1,125	1,269
	Other	103	381	484

ix) Since the projected GDP of the City in 2000 is ₱ 9,625 million at 1972 constant prices, the proportion of public investment to GDP is 6.8% and 8.2% for cases I and II respectively. These shares are smaller than the regional average due to the high per capita GDP of the City.

x) In the period of 1981 - 1990, the amount of public investment of the City is very small compared to that of the period of 1991 - 2000. However, by issuing public bonds, advanced public investment will be possible.

xi) Assuming price index of 2.5, the 1972 constant prices can be converted into 1980 constant prices, as shown in Table 1.26.

Table 1.26 Accumulated Public Investment at 1980 Constant prices, Davao City

	₱ Million		
	1981 - 1990	1991 - 2000	Total
Case I Public Investment	-	-	-
Transport Sector	580	3,243	3,823
Land Transport	343	2,425	2,768
Other	237	818	1,055
Case II Public Investment	-	-	-
Transport Sector	618	3,765	4,383
Land Transport	360	2,813	3,173
Other	258	952	1,210

SOURCE: DCUTCLUS TEAM

5.3 Conclusion

With regard to the Project Area, the amount of possible public investment there can be calculated from Table 1.26 by using the shares of the Area in population and GDP, as presented in Table 1.27.

Table 1.27 Accumulated Public Investment at 1980 Constant Prices, Project Area.

	₱ million		
	1981-1990	1991-2000	Total
Case I (Population Proportional)			
Transport Sector	400	2,238	2,638
Land Transport	237	1,673	1,910
Other	163	565	728
Case I (GDP Proportional)			
Transport Sector	452	2,530	2,982
Land Transport	268	1,892	2,160
Other	184	638	822
Case II (Population Proportional)			
Transport Sector	426	2,598	3,024
Land Transport	248	1,941	2,189
Other	178	657	835
Case II (GDP Proportional)			
Transport Sector	482	2,937	3,419
Land Transport	281	2,194	2,475
Other	201	743	944

Based on "Philippine Island Road Feasibility Study" (MPH, 1980), annual cost for maintaining existing roads in the Project Area is estimated at ₱9.6 million, which nearly double the current insufficient budget allocation for road maintenance in the Project Area. Therefore, public investment on new land transport facilities can be calculated at ₱1,718 million for the most conservative Case I (Population Proportional) and ₱2,283 million for the most optimistic Case II (GDP Proportional), for the period 1981-2000.

II. FUTURE TRAFFIC DEMAND FORECAST

CHAPTER 1

OUTLINE

1.1 Purpose

The process of planning always accompanys, as an initial and indispensable part of the overall process, the work of defining the present and of predicting the future based on the present. Davao City Urban Transport Cum Land Use Study (DCUTCLUS) proposes not only to solve the existing traffic problems which are plaguing the City, but also to design an efficient and desirable future land use plan and, based on this plan, a transportation plan which will be commensurate with the future development of socio-economic activities in Davao from the three aspects of:

(i) Road/Street network planning;
(ii) Public transportation system planning, and
(iii) Traffic management system planning

for the target years of 1990 (as medium range planning) and 2000 (as long range planning), and, therefore, the purpose of forecasting hereby is to provide sufficient information on the movement of people and vehicles in these target years as necessary input for the planning.

1.2 Structure

Prior to developing models and forecasting traffic demands, it is indespensable to make obvious the relationship between zonal characteristics of the Project Area (i.e. size and structure of population, land use pattern, economic activities, life styles, etc.) and trip characteristics. When developing models, the following must be taken into consideration;

a) Models must fully reflect zonal characteristics on trip characteristics;
b) Models must not only explain the current status but must also be applicable to the future changes or development of the area.

c) Models must be as efficient as possible within the allowable limit of required accuracy.

As for a), trip characteristics have been identified on the basis of the analysis of the person trip survey results, then, the most appropriate model has been selected through comparison of several typical models which are commonly used.

As for b), factors of which drastical changes could be expected in the future have been carefully assessed and included in models. Typical of these factors are changes in industrial structure and car ownership.

As for c), effects of forecast accuracy on transportation planning which is the final target of the study have always been considered. Simpler methods have been selected as long as they assured required accuracy.

Models and forecast methods have been selected among simple methods which are commonly used and selection of unique models or methodology has been avoided.

While, information pertaining to the trips which people make can be expressed generally in terms of:

(1) Purpose
(2) Mode of travel
(3) Geographical positions of the origin and destination (represented by zones)
(4) Route
(5) Terminal (both trip ends) facilities
(6) Time of departure and time of arrival

Of these, minimum essential to planning are purpose, mode, origin and destination and route. In other words, the task of forecasting here is to find "how many trips will in the future be made from where to where by which mode of travel through which route for what purpose." The forecast of this set of data is traditionally accomplished through the following four steps:

Step 1 "How Many trips?"

This is done in two sub-steps

Sub-Step 1-1 "Project area as a whole?"

This is the estimation of total generated trips in the project area, the data being used as a control total.

Sub-Step 1-2 "By Zone?"

This is the estimation of generated/attracted trips by zone.

Step 2 "Where will these trips go?"

This is the estimation of distributed trips.

Step 3 "What mode of travel?"

This is the estimation of number of trips by mode of travel.

Step 4 "Through which route?"

This is the estimation of assigned traffic.

Thus, the findings of the Person Trip Survey taken in a part of Davao can be extrapolated into the future data through these four steps. As for the trips inside the Person Trip Survey area made by the inhabitants outside the Person Trip Survey area, which are few in number and insignificant in activities and about which little is known, these are predicted simply using growth rates and other tools, rather than going through the four steps. (See Fig. 2.2)

Fig. 2.1. PROCESS OF FORECAST OF FUTURE TRAFFIC VOLUME

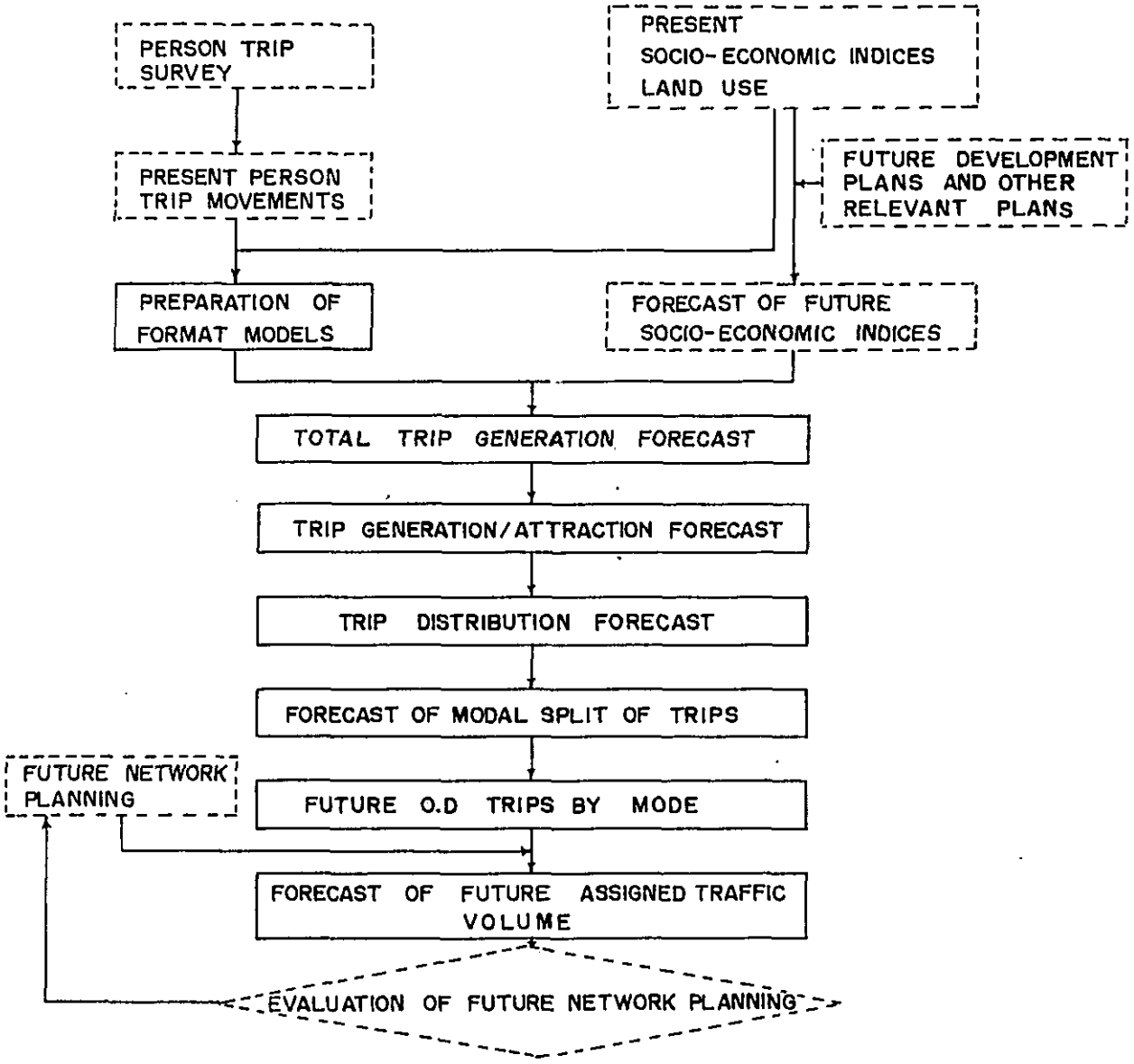
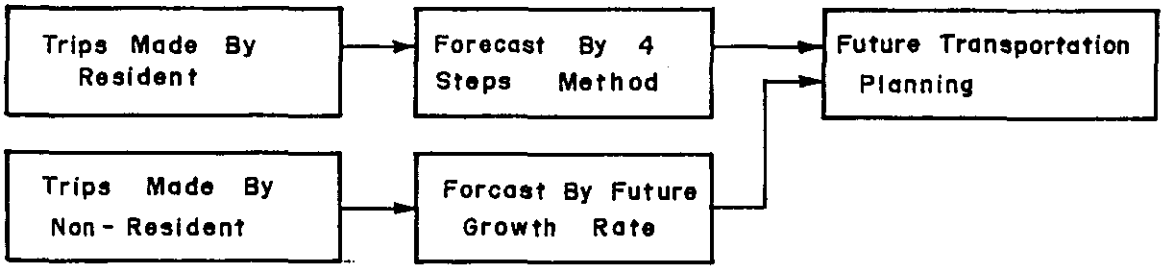
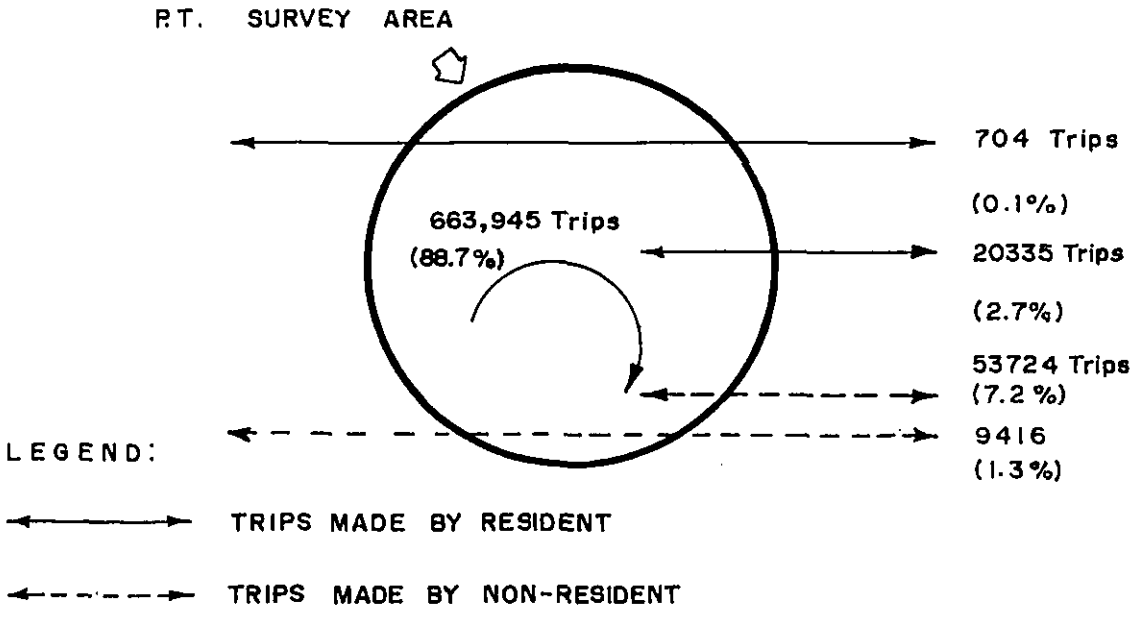


FIG. 2.2 FORECAST OF TRIPS MADE BY RESIDENT OUTSIDE PROJECT AREA (NON-RESIDENT)





CHAPTER 2

TOTAL TRIP GENERATION FORECAST

2.1 Forecast Method

Forecast methods to predict total generated trips in the Project Area are as follows;

a) Projection method based on the past trend analysis;
b) Forecast method using socio-economic indicators as explanatory variables;
c) Focusing on a person as the minimum unit of trip generator, the method is to get per capita trip rate for various personal attributes, then to forecast by multiplying trip rate by future population.

Projection method based on the past trend analysis cannot be applied because of non-availability of past survey data. Although forecast method using socio-economic indicators (i.e. GNP, Value of manufacturing producers' shipment, etc.) has good possibility to convert a tendency of economic activities into trips, this method has been avoided because:

i) Values of socio-economic indicators have rather wide allowable range, and
ii) When future industrial structure change drastically compared to the present, forecast made by this method will produce rather inaccurate results.

Analysis of the person trip survey data made by the DCUTCLUS team and other Transport Studies have also proved that per capita trip rate has fairly stable accuracy, therefore, the forecast method using per capita trip rate has been selected.

2.2 Selection of Personal Attribute

Various attributes of a person affect or determine his trip rate. In the Person Trip Survey, such personal attributes were surveyed as place of living, sex, age, occupation, industry engaged in, car ownership and income, all of which have been revealed by analyses to have substantial influences on trip rate.

Trip rate of male is higher by 1.33 times than that of female. Age group of 30s and 40s of male has the highest trip rate, then age group of 10 to 14 of both sexes come next. In case of female, trip rate of over 20 years old is considerably low, however, that of male up to the age of 50 is high, which implies that they are still active.

As for trip rate by industry engaged in, people engaged in the tertiary industry shows the highest rate, followed by people engaged in the secondary industry, students and pupils. On the other hand, trip rate of housewives and the jobless is substantially low.

Car ownership also gives big impact on trip rate. At present, trip rate of family members who belong to a car owned household is higher by 1.84 times than that of non-car owned household members.

However, an attribute which meets the following conditions should be selected as that which will support the prediction of future trip rate:

1) That its distribution among a population is expected to change at a fair degree in the future such as distribution by industry which can change substantially in the future, as opposed to distribution by sex which can be expected to change only little.

2) That its relationship with trip rate is believed to remain relatively constant in the future, and

3) That the estimation is possible of future population by that attribute.

FIG. 2.3 TRIP MADE BY SEX & BY AGE (TRIP/ PERSON)

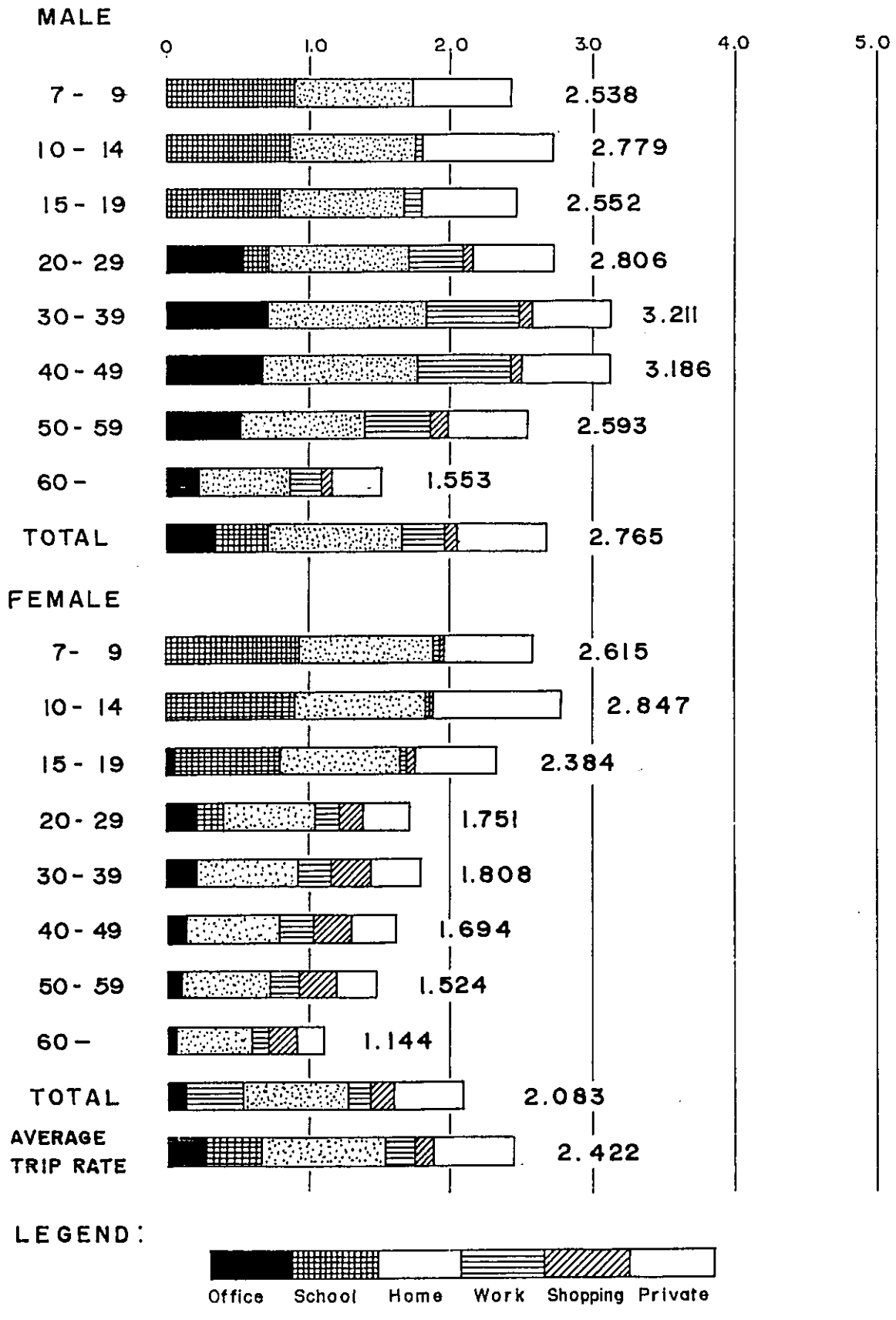


FIG. 2.4 TRIP MADE BY INDUSTRY (TRIP/PERSON)

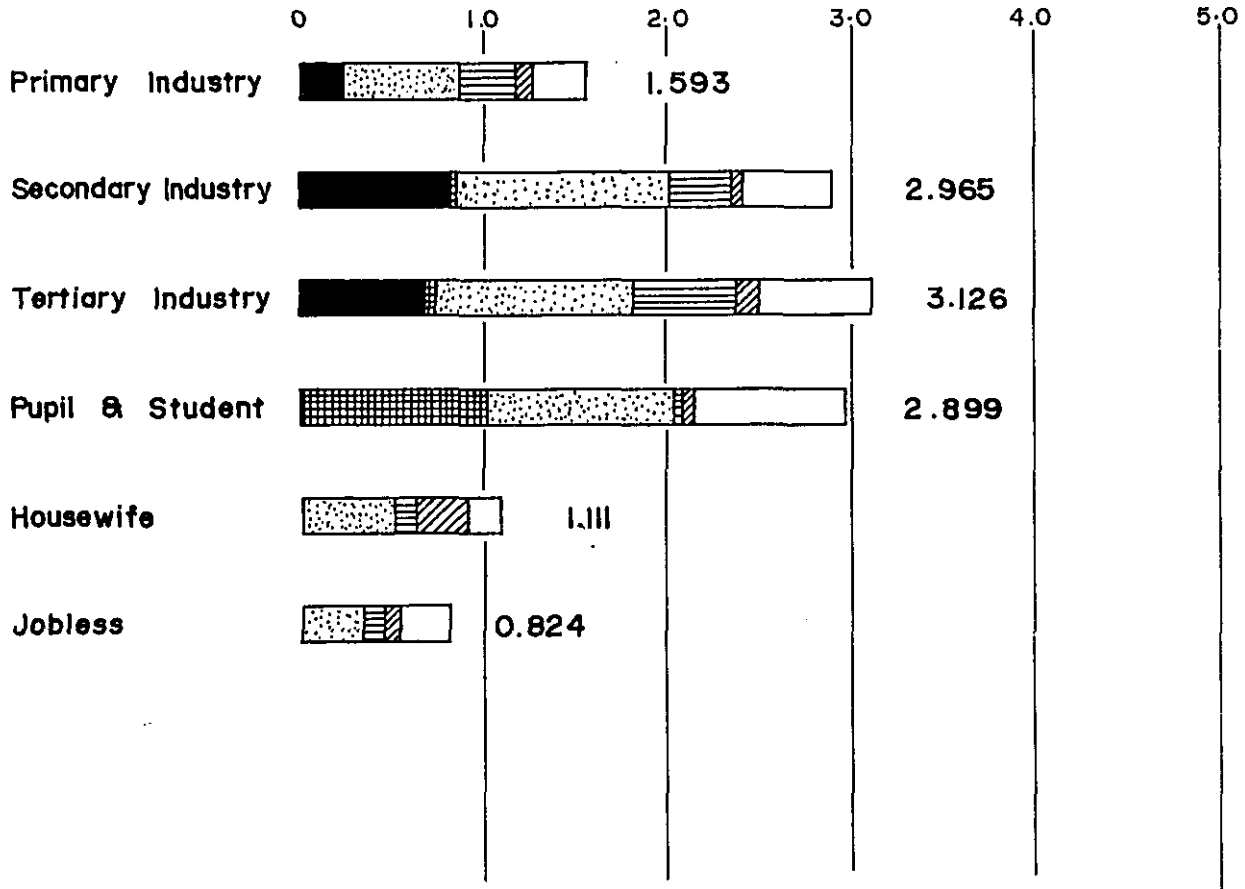
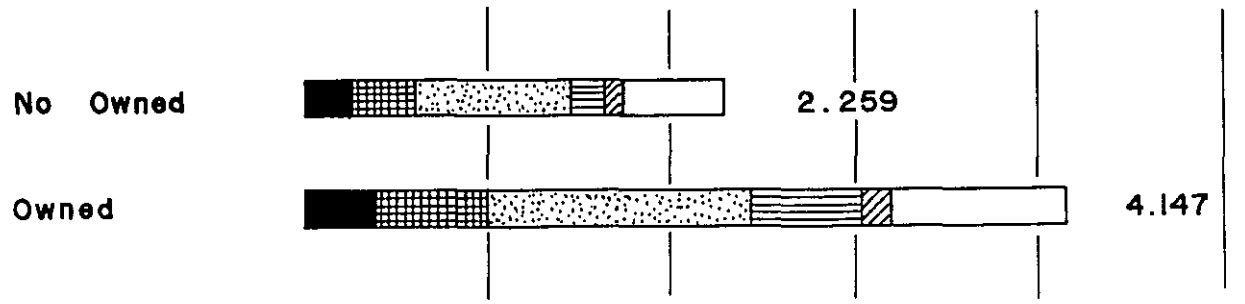
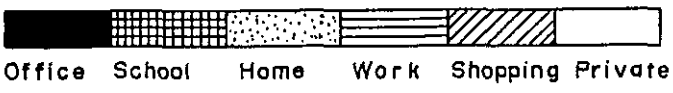


FIG. 2.5 TRIP MADE BY VEHICLE OWNED (TRIP / PERSON)



LEGEND :



No drastic change of age and sex structure will be expected in the future. Forecast of employment by occupation and of income level is quite difficult. Therefore, personal attributes such as age, sex, occupation and income level are not suitable for forecast of total trip generation.

In the future, it is expected that industrial structure will change drastically, i.e. switch-over of primary industry to secondary and/or tertiary industry, increase of employment rate and increase of school attendance rate. These changes give so big influence on total trip generation that trip rate by industry has been selected for forecast. Factor of Car ownership will be considered when developing modal split model.

Table 2.1 FUTURE POPULATION BY INDUSTRY AND CAR OWNERSHIP

INDUSTRY	1979		2000	
	Number	Share (%)	Number	Share (%)
Population	360,000	100.0	900,000	100.0
Population Below 5 Years	77,400	21.5	193,000	21.4
Primary Industry	24,000	6.7	9,000	1.0
Secondary Industry	21,900	6.1	88,000	9.8
Tertiary Industry	69,100	19.2	227,000	25.2
Pupil and Student	109,700	30.5	288,000	32.0
Housewife	36,700	10.2	60,000	6.7
Jobless	21,200	5.9	35,000	3.9

2.3 Future Trip Rate

This study will basically use present trip rate by industry for forecast of total trip generation. Trip rate of housewives and the jobless is quite low at present compared to that of other categories. This is mainly because trip maker ratio of these two is low. While trip maker ratio of secondary and tertiary industries, students and pupils is high ranging from 80% to 90%. These values are considered to remain constant even in the future. However, trip maker ratio of housewives and the jobless is expected to increase in the future in view of urbanization of the area, development of standard of living and increase of mobility. This is proven by the following facts: When looking into trip maker ratio by zone, that of secondary and tertiary industries, students and pupils has little zonal dispersion. On the other hand, that of housewives and the jobless shows considerable zonal difference between Poblacion where urbanization has progressed and the rest of the area. Difference between these two areas will become less and trip maker ratio as a whole will increase in the future, taking into account the future land use plan.

As a conclusion, trip rate of housewives and the jobless has been revised on the assumption that trip maker ratio would increase to the present level of Poblacion. Revised trip rate has been used for forecast of total generated trips. Present trip rate has been used for the rest of the categories, i.e. secondary and tertiary industries, students and pupils.

Table 2.2 NET TRIP RATE and GROSS TRIP RATE

	TRIP MAKER RATIO (%)	NET TRIP RATE	GROSS TRIP RATE
PRIMARY INDUSTRY	53.9	2.96	1.59
SECONDARY INDUSTRY	83.4	3.56	2.97
TERTIARY INDUSTRY	78.6	3.98	3.13
PUPIL & STUDENT	90.1	3.22	2.90
HOUSEWIFE	41.1	2.70	1.11
JOBLESS	28.5	2.89	0.82
TOTAL	71.4	3.39	2.42

GROSS TRIP RATE = Net Trip Rate x Trip Maker Ratio

where:

TRIP MAKER RATIO = Those who made at least one trip ÷ Total Population

Fig. 2.6 TRIP MAKER RATIO (TRIP MAKER / POPULATION)

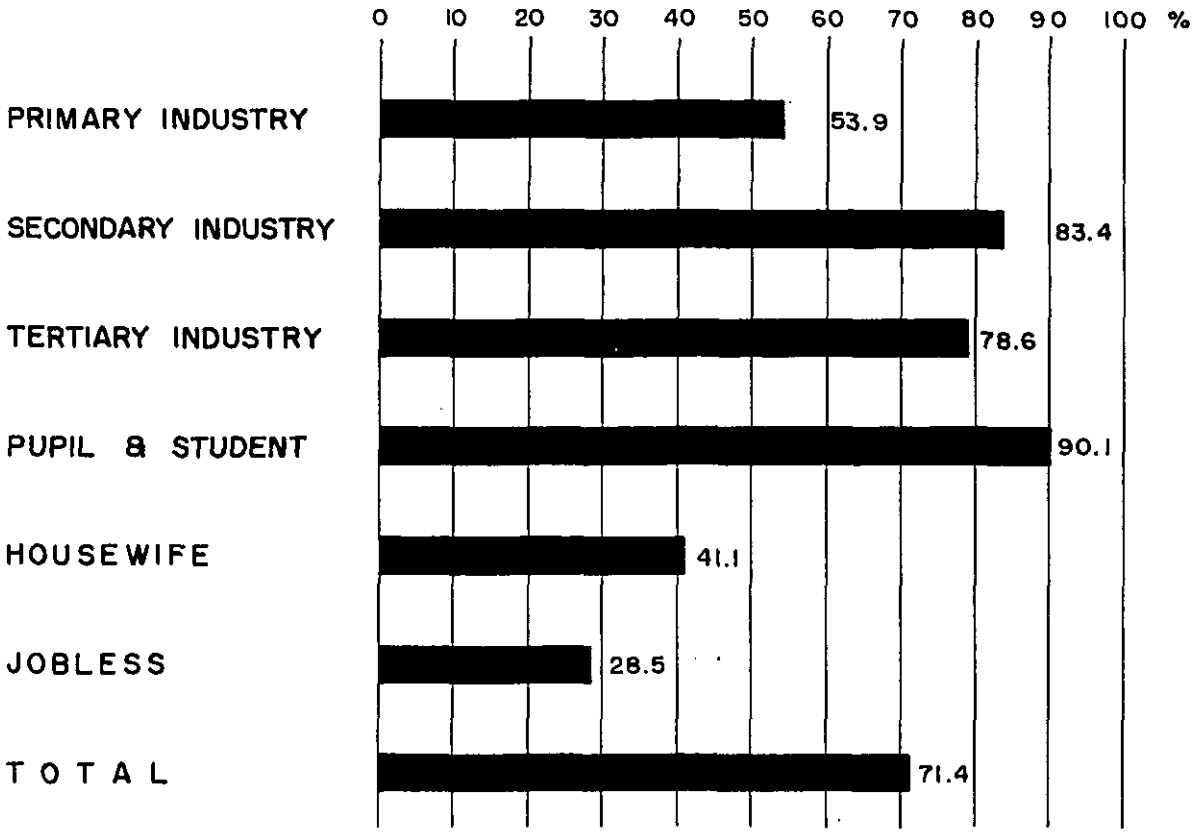


Table 2.3 FUTURE TRIP RATE

(UNIT : TRIP/PERSON)

	PRIMARY	SECONDARY	TERTIARY	PUPIL & STUDENT	HOUSEWIFE	JOBLESS	TOTAL
To OFFICE	0.239	0.838	0.696	0.022	0.011 0.013	0.005 0.007	
To SCHOOL	0.017	0.037	0.043	0.974	0.007 0.009	0.008 0.011	
To HOME	0.630	1.161	1.097	1.014	0.488 0.595	0.351 0.493	
BUSINESS	0.310	0.362	0.561	0.025	0.126 0.154	0.113 0.159	
SHOPPING	0.104	0.060	0.104	0.028	0.298 0.363	0.099 0.139	
PRIVATE	0.293	0.507	0.625	0.836	0.181 0.221	0.248 0.348	
TOTAL	1.593	2.965	3.126	2.899	1.111 1.355	0.824 1.157	2.422 2.768

UPPER: Existing Trip Rate

LOWER: Future Trip Rate. If this column is blank, future trip rate is equal to existing one.

2.4 Results of Forecast

Total number of trips made by the residents in 1979 is 685,000 trips per day. This will be 1,221,000 and 1,957,000 in 1990 and 2000, respectively. Compared to the year 1979, increase of trips in 1990 and 2000 is 1.78 times and 2.86 times, whereas increase of population is 1.64 and 2.50 times, respectively. Increase of trips exceeds that of population. It is reasonable to expect that traffic grows faster than population where rapid development of industrialization and expansion of economic activities are anticipated. Therefore total number of trips forecasted herein is believed to be quite reasonable.

As for number of trips by trip purpose, increase of "going to office" and "business" trips is outstanding. This is due to development of industrialization as well as increase of employment rate.

Increase of truck trips for the purpose of "business" is not always explained by increase of workers. It is believed that correlation between truck trips and economic indices such as GDP is high. In view of the above, number of "business" trips has been increased with reference to the future growth of GDP.

Increase of employment rate is related to relative decrease in the traditional role of housewives. This tendency is reflected on low increase of "shopping" trips.

Trip rate has also been compared to that in various Transport Studies conducted in Japan. Although trip rate in 1979 is a little bit lower than that in Japan, it will almost be the same value as in Japan in the year 2000.

TABLE 2.4 FUTURE TRIP VOLUME

	1979		1990			2000		
	No. Of Trips	Share of Purpose	No. Of Trips	Growth Ratio	Share of Purpose	No. Of Trips	Growth Ratio	Share of Purpose
OFFICE	69,536	10.2	141,000	2.03	11.5	242,000	3.48	12.4
SCHOOL	111,325	16.3	190,000	1.71	15.6	295,000	2.65	15.1
HOME	248,561	36.3	441,000	1.77	36.1	702,000	2.82	35.9
BUSINESS	61,910	9.0	117,000 1/ (3,000)	1.89	9.6	197,000 1/ (13,000)	3.18	10.1
SHOPPING	29,308	4.3	45,000	1.54	3.7	65,000	2.22	3.3
PRIVATE	163,844	23.9	287,000	1.75	23.5	456,000	2.78	23.3
TOTAL	684,984 2/ (2.42)	100.0	1,221,000 2/ (2.63)	1.78	100.0	1,957,000 2/ (2.77)	2.86	100.0

WHERE PRESENT AND FUTURE POPULATIONS ARE

〈1979〉 360,000

〈1990〉 590,000 (1.64) 3/

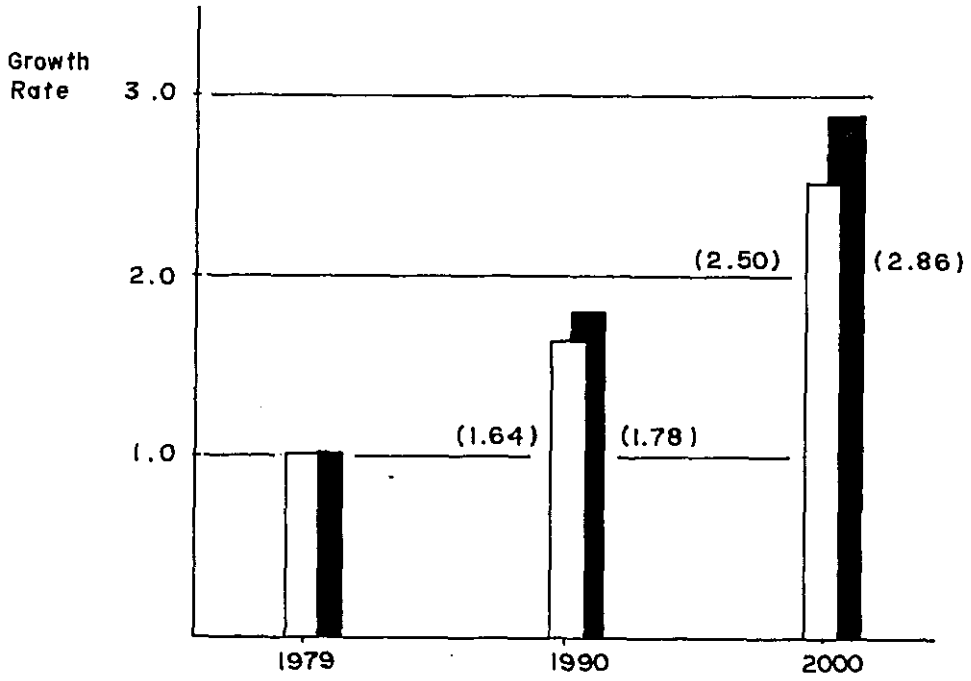
〈2000〉 900,000 (2.50) 3/

1/ ADDITIONAL NUMBER OF TRIPS IN VIEW OF FUTURE GROWTH RATE OF G.D.P.

2/ TRIP RATE

3/ GROWTH RATE OF POPULATION

FIG. 2.7 GROWTH RATE OF POPULATION AND TRIP VOLUME



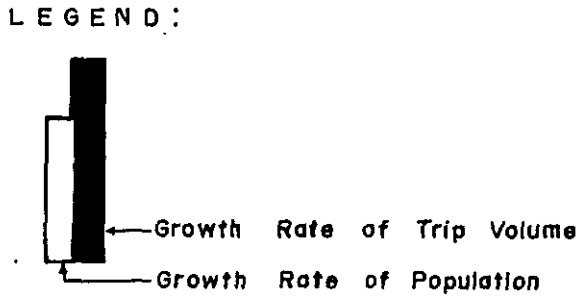
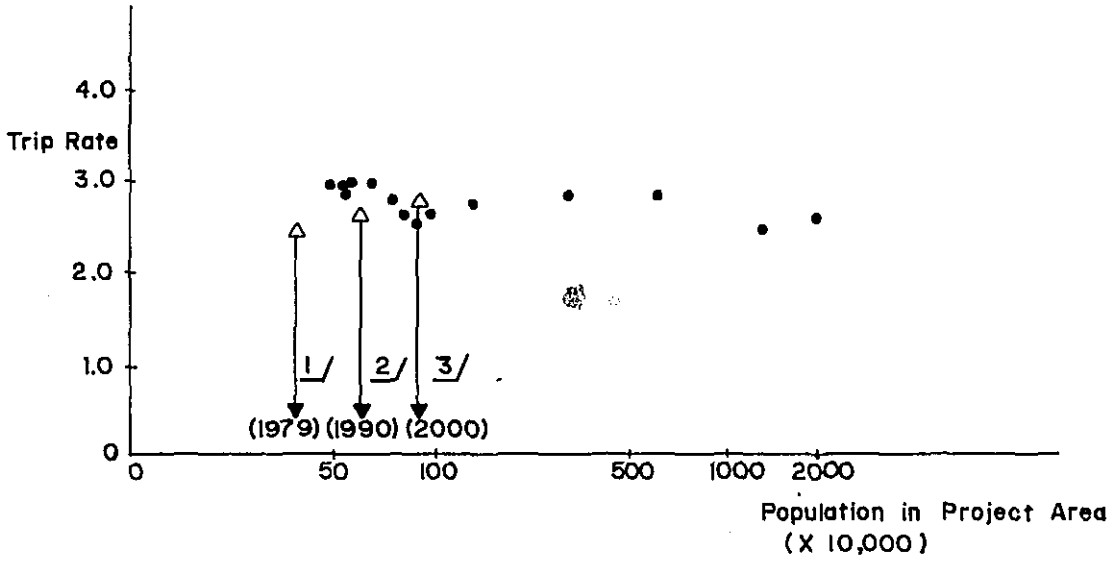


FIG. 2.8 COMPARISON OF TRIP RATES IN OTHER STUDIES



1/ Trip Rate in the Year of 1979

2/ Trip Rate in the Year of 1990

3/ Trip Rate in the Year of 2000

• Trip Rates of Several Cities in Japan

CHAPTER 3

TRIP GENERATION/ATTRACTION FORECAST

3.1 Forecast Model Structure

Trip generation/attraction is forecast by zone and by different purpose, based on the total trip generation in the Project Area, as estimated in the previous step.

Generally, trip generation/attraction forecast methods are grouped into two.

a) Method by generated/attracted trip rate per unit of each land use (unit is expressed as trips per hectare) determined in accordance with land use classification;

b) Method by models which are developed by statistical techniques such as multiple regression model and principal component analysis model, using population as independent variables.

Forecast method based on land use has an advantage in that a future land use plan can directly be reflected on traffic demand forecast however, its disadvantage is that it does not always provide required accuracy. The more accurate forecast is required, the more accurate unit rate (trips per hectare) must be determined, which necessitate a lot of work to do. In case that types of present land use are mixed up and there is no areal unity by type of land use, it is also quite hard to determine accurate unit rate. Application of this method is not easy under the circumstance that there would be big differences between the present and the future land use pattern as in the case of this Project. The forecast method based on land use should be applied where urbanization has already been developed.

Models using population indices as independent variables have been selected for forecasting generated/attracted trips in view of the following aspects; i) they are stable in accuracy and ii) they can reflect ideals of a future land use plan as future population framework is determined on the basis of a future land use plan.

Among function models, multiple regression model has been selected because its structure is simple and clear, its application is easy and it is commonly used.

Of population indices, which represent the very source of trip generation and which can easily be estimated for the future, those which are deeply related to the quantity of trip have been selected by correlation analysis in formulating the following linear multiple regression model:

$$T_i = a_0 + a_1X_{i1} + a_2X_{i2} + \cdots + a_mX_{im}$$

Where: T_i = the quantity of trip generation (or attraction in zone number i

$X_{i1}, X_{i2} \cdots X_{im}$ = The value of the index of the zone (1, 2, ... m)

$a_0, a_1 \cdots a_m$ = Constant

3.2 Selection of Independent Variables

When selecting independent variables for multiple regression model, only those indices which satisfy the conditions that current values are available for all the zones and that their future values (for the year 1990 and 2000) can be forecasted must be considered. In the Person Trip Survey, population by sex, age, occupation and industry for each zone have been obtained. Judging from the appropriateness as independent variables and the possibilities to forecast future values, population by night and by day in relation to industry have been selected as indices.

Table 2.5 Indices Explaining Trip Generation/Attraction

Day 1/	Night 2/
o Day Population	o Night Population
o Total workers	o Total workers
o Secondary Industry Workers	o Secondary Industry Workers
o Tertiary Industry Workers	o Tertiary Industry Workers
o Total of Secondary and Tertiary Industry Workers	o Total of Secondary and Tertiary Industry Workers
o Pupils and Students	o Pupils and Students

NOTE:

1/ By place of work/school
2/ By place of abode

Indices which are deeply related with trip generation/attraction have been selected by using correlation analysis. (Refer to Table 2.6). The preliminary models have been developed using those selected indices and accuracy of models has been checked. Appropriateness of indices has also been confirmed by analizing the Person Trip Survey results (i.e. mechanism of trip generation/attraction has been analized and indices have been checked if each of them explains the mechanism revealed by the analysis). Taking the trip purpose of "going to office" as an example, generated trips of this purpose by zone are determined by number of workers who reside in the zone, regardless of their places of work. Attracted trips of this purpose by zone are determined by the power of employment opportunities which the zone possesses, in other word, by the number of workers in the zone. Therefore, it is reasonable to assume that generated trips are explained by the number of workers by the place of residence and attracted trips by the number of workers by the place of work. These assumptions have been proven by the analysis of the Person Trip Survey results.

TABLE 2.6 INDEPENDENT VARIABLES OF FUNCTION MODELS

TRIP PURPOSE		INDICES I [1]	INDICES II [2]
OFFICE	GENERATION	[3] ○ Population [5] ○ Tertiary [6] ○ Secondary and Tertiary	○ Secondary and Tertiary
	ATTRACTION	[4] ▲ Secondary and Tertiary	▲ Secondary and Tertiary
SCHOOL	GENERATION	○ Population ○ Pupils and Students	○ Pupils and Students
	ATTRACTION	▲ Pupils and Students	▲ Pupils and Students
HOME	GENERATION	▲ Pupils and Students ▲ Tertiary ▲ Secondary and Tertiary	▲ Pupils and Students ▲ Secondary and Tertiary
	ATTRACTION	○ Population ○ Pupils and Students ○ Tertiary ○ Secondary and Tertiary	○ Population
BUSINESS	GENERATION	○ Tertiary ▲ Population ▲ Tertiary ▲ Secondary and Tertiary	▲ Secondary and Tertiary
	ATTRACTION	▲ Tertiary ▲ Secondary and Tertiary	▲ Secondary and Tertiary
SHOPPING	GENERATION	▲ Population	▲ Population
	ATTRACTION	▲ Tertiary	▲ Tertiary
PRIVATE	GENERATION	▲ Population	▲ Population
	ATTRACTION	▲ Population	▲ Population

1/ Indices which are deeply related with generated/attracted trips and appropriate as independent variables

2/ Indices which are selected for second models

3/ ○ indicates population indices at night

4/ ▲ indicates population indices in the day time

5/ "Tertiary" shows Tertiary Industry Workers

6/ "Secondary and Tertiary" shows Secondary and Tertiary Industry workers

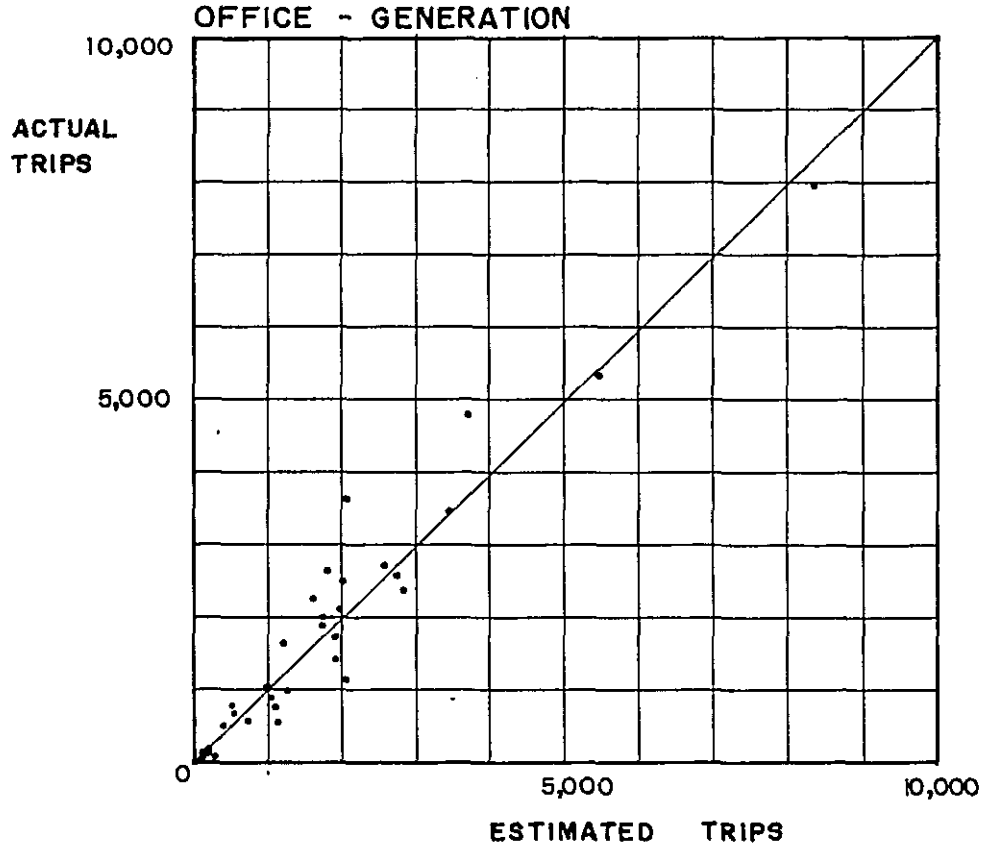
3.3 Multiple Regression Model

Using indices which have been selected by correlation analysis, function models have been developed. Although multiple regression model could be improved by means of increasing the number of independent variables, it is desirable that models are simple and clear. When a coefficient of correlation of model is more than 0.9, model is judged to be satisfactory. As a result, generation model for the trip purpose of "going home" have been required to have two independent variables. The rest of models have been satisfactory with one independent variable. All multiple regression models with a high coefficient of correlation have been developed. Models at this stage are called preliminary models.

Discrepancy between current value (Person Trip Survey results) and estimated values (computed by in-putting base year data in preliminary models) has been checked. Current values and estimated values have been plotted on the figure as shown in Fig. 2.9. Accuracy of estimated values and the existence of zones which could not be explained by preliminary model have been checked. When zones of which estimated value largely differ from current value exist, the structure of model might be distorted. Preliminary models have been modified by eliminating these zones and modified multiple regression models which are called second models have been developed. Forecast of trip generation/attraction has been made by using second models. Table 2.7 shows second models.

As for zones of which estimated value largely differs from current value, forecast has been made separately by taking into consideration the number of generated/attracted trips which could not be explained by model.

FIG. 2.9 GENERATED / ATTRACTED TRIPS ESTIMATION DIAGRAM



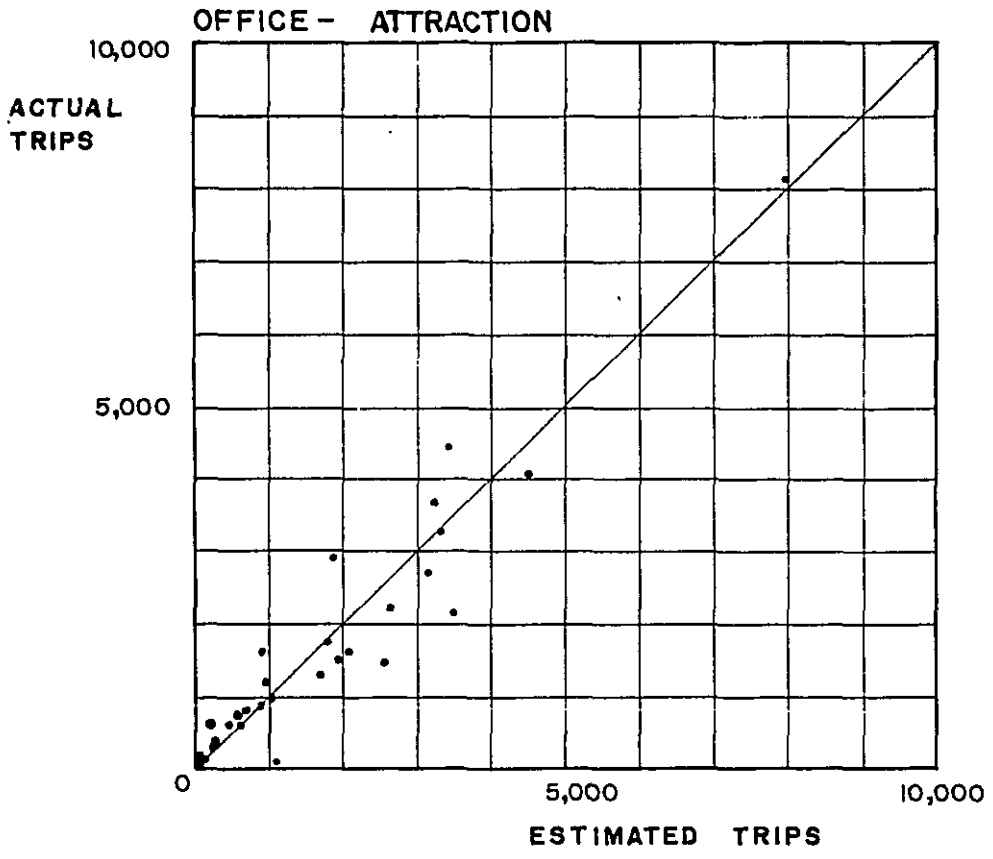


Table 2.7 REGRESSION MODEL BY PURPOSE (FINAL MODEL)

		INDEPENDENT VARIABLE	FORMULA	MULTIPLE CORRELATION
OFFICE	GENERATION	SECONDARY & TERTIARY (Night)	Y = 0.6648X + 134	0.971
	ATTRACTION	—DO— (Day)	Y = 0.8223X − 163	0.975
SCHOOL	GENERATION	PUPILS & STUDENTS (Night)	Y = 0.9904X + 11	0.987
	ATTRACTION	—DO— (Day)	Y = 1.003X − 24	0.999
HOME	GENERATION	(1) SECONDARY & TERTIARY (Day) (2) PUPILS & STUDENTS (Day)	$Y = 1.0940X_1 + 1.2542X_2 - 728$	0.993
	ATTRACTION	POPULATION (Night)	Y = 0.6713X − 438	0.984
BUSINESS	GENERATION	SECONDARY & TERTIARY (Day)	Y = 0.4268X + 278	0.908
	ATTRACTION	—DO— (Day)	Y = 0.6918X − 341	0.962
SHOPPING	GENERATION	POPULATION (Day)	Y = 0.1022X − 253	0.943
	ATTRACTION	TERTIARY (Day)	Y = 0.4777X − 353	0.903
PRIVATE	GENERATION	POPULATION (Day)	Y = 0.4563X − 365	0.962
	ATTRACTION	—DO— (Day)	Y = 0.3981X − 8	0.937

3.4 Results of forecast (Year 2000)

1) Increase of zonal trips

Population in the Project Area in the year 2000 is expected to be 2.50 times as big as that in 1979, whereas increase of trips is expected to be 2.86 times.

Increase of population (1979-2000) by Block is as follows: Block III-B (N) is expected to show the highest increase of 4.75 times, followed by Block I which is expected to increase by 4.41 times, then Block II which will have an increase of 4.24 times. On the other hand, Block II shows the highest trip increase of 6.31 times, followed by Block I and then Block II-B (N). Trip increase in the northern part of the Project Area is outstanding.

Population and trip increase of Block III-A (Poblacion) is quite low compared to other Blocks. Increase of population and trips of Block III-A is estimated to be 1.39 times and 1.67 times, respectively. Accordingly, trip share of Block III-A to the Project Area will decrease from 61% in the year 1979 to 35% in the year 2000. (Refer to Fig.2.10 and Table 2.8).

As for trip density (trips per hectare), at present high trip density is recorded within Poblacion, vicinity of Poblacion (i.e. Agdao and Matina Crossing) and part of Toril. This is especially true with areas within the radius of 2 km from the center of Poblacion. Because of this road/street network is relatively well developed in said areas. In the year 2000, areas with high trip density will become wider centering in Poblacion. When planning transportation facilities in Poblacion, areas within the radius of 4 km from the center of Poblacion must be considered a part of Poblacion. Central zone of each Block such as zones 2012 (Bunawan), 2023 (Panacan) and 5012 (Toril) will have high trip densities, therefore, formation and development of street network in addition to the existing network of major roads might have to be planned.

Table 3.4 GROWTH RATE OF POPULATION AND TRIPS IN THE YEAR 2000 (Unit : Trip)

	POPULATION				GROWTH RATE OF POPULATION (2000 / 1979)		GENERATED/ATTRACTED TRIPS						GROWTH RATE OF TRIPS	TRIP RATE		REMARKS
	1979		2000				1979			2000						
	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	GENERATION	ATTRACTION	TOTAL	GENERATION	ATTRACTION	TOTAL		PER NIGHT POPULATION	PER DAY POPULATION	
2011	3,930	4,063	15,000	12,200	5.82	3.00	5415	5381	10796	23269	23289	46558	4.31	2.04	2.57	
2012	8,540	8,074	45,000	50,800	5.27	6.29	12155	12204	24359	104195	105960	210155	8.63	3.07	2.78	
2013	960	984	10,000	6,900	10.42	7.01	1343	1371	2714	12835	13054	25889	9.54	1.70	2.52	
2021	11,520	9,446	28,000	31,000	2.43	3.28	17555	17347	34902	60107	59075	119182	3.41	2.80	2.58	
SAN ISIDRO	—	—	10,000	6,700	—	—	—	—	—	12863	13253	26116	—	1.71	2.62	
ACACIA	—	—	2,000	1,700	—	—	—	—	—	2178	2258	4436	—	1.46	1.75	
Block I Sub-Total	24,350	22,567	110,000	109,300	4.41	4.84	36468	36303	72771	215447	216889	432336	5.94	2.59	2.65	
2022	4,790	4,010	15,000	12,200	3.13	3.04	7321	7491	14812	25092	25112	50204	3.39	2.20	2.76	
2023	11,260	11,522	75,000	91,600	6.66	7.95	14207	14486	28693	185794	184858	370652	12.92	3.25	2.71	
3011	14,820	16,765	25,000	22,900	1.71	1.36	21651	21947	43598	45409	45914	91323	2.09	2.40	2.69	
MUDIANG	—	—	5,000	3,100	—	—	—	—	—	6103	6032	12135	—	1.60	2.62	
COMMUNAL	—	—	10,000	6,500	—	—	—	—	—	12440	13040	25480	—	1.68	2.63	
Block II Sub-Total	30,670	32,297	130,000	136,200	4.24	4.22	43179	43924	87103	274836	274958	549794	6.31	2.78	2.71	
1010	3,910	4,691	4,500	6,800	1.15	1.45	9666	9676	19342	14049	13877	27926	1.44	4.09	2.76	
1020	13,000	38,454	13,800	38,900	1.06	1.01	77026	77788	154814	92941	93309	186250	1.07	7.93	2.87	
1030	4,650	9,144	5,000	9,100	1.08	1.27	24550	24820	49370	28569	28923	57492	1.16	7.56	4.24	
1040	13,040	13,769	22,500	24,200	1.73	1.76	23799	24038	47837	51273	50531	101804	2.13	2.97	2.83	
1050	5,790	10,057	13,800	14,700	2.83	1.46	17084	17453	34537	28745	28182	56927	1.65	2.71	2.60	
1060	12,060	9,600	35,800	23,400	2.97	2.44	17785	18019	35804	50635	52467	103102	2.88	1.90	2.95	
1070	14,950	17,930	18,200	26,500	1.22	1.48	34505	34301	68806	54954	52573	107527	1.56	3.88	2.72	
1080	18,220	24,326	20,800	30,700	1.14	1.26	51256	51176	102432	65004	63714	128718	1.26	4.08	2.82	
1090	29,450	20,198	27,400	26,400	0.93	1.31	38380	38197	76577	61938	62186	124124	1.62	2.99	3.16	
1100	7,990	10,637	9,200	13,800	1.04	1.30	29965	30002	60007	36572	36144	72716	1.21	5.84	3.54	
3031	45,210	35,700	50,000	63,900	1.11	1.79	65351	64590	129941	132960	127962	260922	2.01	3.44	2.74	
4021	11,670	9,760	30,000	32,100	2.57	3.29	12386	12293	24679	68054	68172	136226	5.52	2.99	2.95	
Block III-A Sub-Total	179,880	202,266	250,000	310,500	1.39	1.54	401753	402393	804146	675694	668040	1343734	1.67	3.54	2.91	
3012	6,990	9,324	40,000	30,700	5.72	3.29	11803	11848	23651	60956	62866	123822	5.24	2.03	2.71	
3021	16,180	11,614	60,000	47,400	3.71	4.08	19974	19655	39629	97901	99509	197410	4.98	3.17	2.80	
4011	12,470	9,563	60,000	50,300	4.81	5.26	14046	14097	28143	105129	104261	209390	7.44	2.30	2.80	
4012	1,810	1,586	10,000	6,800	5.52	4.29	1980	1931	3911	12396	13413	25811	6.60	1.69	2.55	
4022	28,990	21,865	36,000	28,800	1.24	1.32	46987	47517	93504	63990	61522	125512	1.34	2.30	2.92	
4031	4,140	3,941	25,000	20,000	6.04	5.07	6175	6209	12384	41468	41987	83455	6.74	2.20	2.80	
4032	14,070	12,433	40,000	40,600	2.84	3.27	21965	21660	43625	82671	84675	167346	3.84	2.75	2.77	
CABANTIAN	—	—	10,000	6,800	—	—	—	—	—	12398	13413	25811	—	1.69	2.55	
CATALUNAN GRANDE	—	—	5,000	3,700	—	—	—	—	—	5993	6336	12329	—	1.63	2.24	
CATALUNAN PEQUEÑO	—	—	4,000	3,000	—	—	—	—	—	4905	5029	9934	—	1.64	2.23	
Block III-B Sub-Total	84,650	70,326	290,000	238,100	3.43	3.39	122930	121917	244847	487809	493011	980820	4.01	2.23	2.77	
4041	4,670	3,620	22,000	18,800	4.71	5.19	4968	5002	9970	35875	36557	72432	7.26	2.17	2.59	
4042	520	515	3,000	2,000	5.77	3.88	483	516	999	3659	3847	7506	7.51	1.65	2.52	
4043	3,660	4,050	17,000	14,700	4.64	3.63	7221	7415	14636	29689	29679	59348	4.05	2.30	2.71	
5011	8,630	7,430	15,000	13,700	1.74	1.84	15477	15277	30754	28275	27811	56086	1.82	2.46	2.75	
5012	11,690	12,470	34,000	40,100	2.91	3.22	19969	19852	39816	81239	83350	164589	4.13	3.19	2.75	
5021	7,840	6,964	14,000	18,200	1.79	2.61	9727	9571	19298	30681	30283	60934	3.16	2.87	2.25	
5022	2,840	2,240	10,000	13,500	3.52	6.03	1301	1301	2602	24490	23274	47764	18.36	3.15	2.37	
LUBOGAN	—	—	5,000	2,900	—	—	—	—	—	6326	6367	12693	—	1.67	2.93	
Block IV Sub-Total	39,850	37,289	120,000	123,900	3.01	3.32	59141	58936	118077	240214	241138	481352	4.08	2.64	2.61	
GRAND TOTAL	363,000	364,745	900,000	918,000	1.50	2.52	663471	663471	1326942	1894002	1894334	3788336	2.86	2.72	2.77	

Fig.2.10 FUTURE POPULATION & NUMBER OF TRIPS BY BLOCKS

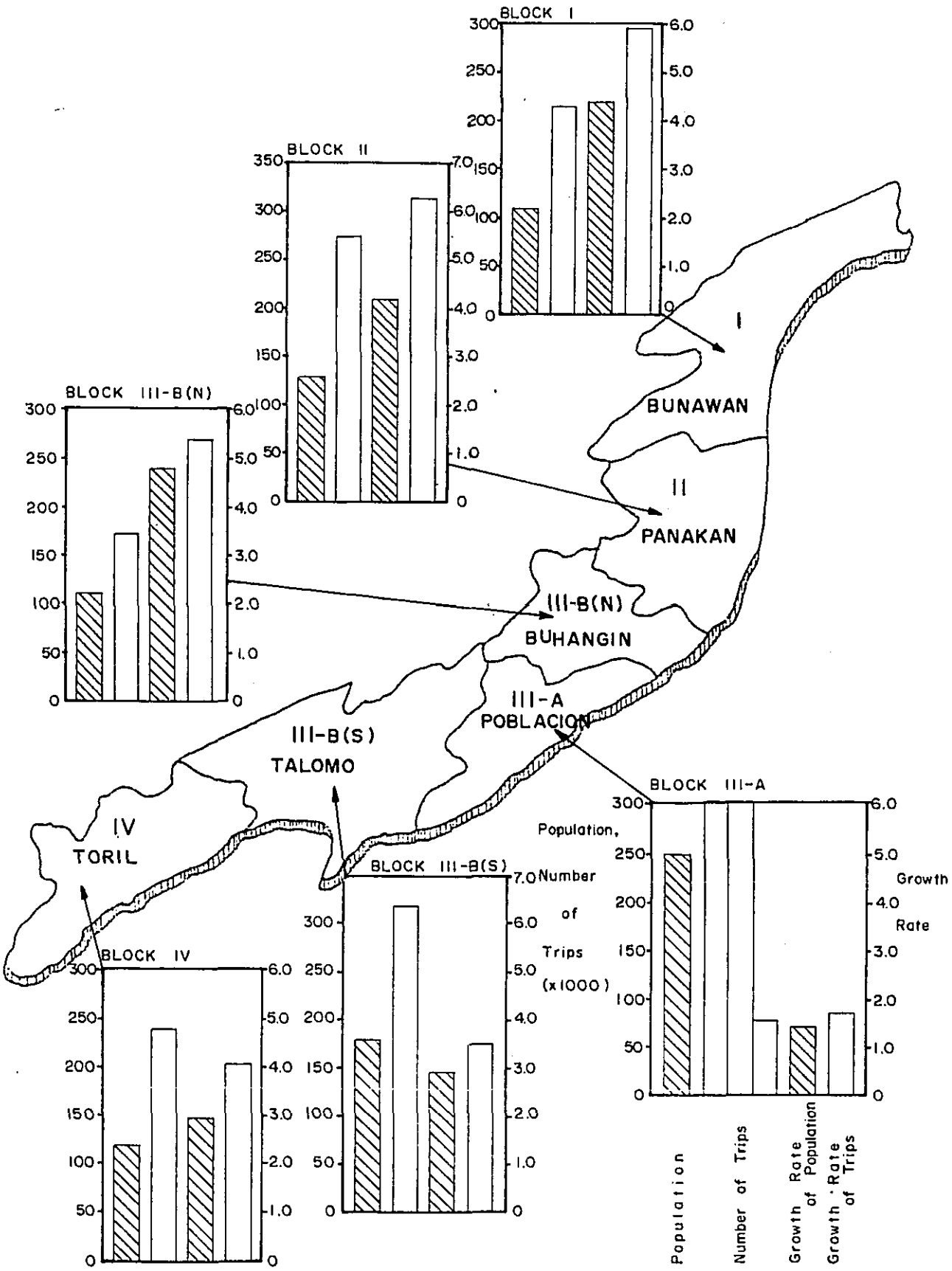


Fig. 2.11 TRIP DENSITY IN THE YEAR 2000

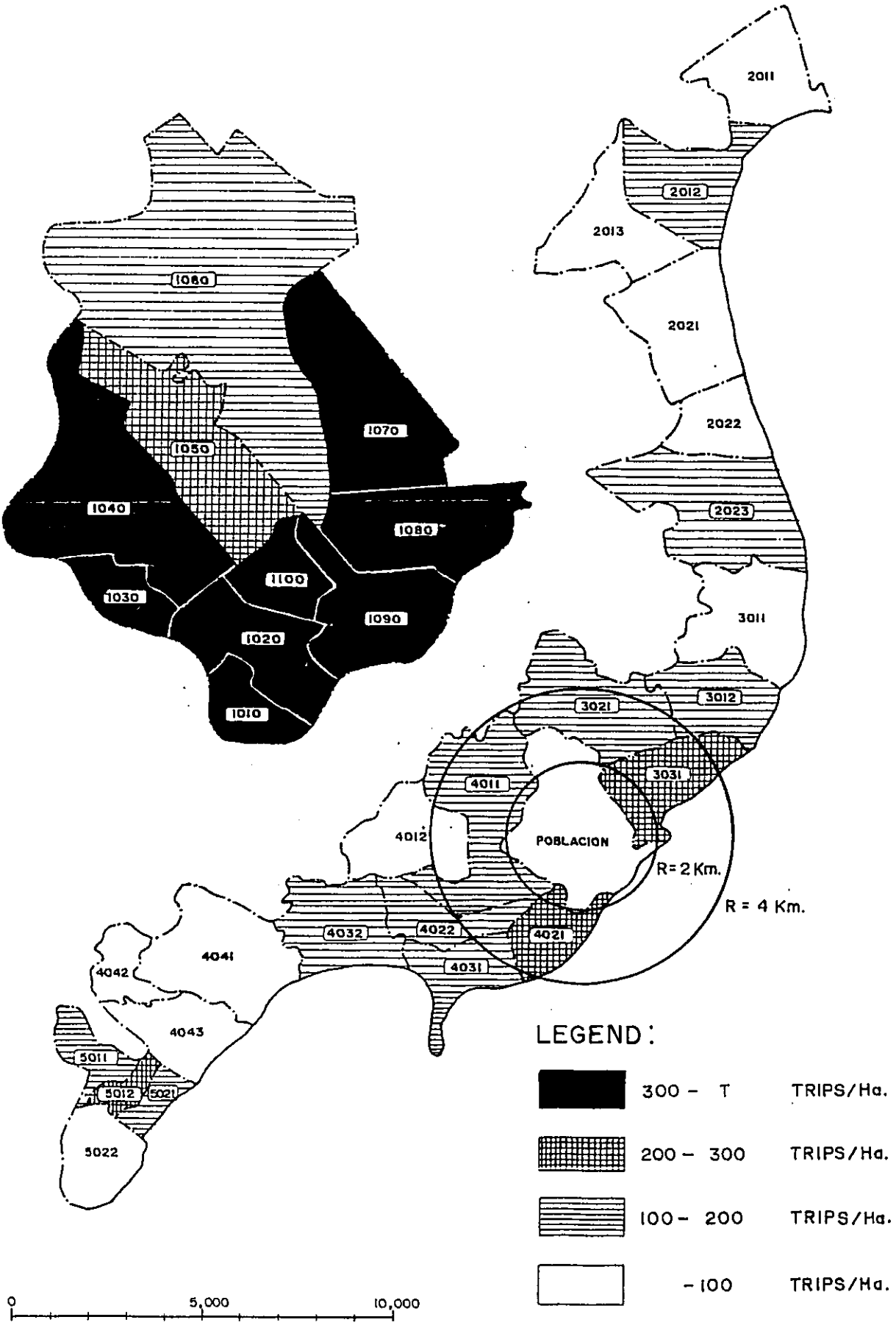
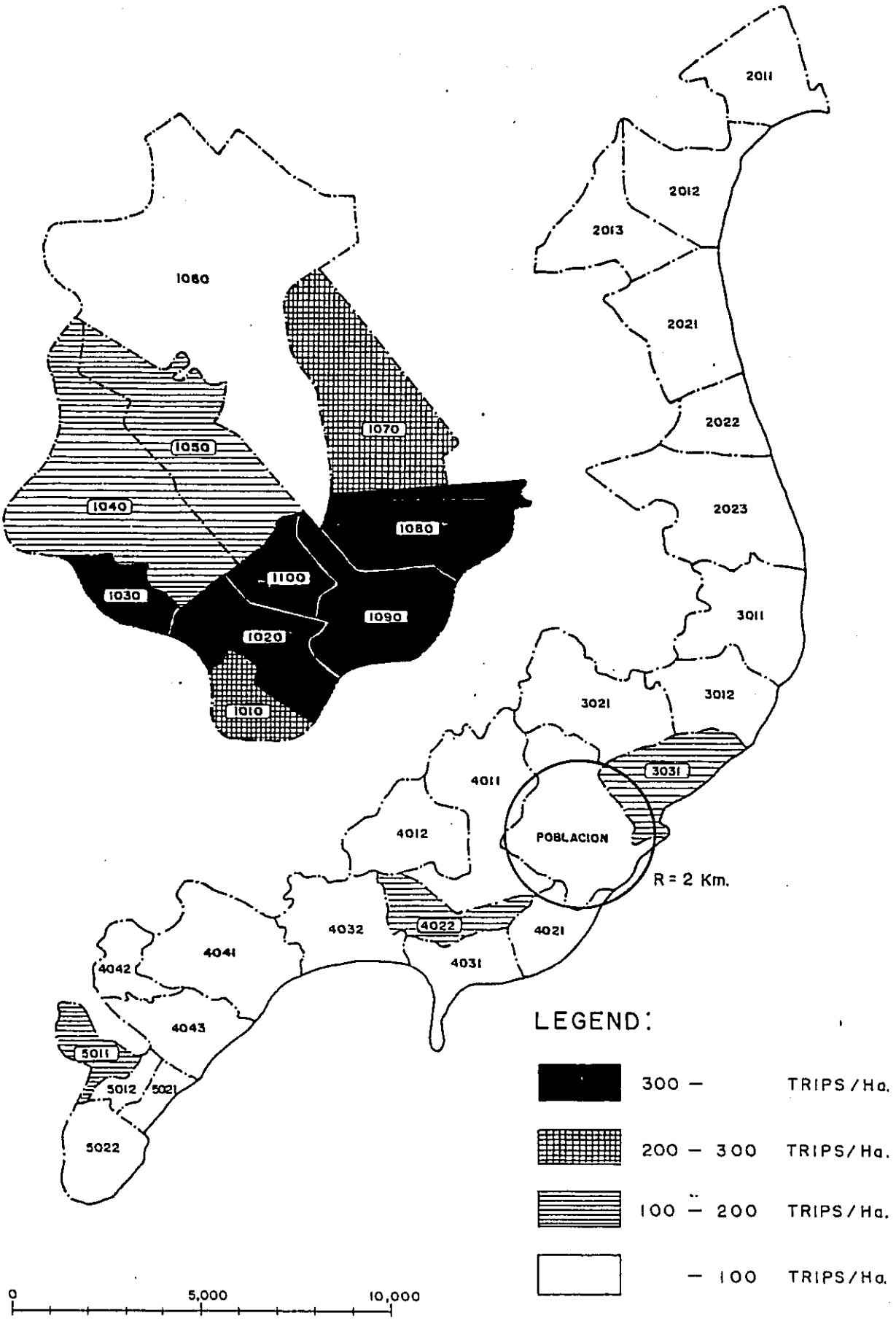


Fig. 2.12 TRIP DENSITY IN THE YEAR 1979



2) Zonal Characteristics

Judging from trip purpose share, characteristics of each Block are as follows;

i) Block I (Bunawan)

Generated trips for the purpose of "going to Office" are estimated to be more than attracted trips for the same purpose. Although business area is allocated within the Block, this Block is characterized as a residential area as a whole.

ii) Block II (Panacan)

As for trip purpose of "going to office",attracted trips exceed generated trips. Share of trips for the purpose of "business" is also high. This Block is characterized as a business area.

iii) Block III-B

Generated trips for the purposes of "going to office" and "going to school" have high share, while share of attracted trips for the same purposes is low. This Block is typically a residential area.

iv) Block III-A

Share of attracted trips for the purposes of "going to office" and "shopping" and generated/ attracted trips for the purpose of "business" is high. This Block is characterized as the central business district of the Project Area.

v) Block IV

Trip purpose share of this Block is almost the same as that of the Project Area. This Block is considered independent and is creating its own sphere of life.

Table 2.9 GENERATED AND ATTRACTED TRIPS BY BLOCK (2000)

(UNIT: TRIP)

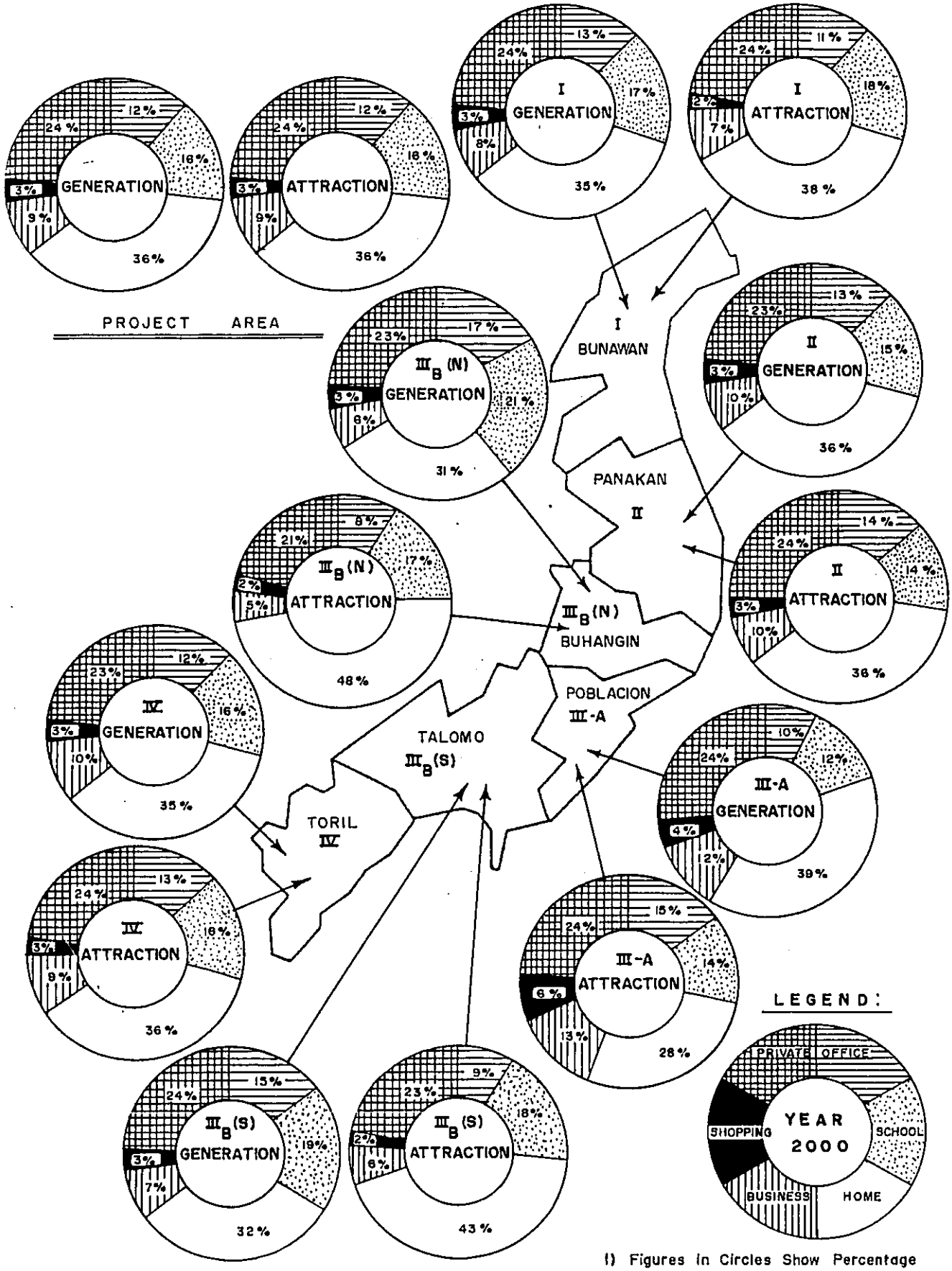
			OFFICE	SCHOOL	HOME	BUSINESS	SHOPPING	PRIVATE	TOTAL
BLOCK I	NUMBER OF TRIPS	GENERATION	28 113	35 720	76 224	16 842	7 157	51 391	215 447
		ATTRACTION	23 542	38 515	81 903	15 726	4 244	52 958	216 889
	SHARE OF PURPOSE (%)	GENERATION	13.0	16.6	35.4	7.8	3.3	23.9	100.0
		ATTRACTION	10.9	17.8	37.8	7.3	2.0	24.4	100.0
BLOCK II	NUMBER OF TRIPS	GENERATION	34 310	42 191	99 311	26 018	9 310	63 696	274 838
		ATTRACTION	38 615	39 354	98 679	26 745	6 878	64 685	274 956
	SHARE OF PURPOSE (%)	GENERATION	12.5	15.4	36.1	9.5	3.4	23.2	100.0
		ATTRACTION	14.0	14.3	35.9	9.7	2.5	23.5	100.0
BLOCK III_B(N)	NUMBER OF TRIPS	GENERATION	28 686	35 686	52 607	9 871	5 426	38 979	171 255
		ATTRACTION	13 216	30 145	84 121	8 150	2 968	37 188	175 788
	SHARE OF PURPOSE (%)	GENERATION	16.8	20.8	30.7	5.8	3.2	22.8	100.0
		ATTRACTION	7.5	17.1	47.9	4.6	1.7	21.2	100.0
BLOCK III_A	NUMBER OF TRIPS	GENERATION	66 686	83 055	261 269	78 391	24 222	162 070	675 694
		ATTRACTION	100 498	91 786	188 324	87 559	37 123	162 744	668 040
	SHARE OF PURPOSE (%)	GENERATION	9.9	12.3	38.7	11.6	3.6	24.0	100.0
		ATTRACTION	15.0	13.7	28.2	13.1	5.6	24.4	100.0
BLOCK III_B(S)	NUMBER OF TRIPS	GENERATION	47 595	58 419	101 874	21 783	10 446	76 437	316 554
		ATTRACTION	26 919	56 503	136 591	17 398	5 807	74 005	317 223
	SHARE OF PURPOSE (%)	GENERATION	15.0	18.6	32.2	6.9	3.3	24.1	100.0
		ATTRACTION	8.5	17.8	43.1	5.5	1.8	23.3	100.0
BLOCK IV	NUMBER OF TRIPS	GENERATION	27 775	38 982	84 741	24 334	8 071	56 311	240 214
		ATTRACTION	30 378	37 756	86 409	21 664	7 611	57 320	241 138
	SHARE OF PURPOSE (%)	GENERATION	11.6	16.2	35.3	10.1	3.4	23.4	100.0
		ATTRACTION	12.6	15.7	35.8	9.0	3.2	23.8	100.0
TOTAL	NUMBER OF TRIPS	GENERATION	233 165	294 053	676 026	177 239	64 632	448 884	1 894 002
		ATTRACTION	233 168	294 055	676 029	177 242	64 629	448 900	1 894 034
	SHARE OF PURPOSE (%)	GENERATION	12.3	15.5	35.7	9.4	3.4	23.7	100.0
		ATTRACTION	12.3	15.5	35.7	9.4	3.4	23.7	100.0

Table 2.10 FUTURE GENERATED / ATTRACTED TRIPS BY PURPOSE

(Unit: Trip End)

	NUMBER OF TRIP ENDS BY PURPOSE (GENERATED TRIPS + ATTRACTED TRIPS)							REMARKS	SHARE OF PURPOSE							REMARKS
	OFFICE	SCHOOL	HOME	BUSINESS	SHOPPING	PRIVATE	TOTAL		OFFICE	SCHOOL	HOME	BUSINESS	SHOPPING	PRIVATE	TOTAL	
2011	5 870	9 020	17 707	2 833	953	10 175	46 558		13	19	38	6	2	22	100	
2012	27 900	28 918	73 506	21 167	6 399	52 265	210 155		13	14	35	10	3	25	100	
2013	3 194	4 957	10 038	1 441	493	5 766	25 889		12	19	39	6	2	22	100	
2021	10 941	25 483	45 247	5 447	2 967	29 097	119 182		9	21	38	5	2	24	100	
SAN ISIDRO	3 340	4 957	10 038	1 441	479	5 861	26 116		13	19	38	6	2	22	100	
A C A C I A	410	900	1 591	239	111	1 185	4 436		9	20	36	5	3	27	100	
Block I Sub-Total	51 655	74 235	158 127	32 568	11 401	104 349	432 336		12	17	37	7	3	24	100	
2022	6 376	8 918	18 699	3 395	1 264	11 552	50 204		13	18	37	7	2	23	100	
2023	49 489	50 241	130 359	39 969	11 889	88 705	370 652		13	14	35	11	3	24	100	
3011	11 999	15 000	34 312	7 695	2 237	20 072	91 323		13	16	38	8	2	22	100	
MUDIANG	1 718	2 421	4 685	588	336	2 387	12 135		14	20	38	5	3	20	100	
C O M M U N A L	3 343	4 957	9 935	1 116	463	5 666	25 480		13	19	39	4	2	22	100	
Block II Sub-Total	72 925	81 545	197 990	52 763	16 188	128 381	549 794		13	15	36	10	3	23	100	
1010	3 245	4 355	9 404	3 633	988	6 301	27 926		12	16	34	13	4	23	100	
1020	14 624	27 901	53 989	16 962	8 104	44 670	166 250		9	17	32	10	5	27	100	
1030	3 875	4 660	21 208	9 827	8 846	9 076	57 492		7	8	37	17	15	16	100	
1040	13 559	13 639	34 757	12 661	3 808	23 380	101 804		13	13	34	12	4	23	100	
1050	5 288	12 482	21 232	2 505	1 414	14 006	56 927		9	22	37	4	2	25	100	
1060	15 913	13 416	38 692	9 711	2 873	22 497	103 102		15	13	38	9	3	22	100	
1070	13 036	15 323	35 770	13 585	4 127	25 686	107 527		12	14	33	13	4	24	100	
1080	16 835	15 015	40 905	19 379	6 970	29 614	128 718		13	12	32	15	5	23	100	
1090	17 374	12 868	36 338	18 501	5 459	33 584	124 124		14	10	29	15	4	27	100	
1100	7 265	7 304	23 636	9 478	3 817	21 216	72 716		10	10	33	13	5	29	100	
3031	37 709	29 929	89 032	32 226	9 725	62 301	260 922		14	11	34	12	4	24	100	
4021	18 461	17 952	44 630	17 482	5 218	32 483	136 226		14	13	33	13	4	24	100	
Block III-A Sub-Total	167 184	174 841	449 593	165 950	61 345	324 814	1343 734		12	13	33	12	5	24	100	
3012	15 586	23 940	49 997	6 832	3 267	24 210	123 822		13	19	40	6	3	20	100	
3021	23 193	36 934	76 806	10 073	4 640	45 764	197 410		12	19	39	5	2	23	100	
4011	25 978	35 920	79 638	13 598	5 306	48 950	209 390		12	17	38	6	3	23	100	
4012	3 123	4 957	9 935	1 116	487	6 193	25 811		12	19	38	4	2	24	100	
4022	15 551	22 521	47 368	9 013	3 214	27 845	125 512		12	18	38	7	3	22	100	
4031	10 298	15 008	31 638	5 082	1 590	19 849	83 455		12	18	38	6	2	24	100	
4032	17088	32 079	61 476	9 293	5 069	42341	167 346		10	19	37	6	3	25	100	
C A B A N T I A N	3 123	4 957	9935	1 116	487	6 193	25 811		12	19	38	4	2	24	100	
C A T A L U N A N G R A N D E	1 280	2 421	4 732	588	332	2 976	12 329		10	20	38	5	3	24	100	
C A T A L U N A N P E Q U E Ñ O	1 106	2 016	3 778	491	255	2 288	9 934		11	20	38	5	3	23	100	
Block III-B Sub-Total	116 416	180 749	375 195	57 202	24 645	226 609	980 820		12	18	38	6	2	23	100	
4041	9 336	13 080	28 446	5 243	2 312	14 015	72 432		13	18	39	7	3	19	100	
4042	1 035	1 509	3 068	394	193	1 307	7 506		14	20	41	5	3	17	100	
4043	7 239	10 441	22 037	4 079	1 546	14 006	59 348		12	18	37	7	3	24	100	
5011	7 162	9 529	20 435	4 373	1 563	13 024	56 086		13	17	36	8	3	23	100	
5012	17 044	26 390	54 826	16 486	7 177	42 566	164 589		10	16	33	10	4	26	100	
5021	6 393	8 411	20 125	6 709	1 849	17 441	60 934		10	14	33	11	3	29	100	
5022	7 978	4 957	17 031	7 986	771	9 041	47 764		17	10	36	17	2	19	100	
L U B O G A N	1 966	2 321	5 182	722	271	2 131	12 593		15	18	41	6	2	17	100	
Block IV Sub-Total	58 153	76 638	171 150	45 998	15 682	113 631	491 352		12	16	36	10	3	24	100	
GRAND TOTAL	468 333	559 108	1 352 055	354 481	129 261	897 784	3 798 036		12	16	36	9	3	24	100	

Fig. 2.13 TRIP PURPOSE SHARE BY EACH BLOCKS IN THE YEAR 2000



1) Figures in Circles Show Percentage Distribution of Purpose for the Year 2000.

CHAPTER 4
TRIP DISTRIBUTION FORECAST

4.1 Outline

O-D values are fundamental data necessary for formulating transportation facility planning and transportation policy. Forecast of O-D values in terms of person trips is the objective of this step. Future O-D values (trip distribution) by purpose is to be obtained from future generated/attracted trips by purpose as estimated in the preceding step.

O-D values are grouped into three categories as illustrated in Fig. 2.14.

a) Zone pair trips
b) Intrazonal trips

} Internal trips - Trips inside the Project Area

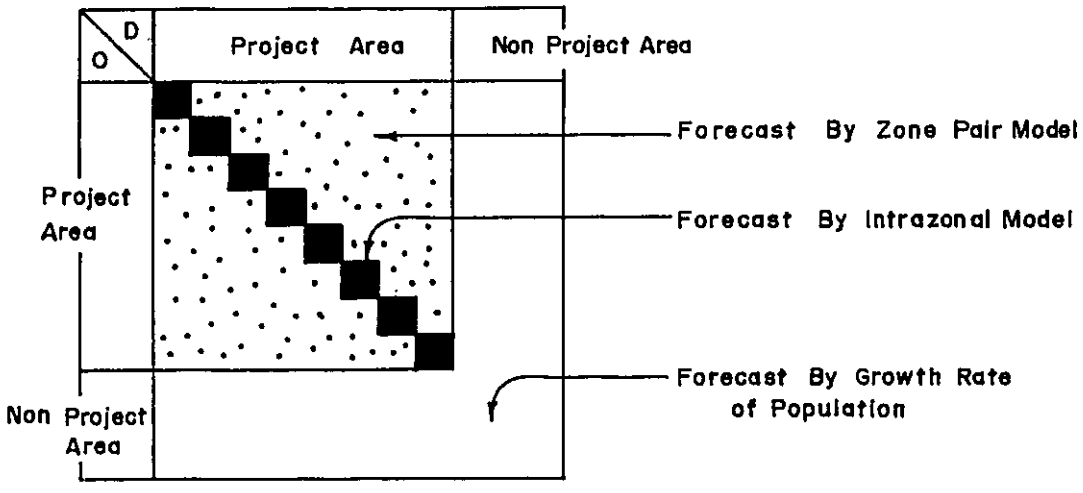
c) External and through trips - Trips outside the Project Area

O-D values should not be forecasted by one kind of model or method but preferably by different kinds of model or method suitable for each O-D category.

One of the characteristics of the Person Trip Survey which aims at obtaining all trips made by a person is that share of intrazonal trips is substantially high. Most of intrazonal trips are short distance trips which are mostly made by walking. Generally, it is known that forecast of intrazonal trips by zone pair model produces inaccurate results. It is decided that forecast of intrazonal trips be made by intrazonal model.

Number of external and through trips is much less than that of internal trips (The Project Area must be determined so as to result in small number of external and through trips). As the result of the Person Trip Survey shows, share of external and through trips in 1979 is about 3% of total trips. Impact of these trips on traffic facility planning is estimated to be very minor, therefore, forecast of O-D value for external and through trips is to be made by simple method using population growth rate.

FIG. 2.14 **Sphere of Forecast By Each Models**



4.2 Zone Pair Model

1) Selection of Gravity Model

Zone pair models are classified largely into the following 3 methodological types:

(i) Present pattern model - Future O-D values are projected by expanding present O-D pattern.

(ii) Gravity model - This is the application of Newton's law of gravity to trip distribution.

(iii) Opportunity model - This is one of probability models. Distance between zones is substituted as the order of nearness of a zone.

The selection of model for the forecast of future trips distribution depends on the degree of future transportation facilities development and changes in land use and industrial structure. When little change is expected of such facilities and trip distribution pattern, the most likely candidate is a present pattern model, while, when substantial changes are expected, as in this Project, gravity models and opportunity models are more suitable.

Between gravity models and opportunity models, the former compare favorably to the lattern in that the former have simpler model structures and easily handled, while the latter are suited to generally urbanized areas rather than areas where zones with different degress of urbanization co-exist, as in the Project Area. Therefore, the forecast hereby is to rely fundamentally on a gravity model.

2) Structure of zone pair model

The gravity model is formulated on the assumptions that number of trips between zones is proportionate to number of generated trips and attracted trips of each zone and is inversely proportionate to resistance (distance) between zones. Basic Formula of the gravity model is expressed below:

$$Xij = K \cdot \frac{Gi^{\alpha} \cdot Aj^{\beta}}{Tij^{\gamma}}$$

where: Xij = number of trips between Zones i and j
Gi = generated trips of zone i
Aj = attracted trips of zone j
Tij = distance between zones i and j
K, α, β, γ = parameter

There are several definitions as to distance between zones. It is defined in this Study to be the distance of the minimum path route between zones on road network which is searched by simulation.

As the structure of model is simple and clear and application is easy, the basic gravity model mentioned above is likely to be used, however, the disadvantage of the model is that long distance trips tend to be over-estimated. In this Study, land use pattern is defined as multi-center type in 2000, that is each block will have a sub-center creating a small size of sphere of life. When we try to reflect concept of land use on traffic demand forecast, it is not desirable if long distance trips are over estimated. Therefore, modification of gravity model became necessary.

Finally, the model selected for distribution model is the modified gravity model which is basically Voorhee's gravity model developed by A.M. Voorhee and is additionally taken into consideration as factor of zonal linkage. It is illustrated by the following formula:

$$Xij = B_{MN} \cdot Gi \cdot \frac{Aj \cdot Tij^{-\gamma}}{\sum_{\substack{j=1 \\ (j=i)}}^{n} Aj \cdot Tij^{-\gamma}}$$

Where:

B_{MN} = coefficient of access which expresses the intensity of zonal linkage between blocks M and N

3) Determination of Parameter

a) Determination of γ

When determining γ , repeated computation based on the current O-D table has been conducted by a computer until γ has been found which made discrepancy between estimated values and current values minimum. The resulting values for γ and the corresponding coefficients of correlation of models are shown in Table 4.1. Coefficients of correlation of any models have been more or less 0.9, so that it is judged that all models have enough accuracy.

TABLE 2.11 γ **and Multiple Correlations of Distribution Models**

PURPOSE	γ	MULTIPLE CORRELATION
OFFICE	0.76	0.888
SCHOOL	1.42	0.914
HOME	0.52	0.905
BUSINESS	0.50	0.847
SHOPPING	0.88	0.892
PRIVATE	0.70	0.897

b) Determination of coefficient of access

Coefficient of access which expresses intensity of zonal linkage in the future has been determined by taking into account current coefficient of access and concept of future land use plan. As a prior step in determining coefficient of access, sphere of influence of a block by trip purpose which is closely related to intensity of zonal linkage has been defined. As intensity of zonal linkage is dependent on a trip purpose, therefore, sphere of influence for each trip purpose has been defined.

Explanation is made below how sphere of influence has been defined. Fig.2.12 shows the area which has strong linkage with a specific block.

i) Trip purpose of "going to office" and "business"

Trips of these two purposes have relatively longer trip length, accordingly sphere of influence is wider. Poblacion will still be the center of business. In addition to Poblacion, sub-centers of business will be created in Blocks I, II and IV. Within those Blocks, concentration of trips of these two purposes in Block II will be intensive, So spheres of influence of Poblacion and Block II are considered to be fairly wide, on the other hand, those of Blocks I and IV are considered not to be very wide.

ii) Trip purpose of "going to school"

Trips of this purpose have short trip length. Compared to trip purpose of "going to office", most trips of this purpose are completed within the Block, therefore sphere of influence is expected to be small. Only adjacent Blocks are considered to have strong linkage with the Block.

iii) Trip purpose of "shopping"

Currently most shopping trips are concentrated in Poblacion. Concentration in Block IV is also observed, although number of trips is quite small.

Even though a commercial center will be developed in each Block in the future, tendency of concentration of shopping trips in Poblacion will be expected to remain, therefore all of the Project Area are considered to have strong linkage with Poblacion.

iv) Trip purpose of "private"

Trips of this purpose have a high rate of completing themselves within the Block. Future generated/attracted trips are also forecast to have the same nature as present. Only adjacent Blocks are considered to have strong linkage with the Block.

Table 2.12 MAGNITUDE OF ATTRACTION BY PURPOSE YEAR 2000

OFFICE

BLOCK NAME	TRIPS INTO BLOCK (A)	TRIPS FROM BLOCK (B)	(A) - (B)
BLOCK I	23500	28100	-4600
BLOCK II	38600	34300	4 300
BLOCK III_B(N)	13200	28700	-15500
BLOCK IV_A	100500	66700	33800
BLOCK IV_B(S)	26 900	47 600	-20 700
BLOCK IV	30400	27800	2600

BUSINESS

BLOCK NAME	TRIPS INTO BLOCK (A)	TRIPS FROM BLOCK (B)	(A) - (B)
BLOCK I	15700	16800	-1100
BLOCK II	26700	26000	700
BLOCK III_B(N)	8200	9900	-1700
BLOCK IV_A	87600	78400	9200
BLOCK IV_B(S)	17400	21800	-4400
BLOCK IV	21700	24300	-2600

SCHOOL

BLOCK NAME	TRIPS INTO BLOCK (A)	TRIPS FROM BLOCK (B)	(A) - (B)
BLOCK I	38500	35700	2800
BLOCK II	39400	42200	-2800
BLOCK III_B(N)	30100	35700	-5600
BLOCK IV_A	91800	83100	8700
BLOCK IV_B(S)	56500	58400	-1900
BLOCK IV	37800	39000	-1200

SHOPPING

BLOCK NAME	TRIPS INTO BLOCK (A)	TRIPS FROM BLOCK (B)	(A) - (B)
BLOCK I	4200	7200	-3000
BLOCK II	6900	9300	-2400
BLOCK III_B(N)	3000	5400	-2400
BLOCK IV_A	37100	24200	12900
BLOCK IV_B(S)	5800	10400	-4600
BLOCK IV	7600	8100	-500

HOME

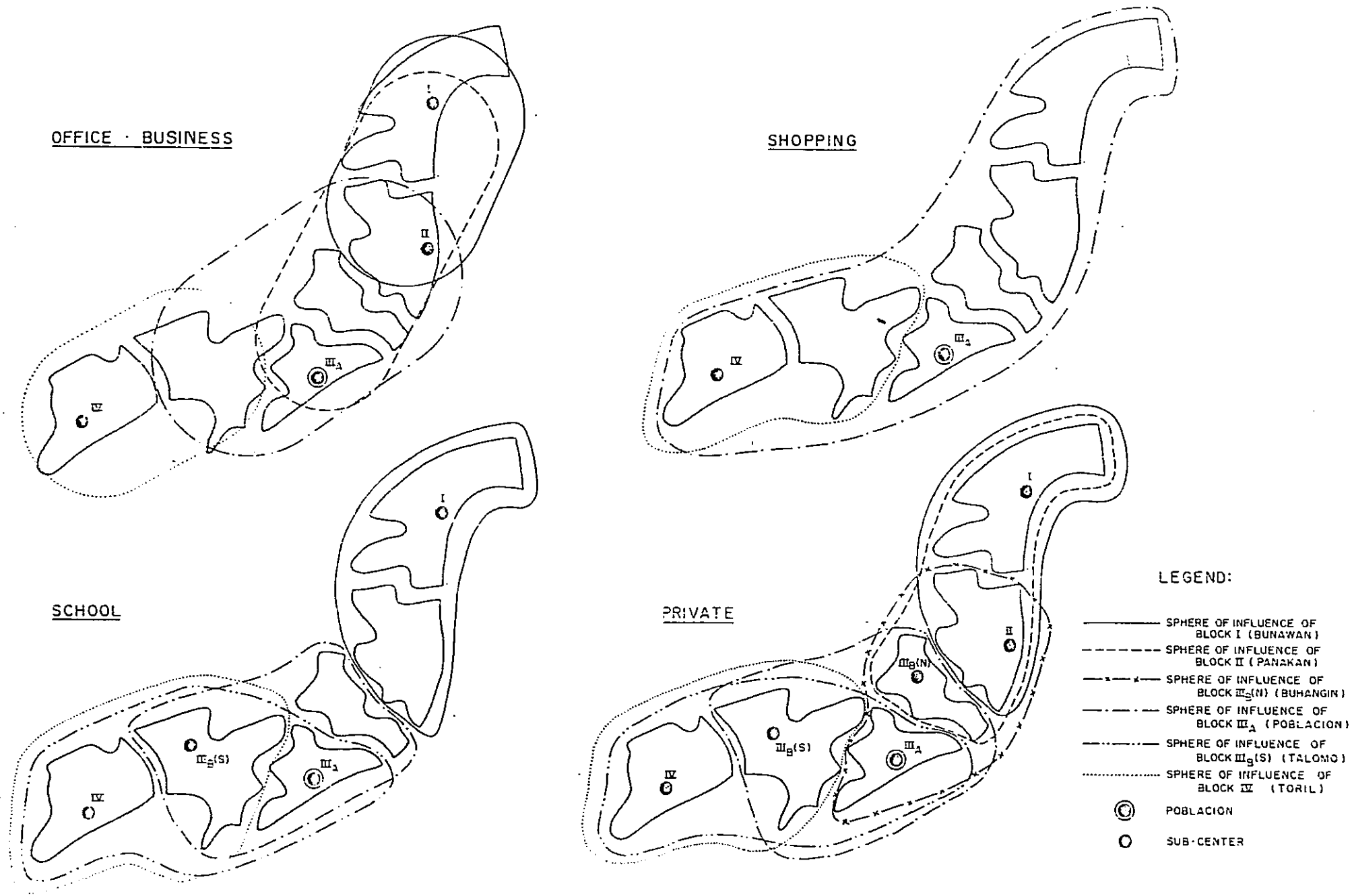
BLOCK NAME	TRIPS INTO BLOCK (A)	TRIPS FROM BLOCK (B)	(A) - (B)
BLOCK I	81900	76200	5700
BLOCK II	98700	99300	-600
BLOCK III_B(N)	84100	52600	31500
BLOCK IV_A	188300	261300	-73000
BLOCK IV_B(S)	136600	101900	34700
BLOCK IV	86400	84700	1700

PRIVATE

BLOCK NAME	TRIPS INTO BLOCK (A)	TRIPS FROM BLOCK (B)	(A) -(B)
BLOCK I	53000	51400	1600
BLOCK II	64700	63700	1000
BLOCK III_B(N)	37200	39000	-1800
BLOCK IV_A	162700	162100	600
BLOCK IV_B(S)	74000	76400	-2400
BLOCK IV	57300	56300	1000

Note : Unit of These Figures is "Person Trip/Day"

Fig. 2.15 SPHERE OF INFLUENCE OF EACH BLOCK IN FUTURE (2000)



4.3 Intrazonal Trip Model

Intrazonal trips are to be forecasted separately from zone pair trips by developing intrazonal trip model.

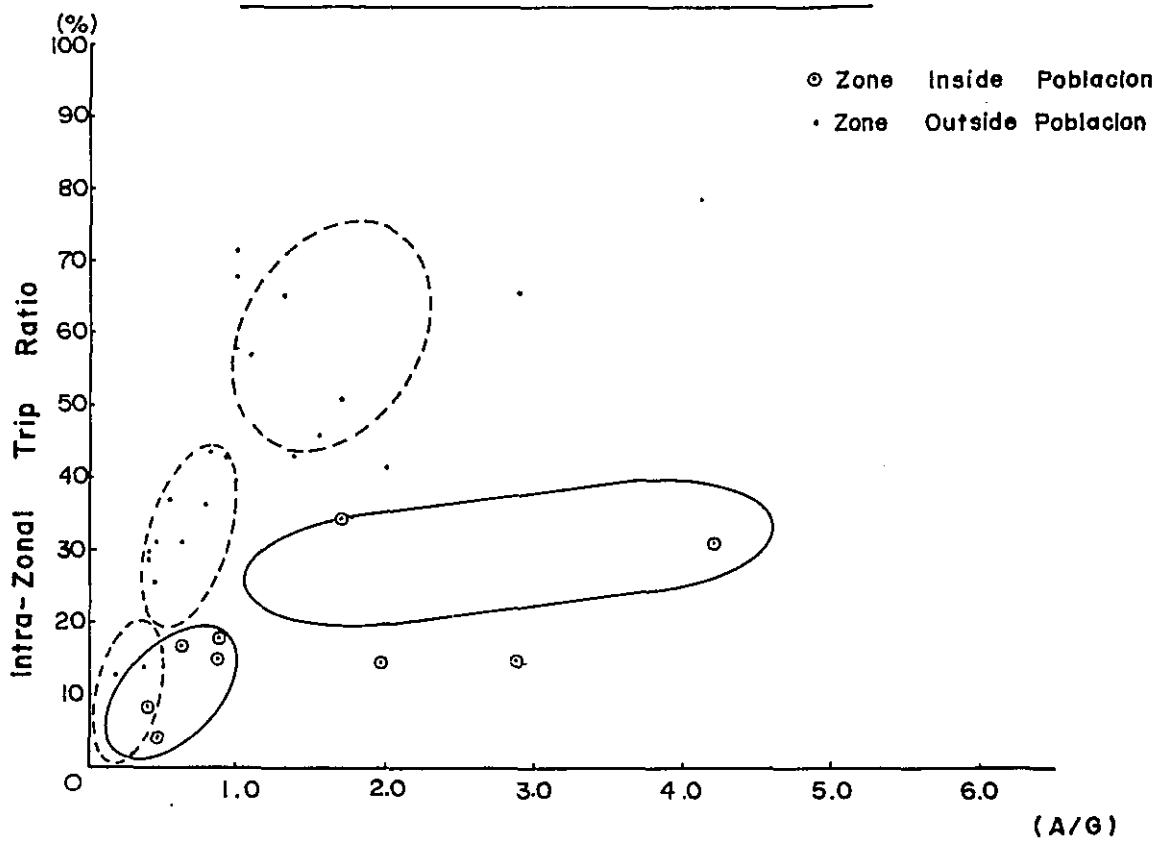
Intrazonal trip models are classified into two types; one is intrazonal trip ratio model which determines the ratio of intrazonal trips to generated/attracted trips and the other is intrazonal trip model which directly determines number of intrazonal trips. Previous studies have not given any answer as to which is the better model. Application of intrazonal trip model to the area where future trips will increase substantially as in the case of this Project will result in rather inaccurate forecast. Intrazonal trip ratio model has been judged to provide relatively stable accuracy and selected for intrazonal trip forecast.

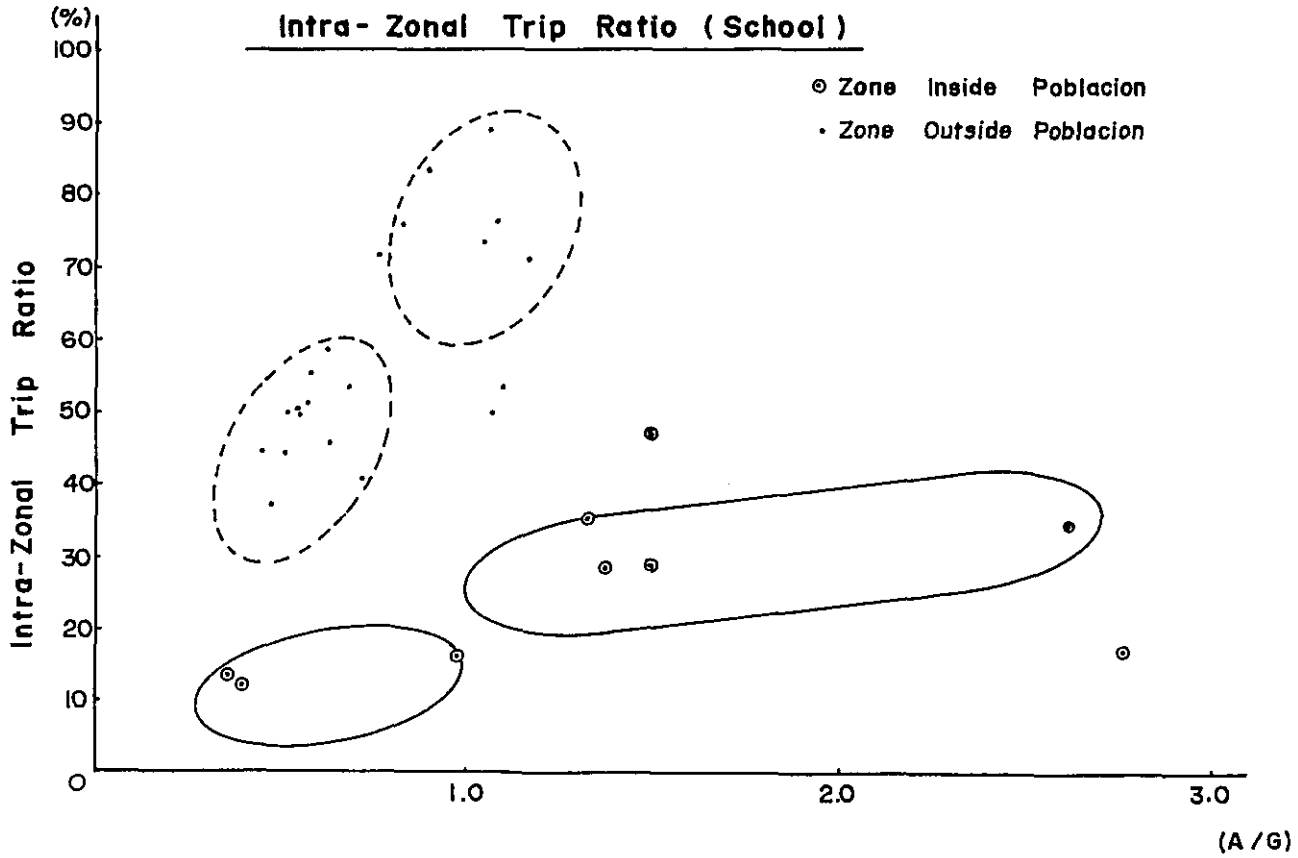
Although zone area and population density are considered to be typical independent variables, several models have been developed using various independent variables and accuracy of models has been checked. Model of which independent variable is the ratio of attracted trips to generated trips (Ai/Gi) has provided satisfactory accuracy for all trip purposes except trip purpose of "private". Index which explains degree of access to other zones (accessibility coefficient) has been selected as an independent variable for model of trip purpose of "private".

As shown in Fig. 2.16, intrazonal trip ratio of Poblacion is quite different from that of zones other than Poblacion. Intrazonal trip ratio model has been developed separately for Poblacion and for the rest of the zones.

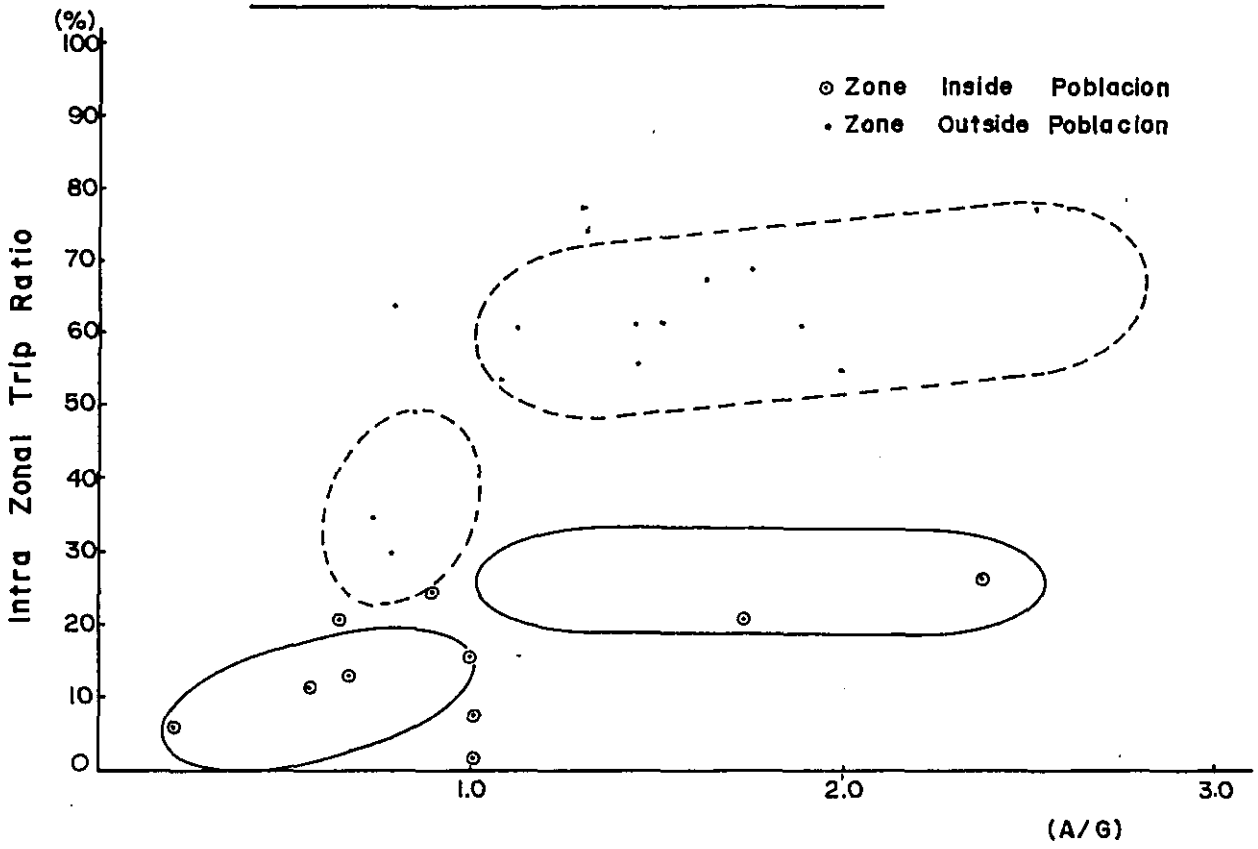
As Fig. 2.16 indicates, ratio of attracted trips to generated trips becomes high, intrazonal trip ratio also becomes high. As for accessibility coefficient, when it becomes high, intrazonal trip ratio becomes low. Intrazonal trip ratios have been determined by grouping some of zones as shown in Table 2.13.

Fig. 2.16 Distribution of Intra-Zonal Trip Ratio by Zones

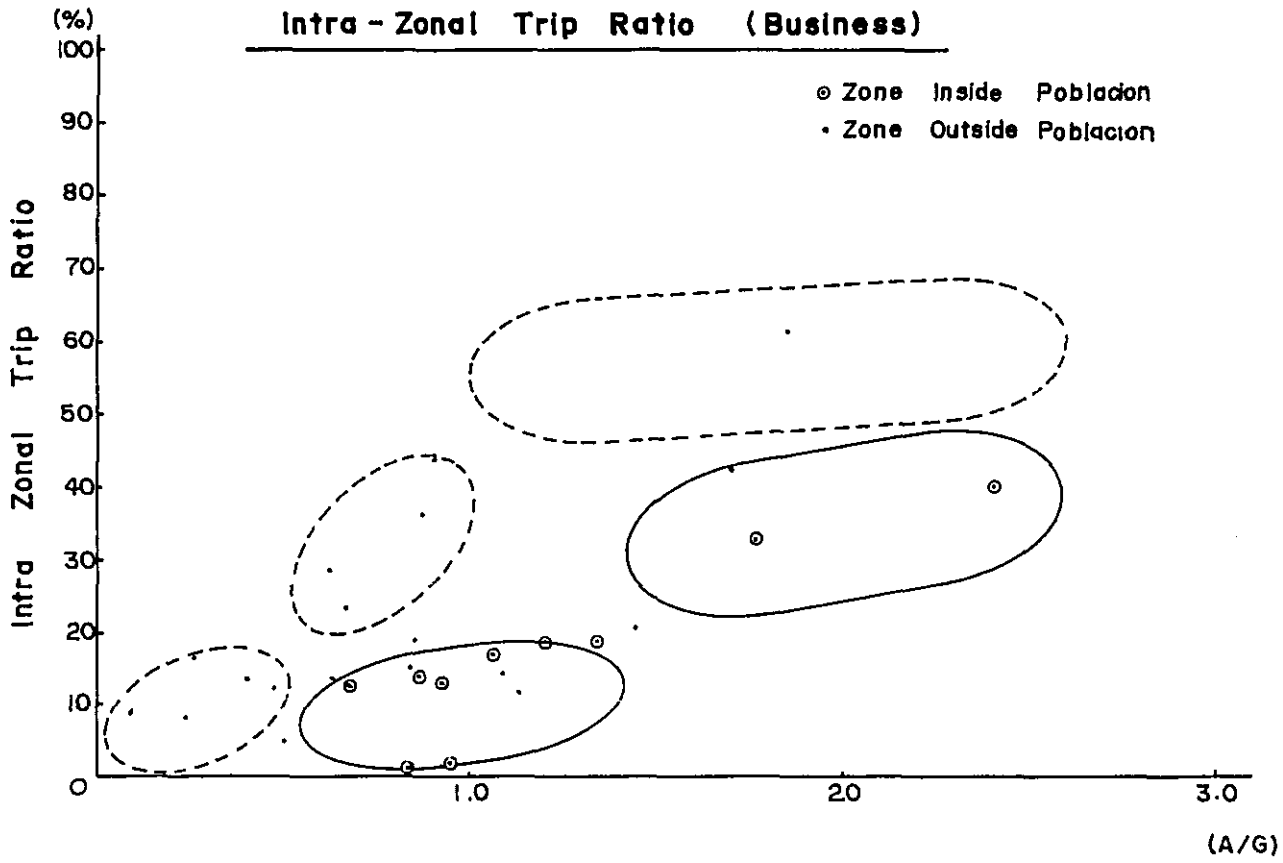


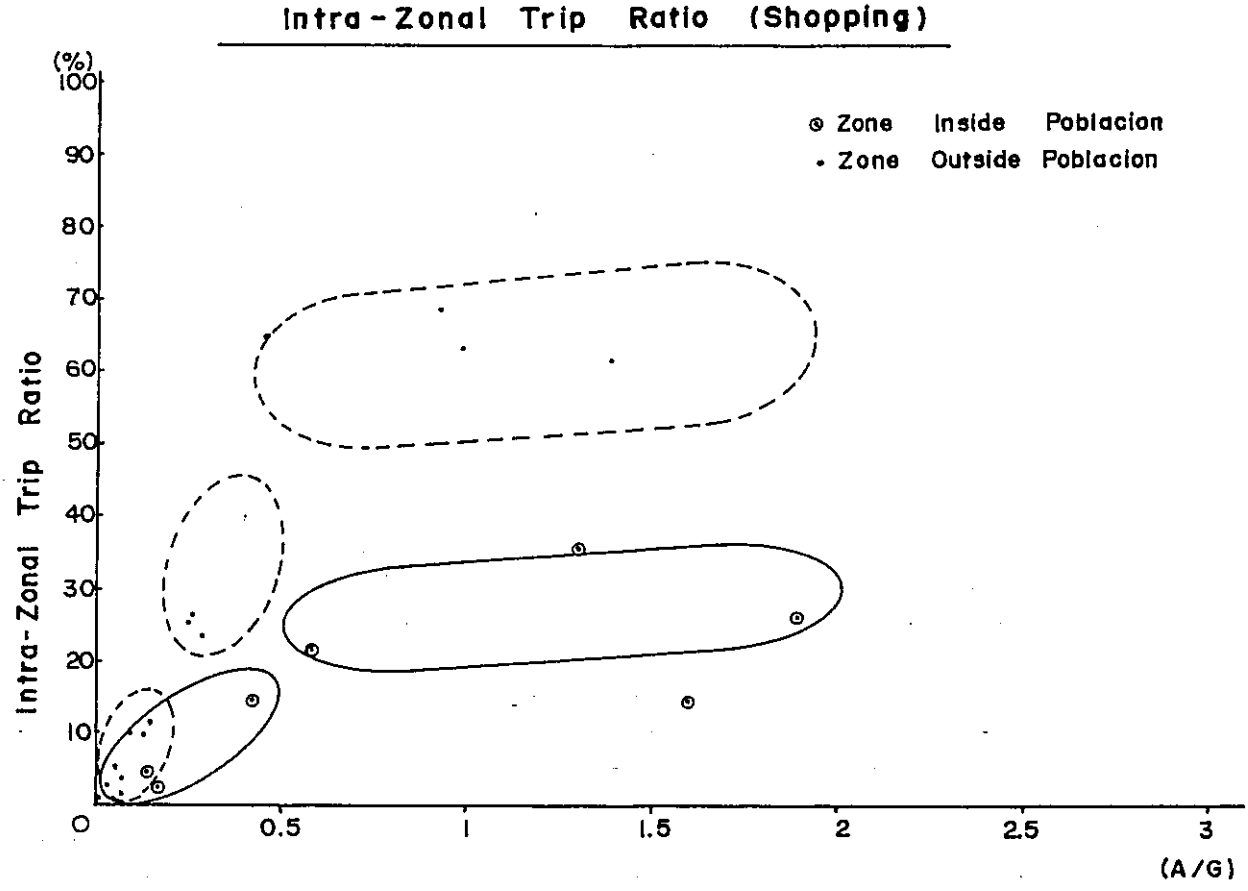


Intra-Zonal Trip Ratio (Home)



Intra-Zonal Trip Ratio (Business)




Intra-Zonal Trip Ratio (Shopping)
(%)
100
90
80
70
60
50
40
30
20
10
0
Intra-Zonal Trip Ratio
⊙ Zone Inside Poblacion
• Zone Outside Poblacion
0.5
1
1.5
2
2.5
3
(A/G)

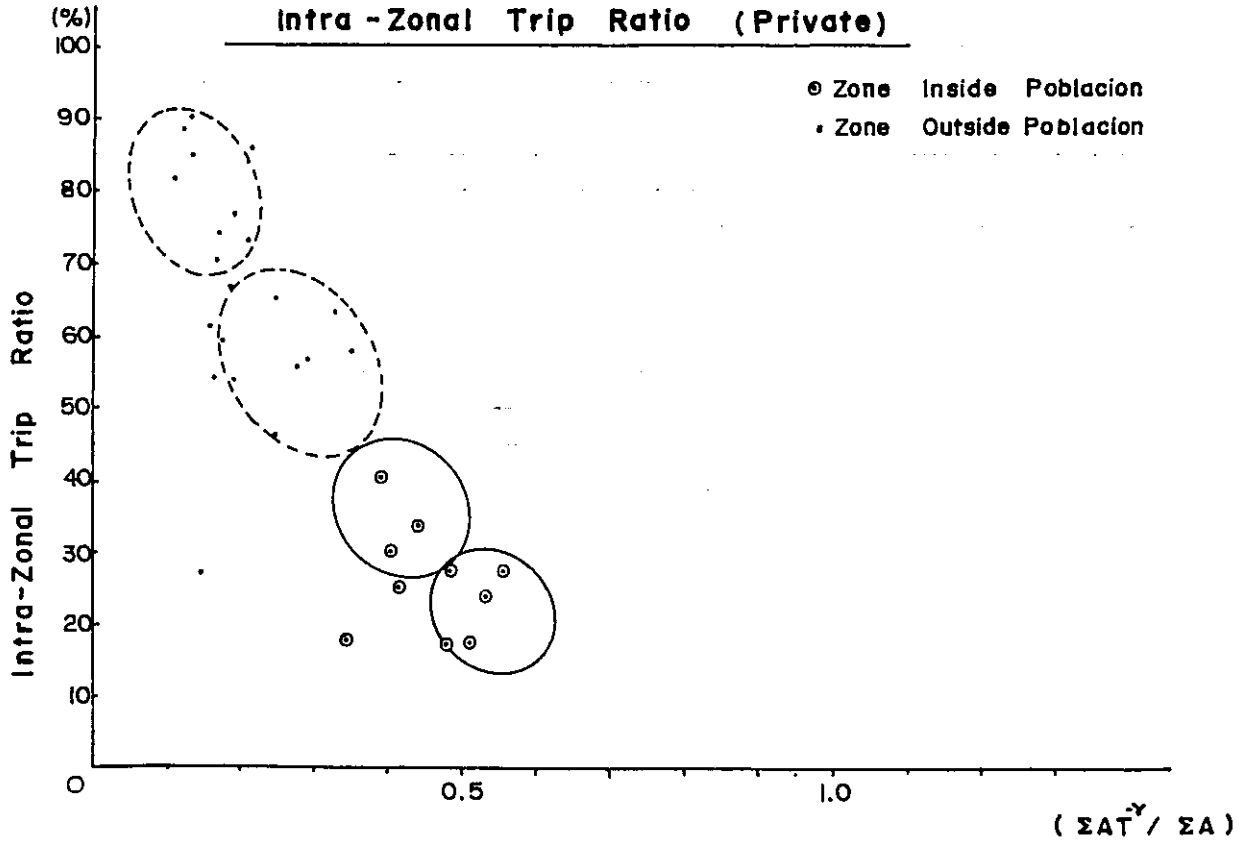

Intra-Zonal Trip Ratio (Private)
(%)
100
90
80
70
60
50
40
30
20
10
0
Intra-Zonal Trip Ratio
⊙ Zone Inside Poblacion
• Zone Outside Poblacion
0.5
1.0
(ΣAT^-γ / ΣA)

TABLE 2.13 Intra-Zonal Trip Ratio

	Purpose	Explanatry Factor	Range of Explanatry Factor	Ratio	Remarks
Zone Inside Poblacion	Office	Ai / Gi	— 1.0	10 %	Residential Area
			1.0 —	30%	Commercial Area
	School	Ai / Gi	— 1.0	15 %	Residential Area
			1.0 —	35%	
	Home	Ai / Gi	— 1.0	10 %	
			1.0 —	25 %	Residential Area
	Business	Ai / Gi	— 1.4	15 %	
			1.4 —	35%	Commercial Market Area
	Shopping	Ai / Gi	−0.5	10 %	Residential Area
			0.5−	25 %	
	Private	$\frac{\Sigma Aj\,Tij^{-\gamma}}{\Sigma Aj}$	−0.5	35%	Commercial Area
			0.5−	20%	
Zone Outside Poblacion	Office	Ai / Gi	−0.5	15 %	
			0.5−1.0	35%	
			1.0 —	60%	Industrial, Commercial Area
	School	Ai / Gi	−0.8	45%	
			0.8−	75%	
	Home	Ai / Gi	— 1.0	35%	Industrial, Commercial Area
			1.0 —	65%	
	Business	Ai / Gi	−0.5	10 %	
			0.5−1.0	30%	
			1.0 —	55%	Industrial, Commercial Area
	Shopping	Ai / Gi	−0.2	10%	
			0.2−0.5	35%	
			0.5−	60%	Market Area
	Private	$\frac{\Sigma Aj\,Tij^{-\gamma}}{\Sigma Aj}$	−0.2	80%	
			0.2−	55%	

Ai : Trips attracted to zone i

Gi : Trips generated from zone i

Tij : Distance between zone i and zone j

γ : Parameter

4.4 Results of Forecast (Year 2000)

1) Linkage between Blocks

Trips which terminate their both trip-ends within the Block are forecasted to be as many as about 80% of the total trips of each Block for Blocks I, II and IV, about 70% for Block III-A and about 65% for Blocks III-B (N) and IV-B (S). Intrazonal trip ratios of Blocks I and IV which receive less influence from Block III-A (Poblacion) are the highest, while those of Blocks III-B (N) and III-B (S) which are greatly influenced by Block III-A are the lowest.

Every Block except Block I has strong connection with Block III-A which is the center of all kinds of activities in the Project Area. Specifically, linkage between Block III-A and Block III-B is quite strong. The biggest volume of trips is estimated between Block III-A and Block III-B (S).

2) Increase of trips at major sections

Volume of trips at the boundary of each Block is shown in Fig. 2.18. Although growth rate of trips is small, section 5 (which is almost along Davao River) has the biggest volume which is about 280,000 trips. Section 4 has the second biggest volume of trips which is almost the same as section 5.

Section 3 shows the highest growth rate of trips followed by Section 2. Increases of trips of both sections are more than 3.5 times. High growth rate of trips in the northern part of the Project Area is outstanding.

Flow of traffic in terms of person trips assigned on the spider network shows that traffic flow between North and South is predominant and traffic flow between east and west is not so significant, which is well-explained by the geographical characteristics of the Project Area. Relatively constant traffic volume is expected from north and south zones to the entrance of Block III-A, then a sudden increase near the entrance of Block III-A, especially near the boundary between Poblacion and Agdao, is forecasted. These characteristics of traffic flow will have to be taken into consideration when planning future transportation system.

Although this is the subject to be studied from now on, pattern of traffic flow seems to be favorable to an introduction of rapid transit system.

Fig. 2.17 Future Person Trip Movements Between Blocks (2000)

1/ Figures Show Number of Person Trips Between Blocks. (Unit : 1000 Trips)

2/ Figures in ( ) Show Growth Rate (2000/1979) of Person Trips.

3/ Growth Rate of Generated/Attracted Trips(2000/1979)

BLOCK NAME	Growth Rate 3/
I (Bunawan)	5.9
II (Panacan)	6.3
$III_B^{(N)}$(Buhangin)	5.4
IIIA (Poblacion)	1.7
$III_B^{(S)}$(Talomo)	3.5
IV (Toril)	4.1
Project Area	2.9

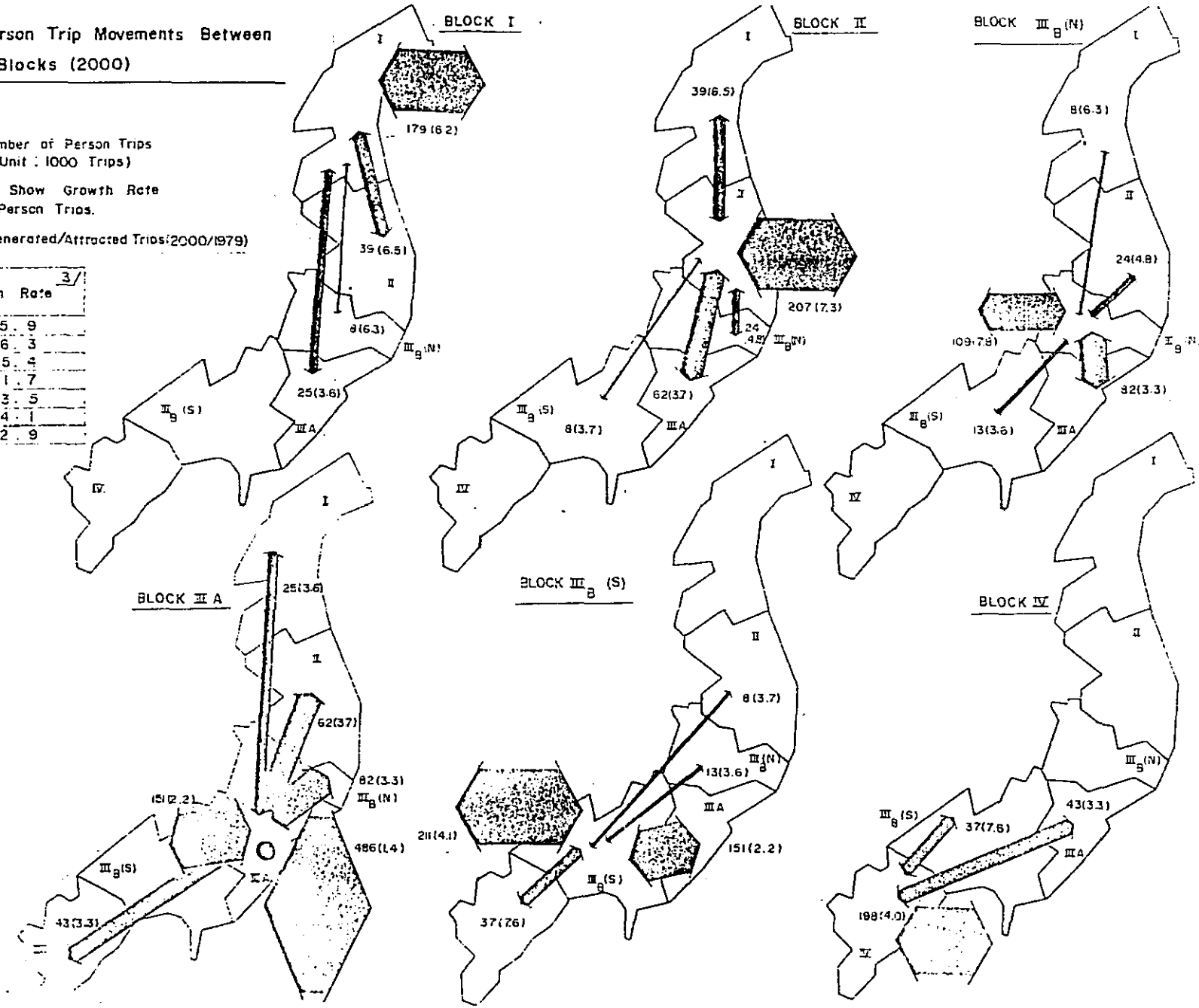
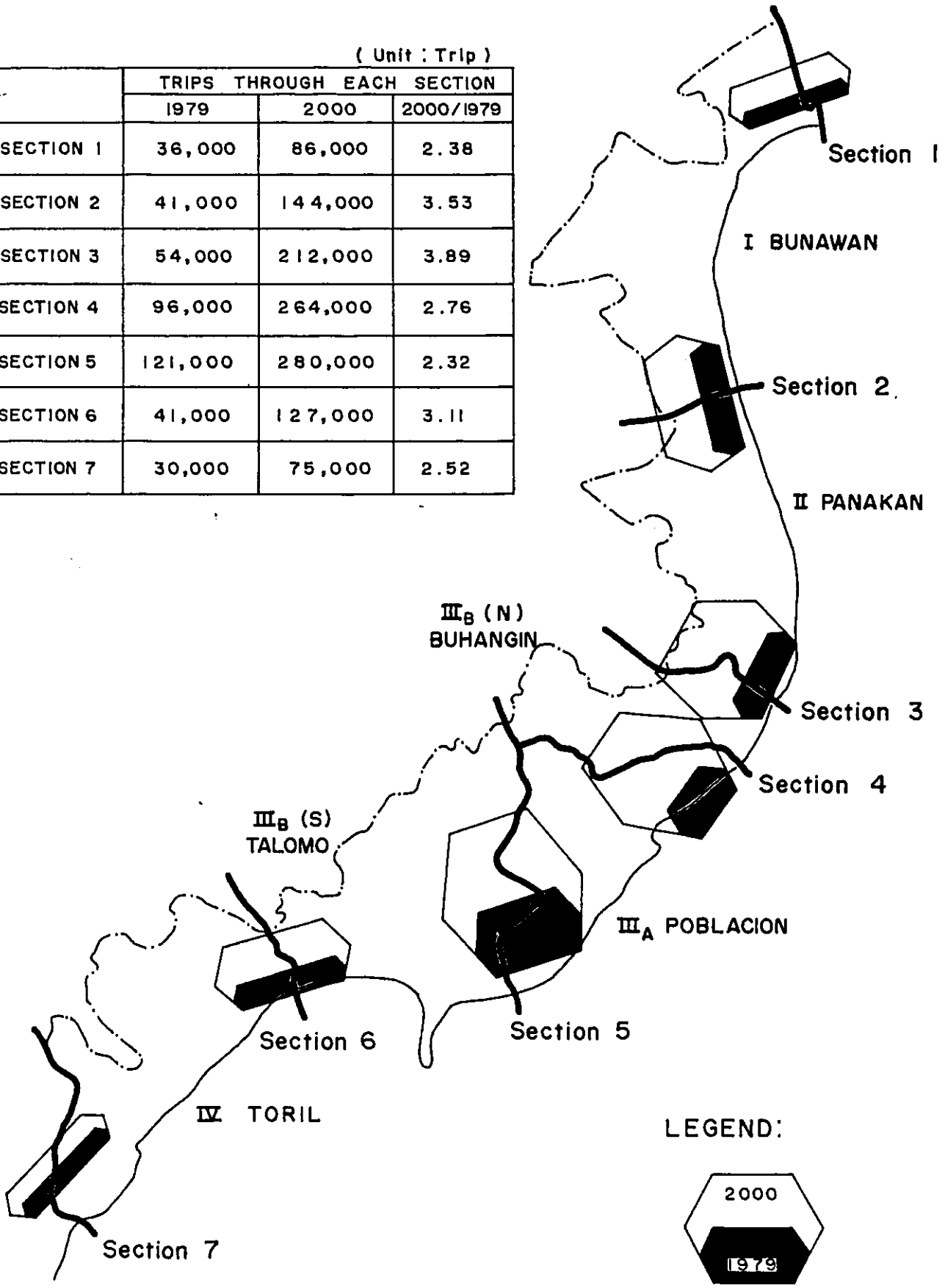


Fig. 2.18 NO. OF P.T. THROUGH EACH SECTION

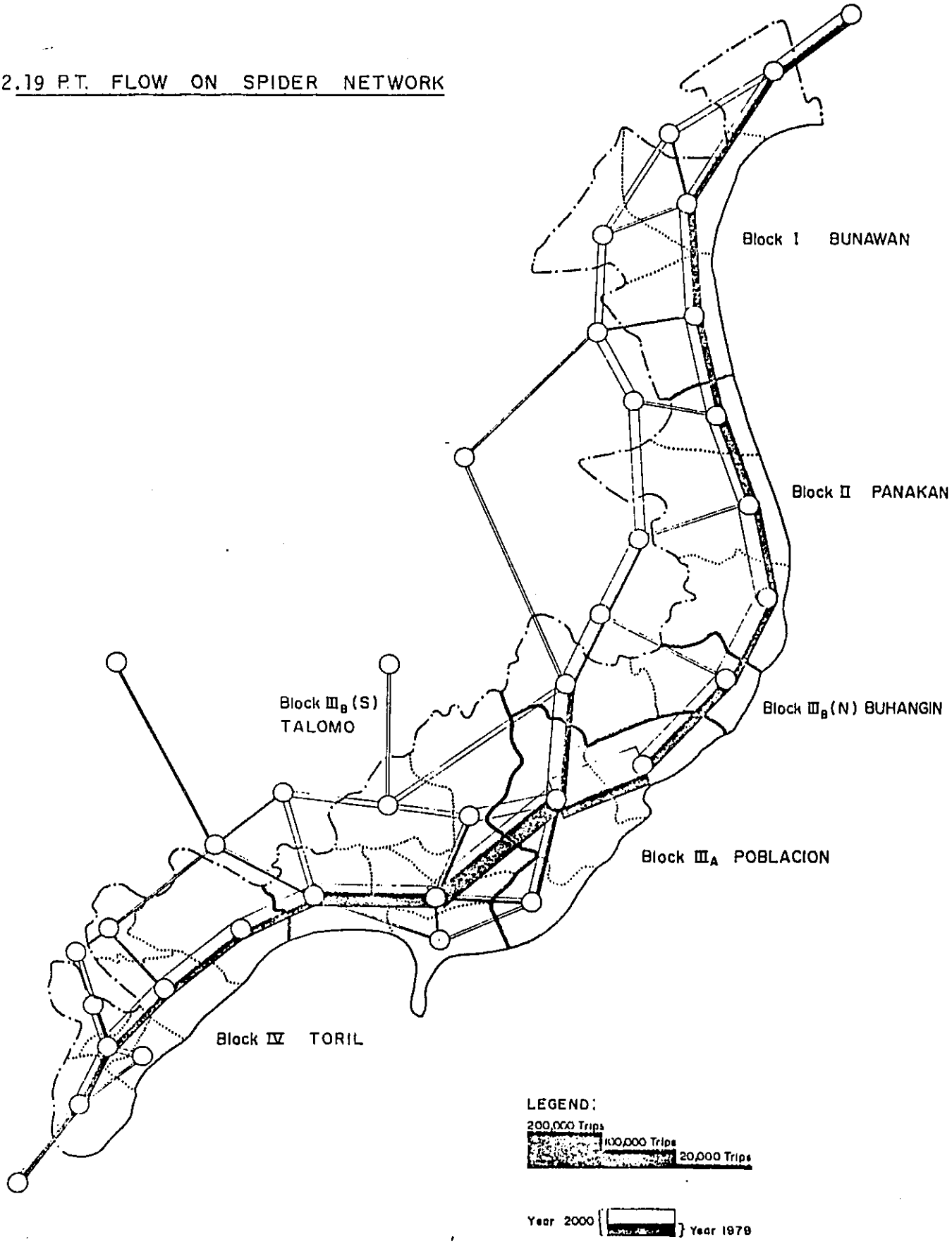
(Unit : Trip)

	TRIPS THROUGH EACH SECTION		
	1979	2000	2000/1979
SECTION 1	36,000	86,000	2.38
SECTION 2	41,000	144,000	3.53
SECTION 3	54,000	212,000	3.89
SECTION 4	96,000	264,000	2.76
SECTION 5	121,000	280,000	2.32
SECTION 6	41,000	127,000	3.11
SECTION 7	30,000	75,000	2.52



Inner Box shows Trips for the year 1979
Outer Box shows Trips for the year 2000

Fig. 2.19 P.T. FLOW ON SPIDER NETWORK



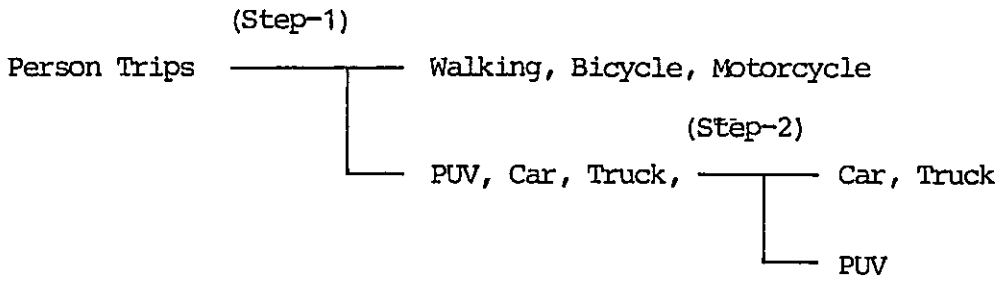
CHAPTER 5

MODAL SPLIT

The transportation modes to be utilized in the future are closely related to the future transport network to be planned and transport policies to be adopted. Forecast of modal share of trips by cars and public transportation modes is to be explained hereunder and modal shares among public transportation modes will be elaborated in Chapter 3 of III OUTLINE OF MEDIUM AND LONGTERM TRANSPORT PLANS.

The present car ownership ratio (number of car-owned household members/total population) is approximately 8%. In the future, this ratio will increase in proportion to an increase in the income level in real term and is expected to become 18.5% in the year 2000. The assumptions taken here were the same growth ratio of income level as that of the gross domestic products in the Project Area and the same ownership ratio corresponding to that of present income level. Almost the same result was obtained when the past growth rate of car ownership was extrapolated in the year 2000. The present car ownership in Metro Manila is approximately 20%.

Forecast of modal split of trips was made by the binary choice method and modes were grouped as follows;



In Step 1, modal shares of each mode group were estimated by the sharing rate curve model developed based on the relationships among trip purpose, car ownership and trip length.

In Step 2, like in Step 1, modal shares of each mode group were estimated by the sharing rate curve mode developed based on the relationship among trip purpose, car ownership and preference of public transportation mode.

The result of forecast is shown in Table 1.9. The modal shares of walking, car, and PUV are 40%, 16% and 44% in the year 1979, and 41%, 19% and 40% in the year 2000, respectively, which indicates that the share of car will increase by about 3%. Car trips show the highest growth rate and they will increase by 3.4 times as big as in 1979.

The desire line charts of cars and PUVs are illustrated in Figures 2.20 and 2.21. A notable characteristic from these figures is a strong tendency that both cars and PUVs are attracted to Block III-A,and that Block III-B(S) and Block III-B (N) which are adjoining blocks of Block III-A show large traffic volumes owing to this tendency.

Table 2.14 No. of Trips by Mode

	Year	Intra Zonal Trips				Inter Zonal Trips				Total			
		Walk	Car	PUV	Total	Walk	Car	PUV	Total	Walk	Car	PUV	Total
No. of Trips (000 trips/ day)	1979	181	20	44	245	85	87	246	418	266	107	290	663
	1990	355	52	94	501	118	178	422	718	472	230	516	1,218
	2000	636	105	171	912	142	284	608	1,034	777	390	779	1,946
Mode of Share (%)	1979	73.7	8.3	18.0	100.0	20.3	20.8	58.9	100.0	40.1	16.2	43.7	100.0
	1990	70.8	10.4	18.8	100.0	16.4	24.8	58.8	100.0	38.8	18.9	42.3	100.0
	2000	69.7	11.6	18.7	100.0	13.7	27.5	58.8	100.0	40.0	20.0	40.0	100.0
Growth Rate	1979	-	-	-	-	-	-	-	-	-	-	-	-
	1990	2.0	2.6	2.1	2.0	1.4	2.0	1.7	1.7	1.8	2.1	1.8	1.8
	2000	3.5	5.2	3.9	3.7	1.7	3.3	2.5	2.5	2.9	3.6	2.7	2.9

Fig. 2.20

PERSON TRIP DESIRE LINE BY CAR (2000)

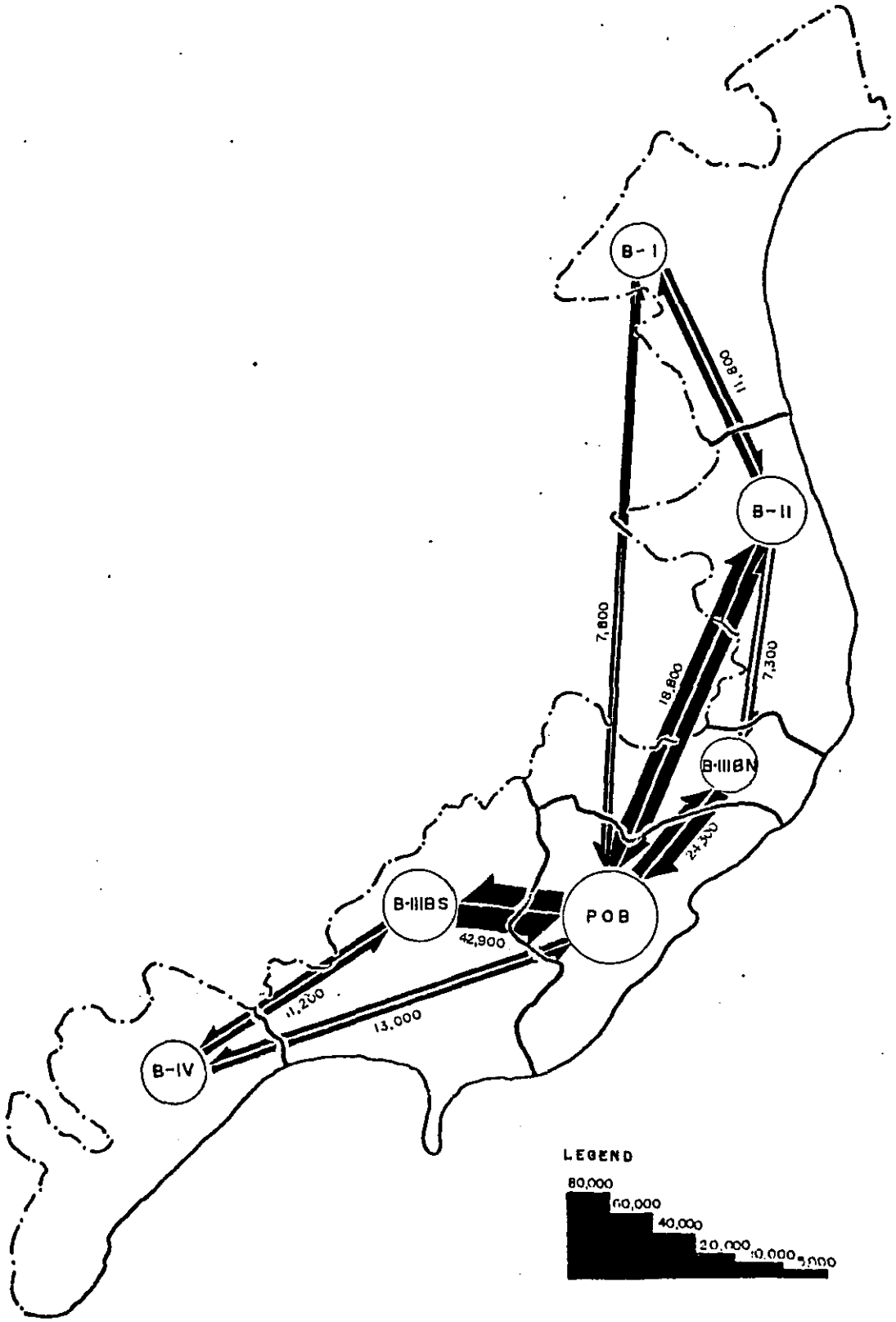
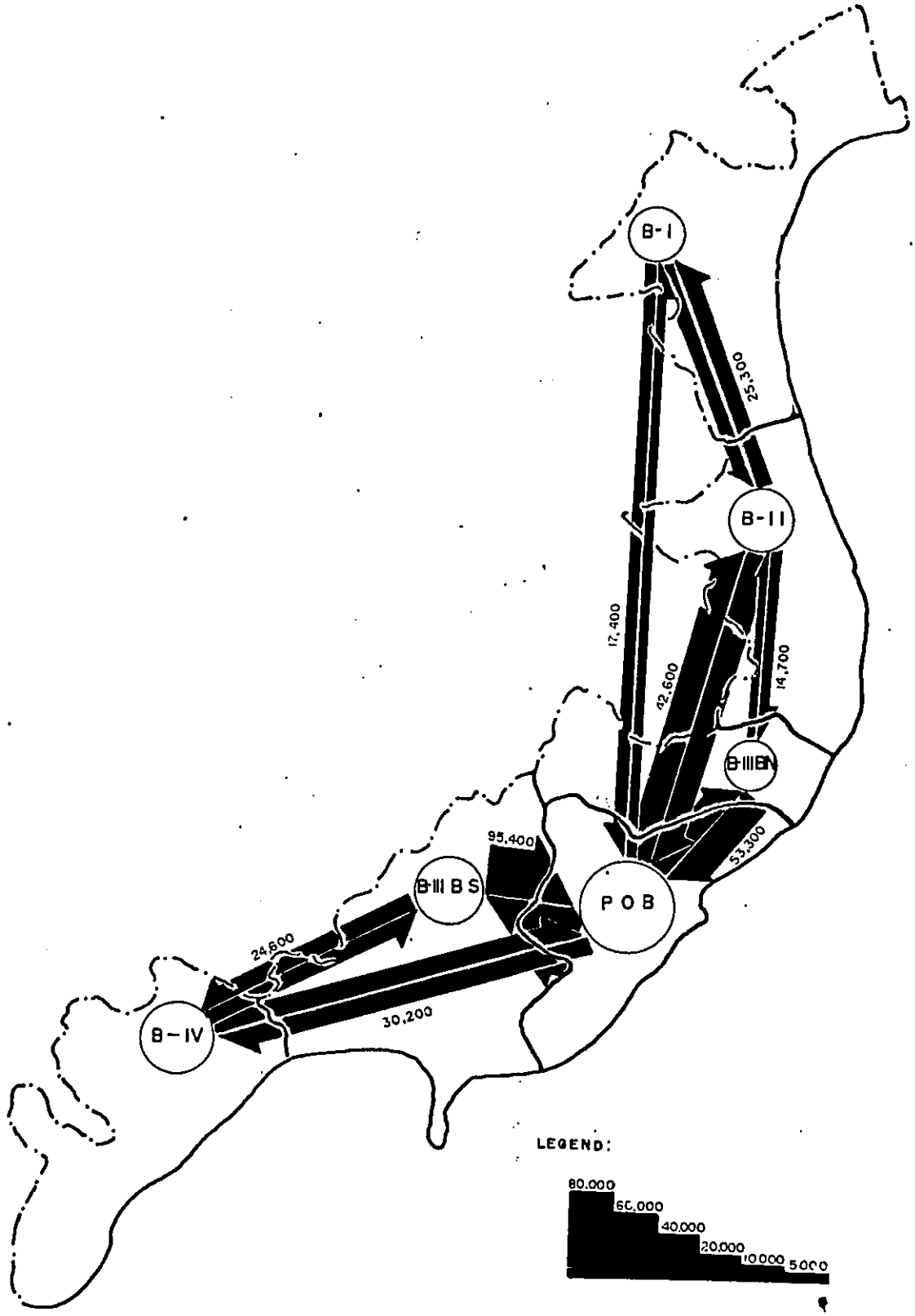


Fig. 2.21
PERSON TRIP DESIRE LINE BY P U V (2000)



CHAPTER 6

TRAFFIC PROBLEMS EXPECTED TO OCCUR IN THE FUTURE

In case of realization of the aforementioned future traffic demand, the best clue in finding out the future occurence of traffic problems can be found in the results of the traffic assignment of future demand to the present road network. In other words, we have to find out what will happen in case no investment in transport facilities is made by the year 2000, and hereinafter, this case will be called a "Do-Nothing Case". In this "Do-Nothing Case", with the assumption that the present trend will remain, PUJs can be considered as the main mode of the PUV service.

(1) Balance between Supply and Demand of Road Facilities

Figure 2.22 illustrates traffic volume and the degree of congestion (volume/capacity ratio) resulting from traffic assignment of "Do-Nothing Case". Figures 2.23 and 2.24 illustrate the result of comparison of the present traffic capacity with the traffic demand at the main sections. The shaded portion in the said figure means the excess volume of traffic, i.e. traffic volume minus traffic capacity.

The future traffic volume of each section will increase 3 to 4 times as big as the present and will turn out to exceed the present traffic capacity substantially. Even in the present condition, traffic volume has almost reached to its maximum capacity in some areas such as Poblacion and its vicinity where traffic congestion is observed. In the future, most of the roads will suffer from severe traffic snarls. The volume/capacity ratio at Panacan and Talomo is expected to exceed 5 (see Fig. 2.22). Therefore, it is concluded that any failure in the development of new transport facilities will be a major cause of aggravation of traffic environment and paralyzation of urban function as well as substantial negative impact on urban economics.

(2) Required Road Facilities

A trial computation was carried out in order to get the amount of road facilities additionally required to cope with excess traffic volume resulting from the aforementioned analysis on the assumption that no other measures but expansion of roads are made. To be sure, construction of new roads is not the only

step to be taken up but also efficient utilization of existing transport facilities by introduction of large-sized public transportation mode (bus service and/or railway service) and implementation of new traffic control system (introduction of an exclusive bus lane, one-way traffic system and regulation of on-street parking) must be considered. Therefore, it should be noted that facilities, only when no other measures are made.

The results of the trial computation is shown in Table 2.15. The capacity of new road in this computation is assumed to be 10,000 PCU/lane/day.

i) Northern Area (Section 1-6)

In the areas of Bunawan and Tibungco, located north of Poblacion, the volume/capacity ratio reaches up to 3 to 4. The volume of average daily traffic becomes bigger and bigger as it approaches to Poblacion comes to about 70,000 PCU/day. Therefore, in addition to the present facilities, the construction of roads equivalent to 4-6 lanes will be required.

ii) Poblacion and its vicinity (Section 7-8)

Traffic volume in central part of Poblacion shows a maximum volume which comes up to 130,000 PCU/day. Therefore, construction of roads equivalent to 6-8 lanes will be required in addition to the present facilities.

iii) Southern Area (Section 9-12)

Traffic demand to and from Poblacion at Talomo and Toril reaches to about 60,000 PCU/day. Therefore new construction of 2-6 lanes roads will be required.

Fig. 2.22

TRAFFIC VOLUME AND VOLUME/CAPACITY RATIO

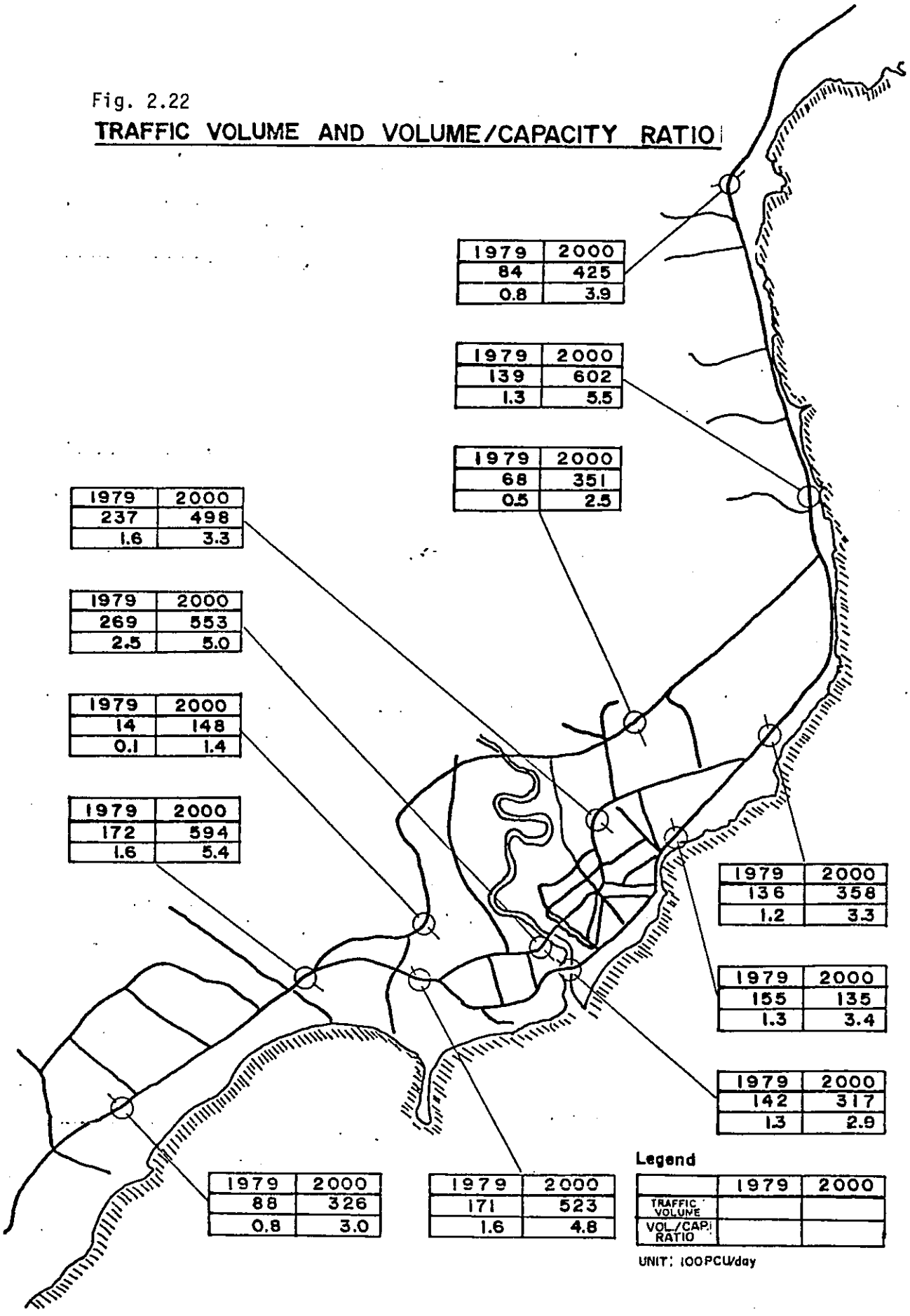


Fig. 2.23 **TRAFFIC DEMANDS AND ROAD CAPACITY**

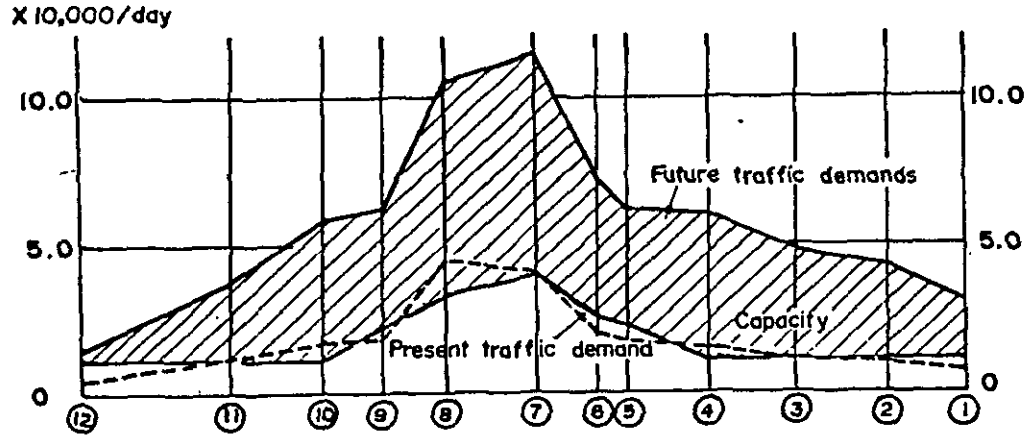


Fig. 2.24 **TRAFFIC CONGESTION OF MAJOR CROSS-SECTION**

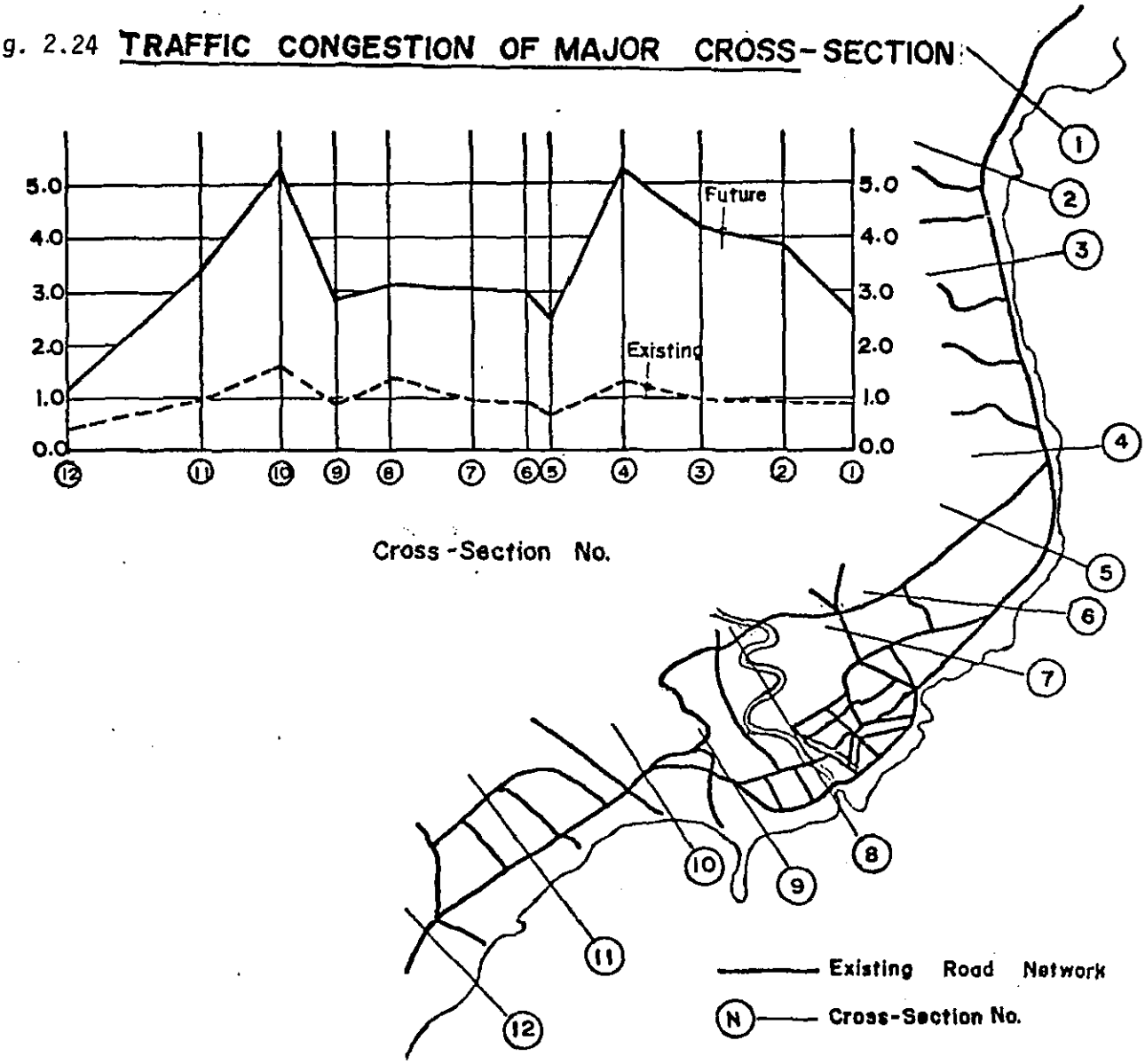


Table 2.15 Required Road Construction at Major Cross Sections

Cross-Section [1]	Present Road Capacity (100 PCU/day)	1979 Present ADT (100 PCU)	1979 Volume/Capacity Ratio	2000 Future ADT (100 PCU)	2000 Volume/Capacity Ratio	Excess volume of Traffic (100 PCU)	Additional Number of lanes Required	Existing Lanes
1	110	84	0.8	300	2.7	190 [2]	4	2
2	110	103	0.9	425	3.9	315	4	2
3	110	110	1.0	471	4.3	361	4	2
4	110	139	1.3	602	5.5	492	6	2
5	240	178	0.7	609	2.5	369	4	4
6	240	204	0.9	689	2.9	449	6	4
7	390	400	1.0	1,152	3.0	762	8	6
8	330	431	1.3	1,042	3.2	713	8	6
9	220	185	0.8	671	3.1	451	6	4
10	110	171	1.6	594	5.4	484	6	2
11	110	101	0.9	374	3.4	265	4	2
12	110	41	0.4	137	1.2	27	2	2

1/ : Cross-Section No. Corresponds to Fig. 1.12.

2/ : Excess Volume of Traffic = Total Traffic Volume - Existing Road Capacity

III. OUTLINE OF MEDIUM AND LONG-TERM TRANSPORT PLANS

CHAPTER 1

PLANNING TARGET AND DEVELOPMENT STRATEGIES

1.1 Planning Target of the Masterplan

In developing the medium/long term transportation master-plan for the Project Area, the following have been set up as the basic targets or goals to be pursued:

(1) Development of the Transportation Network in support of the future Socio-economic Activity

In the next twenty years the Project Area is expected to undergo rapid economic growth and urbanization to a great extent never experienced before. Transportation infrastructure development and realization of the land use plan must play an important role in supporting this growth. In this context, advanced investment in transportation sector should be required, aiming to guide the urban development to a favorable course.

(2) Pursuit of Convenience, Safety and Amenity

The three elements of convenience, safety and amenity should be the main subjects to be pursued whenever the transportation study is conducted. These targets could be accomplished basically through the development of facilities which can cope with the future traffic demand. Some measures of traffic management will be effective also to traffic safety maintenance and environmental conservation. In addition to traffic safety, security of urban transportation function should be maintained. From this point of view, the formation of stable and reliable transportation network should be planned, in which every origin-destination trip could have more than two routes to cope with an emergency case.

(3) Formation of Plan capable of further Development

The target year of this study is the end of this century, but urban growth, of course, will continue beyond the year 2000, and therefore, the traffic demand will correspondingly increase continuously. Taking this fact into account, masterplan should

be designed to give way for further development at the time new requirements come about.

(4) Formation of realizable Plan

The masterplan should be prepared as a guideline for future transportation investment and policy measures to be adopted. The masterplan, which could be an ideal goal in the future, should not be a mere impractical or imaginative theory. In order to make the plan realizable, sufficient study should be required not only on the efficiency and economic viability of the plan as a whole, but on the required investment and feasibility of main projects as well.

1.2 Development Strategies for Transportation System

The following strategies are to be highlighted to accomplish the aforementioned targets. The validity and efficiency of the plan will be examined through the evaluation of alternative plans and discussion on the feasibility of main projects.

(1) Harmonization with the Urban Development Pattern

For the future urbanization of the Project Area, multi-center development pattern has been recommended, in which the Project Area is divided into six blocks, and within each block, socio-economic activities can be self-sustained to some extent. Consequently, future traffic demand in the Project Area can be classified into two categories; one is inter-block trips with medium or long trip length, the other is intra-block trips with rather short trip length. This must be taken into consideration in planning future public transportation service and facilities.

(2) Effective Utilization of Transportation Infrastructure

Generally, a huge amount of investment will be required to develop transportation infrastructure such as roads, bridges and terminals, so newly developed facilities as well as existing ones should be used with the greatest efficiency in their utilization. From this point, the introduction of bigger-sized PUVs could be suggested.

(3) Formation of Project Packages

When making a development schedule, special attention should be given to the inter-relationship between projects; some project may be exclusive of or supportive to another and one project may require to be implemented prior to another. Based on the study of these inter-relationship, project packages will be consolidated. To develop the project packages, especially important is the bombination of hard-ware projects such as construction or improvement of facilities with soft-ware projects such as the management and operation of these facilities.

(4) Coping with further Motorization and Fostering Public Transportation Service

The present car ownership ratio is still low in the Project Area, but in the future, fairly rapid motorization can be expected to advance, reflecting the past trend of vehicle increase and the rise of income-level. Under such situation, not only traffic volume will increase, but also parking problem will become more serious in the central part of the City. Greatest effort should be continued to raise the current parking capacity both in the public and private sector. More essentially, however, conversion of passengers from cars to PUVs should be promoted by up-grading the PUV service level. In other words, one of the basic strategies to realize an efficient public transportation service is that urban activities could function without private cars. In order to accomplish this, it is essential to foster the privately operated PUV service.

(5) Reinforcement of Administrative Institution in Transportation Sector

The traffic issues will become more complicated and more serious, and will require multi-disciplinary approach to solve than ever. To tackle these difficulties, it is inevitably necessary to promote a strong organization which could function effectively in making a survey, planning and implementing of all the required measures, from the user, operator and administrator's viewpoint. This institutional arrangement should be recommended strongly.

1.3 Planning Approach

The steps and procedures in formulating the masterplan are as follows, and as shown in Fig. 3.1.

Step 1 : Based on the information in the previous chapter, several alternative transportation policies are set up. These policies are expected to exert a big influence upon the future network plan.

Step 2 : Next step is to make alternative network plans to cope with alternative policies. Each plan will correspond to one policy.

Step 3 : The amount of investment required to each alternative plan will be estimated.

Step 4 : Comparative evaluation among the alternative plans is to be done through the examination of traffic volume, travelling speed and volume/capacity ratio of each link, using the result of traffic assignment.

Step 5 : Economic evaluation will be made by comparing the efficiency and required investment of each alternative plan. Together with the result of Step 4, overall evaluation and identification of the most advantageous alternative will be achieved.

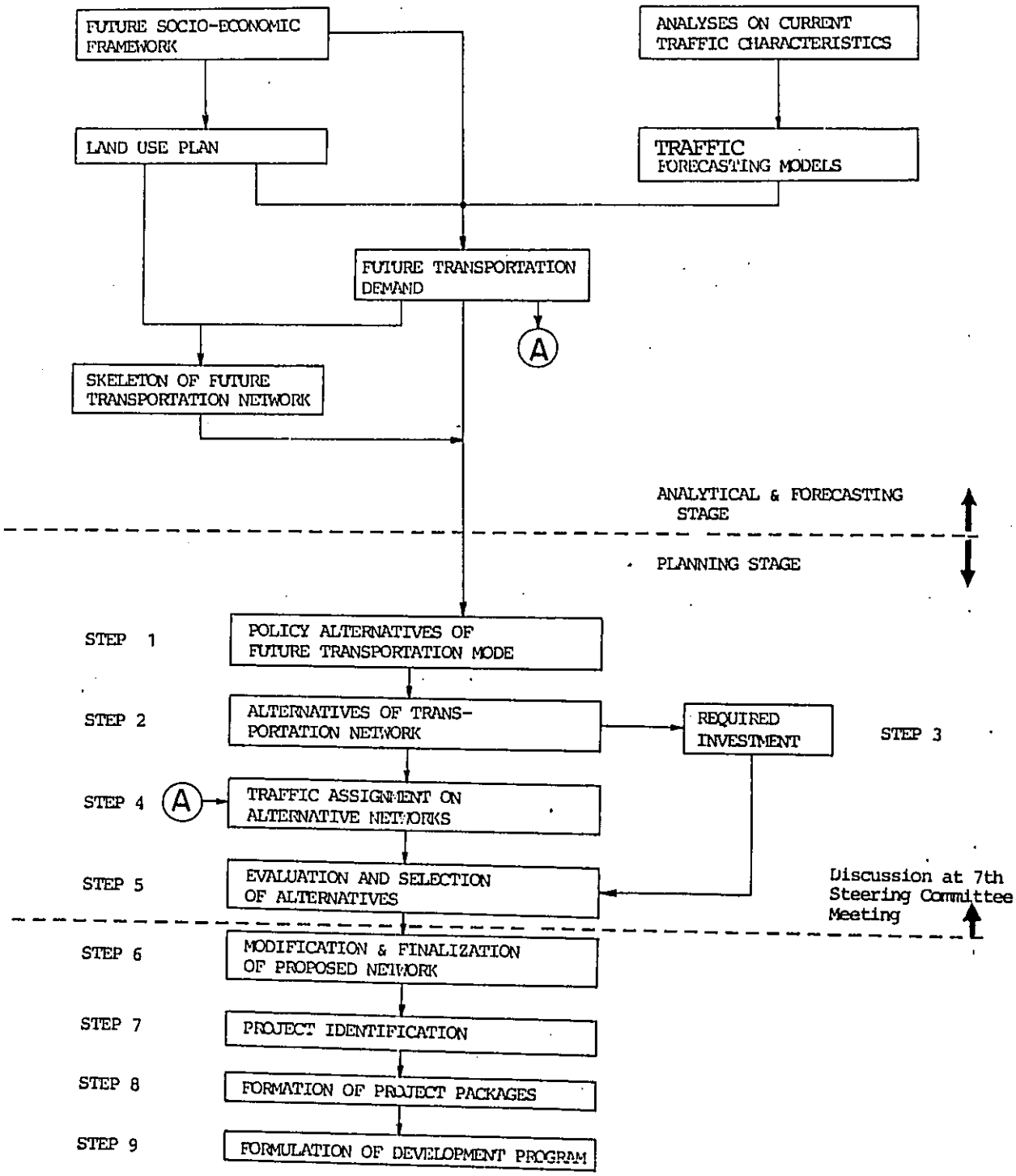
Step 6 : After a reexamination of assigned traffic volume of the selected alternative, it will be modified, if necessary, into the final masterplan.

Step 7 : Development projects of transportation facilities and traffic management will be identified and compiled based on the masterplan.

Step 8 : Project packages are composed through the study of inter-relationship among projects.

Step 9 : Implementation schedule of each project will be set, taking into consideration the possibility of realization of the regional development projects, the importance and urgency of the project based on the future traffic volume and possible amount of investment, and thus, finally investment program will be formulated.

FIG.3.1 FORMULATION PROCEDURE OF LONG-TERM TRANSPORTATION MASTERPLAN FOR THE PROJECT AREA



SOURCE: DCUTCLUS TEAM

CHAPTER 2

FORMATION AND EVALUATION OF ALTERNATIVES

2.1 Formation of Alternative Plans

2.1.1 Conceptual Pattern of Transportation Network

Chapters 1 and 2 show the basic information to be considered when making future transportation plan of which the most essential point could be summarized as follows:

i) Population Increase

Total population in the Project Area will increase from 370,000 in 1979 to 900,000 or at an increased rate of 2.5 times in the year 2000. Similarly, the number of employment will also increase from 115,000 to 324,000 during the same period.

ii) Changes in Land-Use

Currently, most urban facilities are concentrated in Poblacion and the urbanized area stretches along a narrow strip at the coastal area. In the future, six regional blocks, socio-economically independent to some extent, will be established each of which will have its own commercial, industrial, and institutional core. The urbanized area will also expand from strips to broader band.

iii) Changes in Transportation Demand

Total number of daily trips will rise at 2.9 times from 650,000 in 1979 to 1,960,000 in 2000. The distribution of trip is shown in Fig. 3.3 in spider network. The main stream of demand will flow parallel to the coastal line and flows from inland areas to the coast will have less significance.

The share of inter-block trips with medium and long trip length will fairly increase in the future (see Chapter 3.2).

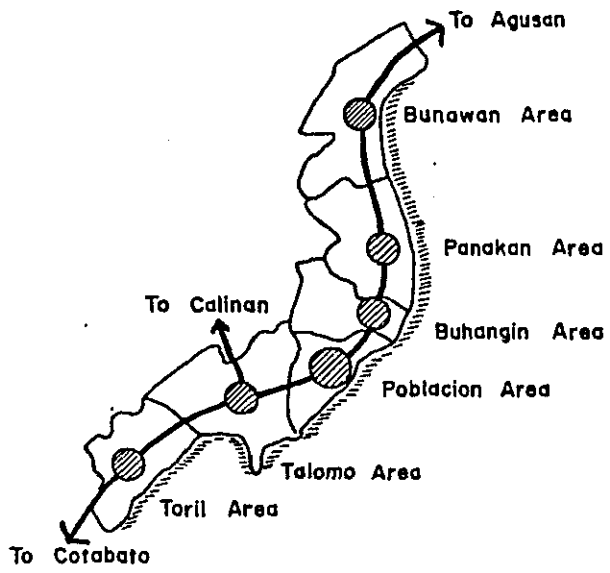
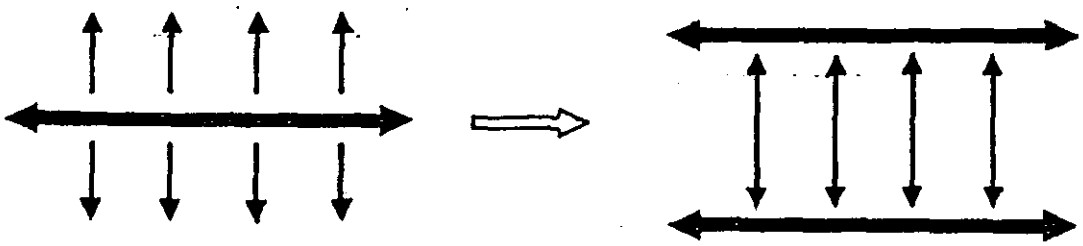


Fig. 3.2

PROJECT AREA DIVIDED INTO BLOCKS

To set up a basic pattern of future network for the Project Area, careful inspection and review have been made in detail on such information as future transportation demand structure, land-use plan and topographical conditions already described in chapter 1. As a result, the network pattern shown in Fig. 3.4 is to be recommended finally. The basic ideas pertinent to this network are as follows:

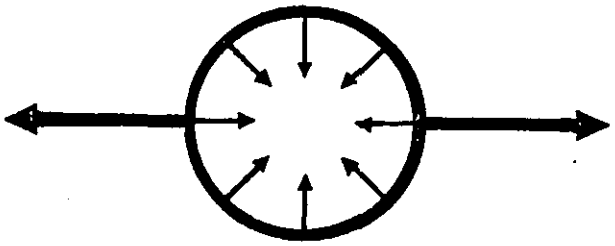
(1) The most basic concept is that the ladder-type network could have a big advantage to such long and slender area as the Project Area. This ladder-type network could achieve a stable and reliable transportation service, which is one of the planning targets explained in Chapter 1.



A) FISH - BONE TYPE

B) LADDER TYPE

(2) A ring road which will function as a distributor should be developed surrounding the Poblacion where the heaviest traffic are to be concentrated also in the future.



C) RING - ROAD AS DISTRIBUTOR

(3) Trunk roads should be located in principle with 1.0 - 1.5 km. intervals, and at the widest, 2.0 km. Consequently there should be two (2) trunk roads from south to north direction in the northern part of the Project Area (Bunawan, Panakan) and three (3) trunk roads in the southern part (Talomo, Toril).

(4) Among these north and south trunk roads, Davao-Agusan Road and Davao-Cotabato Road which are now existing and should be upgraded in the future, would be the most important highways in the Project Area.

(5) Diversion Road should be extended to form another linkage from Bunawan to Toril. However, one section of about 5.5 km between Ma-a and Talomo would remain as a missing link because of topographical difficulty of road construction. This link might be realized in the next century.

(6) Two inter-regional roads going into the inland area (the Non-Project Area) will have their origins at Talomo and Bunawan, and they will meet at Calinan.

Fig. 3.3 P.T. FLOW ON SPIDER NETWORK

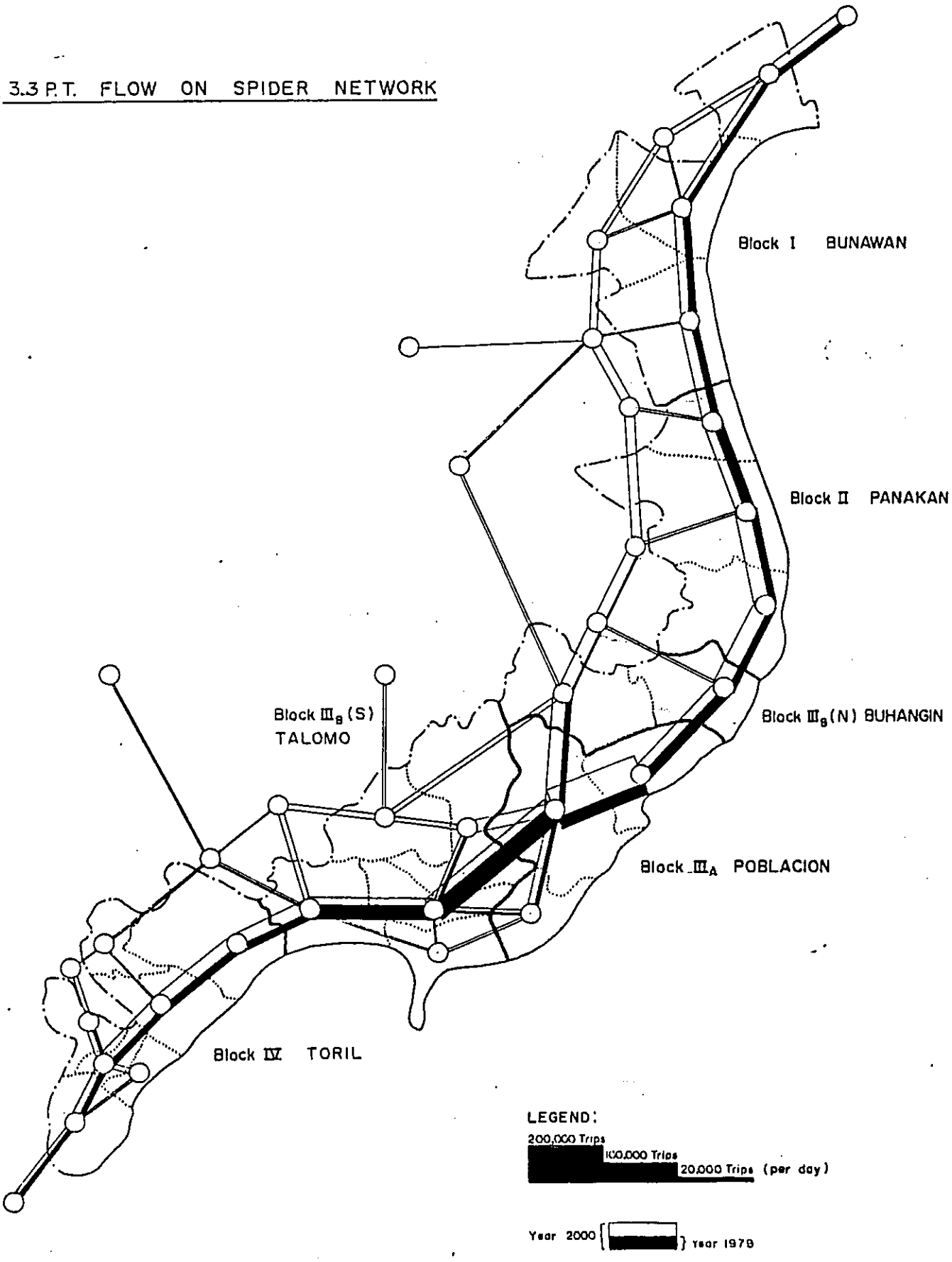
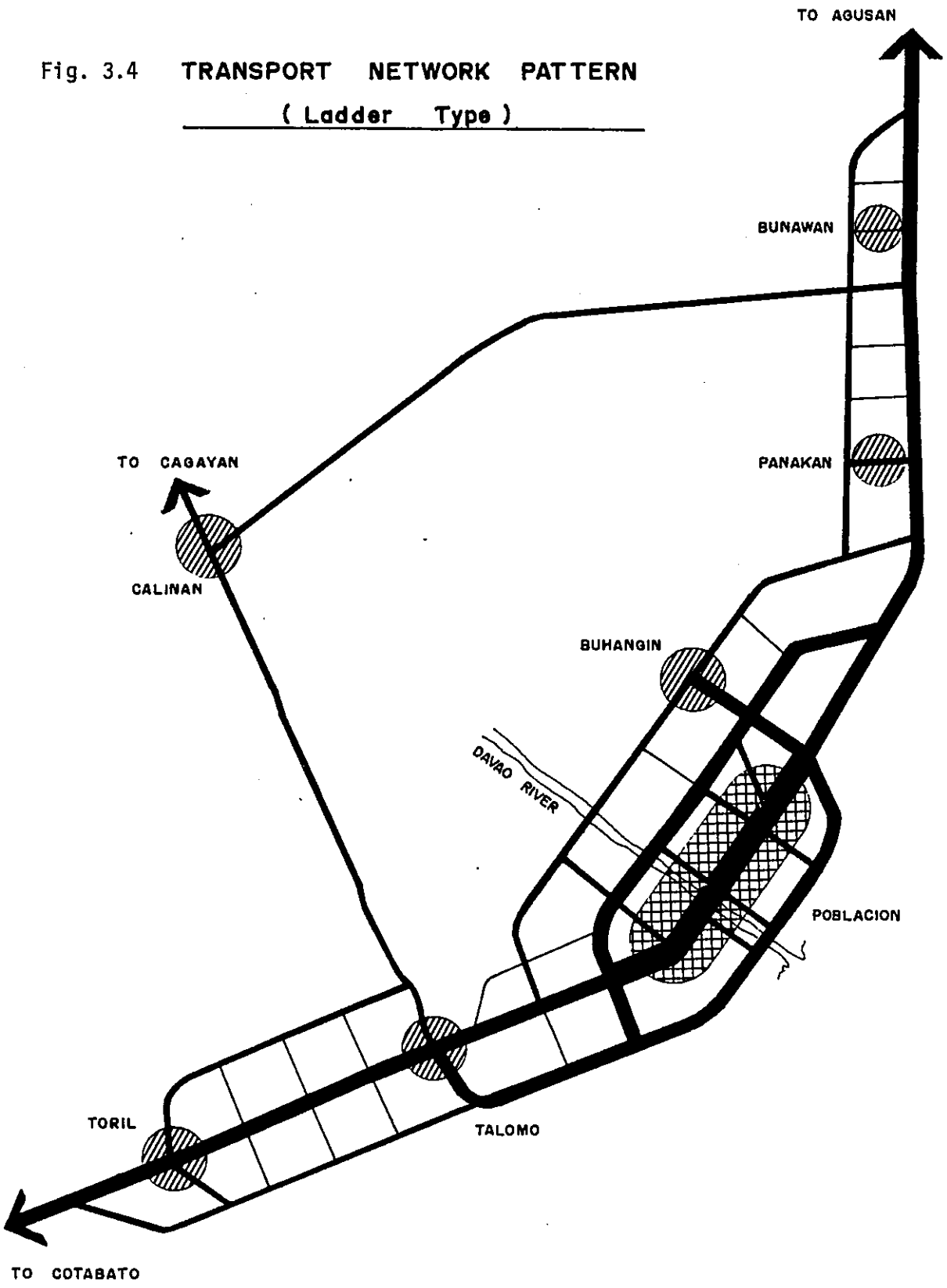


Fig. 3.4 **TRANSPORT NETWORK PATTERN**

(Ladder Type)



WIDTH OF EACH LINE REFLECTS SCHEMATICALLY
THE RELATIVE IMPORTANCE OF ITS ROLE AS TRUNK LINE

2.1.2 Transportation Policies and Alternative Network Plans

In the previous section, single network pattern has been recommended. This pattern is credited to be quite appropriate to the Project Area, so that there might be only partial and small changes even if the pattern will require some modification. Accordingly, alternative plans will be prepared mainly based on the capacity of the network links, rather than the necessity of links. The required capacity of the network links depends on what kind of transportation mode will serve the future demand. This is principally a matter of transportation policy on what mode should be introduced for public transportation service in the future.

In chapter 1, bigger size PUVs have been suggested to be introduced from the standpoint of effective use of transportation facilities. To be more concrete here, railway transit service and bus service will be adopted in making the alternative plans, and in addition there will be another case in which jeepneys will remain the major mode without introduction of any new service. The "do-nothing" case will be used as the basis to evaluate these alternatives. (Table 3.1)

Table 3.1 Public Transportation Modes and Alternative Plans

Alternative Plan	Railway	Bus	Jeepney
Plan-A	◎	○	○
Plan-B		◎	○
Plan-C			◎
Do Nothing Case			◎

◎ Major Public Transport Mode on Trunk Line
○ Feeder Service Transport Mode
○ Local Service Transport Mode for Short Trip

Note: In each case long distance Provincial Buses are operated.

Fig. 3.4 illustrates the road network shown in the map, which was planned based on the network pattern in Fig. 3.4. This road network will be the base common to all alternatives. The network comprises 160 km. existing roads which should be up-graded in the future and 51 km new roads, totalling 211 km. road sections. It should be noted that a part of Davao-Agusan Road would be relocated at Sasa in order to expand the Sasa port.

(1) Alternative A (Fig. 3.6)

This plan assumes the introduction of a railway transit supposedly similar to the light rail transit now being planned in Manila. The railway will be installed along Davao-Agusan Road and Davao-Cotabato Road where the highest traffic density is expected in the future, except one section around Ecoland, where the railway will detour to the coastal area. The total length of railway will be 35.7 km.

As railway service is superior to the other road transportation service with regard to rapidness, punctuality and less energy consumption, big conversion from car and bus service to railway service can be expected to occur. Thus the volume of road construction requirement will be fairly reduced and for this reason, Plan A has the least capacity of road network among the alternatives. In this plan, bus service will be assigned to major arterials, supporting the railway service.

(2) Alternative B (Fig. 3.7)

Bus is the major mode of transport in this plan. By introducing bus service for medium and long distance trips instead of jeepneys, necessary road construction can be reduced in volume.

In order to keep the bus service in high level, exclusive bus lanes should be installed along the major trunk road where traffic congestion tends to occur, that is, about 22 km section of R. Castillo St. - Quirino Avenue - McArthur Highway between Panakan and Talomo should be up-graded, widened to six lane road, of which two lanes should be used as exclusive bus lanes.

In this plan, jeepneys will play a vital role as local feeder service in the future.

(3) Alternative C (Fig. 3.8)

In this plan, no introduction of new mode is assumed and present modes will remain as they are. Jeepneys will continue to be the most important mode and AC and tricycles will serve locally. The requirement for road construction of this plan is larger than those of other alternatives.

Fig. 3.5 PROPOSED ROAD NETWORK

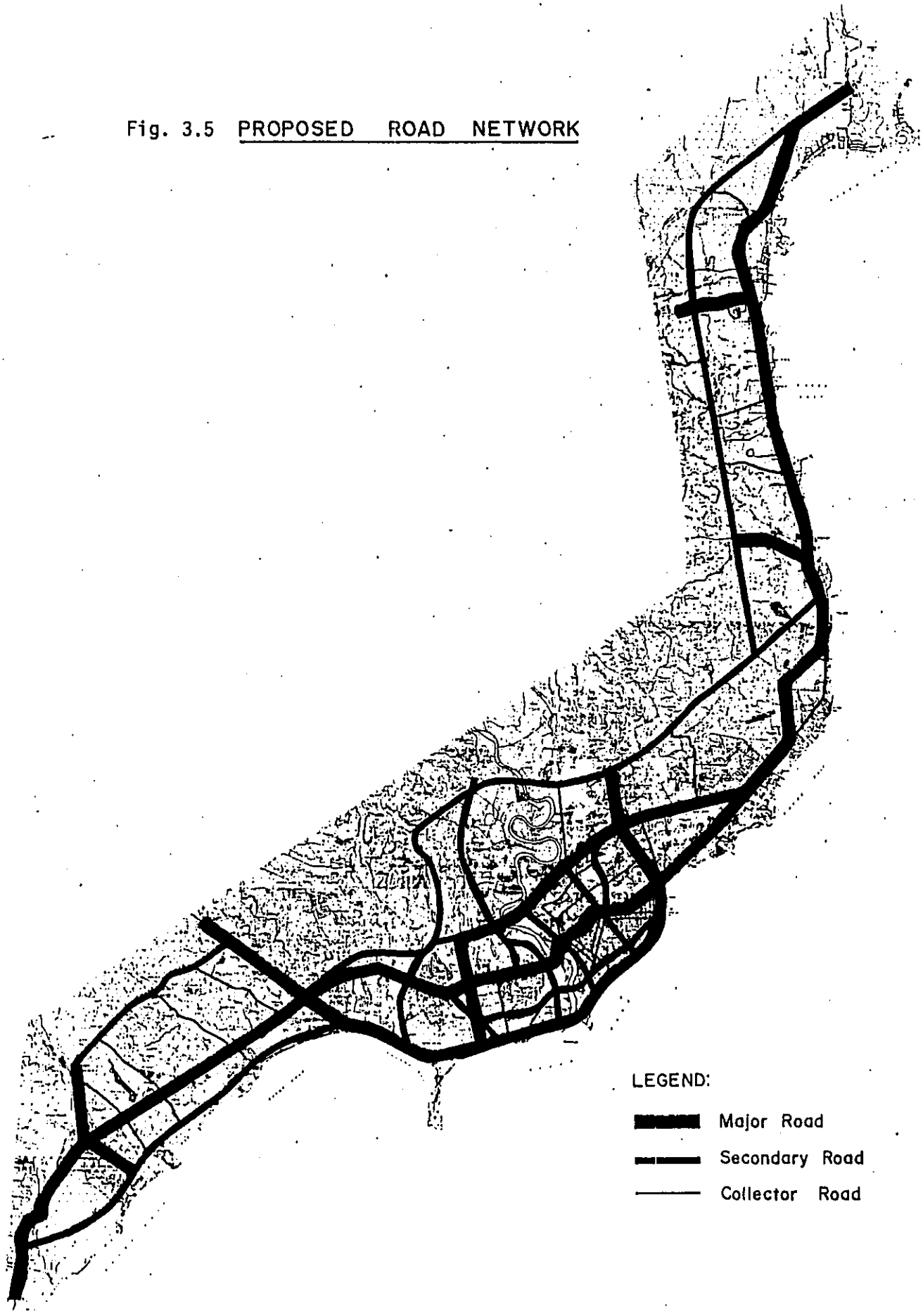


Fig. 3.6 **PLAN-A**

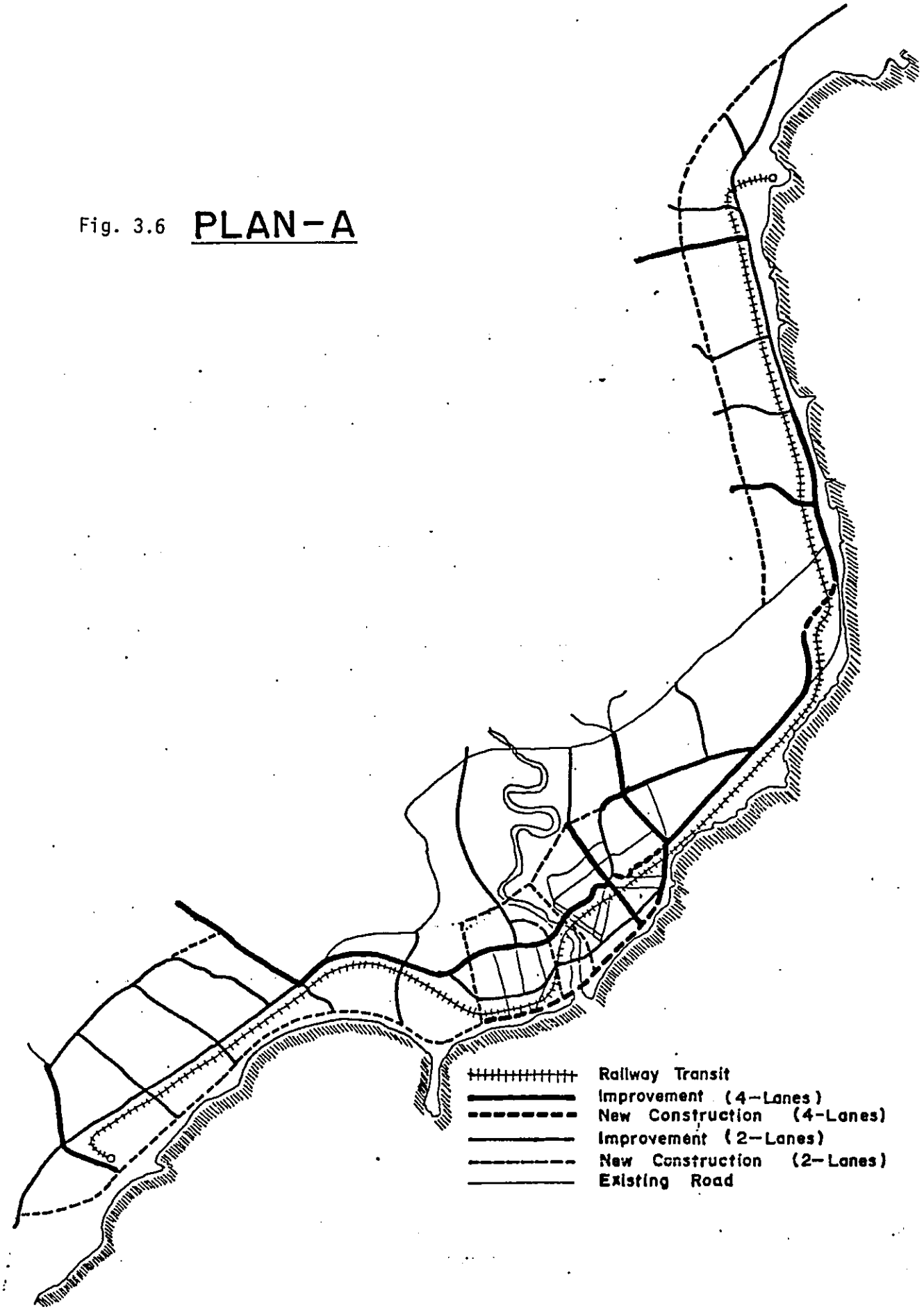

Railway Transit
Improvement (4-Lanes)
New Construction (4-Lanes)
Improvement (2-Lanes)
New Construction (2-Lanes)
Existing Road

Fig. 3.7 · PLAN-B

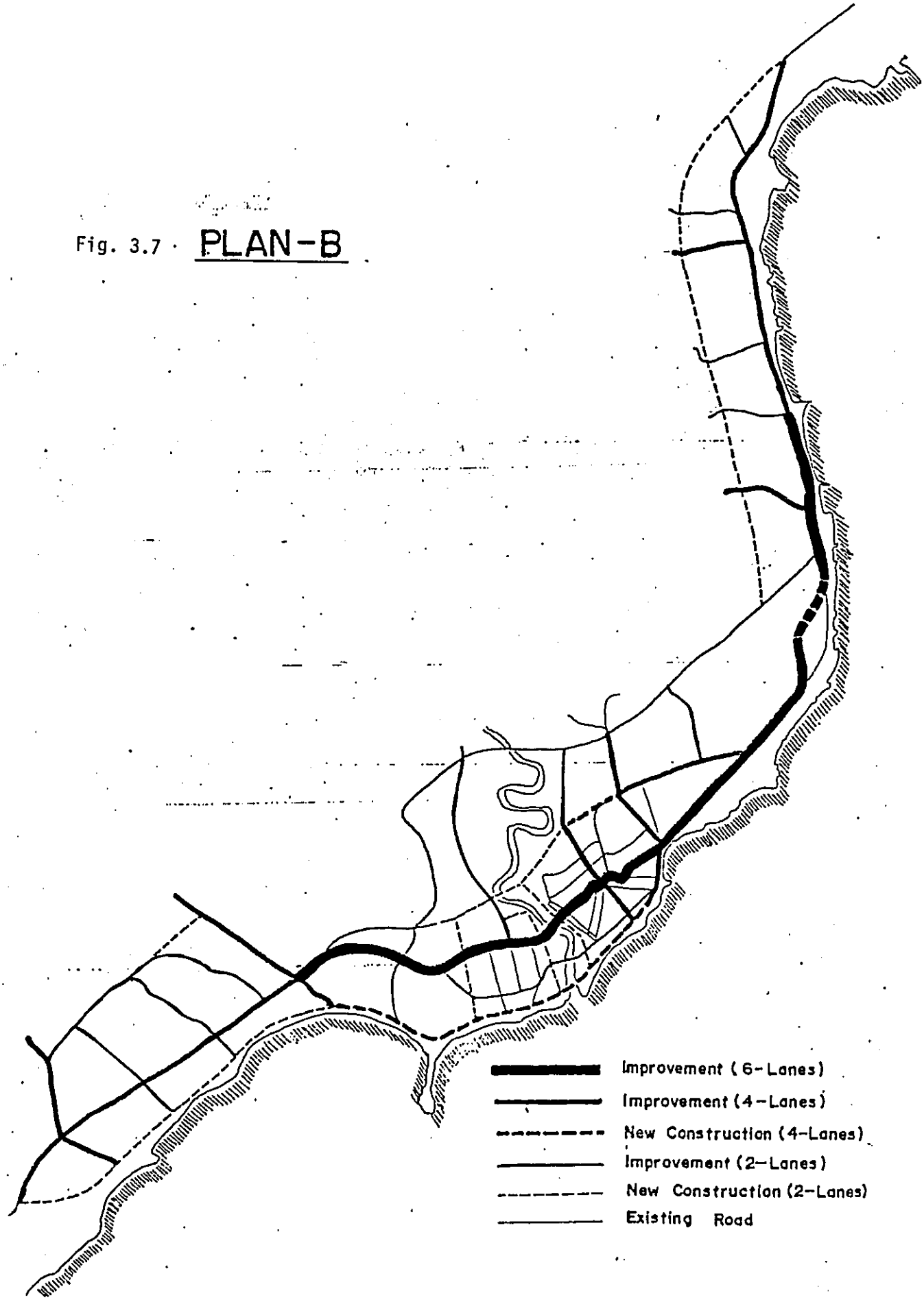
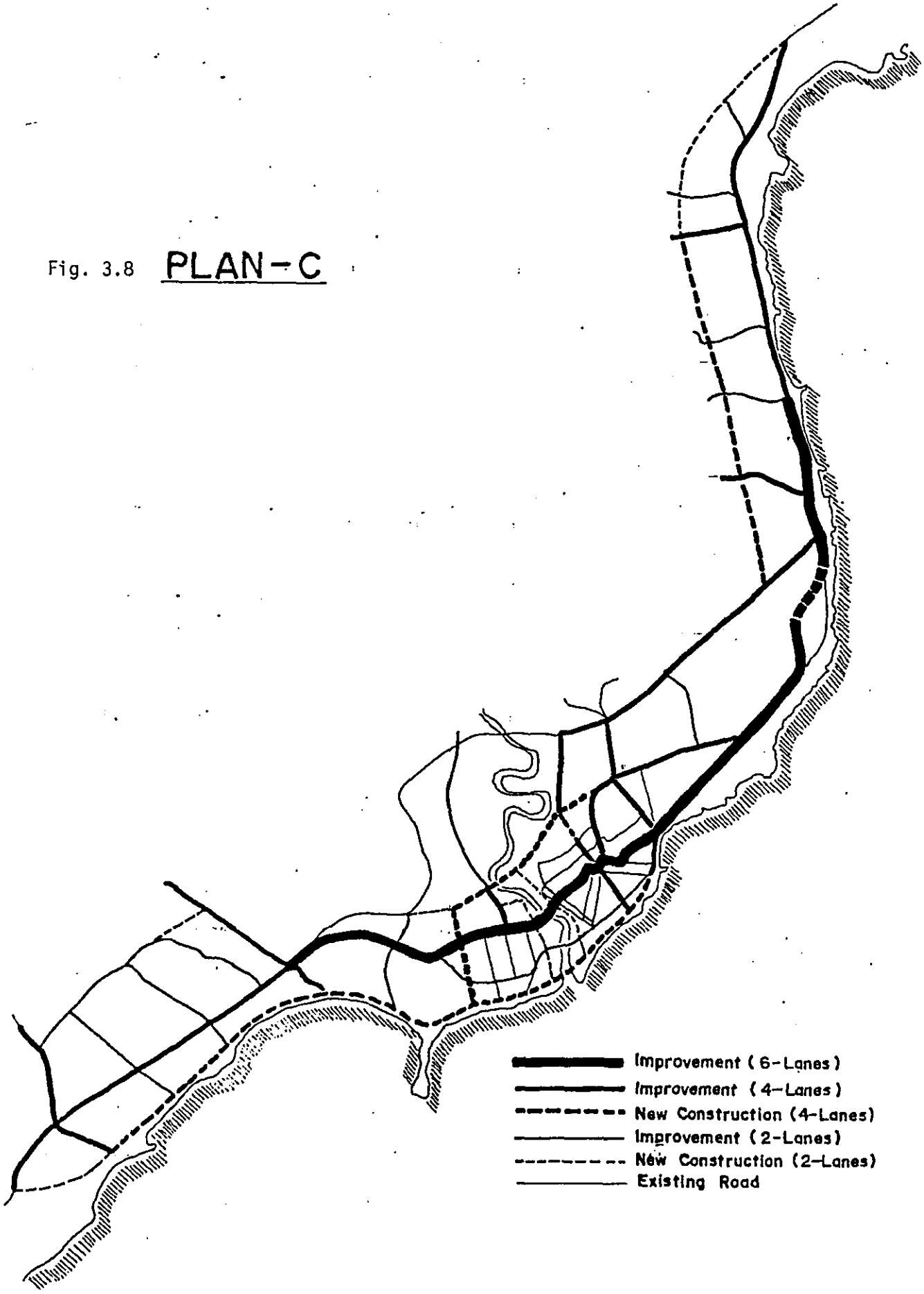

Improvement (6-Lanes)
Improvement (4-Lanes)
New Construction (4-Lanes)
Improvement (2-Lanes)
New Construction (2-Lanes)
Existing Road

Fig. 3.8 PLAN-C


Improvement (6-Lanes)
Improvement (4-Lanes)
New Construction (4-Lanes)
Improvement (2-Lanes)
New Construction (2-Lanes)
Existing Road

2.2 COST ESTIMATE OF ALTERNATIVE TRANSPORT PLANS

The results of cost estimate of alternative transport plans are presented in Table 3.2, where maintenance cost of roads and railway and operating cost of railway are not included. The basic conditions of the cost estimate are:

1) The cost was estimated on a preliminary basis, indicated in 1980 constant prices.

2) The road construction cost was estimated based on the data of actual expenditure provided by the Bureau of Construction, MPH. The local conditions of Davao City such as market prices of materials, designed cross-section of roads and the geographical features of the city were taken into account in this procedure.

3) The estimate of land acquisition cost was carried out based on the land prices calculated by the Tax Assessor's Office of the City Government.

4) The compensation cost was estimated based on the present distribution of houses and other buildings.

5) The construction cost of railway was calculated on the assumption that the railway has similar features to the MLRT (Manila Light Rail Transit).

Table 3.2 Cost Estimate of Highway and Railway Facilities

			Plan A	Plan B	Plan C
Highway Facility 1/ (in km.)	New Construction	6-lane	-	3.0	3.0
		4-lane	11.1	9.1	30.9
		2-lane	38.8	39.1	17.3
		Sub-Total	49.9	51.2	51.2
	Up-grading	6-lane	-	19.1	19.1
		4-lane	43.1	47.0	62.3
		2-lane	44.1	31.6	26.3
		Sub-Total	87.2	97.7	107.7
		Total	137.1	148.9	158.9
Railway Facility (in km.)		at Grade	31.7	-	-
		Elevated	4.0	-	-
		Total	35.7	-	-
Highway Construction Cost 2/ (in million pesos		New Construction	294.2	387.4	476.1
		Up-grading	285.5	403.6	449.5
		Land Acquisition	453.9	616.6	669.5
		Sub-Total	1,023.6	1,407.6	1,595.1
Railway Construction Cost 2/ (in Million pesos)		Civil Work	561.2	-	-
		Rolling Stocks	390.3 3/	-	-
		Power Supply, Signalling, etc.	302.1	-	-
		Land Acquisition	58.1	-	-
		Sub-Total	1,311.7		
Total Cost 2/ (in Million Pesos)			1,945.0	1,407.6	1,595.1

Note: 1/ Trunk roads only, collector and local roads are excluded.

2/ Cost at 1980 constant prices

3/ Not included in the total for the convenience of comparing Plans A, B and C.

2.3 TRAFFIC DEMAND ESTIMATE OF ALTERNATIVE TRANSPORT PLANS

The modal share between private car and public utility vehicles was determined in Section 1.2 based on the future land use plan and the socio-economic framework.

In this section, the modal share of each mode of PUV is estimated for the alternative transport plans.

2.3.1 Estimating Process

The basic transport policies of the alternative plans can be summarized as follows:

1) Introduction of Railway Transit for Plan A;
2) An Intensive use of city bus system for Plan B;
3) No change in the modal share of PUV modes.

At present, mass transit system is not found in Davao City. Therefore, it is difficult to forecast the traffic demand for mass transit system based on the analysis of present situation.

However, taking into account the characteristics inherent to mass transit system such as punctuality, high speed, low fare, etc. and the planned role of each PUV mode in urban transport, the future traffic demand for each public transport mode was estimated.

Fig. 3.9 illustrates the estimating process.

1) PUJ

The current role of PUJ is for short- and medium-length trips. In the future, PUJ will be moving around within Blocks mainly carrying short- distance passengers, and AC (Auto Calesa) will be substituted by PUJ, while tricycle will still play an important role in some limited areas.

2) Bus

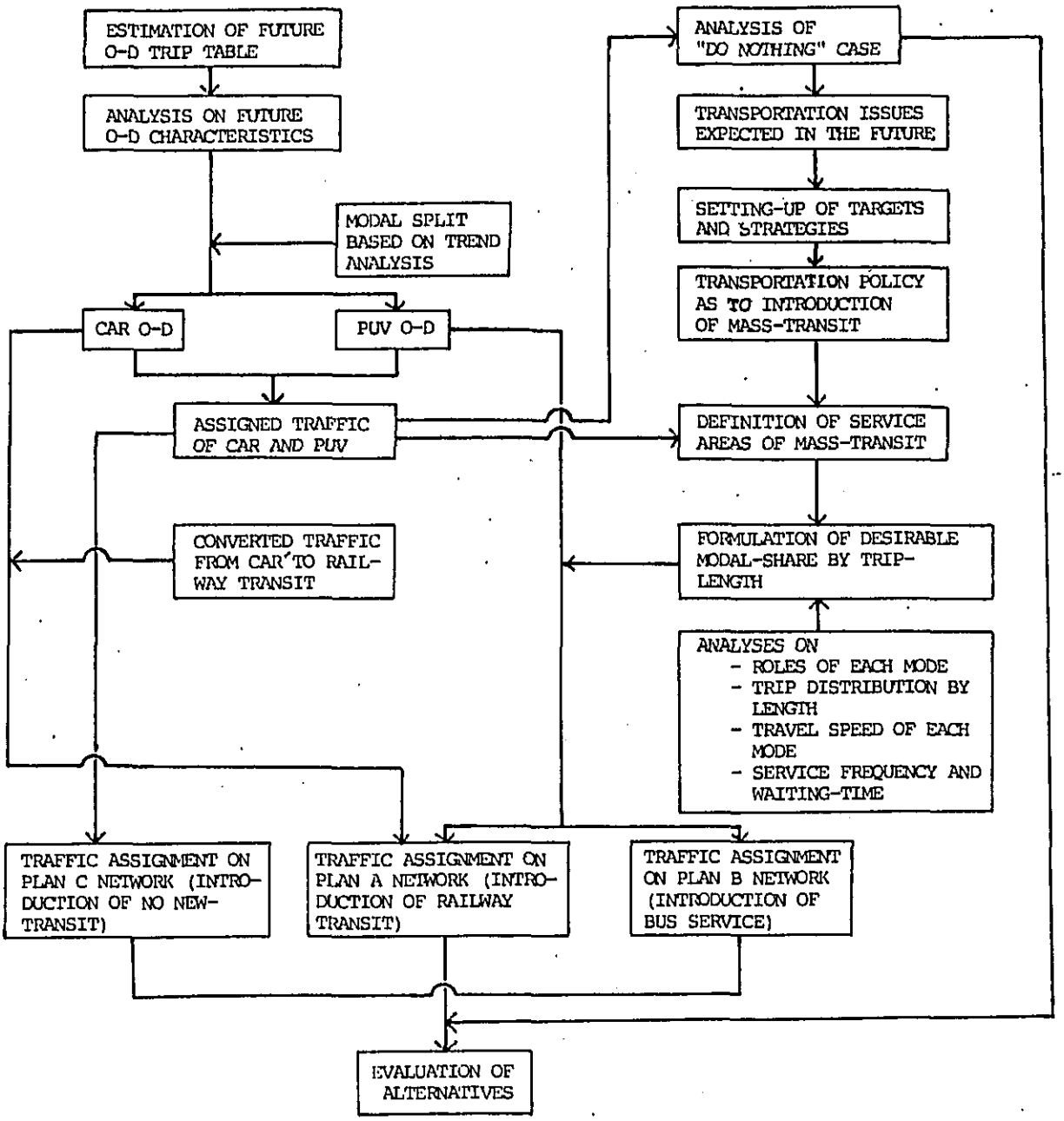
At present, bus is used only for inter-city passenger transport as provincial bus. In the future, however, bus will play a vital role in urban transport services. In Plan B, bus is considered the unique mode plying the major thoroughfares as a trunk-line service. Bus will also be used as a feeder mode to the trunk-line service in Plans A and B. The feeder bus service will be provided within Blocks or between 2 Blocks.

For inter-city passenger transport, provincial bus will keep its position as in the present.

3) Railway Transit

In Plan A, the railway will carry passengers travelling relatively long distance as a trunk-line service in the Project Area.

FIG. 3.9 PROCEDURE OF TRAFFIC FORECASTING AND EVALUATION OF ALTERNATIVES



2.3.2 Traffic Demand Estimate

(1) Modal Share by Alternative

Preceding the planning of modal split, the following items were examined:

1) Trip distribution by distance
2) Role of each mode
3) Running speed of each mode
4) Service frequency and waiting time of passengers
5) Modal Split found in other cities

Based on these discussions, the modal share of PUV modes by distance was determined, as illustrated in Figure 3.10, where the modal split of Plans A and B is indicated. The modal shares of P.U. Taxi and PUJ are unchanged for Plans A and B, since these modes are planned to have similar roles for both cases. The only difference between Plans A and B is the mode of trunk-line service and the modal share of the feeder bus.

In addition, no change in modal split was assumed for Plan C, where PUJ is predominant as in the present.

(2) Traffic Conversion from Private Car to Railway Transit

Due to a variety of advantages inherent to the proposed railway transit such as punctuality, high speed, comfort, etc., conversion of traffic from private car to railway can be expected to some extent. Based on the analysis of the parking characteristics of private cars observed in 1979 in Davao City, cars having the following characteristics were assumed to be converted to the railway.

1) Trip Purposes of "Going to Office" and "Going to School"
2) Parking Hours of more than 4 hours

About 40% of cars having trip purposes of "Going to Office" and "Going to School" were estimated to have parking hours of more than 4 hours.

Car trips expected to be converted to railway were estimated at approximately 73 thousand trips per day or 19% of the total number of car trips in 2000.

(3) Results of Estimate

The planned modal split of the alternatives are shown in Figure 3.11 and Table 3.3.

The total traffic demand in 2000 (excluding "walk", "bicycle" and "motorcycle") shows a growth of 3.3 times of that in 1979. In particular, the growth rate of cars and trucks is very high, i.e. 3.5, 4.1 and 4.1 times for Plans A, B and C respectively, while PUV shows a moderate growth rate of 3.2, 3.0 and 3.0 times for Plans A, B and C.

With regard to the number of trips, car shares 300-370 thousand trips, while PUV shares 600 - 660 thousand trips, which is nearly double of the 1979 figure.

Fig. 3.12 illustrates the desired lines by Block of passenger trips of the railway providing the trunk-line service in case of Plan A. Among the Block pairs having large demand for the railway, the most important are:

1) Block III-A (Poblacion) - Block-II (Panakan)
2) Block III-A (Poblacion) - Block-IV (Toril)
3) Block III-A (Poblacion) - Block-III BS (Talomo)

These are all relatively long-distance pairs, which implies that the railway transport is utilized mainly by passengers travelling medium and long-distance.

Fig. 3.13, on the other hand, shows the desired lines by Block of the passenger trips of the city bus system proposed in Plan B. Since the city bus system comprises the trunk-line service, the tendency of the desired lines is similar to that of the railway.

Table 3.3 Traffic Volume by Mode and by Alternative

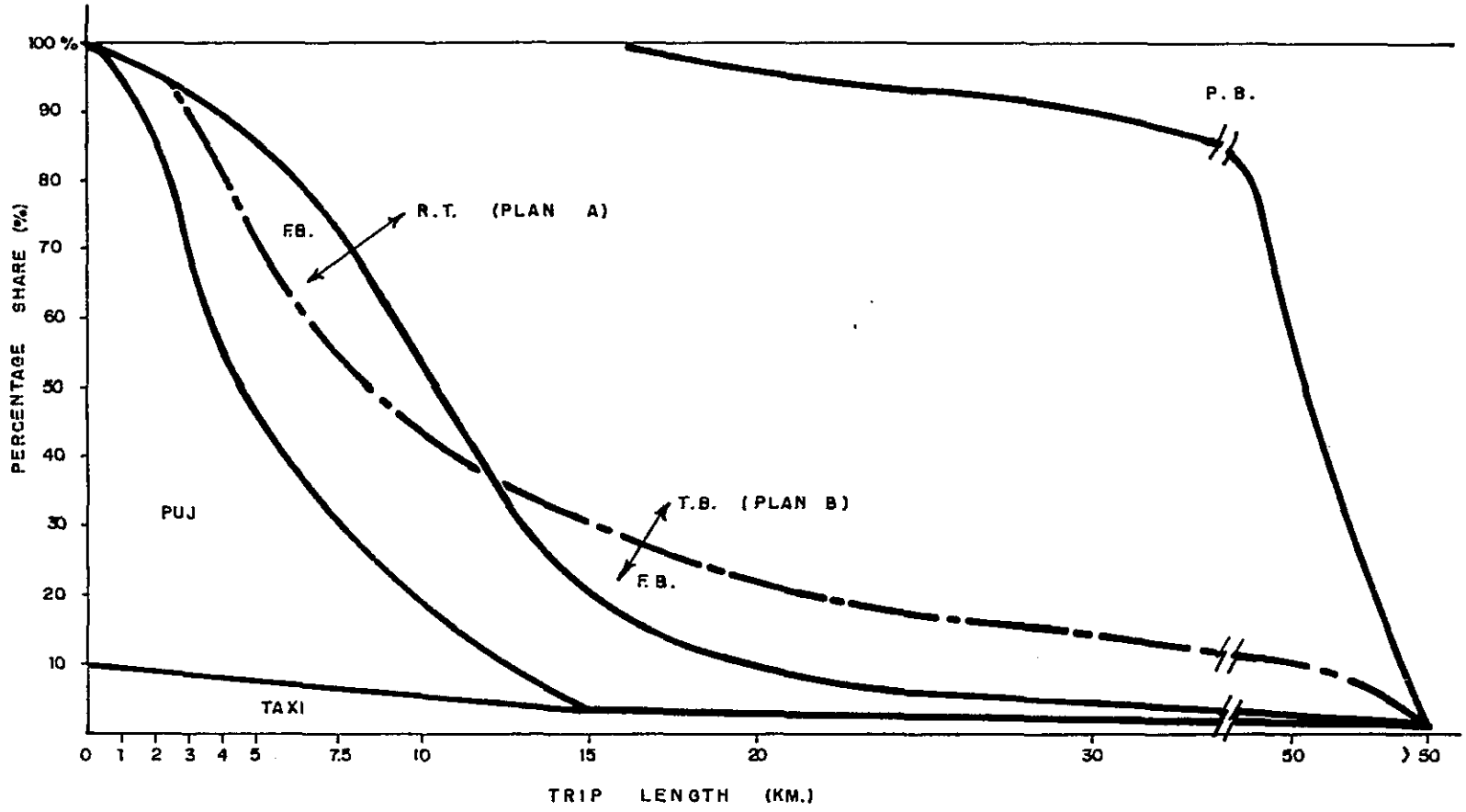
		1979	2000 Plan - A	2000 Plan - B	2000 Plan - C
Car/Truck		118 (28.3)	363 (27.4) ((3.1))	436 (32.9) ((3.7))	436 (32.9) ((3.7))
P U V	R.T.	- -	228 (17.2)	- -	- -
	BUS	10 (2.4)	335 (25.3)	491 (37.0)	144 (10.8)
	PUJ AC TRICYCLE	271 (64.8)	352 (26.4)	352 (26.4)	712 (53.7)
	TAXI, PU	19 (4.5)	49 (3.7)	48 (3.7)	34 (2.6)
	SUB-TOTAL	418 (71.7)	963 (72.6) ((3.2))	890 (67.1) ((3.0))	890 (67.1) ((3.0))
	TOTAL	418 (100)	1,327 (100) ((3.2))	1,327 (100) ((3.2))	1,327 (100) ((3.2))

Note: Upper : Number of Person Trips (x 1000 P.T.)

Under : ( ) share (%)

(( )) Growth rate of Traffic Volume (2000/1979)

Fig. 3.10 **MODAL SHARE OF PUBLIC TRANSPORT MODES**



NOTE:

R.T. - RAILWAY TRANSIT
T. B. - TRUNK SERVICE BUS
F. B. - FEEDER SERVICE BUS
P. B. - PROVINCIAL BUS

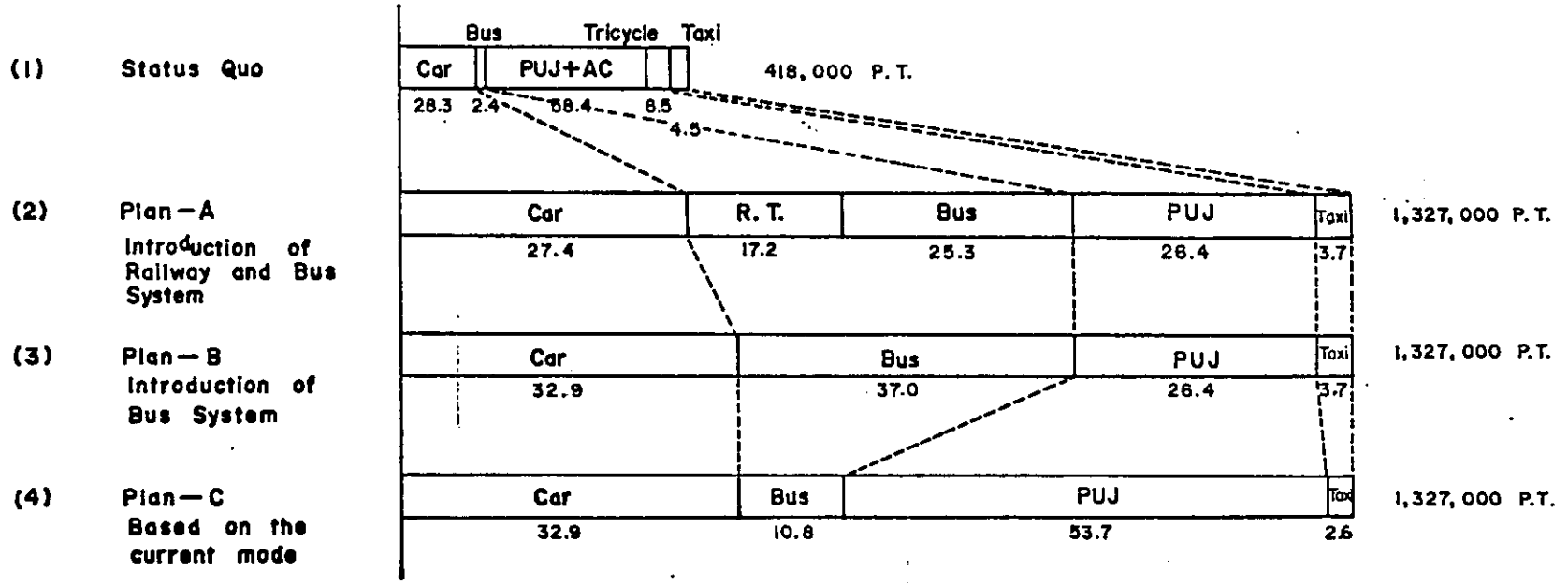


Fig. 3.11 **MODAL SHARES BY ALTERNATIVE**

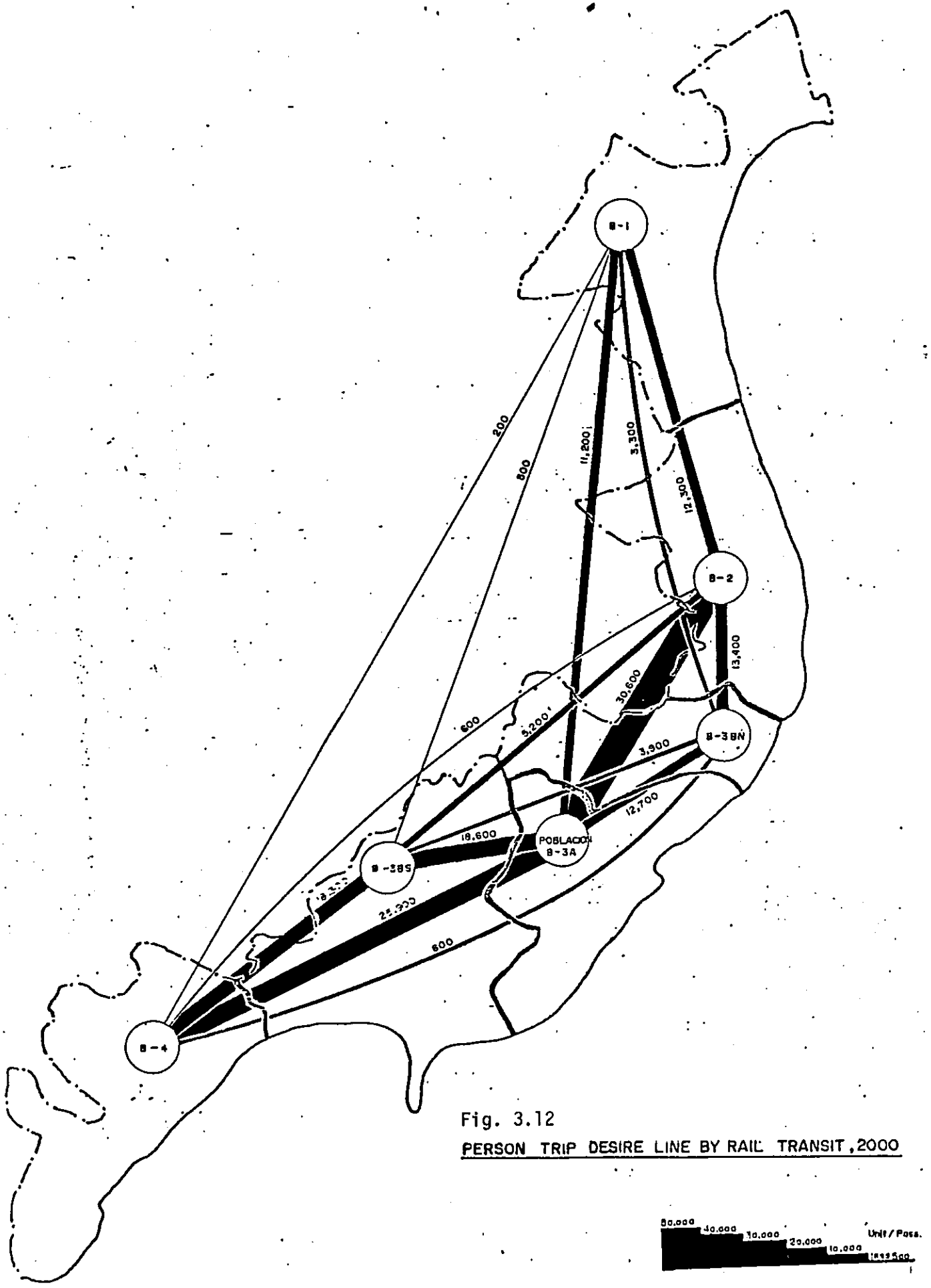


Fig. 3.12

PERSON TRIP DESIRE LINE BY RAIL TRANSIT, 2000

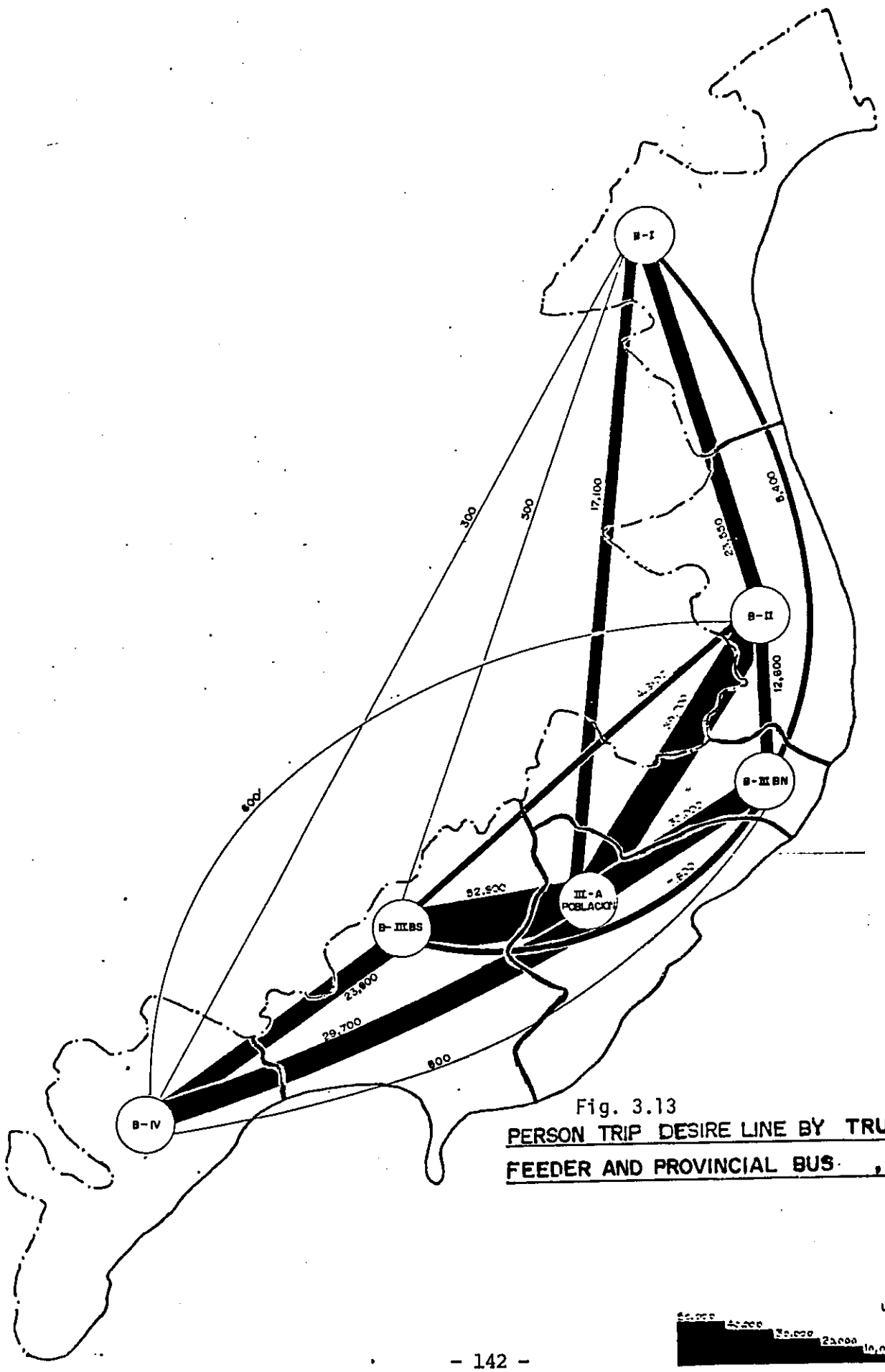


Fig. 3.13
PERSON TRIP DESIRE LINE BY TRUNK, FEEDER AND PROVINCIAL BUS , (2000)

2.4 Traffic Assignment

The future traffic demand estimated in Section 3.2 was assigned to the alternative transport networks planned in the previous section.

A popular and widely used method was adopted in the traffic assignment, i.e.:

i) Firstly, the traffic of public transport (PT, bus and PUJ) is assigned to the minimum-time paths without capacity restraint.

ii) Secondly, the rest of the total traffic is assigned to the road network, where the minimum-time path changes from one to another depending on the traffic volume according to the predetermined speed-volume relationship.

Figures 3.14 to 3.17 show the assigned traffic volumes of "Do-Nothing" case and alternative transport plans. In the case of "Do-Nothing", all road sections have relatively equalized traffic volumes compared to Plans A, B and C. This implies a considerable overflow of traffic from major thoroughfares to less important roads, causing serious traffic problems in the City.

The assigned traffic volumes of Plans A, B anc C are in harmony with the conceptual transport networks shown in Fig. 3.15 to 3.17. The busiest roads in Plans A, B and C are Quirino Avenue and R. Castillo Street, where public transportation routes are concentrated and the total traffic volume will be 40-50 thousand pcu's per day.

On the other hand, the newly constructed roads, i.e., the road running in the west parallel with the Davao-Agusan Road and the Coastal Road, are projected to have a traffic volume of 15 - 30 thousand pcu's per day.

The Ring Road linking J.P. Laurel Avenue with the coastal Road via Ma-a shows a traffic volume of 10-30 thousand pcu's per day in all alternative plans. In particular, the importance of this road becomes very high in Plans B and C, due to the diverted traffic of 10-13 thousand pcu's per day from McArthur Highway, which is caused by the proposed tunnel connecting this road directly with the Diversion Road.

The demand for public transport mode providing the trunk-line service is illustrated in Figures 3.18, 3.19 and 3.20 for Plans A, B and C respectively.

The demand for RT is estimated at approximately 71 thousand person -trips/day at the busiest section including Poblacion, showing a gradual decrease to the North and the South. In addition, considerable demand gaps are found in Panakan for the North and Talomo in the South.

With regard to the demand for buses, Quirino Avenue shows the largest traffic volume of about 9 thousand pcu's per day, as shown in Fig. 3.19 . The Davao-Cotabato Road, Buhangin Road and the Diversion Road have also large volumes of bus traffic. Traffic demand for PUJ's (see Fig. 3.20) has a similar distribution pattern.

Table 3.4 presents modal shares at the cross-section of Davao River in terms of person-trips. The total number of person-trips crossing Davao River is approximately 300 thousand per day, out of which RT in Plan A shares 19% or 56 thousands and city bus in Plan B shares 49% or 150 thousand while PUJ in Plan C accounts for 50% or 150 thousand.

Table 3.4 Person Trips by Mode crossing Davao River

	Mode	Plan-A	Plan-B	Plan-C
Person Trips (x 100 PT)	Car	785	923	923
	Railway	569	-	-
	Bus	1,019	1,450	270
	PUJ	473	473	1,634
	PU	97	97	116
	Total	2,943	2,943	2,943
Modal Share (%)	Car	26.7	31.4	31.4
	Railway	19.3	-	-
	Bus	34.6	49.2	9.2
	PUJ	16.1	16.1	55.5
	PU	3.3	3.3	3.9
	Total	100.0	100.0	100.0

Fig. 3.14 **ASSIGNED TRAFFIC VOLUME**
(Do Nothing Case)

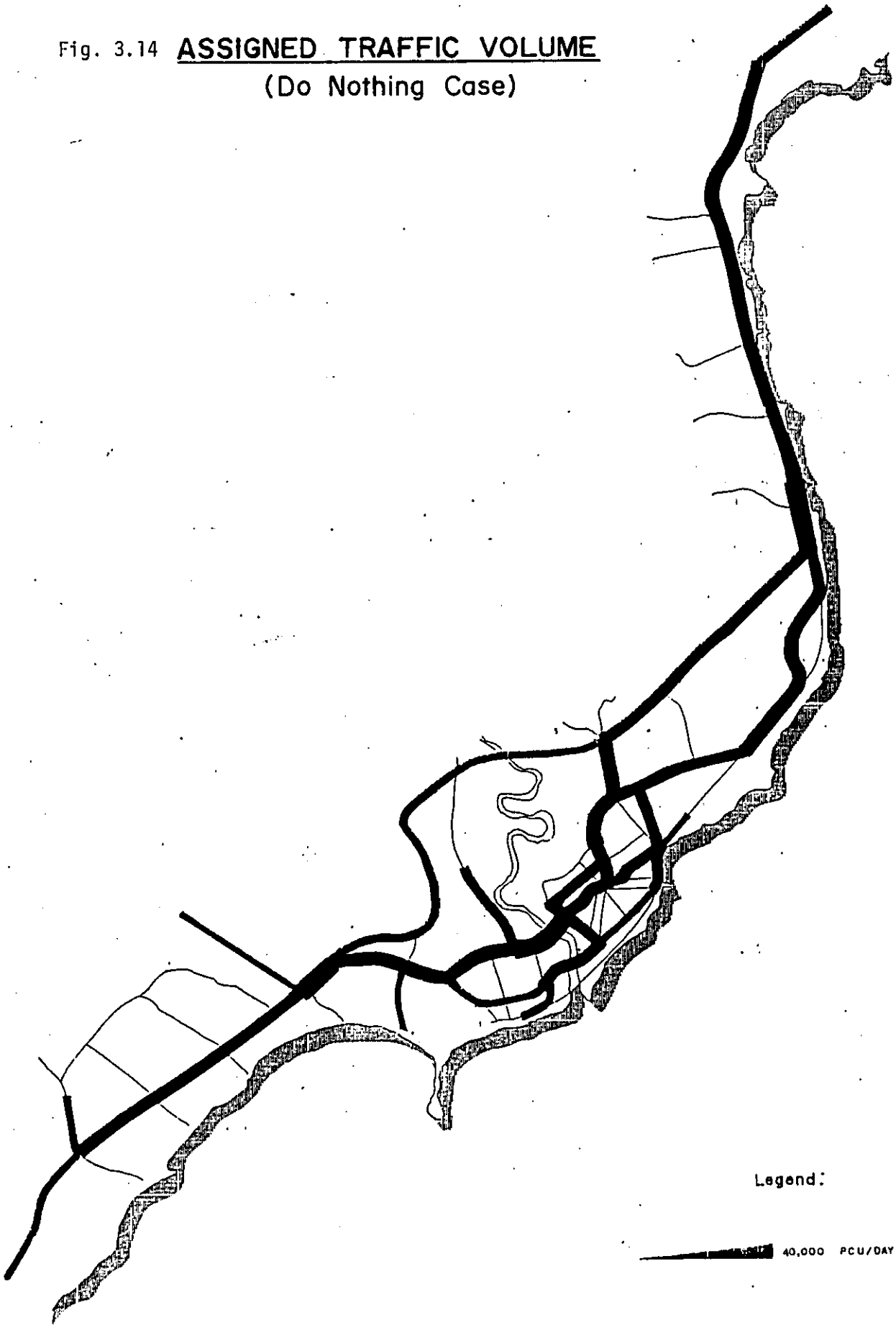


Fig. 3.15 **ASSIGNED TRAFFIC VOLUME (PLAN A)**

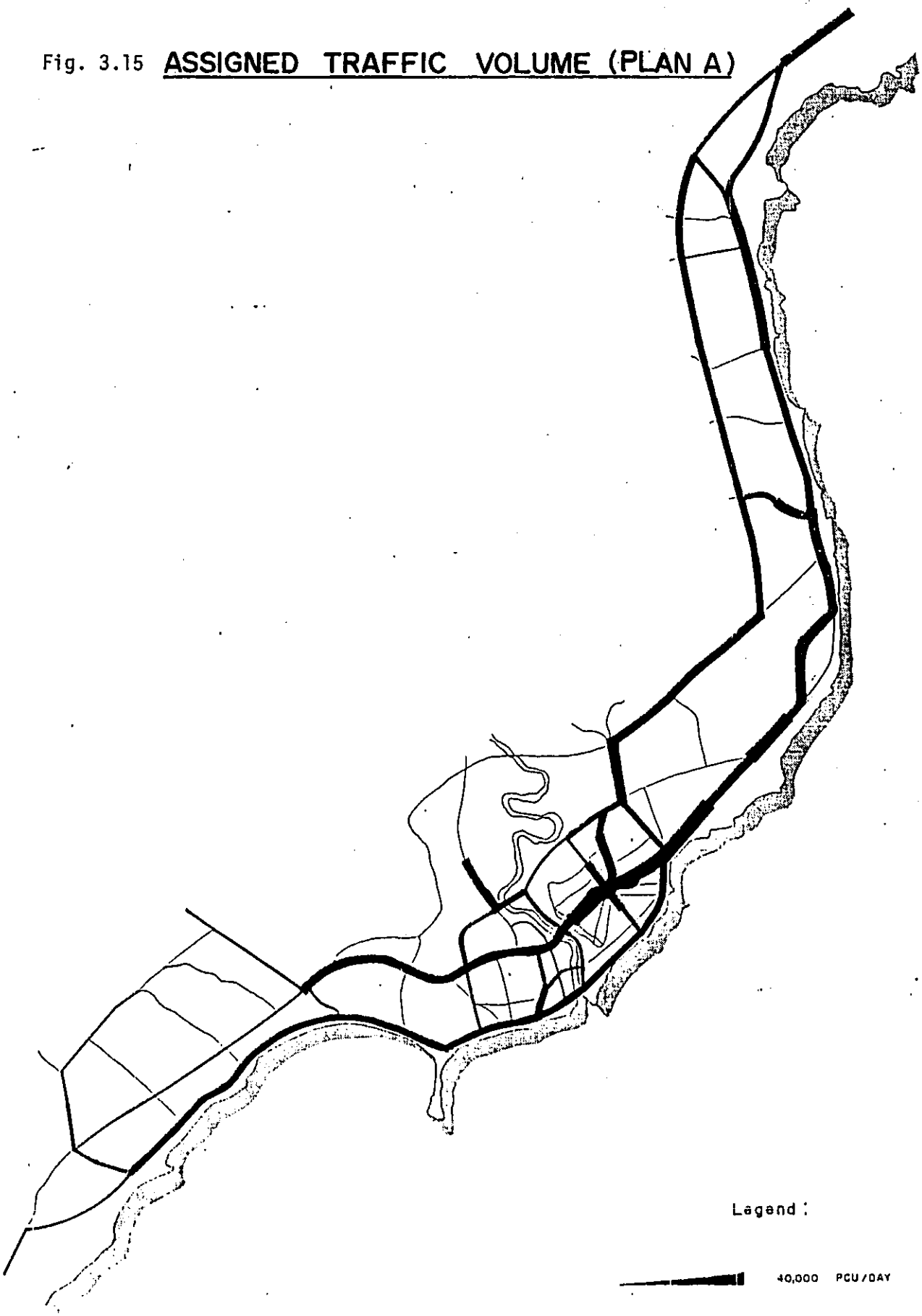


Fig. 3.16 ASSIGNED TRAFFIC VOLUME (PLAN B)

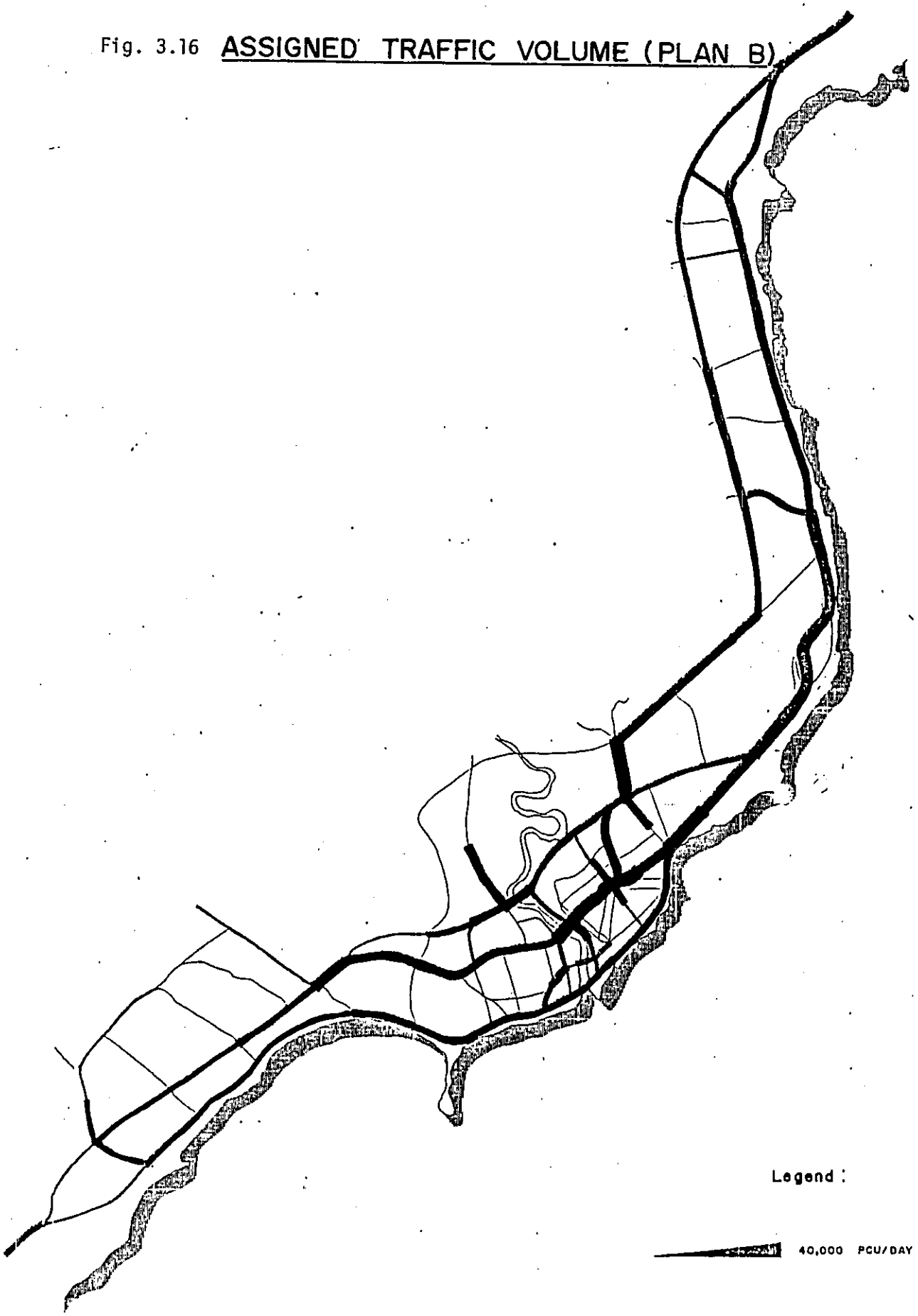


Fig. 3.17 ASSIGNED TRAFFIC VOLUME (PLAN C)

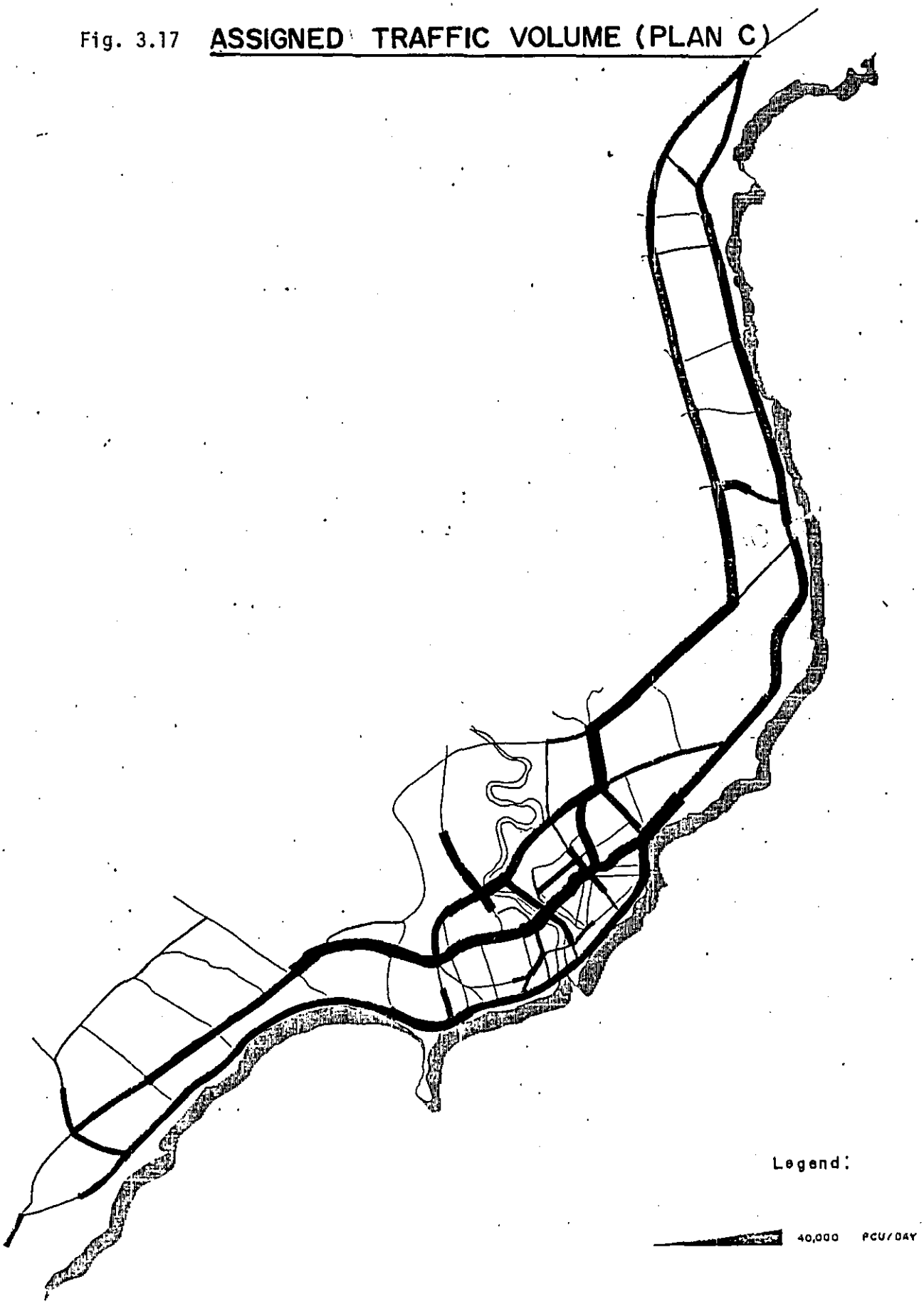


Fig. 3.18 **TRAFFIC DEMANDS (Railways)**

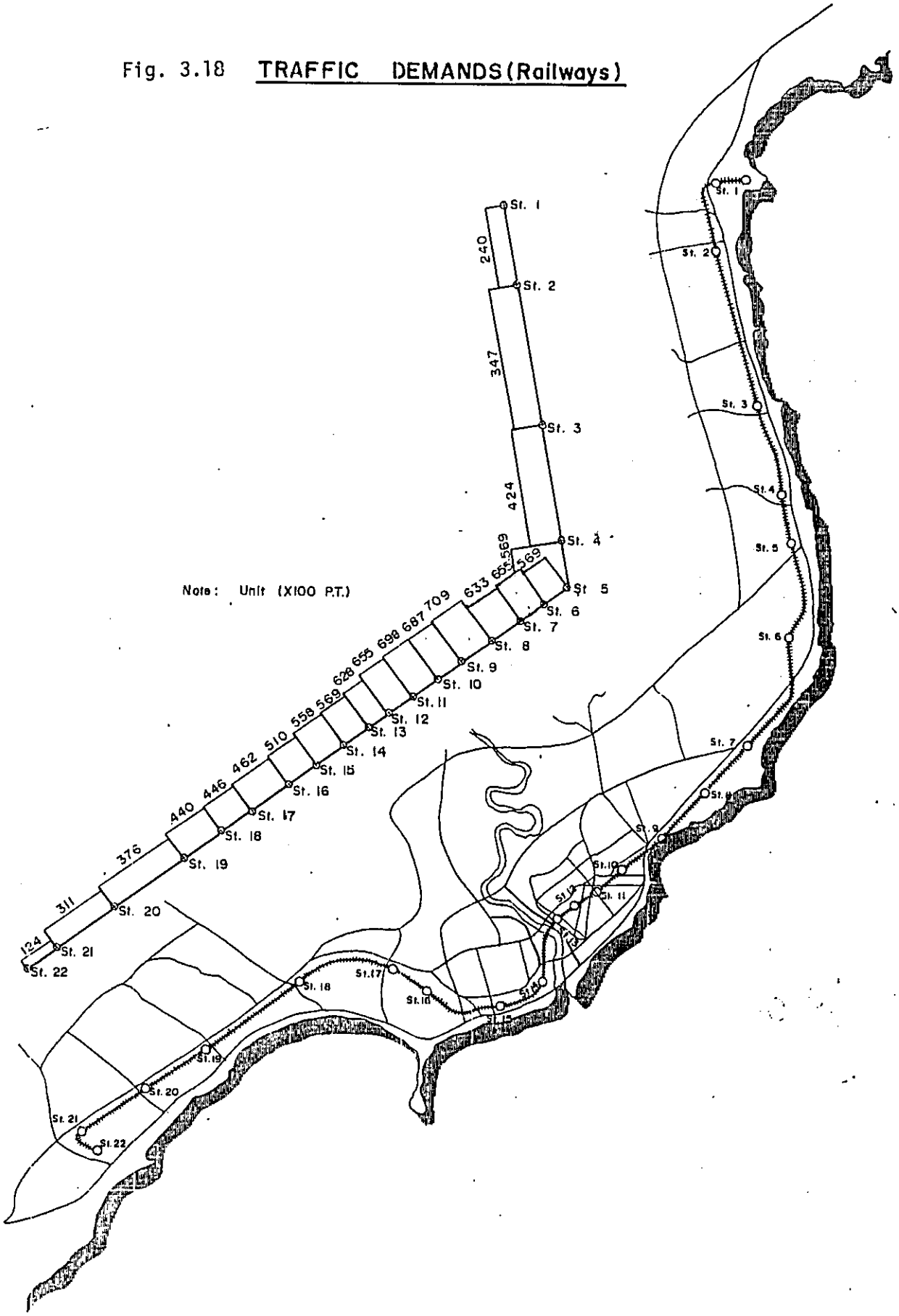


Fig. 3.19 **TRAFFIC DEMANDS (BUS)**

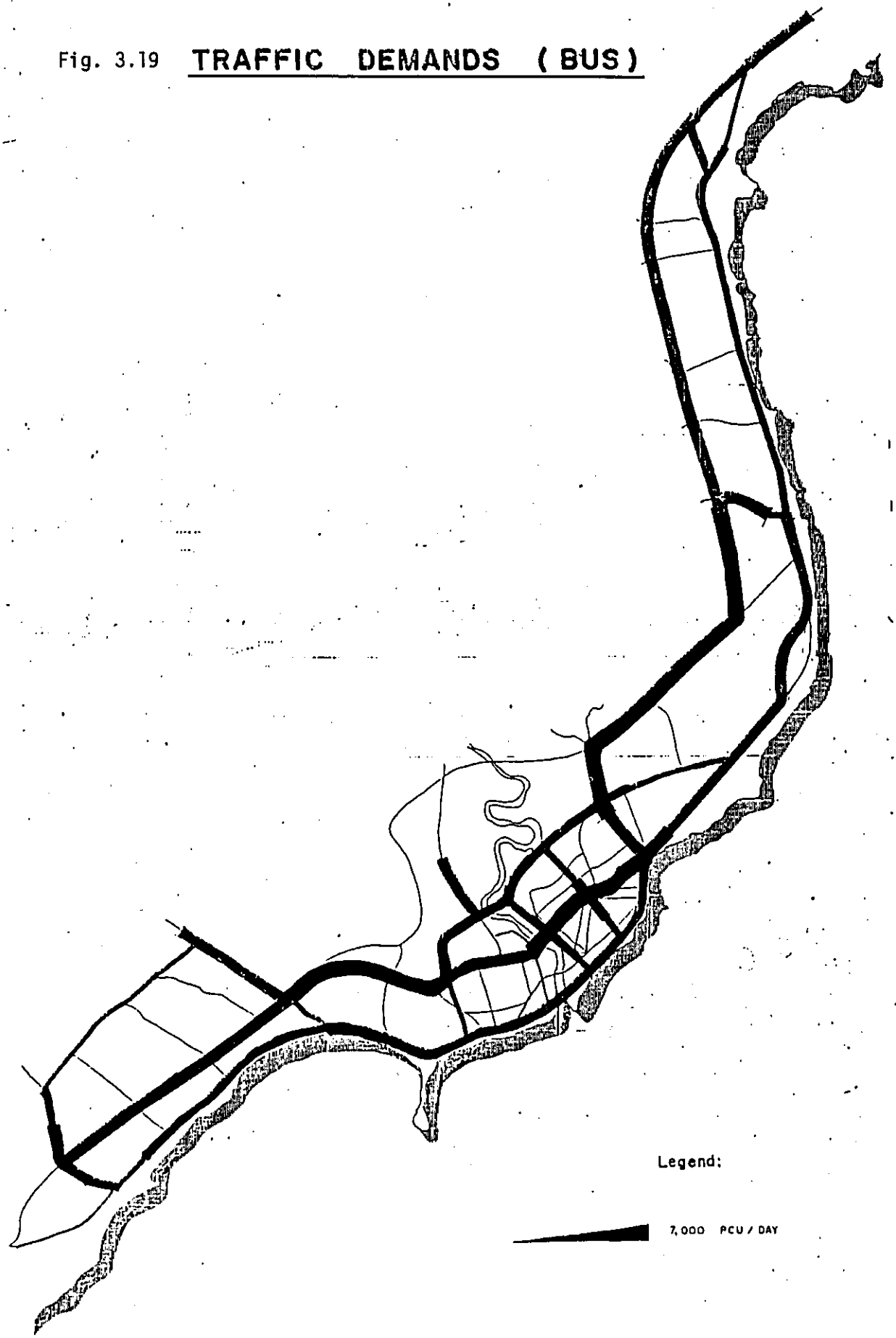
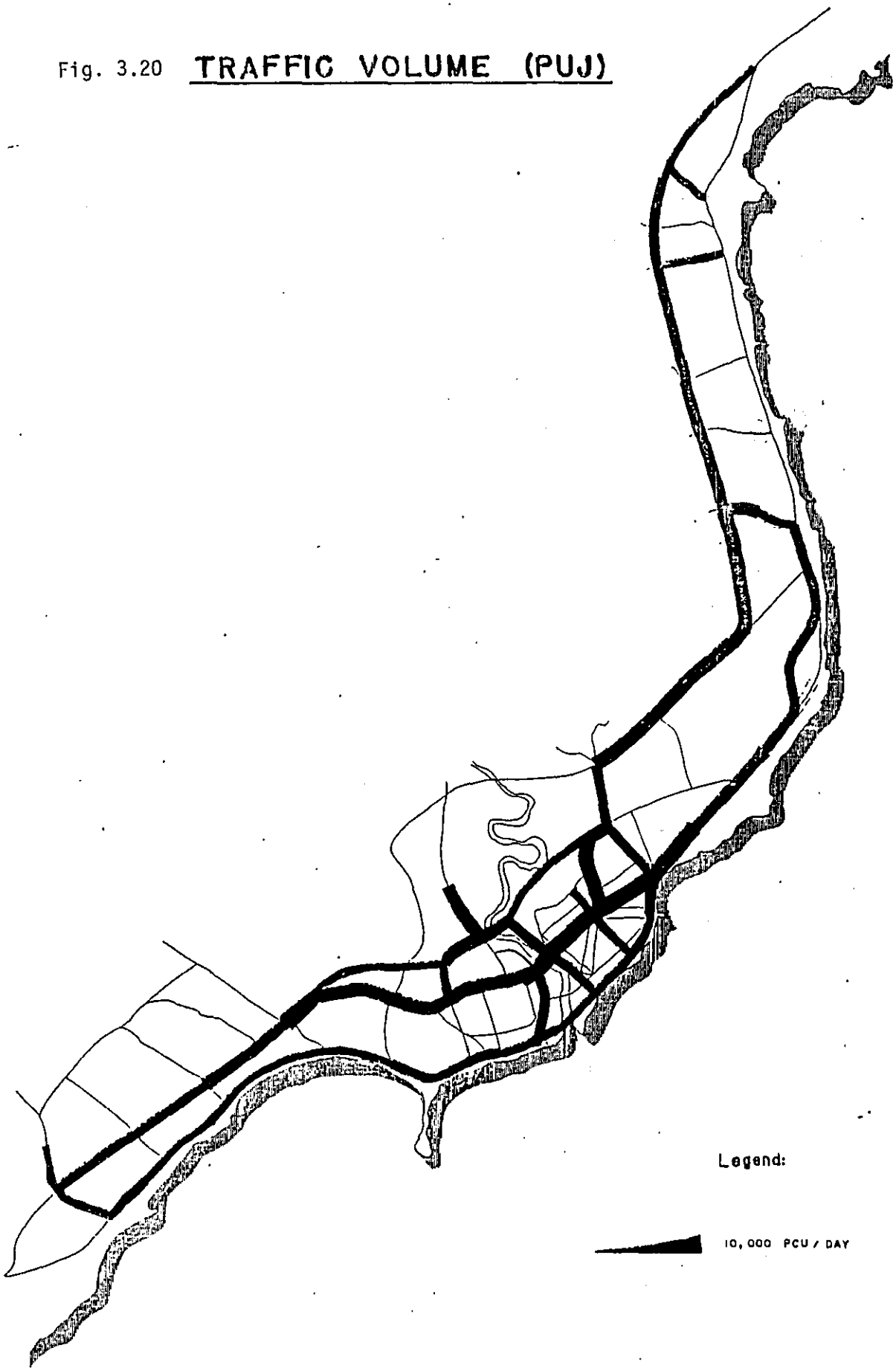


Fig. 3.20 **TRAFFIC VOLUME (PUJ)**



2.5 Evaluation of Alternatives

2.5.1 Methodology

This section deals with the overall evaluation of the aforementioned alternative transport plans.

The evaluation procedure is as follows:

a. Uplisting of the important features of each alternative

b. Economic evaluation

c. Sensitivity analysis of energy price on the results of economic evaluation

With regard to economic evaluation, the methodology is illustrated below:

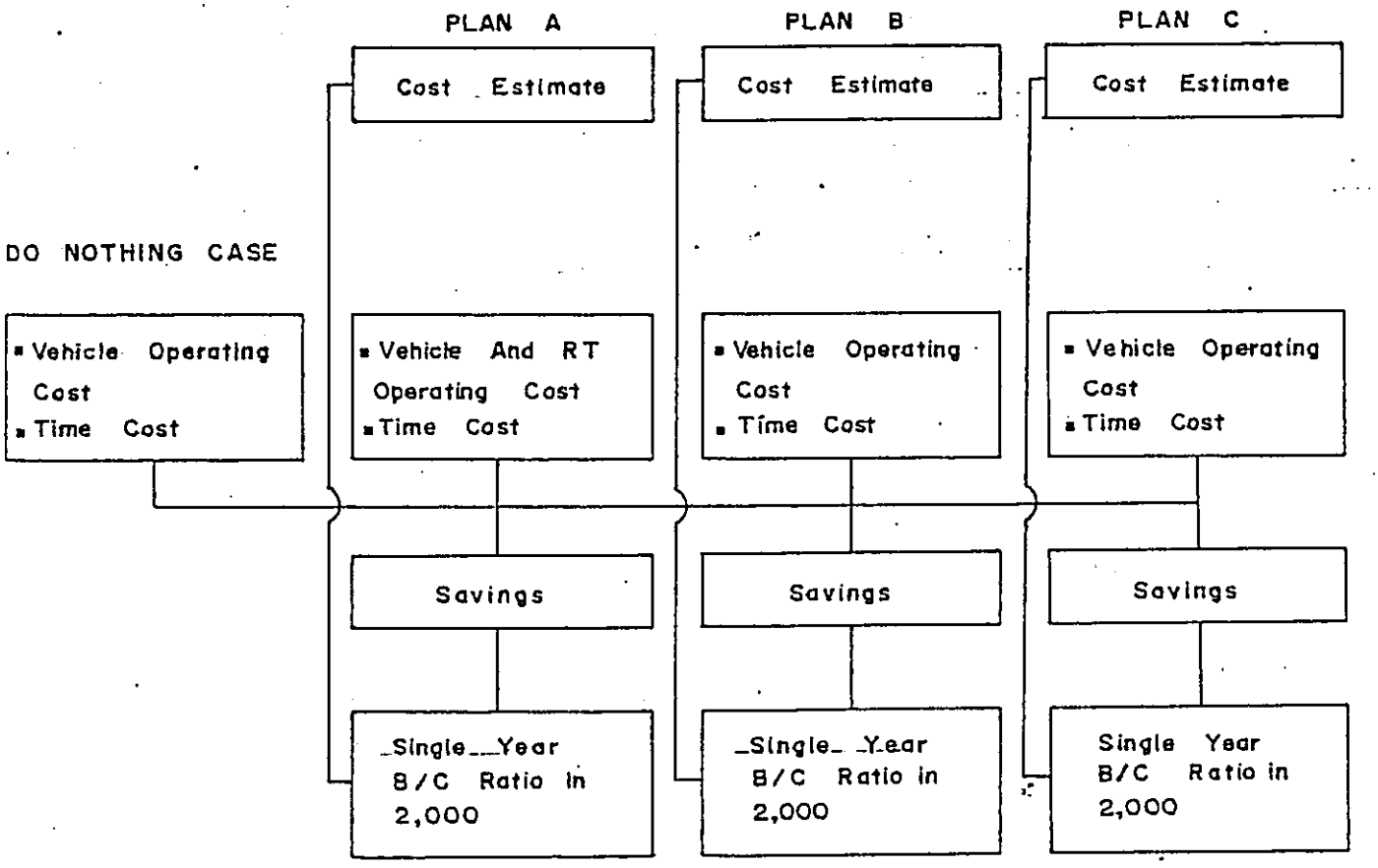


Fig. 3.21 Method of Economic Evaluation

The basic features of this economic evaluation are:

a. That economic benefit is defined as savings in vehicle operating cost and passenger time cost, and

b. That B/C ratio is calculated by dividing the single-year benefit in 2000 by the annualized cost.

2.5.2 Characteristics of Alternative Plans

Major characteristics of the alternative plans are summarized in Table 3.5, where indicators of traffic such as passenger-kms, passenger-hours, vehicle-kms by mode and vehicle-hours by mode, and other indicators showing the overall road capacity, volume/capacity ratio and length of road sections congested are listed.

With regard to passenger-kms, Plans B and C excel Plan A, where additional passenger-kms generated by the feeder links to/and from railway stations are taken into account. As for passenger-hours, Plan B is pre-eminent as a whole, although the passenger-hours of PUV (including RT) is the lowest in Plan A owing to the high speed of RT. The superiority of Plan B largely depends on the transport policy of making maximum use of bus being supported by auxiliary facilities like exclusive bus lanes.

On the other hand, Plan A is most efficient in terms of vehicle-kms and vehicle-hours, if train-kms and train-hours of RT can be neglected, Followed by, Plan B which shows second best figures due to the intensive use of bus instead of PUJ.

In case of "Do-Nothing", the average volume/capacity ratio increases up to 1.86, and, as illustrated in Fig. 3.15, the proportion in total length of roads of the road sections with 2.5 or more volume/capacity ratio is considerably high, implying that the traffic improvement be very urgent.

Plan C records the least value of volume/capacity ratio, followed by Plans B and A. This is considered reasonable, compared to the planned quantity of road construction and improvement. Plan B, however, has a similar distribution pattern of volume/capacity ratios with little difference from Plan C, while Plan A, has a relatively high proportion in total length of roads of the road sections with 1.0 or more v/c ratio.

As shown clearly by the indicators mentioned above, all of the alternative transport plans will be able to cope with the future traffic demand with remarkable improvements in traffic compared to the "Do-Nothing" Case.

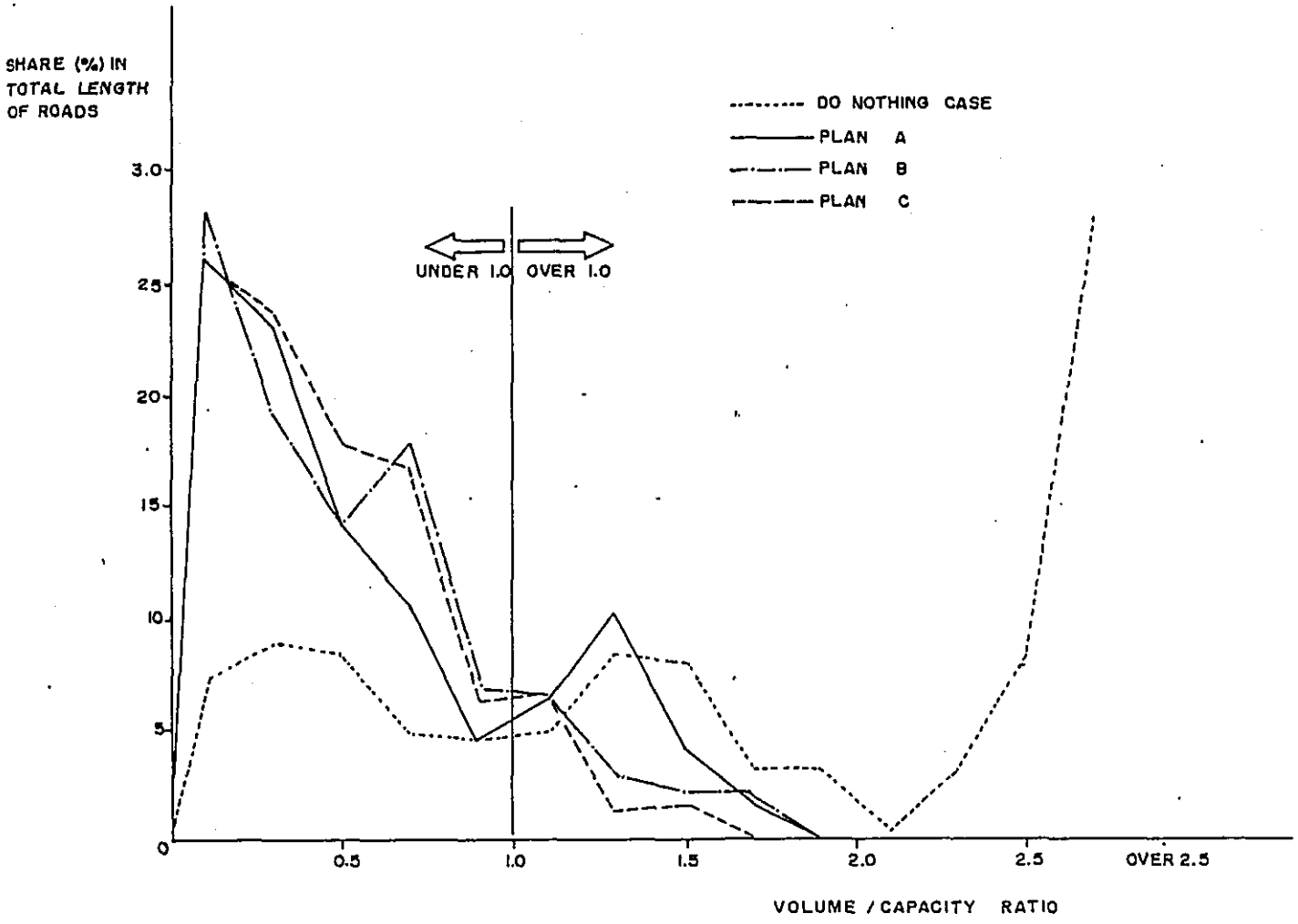


Fig. 3.22 DISTRIBUTION OF VOLUME/CAPACITY RATIO

Table 3.5 Major Indicators by Alternative

			Do-Nothing Case	Plan A	Plan B	Plan C
TRAFFIC DEMAND	Passenger - Kms		9,215,000	9,244,000	8,835,000	8,738,000
	Passenger - Hours		878,000	372,000	353,000	365,000
	Vehicle-kms by Mode	Car	1,075,000	870,000	995,000	997,000
		Jeep	483,000	391,000	447,000	448,000
		P.U. Taxi	293,000	318,000	316,000	271,000
		PUJ	595,000	177,000	118,000	564,000
		BUS	54,000	147,000	222,000	54,000
		Truck	301,000	255,000	279,000	279,000
		Total	2,802,000	2,158,000	2,375,000	2,612,000
	Vehicle-Hours by Mode	Car	69,000	27,000	30,000	29,000
		Jeep	31,000	12,000	14,000	13,000
		P.U. Taxi	19,000	10,000	10,000	9,000
		PUJ	68,000	10,000	7,000	28,000
		BUS	5,000	6,000	9,000	2,000
		Truck	28,000	11,000	12,000	11,000
		Total	221,000	78,000	82,000	93,000
Other Traffic Indicators	Overall Road Capacity of the Project Area (PCU x Km)		1,645,000	4,394,000	5,061,000	5,854,000
	Total length of Road Sections with 10,000 or more PCU's/day (kms)		97.5	96.3	108.8	113.4
	Total length of Road Sections with 40,000 or more PCU's/day (kms)		22.1	3.5	5.0	5.9
	Average Volume/Capacity Ratio		1.86	0.55	0.51	0.47
	Total Length of Road Sections with 1.0 or more v/c ratio (kms)		92.1	48.6	30.1	21.1
	Total length of Road Sections with 1.5 or more v/c ratio (kms)		69.8	8.5	5.4	2.2

2.5.3 Economic Evaluation

(1) Review of Costs

Initial cost and its related maintenance cost are shown in economic prices in the following table. The initial cost, after converted to the annualized cost, is added to the annual maintenance cost in order to estimate the average annual cost.

In addition, the cost of rolling stocks of the proposed rail transit is included in the annual operating cost.

(2) Economic Benefit Calculations

The economic benefit of each alternative transport plan comprises the savings in vehicle (or RT) operating cost and passenger time cost, which can be calculated by comparing the alternative with "Do-Nothing" case.

The unit vehicle operating cost and passenger time cost used in the calculation are presented below:

Using the tables above, economic benefits of alternative transport plans were calculated, as shown below. In addition, operating cost of RT in Plan A was estimated based on the data of the proposed MLRT (Manila Light Rail Transit).

(3) Benefit-Cost Analysis

Benefit-cost ratios of alternative plans can be calculated for the year 2000 by dividing the economic benefit in 2000 by the annualized cost, as shown in the following table.

The result shows that all alternative plans are economically feasible. More specifically, Plan B, which calls for a full utilization of city buses.

(4) Sensitivity Analysis

Energy cost is continuously going up due to the recent rapid increase of oil price.

On the assumption that vehicle fuel cost would grow at 5% per annum up to the year 2000, when the fuel price would be 2.65 times higher than the current price, the result of economic evaluation was tested. Other cost items, however, are assumed to be constant.

The result of the analysis revealed that all alternatives become more feasible than in the original evaluation. This implies that the more oil price increases the more urgent becomes the traffic improvement.

Plan B still maintains the highest ranking followed by Plan C.

Table 3.6 Summary of Economic Cost

(₱ Million)

	Plan A	Plan B	Plan C
INITIAL COST			
Road			
A. New Construction	250.1	340.9	419.0
B. Improvement	251.2	355.2	395.6
C. Land Acquisition/compensation	440.3	598.1	649.4
Sub-Total (A + B + C)	941.6	1,294.2	1,464.0
Rail Transit			
D. Civil Work	493.9	-	-
E. Electro Mechanical Equipment	241.7	-	-
F. Land Acquisition/compensation	56.4	-	-
Sub-Total (D + E + F)	792.0	-	-
TOTAL	1,733.6	1,294.2	1,464.0
ANNUALIZATION OF INITIAL COST			
Depreciation 1/ ($\frac{1}{20}$ (A + B + D + E))	61.8	34.8	40.7
Capital Opportunity Cost (Total Initial Cost x 0.15 x ½)	130.0	97.1	109.8
TOTAL	191.8	131.9	150.5
MAINTENANCE COST PER ANNUM			
For roads	6.5	6.9	7.2
For RT (1% of D & E)	7.4	-	-
TOTAL	13.9	6.9	7.2
*Note: Annual maintenance cost of roads in "Do-Nothing Case" is estimated at ₱ 8.5 M.			
TOTAL ANNUAL COST	205.7	138.8	157.7

Note 1/ Depreciation period is assumed 20 years considering the present railway situation in the Philippines.

Table 3.7 Economic Vehicle Operating Cost, Davao, 1980

Cost Item	Car	Jeep	P.U. Taxi	Jeepney & Auto Calesa	Bus	Truck
RUNNING COST (₱ /vehicle/km)						
Fuel	0.319	0.383	0.255	0.351	0.559	0.606
Lubricant Oil	0.005	0.008	0.004	0.007	0.023	0.023
Tire	0.026	0.028	0.029	0.051	0.109	0.113
Maintenance (Spare Parts	0.069	0.087	0.021	0.050	0.170	0.201
Maintenance (labour)	0.041	0.052	0.028	0.035	0.039	0.058
Depreciation (Distance)	0.137	0.075	0.120	0.086	0.226	0.156
T O T A L	0.597	0.633	0.457	0.580	1.126	1.157
FIXED COST (₱/vehicle/hour)						
Depreciation (Time)	1.030	0.404	0.318	0.302	1.605	1.398
Capital Opportunity Cost	1.579	1.350	0.495	0.795	4.430	3.758
Crew Cost	1.200	1.600	2.700	2.600	6.800	5.700
Overhead & Motor Vehicle Fee	0.360	0.480	1.210	1.840	8.510	6.040
Insurance	0.460	0.460	0.460	0.810	1.000	0.890
T O T A L	4.629	4.294	5.183	6.347	21.805	17.786

Source: Estimated Based on the Highway Planning Manual, Volume 4, PPDO, MPH

Table 3.8 Passenger Time Cost, Davao, 1980

Type of Passenger/Driver	At Work	To/From Work	Other Purposes
Car/Jeep Driver (Owner)	10.35	5.18	0
Car/Jeep Passenger	4.14	2.07	0
P.U. Taxi Passenger	4.14	2.07	0
Jeepney/Auto Calesa Passenger	2.07	1.04	0
Bus Passenger	2.61	1.31	0
Truck Passenger	1.55	0.78	0

Source: Estimated Based on the Highway Planning Manual, Vol. 4, PPDO, MPH

Table 3.9 Summary of Economic Operating Cost, 2000

(₱ million/year)

	Do-Nothing Case	Plan A	Plan B	Plan C
ROAD				
Vehicle Operating Cost	1,250.7	771.3	864.4	868.4
Passenger Time Cost	333.6	130.8	147.4	139.2
Sub-Total	1,584.3	902.1	1,011.8	1,007.6
RAIL TRANSIT				
Maintenance (1% of Rolling Stock)	-	3.1	-	-
Labour	-	13.6	-	-
Material	-	6.2	-	-
Power	-	9.9	-	-
Overhead	-	3.3	-	-
Depreciation (Rolling Stock over 20 years)	-	10.4	-	-
Capital Opportunity Cost (Rolling stock Cost x 0.15 x ½)	-	23.4	-	-
(Sub-Total)	-	69.9	-	-
Passenger Time Cost	-	27.7	-	-
Sub-Total	-	97.6	-	-
TOTAL	1,584.3	999.7	1,011.8	1,007.6
SAVINGS	-	584.6	572.5	576.7

Table 3.10 Benefit - Cost Ratios in 2000

	Plan A	Plan B	Plan C
Savings in 2000 (₱ million)	584.6	572.5	576.7
Annualized Cost (₱ million	197.2	130.3	149.2
B/C Ratio in 2000	3.0	4.4	3.9

Table 3.11 Results of Sensitivity Analysis

	Plan A	Plan B	Plan C
Savings in 2000 (₱ million)	740.3	645.9	618.8
Annualized Cost (₱ million)	197.2	130.3	149.2
B/C Ratio in 2000	3.8	5.0	4.1

2.5.4 Preliminary Financial Evaluation of RT (Rail Transit) and City Bus

(1) RT (Rail Transit)

The outline of the proposed DRT (Davao Rail Transit) is as follows:

- Length: 35.7 kms. Toril - Poblacion - Bunawan
  (Maximum utilization of right-of-way of existing and planned roads)
- Type of DRT: Similar to MLRT
- Maximum Passenger Capacity: 6,7000 passengers/hour/direction
  (assuming a practical capacity of 280 passengers per 1-car train)
- Minimum Headway : 2.5 minutes
- Track : Double Track with 7.5 m Width
- Station: 37 (about 1 km interval)
- Marshalling Yard : 2 Yards (1.1 ha.)
- Demand for DRT: Approximately 200 thousand person trips per day (25% of the total demand for public transport) with relatively long trip lengths
- Service Frequency:

  179/day/direction for Ulas-Poblacion-Panakan with the minimum headway of 3 minutes, and 86/day/direction for other sections with the minimum headway of 6 minutes

- Service Hours: 5:00 - 24:00
- Required No. of Rolling Stock : 51
  (including 10% reserved capacity)

Based on these characteristics of DRT, preliminary financial evaluation was carried out as follows:

i) Estimate of Annual Revenue

Passenger-Kms per Day: 1.91 million passenger-kms

No. of Operating Days per Annum: 307 Days
(assuming half demand on Sundays, Saturdays & Holidays)

Annual Passenger-kms: 586.37 million passenger-kms
(1.91 x 307)

If passenger fare is set at ₱0.129/passenger/km., which is similar to other public transport modes, the annual revenue can be calculated at ₱75.64 million.

ii) Estimate of Operating Cost

Mainly based on the data of MLRT, annual operating cost was estimated as follows:

I.	Fixed Cost	
	A. Maintenance	₱ 12.54 million
	B. Labor	11.68 million
	C. Power	0.90 million
II.	Variable Cost	
	A. Material	₱ 7.80 million
	B. Labor	2.31 million
	C. Power	10.15 million
III.	Overhead	₱ 4.54 million
	Total Operating Cost	₱ 49.92 million/year

iii) Preliminary Financial Evaluation

I.	Income	₱ 75.64 million/year
II.	Expenditure	
	A. Operating Cost	₱ 49.92 million/year
	B. Depreciation (over 2000 years)	₱ 62.68 million/year
	C. Interest (Capital Opportunity Cost - Average over Project Life) (Total Initial Cost x 0.15 x ½)	₱ 98.38 million/year
	Total Expenditure	₱ 210.98 million/year

As explicitly shown above, the estimated income is much lower than the estimated expenditure, showing that the DRT management is extremely difficult on a commercial basis. Even if the initial investment is made interest-free, it is very hard to run DRT since the depreciation cannot be paid by the revenue from passenger fares. Further, even if the depreciation period can be extended from 20 years to 30 years for rolling stock and electro-mechanical equipment and 60 years for civil works, the annual expenditure will be ₱82.35 million, which still exceeds the estimated annual income.

(2) City Bus

An intensive utilization of city bus is proposed in Plan B, while Plan A introduces DRT. The service area of city bus is limited within Davao City with provincial bus being the mode for intercity passenger transport.

The service of city bus is outlined below:

- Demand for City Bus: 780 thousand person-trips/day
  3,267 thousand passenger-kms/day
- Required No. of Buses : 624 (capacity: 50 pass.)
  (including 10% reserve)
- Bus Routes: All Major Thoroughfares of the City
- Fare: Same as other Modes of Public Transport

Based on these characteristics, preliminary financial evaluation was conducted as follows.

In addition, it is assumed here that the city bus be operated by one operator for the convenience of calculation, although it is not desirable for city bus to be actually operated by a single company in the future.

i) Estimate of Annual Revenue

The annual revenue, which is earned only by collecting passenger fares, can be calculated by the following equation:

Passenger-Kms per Day x No. of Operating Days per Annum x Fare Rate

= 3,267,000 x 338 x 0.129

= 142,400,000

Namely, the annual revenue is calculated at ₱142.4 million.

ii) Estimate of Annual Expenditure

Based on the aforementioned method for calculating vehicle operating cost, the annual expenditure can be calculated as follows:

I. Running Cost

148,008 veh.kms/day x 338 days/year x ₱1.354/veh.km
= 67,700,000 (₱/year)

II. Fixed Cost

4,502 veh.hrs/day x 338 days/year x ₱23.205/veh.hr

= 35,300,000 (₱/year)

TOTAL ₱103.0 million/year

iii) Revenue/Expenditure Ratio

132.4/103.0 = 1.38

As estimated above, the city bus industry can be operated on a commercial basis. Since the profitability is very high, city bus operation can possibly be one of the major revenue-earning projects required for the City.

2.5.5 Tentative Conclusion with Regard to the Evaluation of Alternative Transport Plans

(1) Plans A, B and C proved economically feasible, with relatively high B/C ratios. Although economic evaluation has limited significance from the viewpoint of having well-organized urban transport system, Plan B has a comparative superiority over Plans A and C with relatively small difference.

(2) With regard to Plan C, no significant increase of economic benefit is seen compared to the cost increase. Public transport system depending only on PUJ's requires the largest public investment on roads and highways, and, moreover, energy consumption is very high.

Hence, Plan C may possibly be abandoned in this stage of the Study.

(3) Since the B/C ratio of Plan A is relatively low due to the huge amount of investment on railway and the insufficient demand estimated for the year 2000 compared to its potential capacity of railway, the construction of railway might be considered still pre-matured even in 2000.

However, Plan A cannot be rejected based only on the analyses carried out so far, from the following viewpoints:

a. Railway has a variety of characteristics superior to road transport, such as rapidness, punctuality, less pollution, less energy consumption for operation and so on.

b. If the traffic demand will increase at a growth rate higher than the DCUTCLUS estimate, the benefit of Plan A will grow more rapidly than Plans B and C.

c. The introduction of railway into urban transport system is a world-wide tendency, which can be seen in the major cities of developed countries and in some capital cities of developing countries.

(4) The timing of railway construction will vary according to the progress of regional development and road construction, growth of traffic demand in the future, increase of fuel cost and other factors. It is convinced, however, that, in the near future, the time will come when railway must be constructed. Therefore, it is essential to realize an urban transport system that could accommodate railway system easily and without any conflict whenever the railway is required. It is deemed possible to preempt the land space to be used by railway in the future without huge amount of investment.

(5) On the assumption that railway will be constructed sometime in the future, the road network targeted in Plan B may be considered an over investment. In addition, the results of traffic assignment in Plan B show a relatively low volume/capacity ratio on average which means the road network of Plan B comprises, to some extent, idle capacity in several links.

(6) Based on the discussions above, the road network of Plan A will be adopted as the base for formulating a master-plan of urban transport of the City. However, it should be noted that capacities of some road sections might not be able to cope with the estimated traffic demand in the absence of railway. In Particular, the road sections between Bunawan and Panacan, and near the Bangoy Airport, which are in the North of Poblacion, will suffer from the lack of capacity. Hence, the road network of Plan A will have to be modified slightly according to the concepts of Plan B.

(7) The project of railway construction should be carefully studied in the review and revision of this masterplan which is supposed to be conducted in the future, based on the results of introducing bus system, the progress of regional development and the tendency of fuel price. More specifically, the efficiency, financial conditions and the effects in urban transport of MLRT (Manila Light Rail Transit), which is provisioned to have commence its operation in 1983-84, should be monitored and examined to reflect the results in the future study.

CHAPTER 3

MEDIUM AND LONG-TERM PERSPECTIVES FOR PUBLIC TRANSPORT SERVICE

3.1 Evolution of Public Transport Mode

(1) Scale of Urban Area and Public Transport Service

The agglomeration and the development of urban functions such as industries, culture and administration bring about an increase in urban population resulting in rapid urbanization, expansion of the built-up area and density population and an increased demand for transportation.

In the case of a small town in a provincial area solely dependent on the primary industry for its main products, almost all of the urban facilities are concentrated in the center of the town. In such case, therefore, role of public transport service is not so much expected and if any, even private tricycle -like service might just be enough. Such conditions can be seen in most towns elsewhere in Southeast Asian countries with population of 20,000 - 30,000.

In the case of bigger scaled cities in rural area governmental facilities, commercial buildings are situated in the center of town and forming the business center while, in the midtown area educational and cultural facilities are located. The industrial zones are distributed in the suburbs of the town.

As to the transport demand in such cities, an ideal transport service could be provided by PUJ-like vehicles with a small capacity but efficient flexibility. Such type of small-sized vehicle as modified pick-up-vans, jeeps and trucks generally can support the transport demand in cities with population of 500,000-700,000 in Southeast Asian countries like the Philippines and Indonesia.

But in much bigger cities, such small sized vehicles might not be sufficient to cope with the demand. The specialization of land-use such as Central Business District (CBD), Industrial District, and Residential Districts, will generally cause bigger and constant traffic demand in certain directions. From this point of view, the flexibility which small-sized transport vehicles offer as their advantage will be relatively inconspicuous and only its ineffectivity will be recognized. In this step the utilization of medium sized transport system like bus, monorail, light rail transit (LRT), etc. are motivated. Most of the capitals in Southeast Asian countries have been making efforts to strengthen the bus service system as the most important urban transport mode. On the other hand, in some of the capitals of Southeast countries, they have begun to study the introduction of rail transit as an urban transportation mode such as the subway in Singapore, the light rail transit in Manila and commuter service of railway in Jakarta. Although the manner of the introduction of rapid mass-transportation system might differ depending on the shape of the cities and the condition of traffic demand, generally speaking, it will become difficult to cope with the demand just by bus service in cities with population of 1-2 million, and it is also impossible to maintain urban functions without railway facilities in huge cities with a population of more than 4-5 million. The general relationship between urban transport system and the scale of agglomeration of the city is shown in Table 3.12 which illustrates actual example of cities in Southeast Asian countries.

Table 3.12 Comparison of Public Transport Characteristic of Major City in Asia

Name of City	ALOR SETAR	FUKUI	DAVAO	KUALA LUMPUR	CEBU	CHIANG MAI	BANGKOK	JAKARTA	MANILA	SEOUL	TOKYO
Population (Million)	0.1 (1970)	0.5 (1975)	0.6 (1979)	0.8 (1970)	0.9 (1980)	1.1 (1975)	3.1 (1970)	4.2 (1970)	4.0 (1971)	5.5 (1970)	28.0 (1975)
*3 Modal Share for Public Transportation Mode	20 %	13 %	44 %	40 %	81 %	61 %	66 %	61 %	62 %	95 %	53 %
Public Transportation Mode at present	Rail 0 % Bus 15 % PC 5 %	Rail 6 % Bus 7 % —	— Bus 1 % PC 43 %	— Bus 35 % PC 5 %	— Bus few PC main	— Bus 19 % PC 42 % (Mini Bus)	— Bus 59 % PC 7 %	— Bus 60 % Other 1 %	— Bus 19 % PC 37 % Other 6 %	— Bus 95 % PC 21 %	Rail 45 % Bus 8 % —
Plans for R.T. Service	*2 Introduction of Intracity Bus Service	Improvement of Bus System is on going.		• RT will be introduced after 2000. • Bus system Improvement is now on-going.	• LRT will be introduced after 2000. • Introduction of Intra-City Bus will be in 1990.	*2 Improvement of Mini-Bus System.	Bus Project	• Study for Introduction of Commuter Service is on going. • Improvement of Bus Project is on going.	LRT project is on going O. Commuter Service began at 1973.	Sub Way was introduced Expansion Project of Sub-way is now under implementation	Continuous railway (Subway) Construction

*1 Metropolitan Area
*2 As recommended in Source I
*3 According to no. of person Trips

SOURCES:
1. Public Transport Requirements in Intermediate Size Cities, Oct. 1977, Mitsui Consultants Co., Ltd.
2. Population Movement in Metro Tokyo, May 1979
3. Draft Final Report of "Metro Cebu Land Use and Transport Study"
4. Comprehensive Urban Transportation Planning 1980, JICA
5. DCUTCLUS

(2) Urbanization and Public Transportation Demand in Davao City

The expected growth in Davao City is remarkable especially in the Project Area, where population will be 2.5 times than that of the present (920,000 persons by the year 2000) and GRDP is also estimated to be about 4 times that of the present. Consequently urbanized area will extend not only in Poblacion, but also in the areas of Bunawan, Panakan and Toril along the coastal line.

The traffic demand in the year 2000 is estimated to be at the rate of 3.5 times as big as the present in terms of the number of trips. Among these, share of public transport demand of the total traffic , will fluctuate from 65 to 75% depending on the characteristics of the block. In this connection, the demand for public transport modes will increase about 2.6 times as big as the present. The public transport demand will remarkably change not only in quantity but also in quality.

The major characteristic of future public transport demand is to increase trips from 5 to 10 kilometers trip length which is relatively minor at present. Most of this medium-distance transport will be distributed along the coastal line as a reflection of a multi-center type urban area mentioned in the previous section. And this means introduction of mass transit system should be studied in the future.

(3) The Principle of Public Transport Service

For a better public transportation service to cope with the increasing demand the following are laid down as the basic principles of public transportation service:

1) To separate and strengthen the role of medium distance transport service from PUJ
2) To establish service sphere for each public transportation mode serving short distance trip and to distinguish the relationship of each other for efficient service.
3) To establish terminals at major nodal points in order to facilitate the utilization of the public transport system and their interrelated connections.

4) To establish and/or strengthen the organization for promotion and implementation of new public transportation system mentioned above and for better management of the system beneficial for both users and operators.

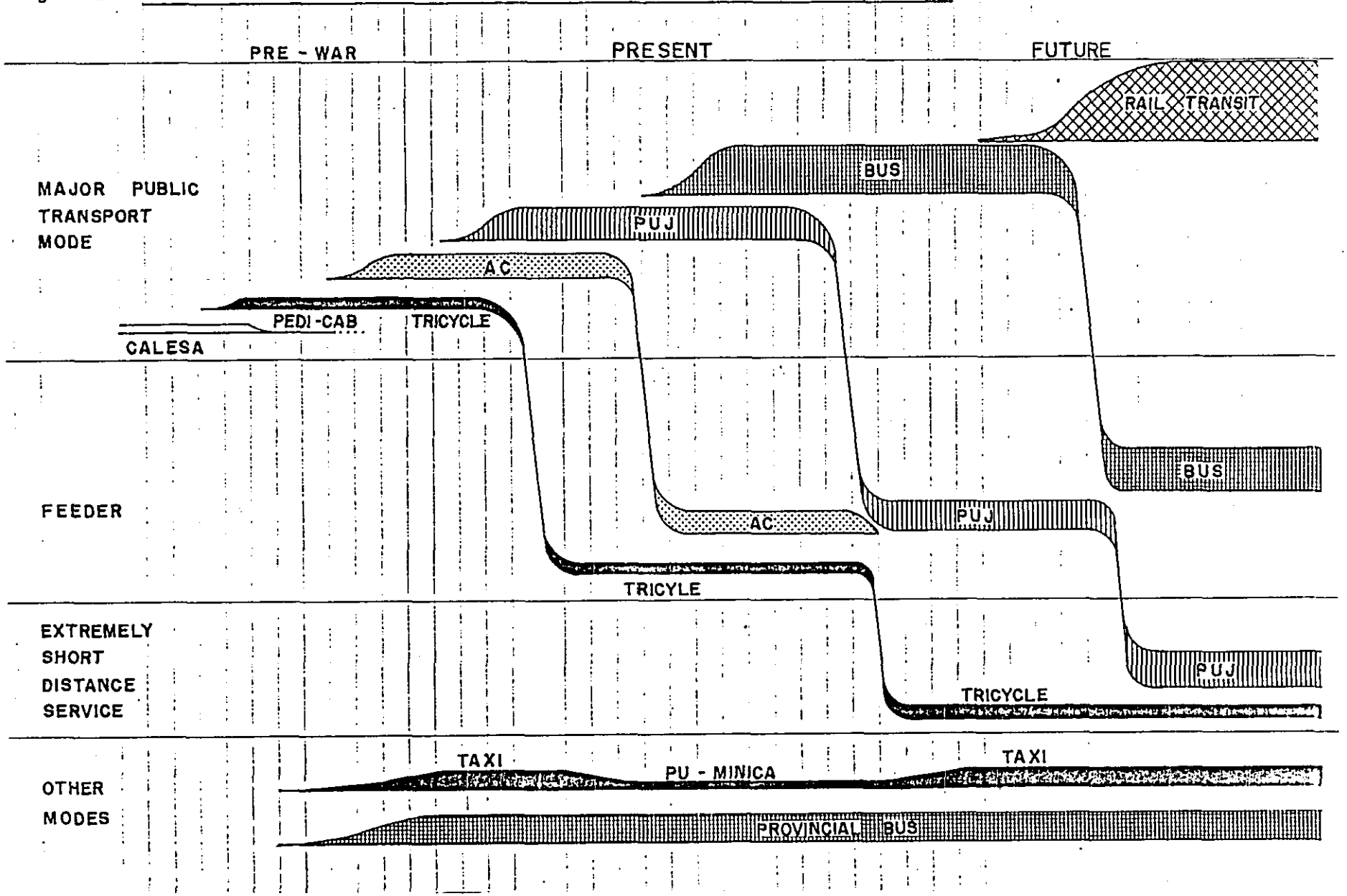
The reason for reversing the medium-distance transport service from PUJ service to another transport system with bigger capacity is to attempt to ease up the traffic jam, and at the same time, to ensure a high level of service from the points of punctuality and conveniency of public transport users. Bus service system using ordinary bus can be considered possible at the outset. In order to reverse the demand from PUJs which can offer users door-to-door service to Bus, a strong incentive should be directed to the minds of users through practical conditions such as establishment of exclusive bus lanes, assurance of high speed and punctuality, adoptation of air-conditioning and the determination of the fare making it as cheap as possible. From this point of view, nevertheless, the transport capacity of the bus is limited as mentioned before, so the introduction of rail transit system will be studied in the future for the purpose of long-term perspective.

PUJs and ACs will remain for the more localized feeder service and will fully bring their convenience into short-distance transport system. The forecast of the future state of the tricycle is considered to be difficult, but if it remains in existence, its service would be limited to the extremely short distance traffic in specialized districts such as subdivision areas or academic towns.

The separation of services between medium-distance transport and short-distance transport will naturally cause inconvenience in exchanging vehicles.

The powerful organization should be established to realized rational location of bus terminals for easier exchange of different transport modes and also to make coordination of operation control and fare system for various kinds of modes for bus user's convenience. Figure 3.23 illustrates schematically the prospective change of the public transport system in the Project Area.

Fig. 3.23 EVOLUTION MODEL OF PUBLIC URBAN TRANSPORT MODE IN DAVAO CITY



3.2 The Role of Public Transport Service and Service Area

(1) The Change of Public Transport Demand

The public transport demand for the target year is about 780,000 trips which is estimated to be about 2.6 times as big as the present. Similarly about 60% of this demand shows a trip length of 1-3 kilometers, and about 15%, 7-10 kilometers, and these percentage structures of trip length using public transport modes are reflected from the shape or urbanized area which has only one center, Poblacion.

By the year 2000, short-distance trips (ex. 1-3 kilometers) are forecasted to increase less than 2 times as much as the present, and 4 times for medium-distance trips (ex. 7.5-10 kilometers). In addition to the increase in absolute quantity for short distance trips, medium-distance trips will have both absolute and relative increases, as a result of the formation of multi-center cities caused by the urbanization of rural areas such as Bunawan, Panacan and Toril.

(2) Modal Share of Public Transportation

Considering the present modal share of public transportation, PUJs share is 60% of the total public transport demand in terms of person trip, contributing greatly in carrying passengers with medium-distance transportation and play the role of a distributor in the built-up area. ACs and tricycles shared the extremely short-distance transport demand at the rate of about 20% and 10% respectively. Buses serve only the provincial transport demand at the rate of 3%.

The future public traffic demands in Davao City will be separated into two types. One is called the Interblock demand which occupies 55% of all the demands while the other is the Intra-block demand occupying 45% and their average trip lengths are approximately 2.2 Km and 12.0 Km respectively.

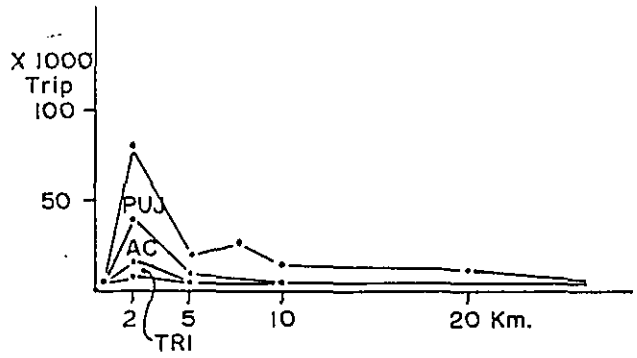


Fig. 3.24 No. of Passengers using PUV by Trip Length 1979

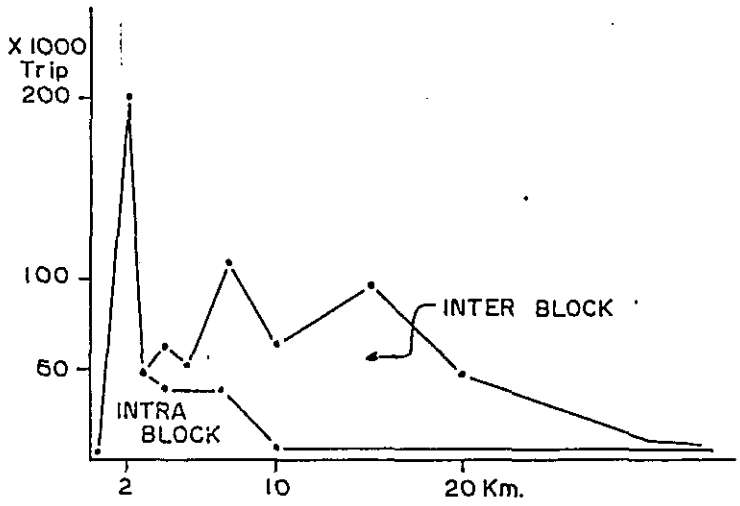


Fig. 3.25 No. of Passengers using PUV by Trip Length 2000

The future Modal shares of public transportation will be reflected in the efficiency of the total public transportation and the conveniency of the passengers. Table 3.13 shows that the efficiency of bus transportation in terms of capacity of one passenger car unit (PCU) is bigger than that of PUJ's and the efficiency to reduce travel time by using more buses as trip distance increases.

Tab. 3.13 Capacity of Public Urban Transport Modes

	Average Occupancy	P.C.U. Equivalent	Passenger carried per P.C.U.
CAR	1.8 person	1.0	1.8 person
PUJ	8.0 person	1.5	5.3 person
BUS	22.0 person	2.0	11.0 person

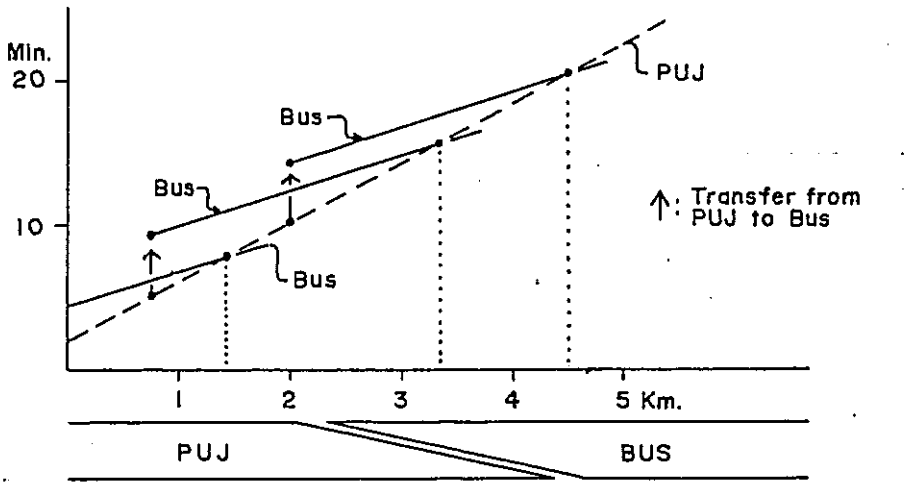


Fig.3.26 Relationship between Travel Time and Length of PUJ and BUS

After the introduction of bus operation with the fixed schedule, passengers' convenience to go to school and to office will be increased.

The future modal shares of public transportation in Davao City which is shown in Figure 3.27 is rational in the view point of each characteristics of mode after introduction of BUS as a trunk service in the city especially for interblock transport mode and PUJ (partially including tricycles) as a feeder service for intrablock transport mode.

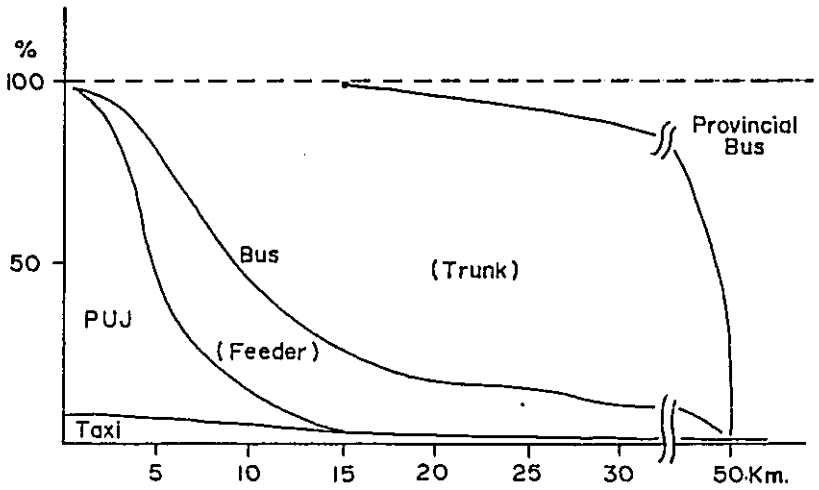


Fig.3.27 PUV Modal Shares by Trip Length

(3) Service Area of Public Transportation Modes

The transportation demand for bus in the future is estimated to be 55% of the total public transport demand (PUJ-about 40%) in terms of person trips.

Distribution of Bus desire lines in Davao City in the year 2000 is shown in Fig. 3.28. Based on this, Poblacion will be connected closely to Talomo, Sasa and Panakan with 10 to 30 thousand passengers a day.

Based on the future Bus demand bus route plan is formulated and is shown in Fig. 3.29. All bus routes are set along major roads.

PUJs will serve areas enclosed by McArthur Highway and the coastal road and by Davao-Agusan Road and newly constructed road in the inland area because the distance of two roads is about 1.5 kilometers.

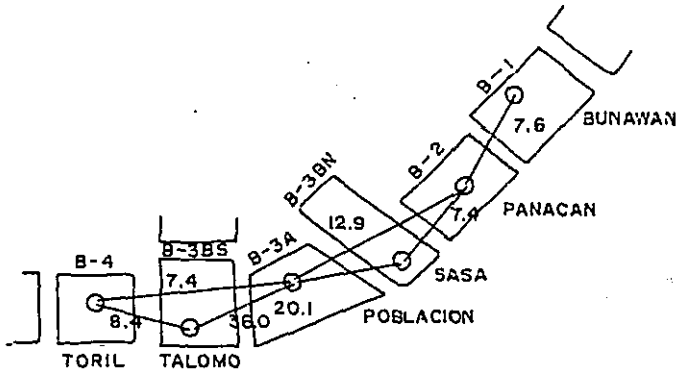


Fig. 3.28 Desire Line of PT using Bus

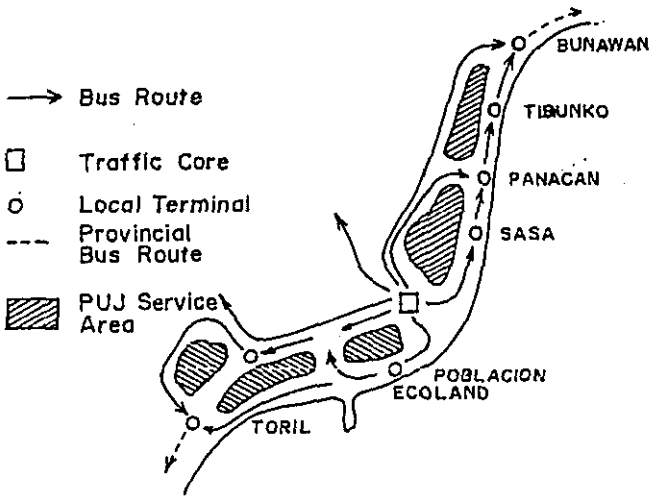


Fig. 3.29 Image of Bus Routes

Table 3.14 Supporting Facilities for the Bus Operation

Facilities	Number of Facility Equipment	Area
No. of Bus	624 Units	-
BUS Base		7.9 ha.
Work Shop *1	1	1.3 ha.
Parking space	1 or 2	4.0 ha.
Office *2	1	0.3 ha.
Recreation space and others		0.4 ha.
BUS Terminals	8	7.7 ha.
Total Area		15.6 ha.

*1 Including utilities

*2 Including Main Office

3.3 Facility Plan for the Introduction of Bus Service

(1) Operating Organization

Provincial bus, PUJ, and taxis are operated at present, by the private sector and this system is expected to remain8 in the future. As for the new bus system, however, it might be operated by a government or semi-government organization within the planned year.

(2) Facilities to Support the Bus Operations

The future number of bus-users is estimated to increase to about 370,000 pass/day, and the number of buses necessary to cope with this increase will be about 624 units. It also shows the daily average occupancy ratio which is estimated at around 42%. Trunk buses will serve along major roads which connect commercial areas located in each block center while feeder buses will serve through major road also connecting residential areas located around block centers. Bus route network is shown in Fig. 3.30. The supporting facilities and their required land space for bus operation are also illustrated in Table 3.15.

Table 3.15 Supporting Facilities for the Bus Operation

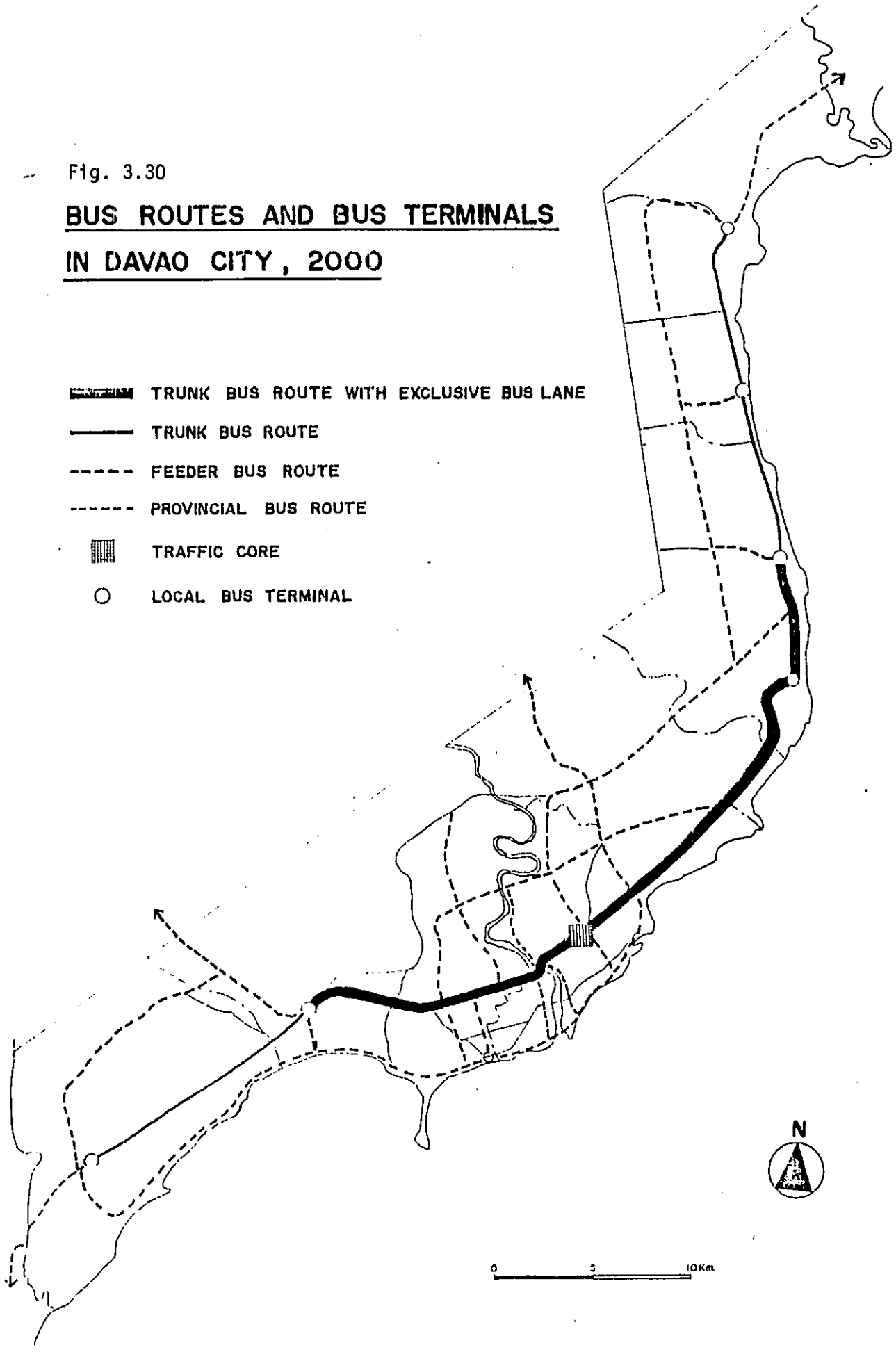
Facilities	Number of Facility Equipment	Area
NO. OF BUS	624 Units	-
BUS SPACE		7.9 ha.
Work shop *1	1	1.3 ha.
Parking space	1 or 2	4.0 ha.
Office *2	1	0.3 ha.
Recreation space and others		0.4 ha.
BUS TERMINALS	8	7.7 ha.
TOTAL AREA		15.6 ha.

*1 Including utilities

*2 Including Main Office

Fig. 3.30

BUS ROUTES AND BUS TERMINALS IN DAVAO CITY, 2000



(3) Bus Terminals

Introduction of BUS service which has fixed routes and bus stops can be expected to increase the efficiency of public transportation capacity in place of PUJs and ACs which offer, as we call it, "door to door service". On the other hand, the necessity of transfer between public transport modes will arise. The facilities to realize a smooth transfer are the terminals. In this plan some places where there is a nodal point of Bus routes and where one of the block centers is located are selected as a suitable place for local bus terminal. At the same time central bus terminal which includes traffic core is proposed in the central area of Poblacion.

Central Terminal:

Departure and arrival of trunk bus, provincial bus and circulation bus in or outside Poblacion will be at the central bus terminal including transfer between bus and PUJ, TAXI, serving Poblacion and it's vicinity.

Fig. 3.31 shows the model of Central Terminal in traffic core in Poblacion. Major characteristics of this terminal are:

1) There is no crossing for pedestrians and buses at same level
2) Buses always run in a clock-wise direction in the bus space
3) Special fly-overs are provided as entrance/exit across major roads and intersections near the central terminal to cope with the huge number of buses.
4) PUJ and Taxi loading and unloading zone are established in front of the terminal to have an easy connection between bus and other public transport modes.

Local Terminals:

Major functions of this terminal are the following:

a) Departure and arrival of trunk buses, feeder bus and provincial buses.
b) Transfer between three kinds of bus service and between bus and PUJ.

Fig. 3.32 shows the model of local bus terminal in Bunawan. Major characteristics of local terminal are:

1) Loading and unloading spaces for various kinds of bus such as trunk bus, feeder bus and provincial bus are located in the same place.
2) At the same time PUJ Loading/Unloading zone is located for easy connection between different public transport modes.

Table 3.16 Required Area of Bus Terminals*1

	No. of bus Berth Required	Area of Site
Traffic Core in Poblacion	44 Berth*2	3.3 ha.
Bunawan	12 Berth	0.8 ha.
Tibungco	5	0.3
Panakan	13	0.9
Sasa	6	0.4
Ecoland	6	0.4
Ulas	7	0.5
Toril	15	1.1
TOTAL	108 Berth	7.7 ha.

Source: DCUTCLUS

*1 Necessary area of each bus terminal should be estimated after designing of the terminal.
In this case area of bus terminal is estimated by using planning standard such as 400 m^2 - 800 m^2/ 1bus berth.

*2 Including bus berths which is used by bus serving in suburban area outside Poblacion.

Fig. 3.31 MODEL OF TRAFFIC CORE OF DAVAO CITY

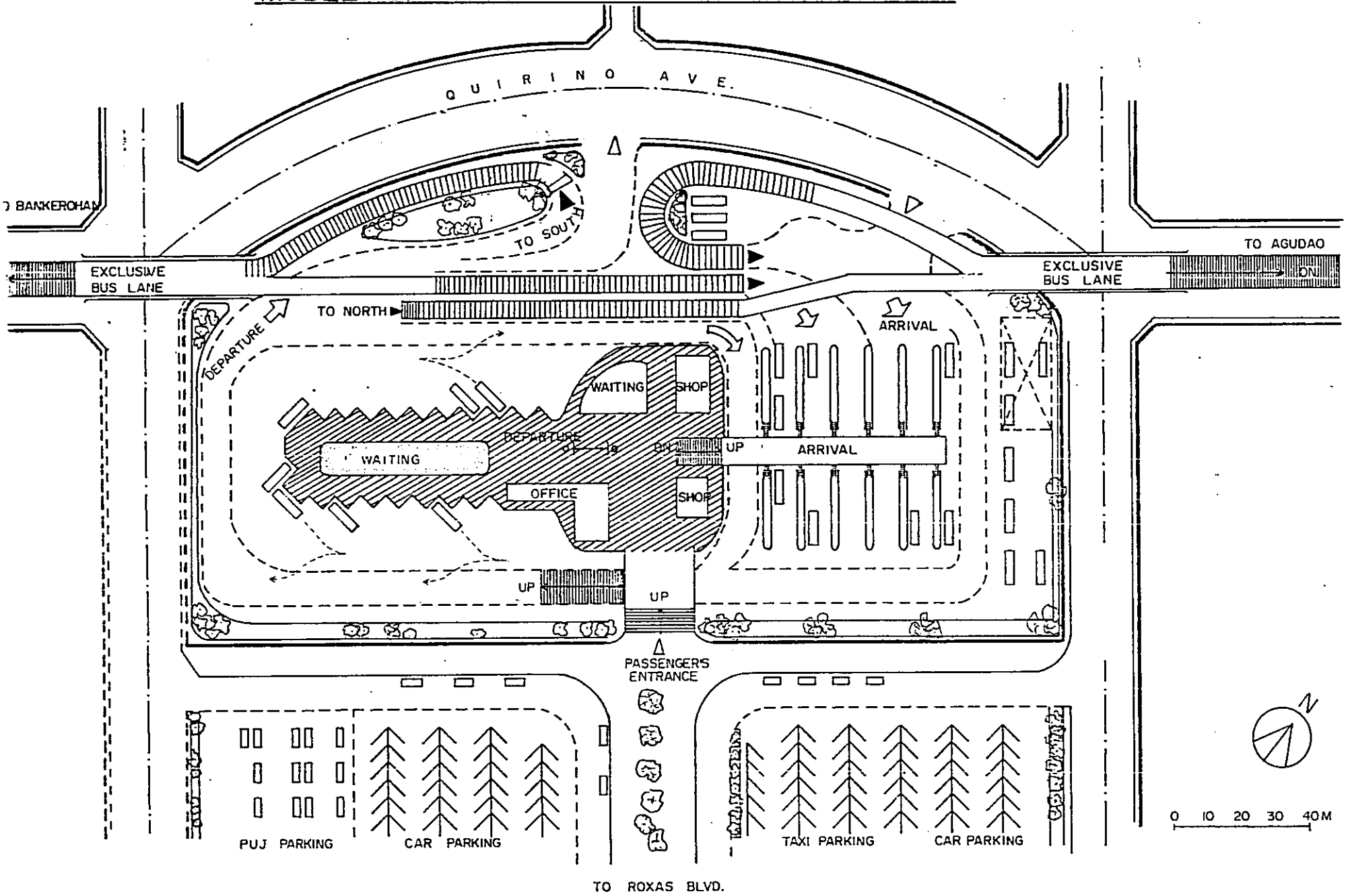
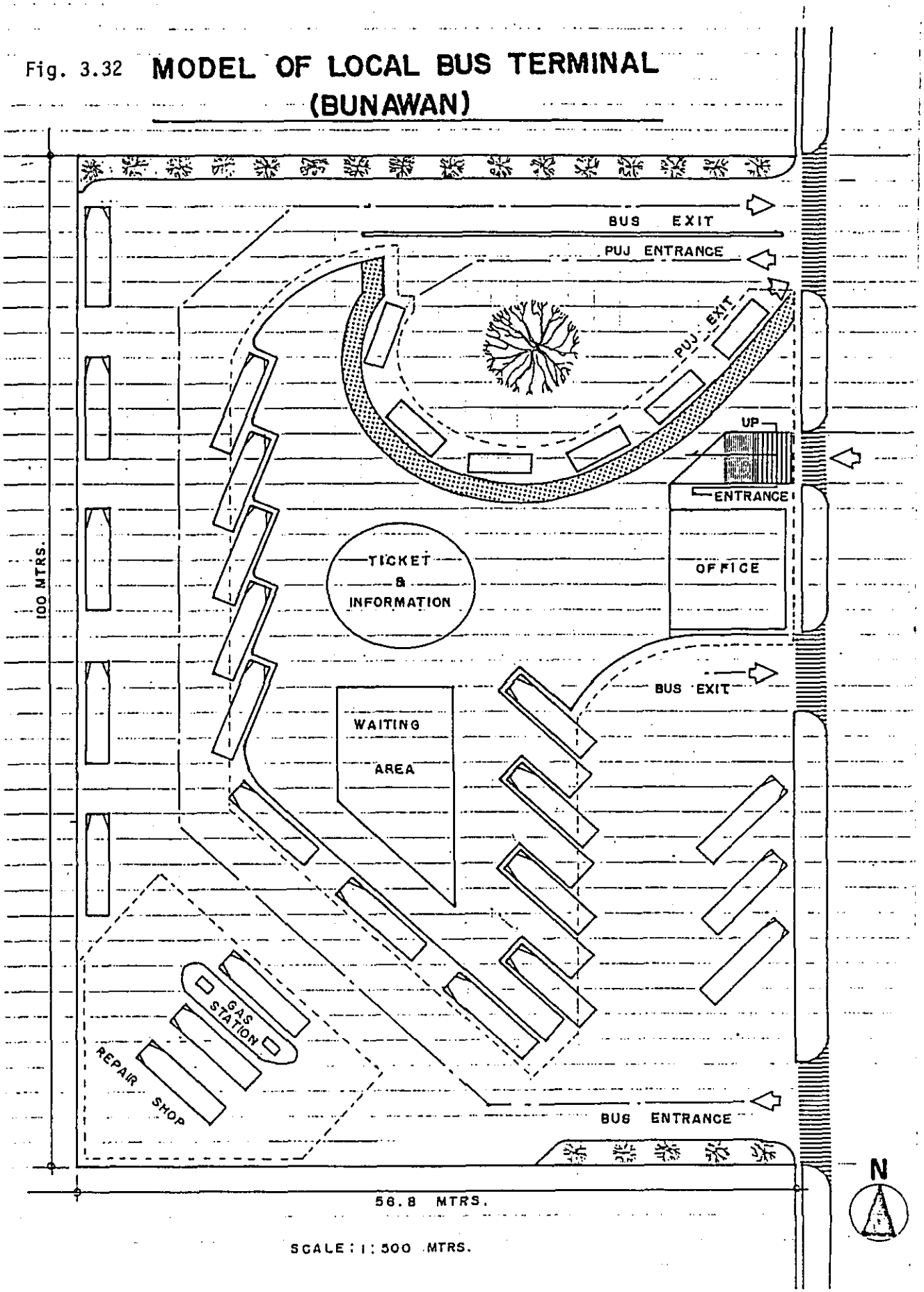


Fig. 3.32 **MODEL OF LOCAL BUS TERMINAL (BUNAWAN)**



3.4 Required Policies to Implement Bus Projects

(1) Perspectives of Revenue/Expenditure of Bus Project

As revenue and expenditure for bus operation which are mentioned in section 3.5 are comparatively good, it might be possible that Bus transport system be operated by private sector.

The selection of implementing body for bus project, private or public, will be done in the view point of better service for bus users.

(2) Identification of Problems and Subjects to be studied

The meaning of bus project is to introduce ordinary sized bus in place of PUJ which has been considered the major public transport mode at present and in other words to promote an increase in size and speed of public utility vehicles.

The objectives of this project are summarized as follows:

a) To realize further that transport capacity is twice than that of PUJ in the view point of economical transportation.

b) To offer a minimum fare rate for public transportation users' benefits.

c) To acquire a public transport mode with faster speed and more punctual services.

On the other hand, however, following problems will be encountered with the introduction of bus instead of PUJ.

d) Transfer between BUS and feeder mode such as PUJ will be necessary for users

e) Competition between BUS and existing modes cannot be prevented

Furthermore, the following conditions will be necessary to expect the above-mentioned objectives of bus introduction.

f) Buses are able to pass through roads smoothly with constant and stable speed

g) An ideal payment system will be adopted to maintain an orderly operation.

h) Passengers will get on and off the bus keeping traffic regulation.

i) Bus maintenance will be kept desirably.

To maintain its good financial condition the bus organization will get government assistance and incentives such as bus terminals which will be constructed as a part of public facilities under the official urban development plan.

For the suitable bus project with ideal condition mentioned above, following study programs should be furnished before implementation of the project.

a) It is difficult to operate 624 buses which are the estimated number of buses necessary to serve the total bus transport demand at the start of bus organization.

Studies for selection of a management body for bus organization (private or public) in the beginning and the programs of expansion not only of the facilities but also of the management system in accordance with the expansion of the number of buses are necessary.

b) Location of bus routes and expansion of bus route network should be coordinated with the programs mentioned in a)with road construction programs.

c) PUJ rerouting scheme should be prepared in coordination with bus route expansion program because PUJ service will compete with bus service.

d) Smooth operation of buses will be realized by using bus exclusive lanes and bus priority signal system in cooperation with the traffic management section.

e) For conveniency in loading and unloading of bus and transfer from bus to bus and from bus to PUJ, eight terminals including traffic core in the Poblacion will be developed in commercial areas where a block center will be located.

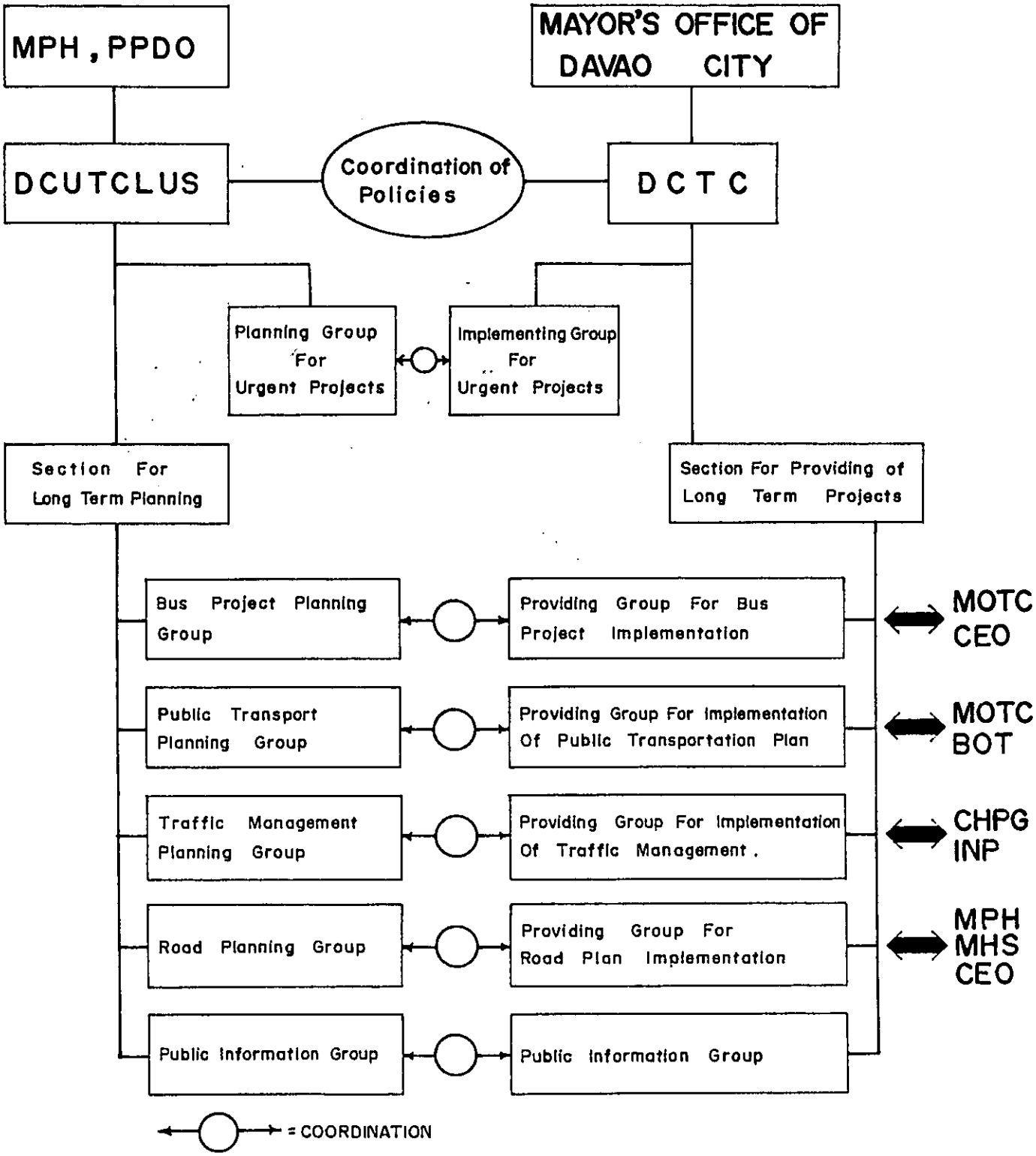
As those terminals will be expected to be developed thru the government terminal development program this should be coordinated closely with the road network plans and the urban renewal plans.

f) In the future feasibility study of bus project, necessary assistance to be given to bus organization directly or indirectly should be considered.

As the Davao City Transport Committee and Davao City Urban Transport Cum Land Use Study group has some functions to assist each other, strengthening of each of this organization is expected in order to establish a comprehensive promotion system of urban transport projects.

For the implementation of the bus project, further studies are necessary such as field survey, planning and detailed design based on local conditions, and proper coordination with the different central government agencies concerned should also be maintained especially for the bus project and related projects, for a side by side implementation program.

Fig. 3.33 **COORDINATION BETWEEN DCUTCLUS & DCTC**



CHAPTER 4

PARKING FACILITY PLAN

4.1 The problem of inadequate parking space in Davao City

The problem of lack of parking facility in Davao City was serious within Poblacion because 48% of all person trips end within Poblacion. According to the result of the parking facility survey conducted in January 1980, along San Pedro St., C.M. Recto St., and Magsaysay Avenue, where the Central Business District (CBD) is located, the capacity of off-street parking spaces was estimated to be 1,306 cars, whereas the area of CBD was 227.5 ha. Supply of parking facility was estimated to be 5.74 cars/ha. (Refer to Table 3.17)

The parking characteristics in Davao City revealed by the person trip survey were as follows:

Type of parking	Number of cars parked per day
On-street parking	13,300 (37%)
Off-street parking	22,700 (63%)
Total	36,000 (100%)

In Poblacion, shortage of off-street parking facilities resulted in a great occupancy of roads by parked cars. Restriction of on-street parking is an important subject to be solved for the sake of traffic safety and smooth flow.

At present, on-street parking regulation is enforced in accordance with traffic ordinance on certain roads which have large volume of traffic. As a result, on-street parking is concentrated on local streets.

4.2 Forecast of Future Parking Demand

From the viewpoint of car-users, adequate supply of parking spaces in relation with the demand would of course, be ideal. But it is actually impossible to accomplish this in the CBD. Therefore, parking demand for the trip purposes of "going to

office" and "going to school", which are considered to be the most habitual trips, was forecasted.

The area for forecast was set to be in Poblacion (Block III-A) where lack of parking facility is a big problem and the condition will worsen in the future.

The number of trips for the trip purposes of "going to office" and "going to school" which terminate at Poblacion will be as follows;

a) Number of private car trip of which destination is Poblacion:

1990 - 104,517 person trips
2000 - 145,167 person trips

b) Number of trips for the purposes of "going to office" and "going to school" of a) above

1990 - 26,060 person trips
2000 - 37,922 person trips

c) Number of car trips converted from b) above (conversion ratio = 1.8 person trips/car trip)

1990 - 14,478 car trips
2000 - 21,068 car trips

d) Number of cars which require parking space per hectare (parking demand density)

1990 - 7.0 cars/ha.
2000 - 10.1 cars/ha.

The result shows that the demand for parking space will increase substantially from 5.7 car/ha in 1980 to 7.0 cars/ha in 1990 and eventually to 10.1 cars/ha in 2000. Likewise, the area required a parking space which will expand to the whole area of Poblacion and lastly to the whole area of the future CBD. Besides, the parking demand density of 5.7 cars/ha in 1980 includes all trip purposes, however, those in 1990 and 2000 are for trip purposes of "going to office" and "going to school" only. When all trips purposes are considered, much bigger demand will be expected. (See Table 3.20)

4.3 Policy measures for parking facilities

(1) Short-term Policy

The following are recommendations specifically intended for CBD in Poblacion as short-term policies for the solution of parking problems in Davao City.

a) Off-street parking facility

Open lots which are not designated for any specific purpose and are available for use as parking space are recommended for utilization with the owner's approval. Required number of parking lot will be 1 or 2 within a block surrounded by local streets and standard accommodation per block will be 20 cars.

b) On-street parking

From the standpoint of traffic safety and smooth movement of traffic, on-street parking should be limited to parts of collector roads and it should be avoided on major trunk roads. Even on collector roads and local roads, on-street parking should be restricted where frequent traffic accidents are observed, or if it connects with major trunk roads.

On-street parking could be allowed even on a major multiple-lane trunk road if space for parking can be accommodated without disturbing traffic flow and PUJ loading/unloading maneuver.

c) Provision of a parking space within a facility lot

Such facilities as factories, schools, churches, offices, department stores, supermarkets and other public facilities where a large volume of traffic converges should be guided properly to provide a parking space within its own facility lot.

(2) Long Term Policy

As mentioned before, parking demand in Poblacion will be about 14,500 cars in 1990 and will increase to about 21,000 cars in 2000. In order to cope with such a big demand, it is necessary to make effort to supply enough parking facilities. On the other hand, it is also important to restrict the utilization of cars and to promote the utilization of public transportation modes.

a) Off-Street parking

The areas where parking facility must be developed will be expanded to the whole area of Poblacion. Each block will be provided with 1 or 2 parking lots which will be capable of accommodating 20 cars. If it is not enough thru the at grade parking system, vertical parking system can be devised.

b) On-street parking

Principally on-street parking will be prohibited in the years of 1990 and 2000. But some parts of the collector roads and local roads will be allowed for parking cars if there is no obstruction to traffic flow.

c) Provision of a parking space within a facility lot

Like the short term policy, any facility with converging traffic should be provided with either a level or a vertical parking space within its own lot. The standard number of cars to be accommodated will be determined depending on the utilization purpose of the building and its size.

d) Introduction of "Kiss and Turn" System

In order to make use of the car's"door to door" advantage, and to control the parking demand, it is also necessary to introduce "Kiss and Turn" system which should be enforced under government guidance.

e) The introduction of "park and ride" system

In order to control the parking demand in Poblacion and the newly established CBD, the traffic terminal constructed in the outskirts of the residential area will be provided with a parking area for possible introduction of "park and ride" system. Introduction of "park and ride" system should likewise be made under government guidance.

f) Guidance of Conversion to Public Transport modes

In order to control parking demand in Poblacion and the newly developed CBD, the regulation of car entry into

CBD will recommend to let them use the public transportation modes as much as possible. This should be supported by administrative guidance. Besides, it is necessary to promote public transportation services from the viewpoint of convenience, amenities and economical advantage.

Table 3.17 Parking Lots in Poblacion

Survey Area	227.5 ha.
No. of Parking Lot	63
Total No. of Parking Capacity	1,306

Source: 1979 Parking Survey

Table 3.18 Classification of Parking Trip by P.T. Survey in 1979.

On Street parking	13,300	(37%)	A
Free-Parking	22,400	(62%)	B
Paid Parking	300	(1%)	C
Total	36,000	(100%)	A + B + C
Off-Street Parking	22,700	(63%)	(B + C)

Source: P.T. Survey in 1979

Table 3.19 Private Car Trip by Blocks

		1979		1990		2000	
		NO.	%	NO.	%	NO.	%
BLOCK	I	3,015	2.7	6,979	3.3	21,961	6.1
	II	6,563	5.8	21,538	10.2	56,366	15.7
	III-A	64,294	57.2	104,517	49.7	145,168	40.4
	III-$B_{(N)}$	6,779	6.0	15,783	7.5	31.155	8.7
	III-$B_{(S)}$	24,065	21.4	45,217	21.5	72,314	20.1
	IV	7,728	6.9	16,446	7.8	32,539	9.0
TOTAL		112,444	100%	210,480	100%	359,502	100%

Source: DCUTCLUS Team

Table 3.20 Private Car Trip Density by Blocks

	Area (ha)	1979	1990	2000
Block I	3,190 ha	0.95	2.19	6.88
II	2,620 "	2.50	8.22	21.51
III-A	2,080 "	30.91	50.25	69.79
III-B (N)	2,240 "	3.03	7.05	13.91
III-B (S)	4,750 "	5.07	9.52	15.22
IV	3,220 "	2.4	5.11	10.11
TOTAL	18,100 ha.	6.21	11.63	19.86

Source: DCUTCLUS Team

Table 3.21 Private Car trip in Block III-A (Poblacion)

Purpose	1979	1990	2000
Office	6,470	17,449	27,288
School	4,279	8,611	10,634
Home	20.948	25,235	32,408
Business	14,392	24,508	35,749
Shopping	1,809	4,069	5,802
Private	16,396	24,645	33,286
TOTAL	64,294	104,517	145,167

Source: DCUTCLUS Team