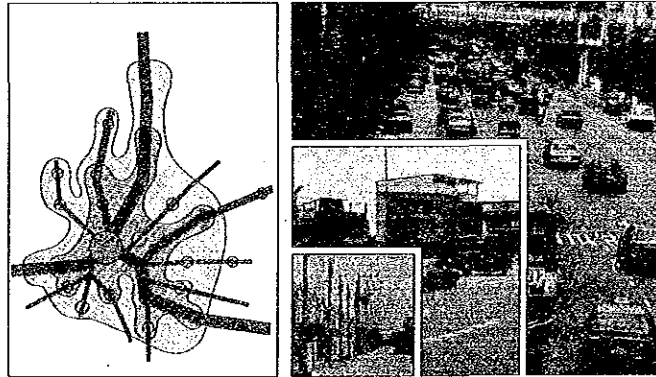


# THE STUDY ON MEDIUM TO LONG TERM IMPROVEMENT/MANAGEMENT PLAN OF ROAD AND ROAD TRANSPORT IN BANGKOK IN THE KINGDOM OF THAILAND

## MEDIUM TO LONG TERM ROAD IMPROVEMENT PLAN MAIN REPORT



MARCH 1990

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**THE STUDY ON MEDIUM TO LONG TERM  
IMPROVEMENT/MANAGEMENT PLAN OF ROAD  
AND ROAD TRANSPORT IN BANGKOK  
IN  
THE KINGDOM OF THAILAND**

**MEDIUM TO LONG TERM ROAD  
IMPROVEMENT PLAN  
MAIN REPORT**

**MARCH 1990**

**JAPAN INTERNATIONAL COOPERATION AGENCY**

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## PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Japanese Government decided to conduct a study on the Study on Medium to Long-term Improvement/Management Plan of Road and Road Transport in Bangkok and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Dr. Juro Kodera, and comprising of members from Yachiyo Engineering Co., Ltd., International Engineering Consultants Association and Almec Corporation from November, 1988 to March, 1989 and from May, 1989 to January, 1990.

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

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

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

March, 1990



---

Kensuke Yanagiya  
President

Japan International Cooperation Agency





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## **INTRODUCTION**



## INTRODUCTION

### 1. Purpose and Background

The Bangkok Metropolitan Area has been suffering from traffic problems for a long time. Due to the rapid growth of population and vehicles during the high economic growth period in the latter part of the 1980's, the problems have become serious more than ever. Traffic jams are a daily occurrence in Bangkok and have reached a point where they obstruct the urban life and economic activity of the capital.

The relevant governmental agencies have struggling against transportation issues by constructing facilities such as expressway, flyovers and bridges over the Chao Praya, as long as the financial resources allow. In order to secure smooth traffic flow, great efforts have been done by applying such measures as one-way control, reversible lanes, bus exclusive lanes and so on. Even now, more than fifty projects are waiting for their implementation.

Transport demand have been growing, however, far more rapidly than the facility supply. In addition, all the projects by many agencies was not implemented with proper coordination, which hindered every project to function effectively. Accordingly, it became commonly recognized that the project priority should be reviewed based on the long-term perspective and in a comprehensive manner, and the transport data-base should be updated to provide a proper base for planning and current traffic control.

The Bangkok Metropolitan Administration (BMA) has given a top priority to the solution of traffic problems in the Metropolitan area. BMA has decided to formulate plans regarding short-term measures for the traffic control and medium- and long-term measures for the improvement of roads. In response to a request by the Government of Thailand to carry out a study regarding these measures, the Japanese Government through the Japan International Cooperation Agency (JICA), in conjunction with BMA and other related agencies, has been conducting the study since November 1988 with the following objectives:

- a. To develop an medium- and long-term plan for the improvement of roads and road transportation .
- b. To conduct a feasibility study regarding the introduction of an area traffic control (ATC) system.
- c. To conduct a preliminary study regarding the need and practicability of common utility duct (CUD) system in the Bangkok Metropolitan Area.
- d. To transfer technology related to the above points to the Thai side.

Out of the three study components, this volume covers the outcome of the medium- to long-term road plan study, together with another appendix volume.

## 2 Study Area

The study covers the area inside the Outer Ring Road, which extends 25-30 km in the east-west direction and 45-60 km in the north-south direction. Total area is 1,640 sq.km. The study area consists administratively of parts of four provinces: BMA, Samut Prakan, Nonthaburi, and Pathum Thani.

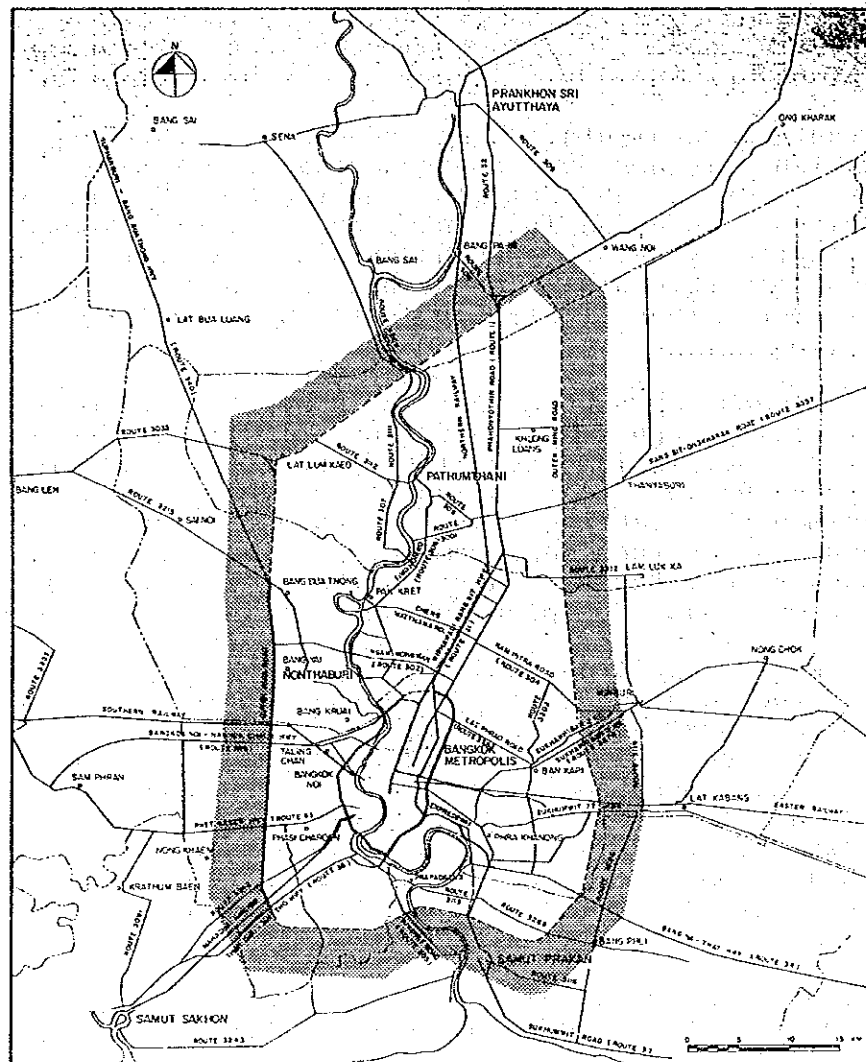


Figure A Study Area

## 3 Work Flow of the Study

This study was commenced in November, 1989 and spent 17 months. Main tasks in the first six months are a review of the existing plans and projects, field surveys, and data-base development, and during the intermediate six months, transportation demand forecast and project formation works were done. The last five months were spent for scheduling and evaluation of projects and report making.

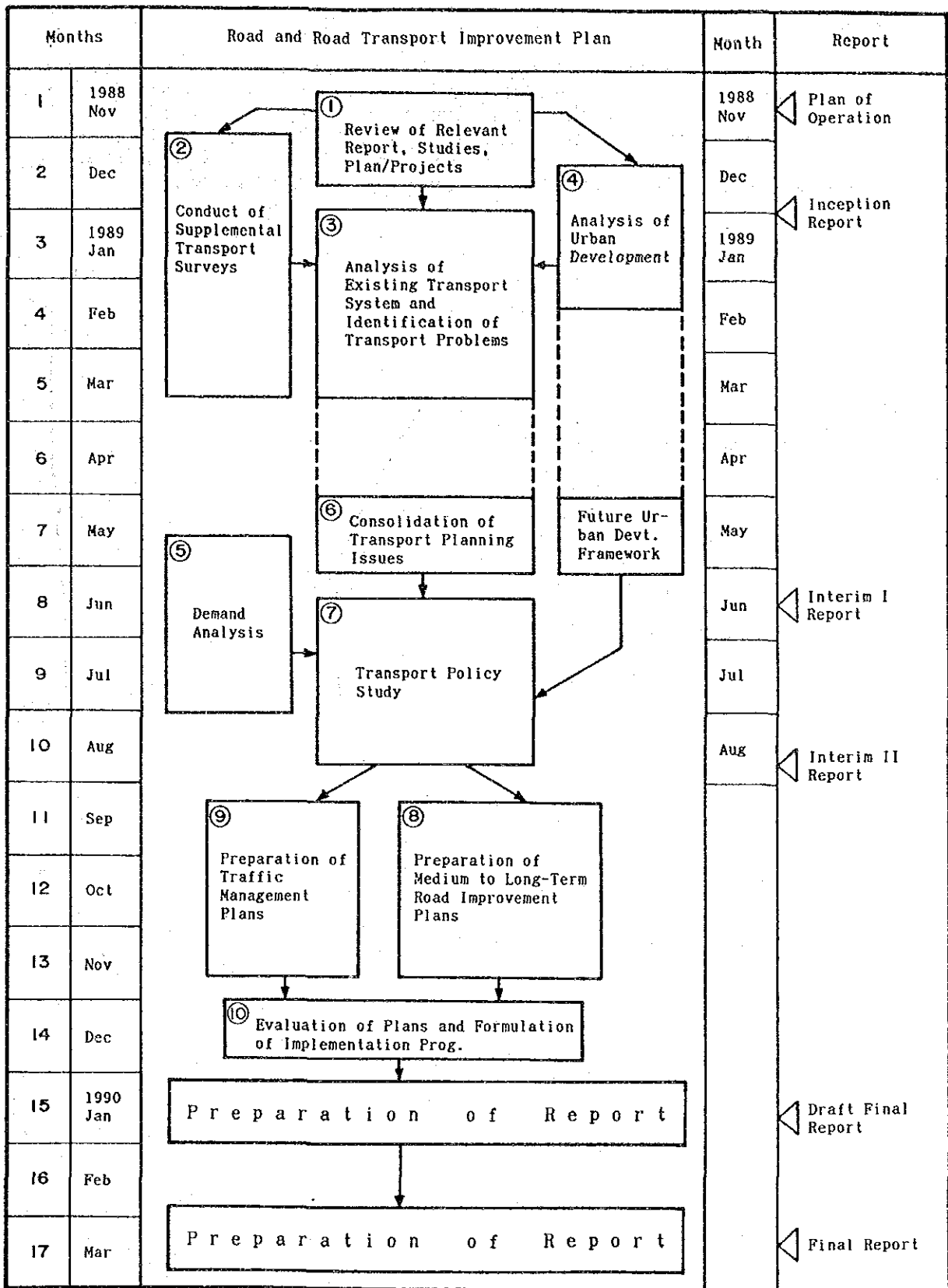


Figure B Work Flow Of the Study

#### 4 Zone Division

The whole Thailand is divided into 90 zones to analyze present transportation demand structure and forecast future demand. 59 zones of them are inside the study area. For the person trip survey purpose, 108 zoning system is used, further subdividing some of the 90 zones. Also, 24 integrated zoning system is used for semi-macroscopic analysis and for the presentation.

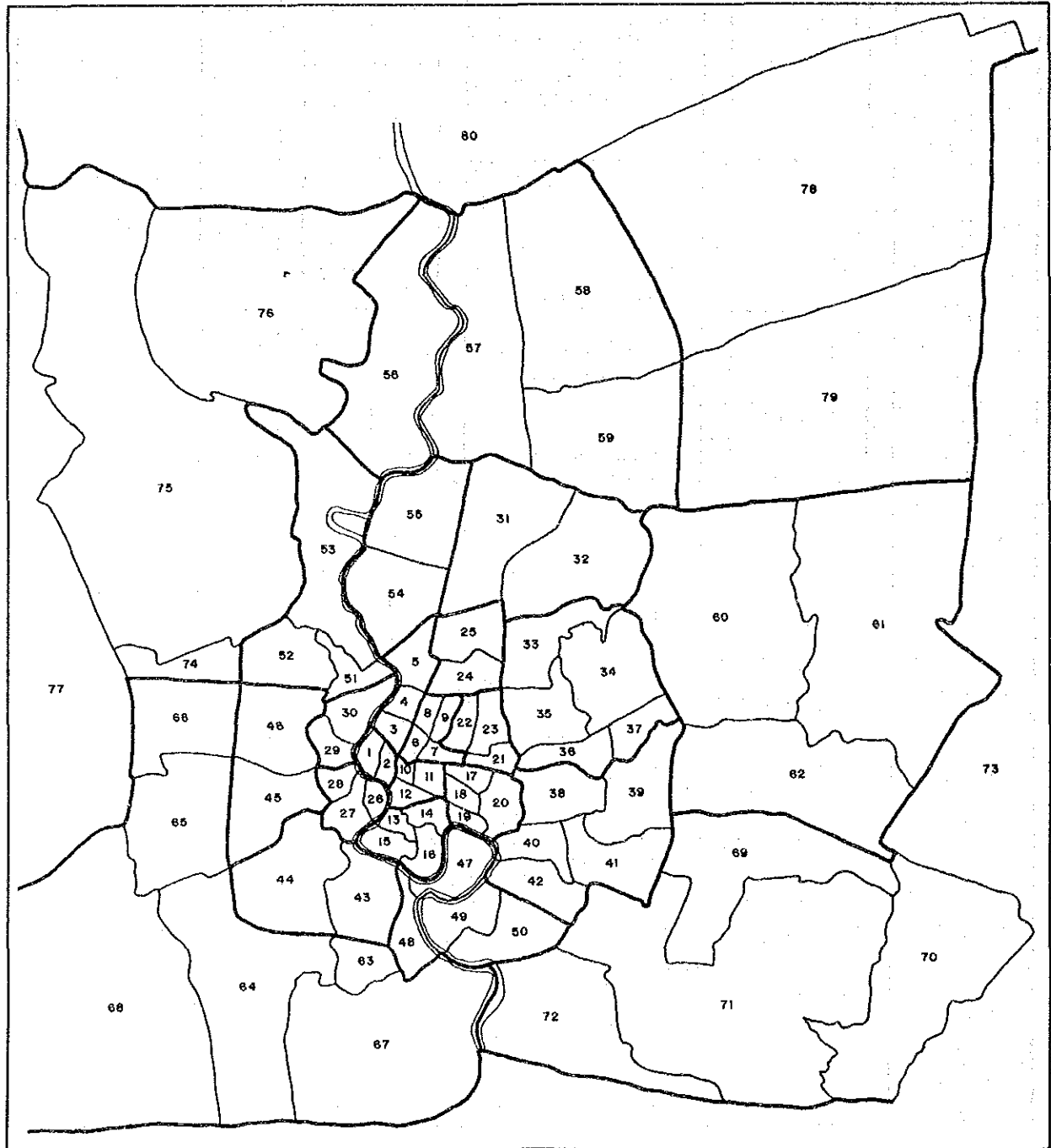


Figure C Zoning Map



## 5 Study Organization

The Study was carried out by the Japan International Cooperation Agency in conjunction with the Bangkok Metropolitan Administration. The organization for the study is as follows:

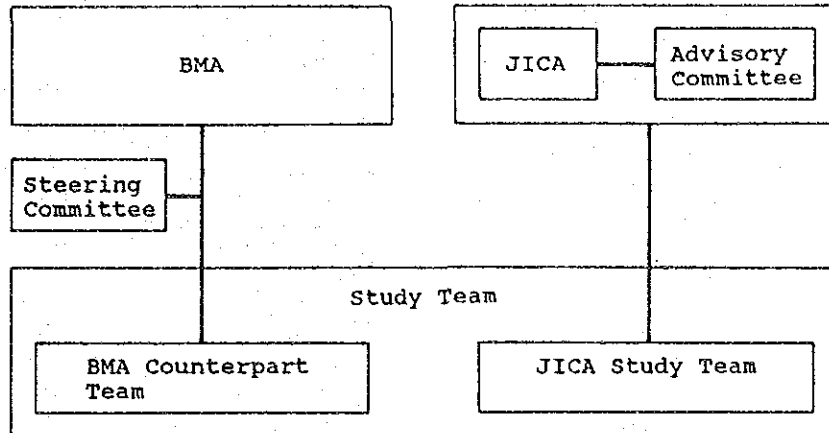


Figure D Study Organization

The study was supervised mainly regarding policy matters by the Steering Committee and regarding technical matters by the Sub-Steering Committee. Both Committees are composed of the representatives of relevant agencies.

## 6 List of Members for the Study

<b>&lt;THAI SIDE&gt;</b>			
<b>Steering Committee (SINR)</b>			
Dr. Wicha Jiwalai	Deputy Governor, BMA	Mr. Wisut Panutat	Director, PWD, BMA
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Mr. Bamphen Jatooapreuk	Director, PWD, BMA	Dr. Yodphol Thanaboriboon	Asian Institute of Technology
Mr. Chalit Sathon	Deputy Director, PWD, BMA	Dr. Teerapong Attajarusit	Director, TD, ETA
Mr. Charuay Chantavall	Deputy Director, PWD, BMA	Dr. Wongchai Charoensawan	Civil Engineer, DOH
Mr. Suwat Wanisubut	Chief, PTSD, NESDB	Mr. Thanit Srichoo	Civil Engineer, PWD, BMA
Mr. Pailop Onkcharoen	Director, TED, DOH	Mr. Rapin Charudul	Civil Engineer, OCMRT, MOI
Dr. Kitipol Asaparporn	Director, TED, DOH	Dr. Suwat Wanisubut	Chief, PTSD, NESDB
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Dr. Kasamesanta Suwannarath	Director, DPP, BMA		
Pol. Lt. Col., Anan Sngasaeang	Traffic Police Division, MPB		

**CHAPTER 1**

**PRESENT URBAN STRUCTURE  
AND LAND USE**



## 1. PRESENT URBAN STRUCTURE AND LAND USE

### 1.1 Overview of BMR

#### 1) Population

The population of the BMR is estimated at some 8.5 million as of 1989.

During the 1970-1980 period, the population growth rate of the region was as high as 3.90% per annum, whereas it declined to 2.41% in the 1980-1989 period.

The BMA which is the urban center of the BMR experienced an annual growth rate of 4.30% in 1970-1980, but suffered a drastic decline to 1.81% in the 1980s.

In contrast, the neighboring provinces of Samut Prakan and Nonthaburi have seen their population growth rates increase from 3.96% in the 1970s to 5.38% in the 1980s and from 3.26% in the 1970s to 5.31% in the 1980s, respectively. Pathum Thani maintained a growth rate of 3.2%.

Table 1.1.1 Population Growth of BMR by Province (1970-1989)

(in thousand, %)

	Number			Annual Growth Rate	
	1970 1)	1980 1)	1989 2)	1970-1980	1980-1989
BMA	3,185	4,852	5,701	4.30	1.81
Samut Prakan	341	503	806	3.96	5.38
Nonthaburi	278	383	610	3.26	5.31
Pathum Thani	242	332	441	3.21	3.20
Nakhon Pathom	434	545	643	2.30	1.85
Samut Sakhon	207	256	312	2.15	2.22
BMR Total	4,687	6,871	8,513	3.90	2.41

Source: 1) NESDB  
2) Study Team Estimation

These trends of provincial population growth imply that the inter- and intraregional migration as mentioned below is continuing.

Migration from the provinces outside the BMR (especially those in the Northeast Region) into the BMA is steadily continuing, while out-migration from the BMA to the neighboring three provinces is accelerating. The largest out-migration stream from the BMA is to Samut Prakan followed by Nonthaburi and Pathum Thani. These three provinces have come to serve as the suburbs of the rapidly growing metropolitan area.

Table 1.1.2 Intraregional Net-migration to BMR, 1975-1980

Region of Departure	Province of Destination		
	BMA	5 Provinces	Total
Central	32,358	13,418	45,776
East	15,296	4,191	19,487
West	24,897	7,489	32,386
Northeast	108,090	23,350	131,440
North	23,522	9,293	32,815
South	21,432	2,939	24,371
Total	225,595	60,680	286,275

Source: 1980 Population Census

Table 1.1.3 Intraregional Net-migration by Province in BMR, 1975-1980

Province of Departure	Province of Destination						Total
	BMA	Samut Prakan	Nonthaburi	Pathum Thani	Nakhon Pathom	Samut Sakhon	
BMA	-	18,212	16,458	6,419	-4,594	-1,520	34,975
5 Provinces	-34,975	889	495	-30	-1,176	-178	-34,975
Total	-34,975	19,101	16,953	6,389	-5,770	-1,698	-

Source: 1980 Population Census

## 2) Economic Activity

### (1) Gross Regional Product

As influenced by the world economic recession, the growth of GDP was modest during the period of the Fifth Plan, 1981-1986. However, from the latter half of 1986 onward, Thailand witnessed an economic upturn due to the influx of investments and good export performance. In 1987, the country achieved a growth of 7.1%, and in 1988, a higher growth of 10% is estimated.

Reflecting this national economic trend more drastically, the annual growth rate of the gross regional product (GRP) of the BMR was only 4.9% in 1981-1986, but it went up suddenly to 11.8% in 1987.

Table 1.1.4 GRP Growth of BMR, 1981-1987, at 1972 Constant Prices

(in million baht, %)

	GRP			Annual Growth Rate	
	1981	1986	1987	1981-1986	1986-1987
	BMA	126,702	159,012	178,062	4.65
5 Provinces	28,183	38,064	42,260	6.19	11.02
BMR	154,885	197,076	220,322	4.94	11.79
Whole Kingdom	318,439	412,608	441,894	5.32	7.10

As shown in Table 1.1.5, the economic sectors that have led the GDP increase in the recent two years are manufacturing and wholesale/retail trade. Again both sectors had major roles in the increase of the GRP of BMR. From the viewpoint of BMR's contribution to the GDP increase, 77.5% of the total GDP increase was achieved in the BMR. By sector, manufacturing and wholesale/retail trade contributed 85.4% and 90.9%, respectively.

Table 1.1.5 Sectorial Composition and BMR's Share of Recent GDP Increase, 1986 and 1987

(in %)

Sector	Sectorial Composition		BMR's Share
	Whole Kingdom	BMR	
	Manufacturing	34.6	
Wholesale & Retail Trade	23.9	28.1	90.9
Services	16.9	10.5	48.1
Others	24.6	23.3	73.6
Total	100.0	100.0	77.5

(2) Major Economic Sectors of BMR

Manufacturing, wholesale/retail trade, and services are the major economic sectors of the BMR.

In the BMA, manufacturing is still the biggest sector in terms of GRP and has been increasing at more than the average growth rate of the BMA.

In the 5 provinces, the leading sector is manufacturing, sharing 40% of the total GRP. However, its share has slightly decreased since 1981, as other sectors such as services, banking/insurance, and transportation/communication have sprouted. This can be viewed as urbanization in the industrial structure.

Table 1.1.6 Growth Rate of GRP and Composition by Industrial Origin at 1972 Constant Prices

(in %)

	BMR			BMA			5 Provinces		
	Composition by Industrial Origin		Annual Growth Rate	Composition by Industrial Origin		Annual Growth Rate	Composition by Industrial Origin		Annual Growth Rate
	1981	1987	1981-87	1981	1987	1981-87	1981	1987	1981-87
Agriculture	3.9	3.5	4.2	1.8	1.8	6.2	13.2	10.4	2.9
Mining	0.3	0.3	7.4	0	0	0	1.5	1.5	7.4
Manufacturing	33.1	33.1	6.1	31.2	31.4	6.0	41.3	40.2	6.5
Construction	4.9	3.4	-0.4	5.7	3.7	-1.4	1.7	2.1	10.9
Electricity and water supply	2.4	2.8	8.6	1.8	2.0	8.1	5.2	5.9	9.3
Transportation and communication	7.2	9.1	10.4	8.2	10.4	10.1	2.4	3.4	14.0
Wholesales & Retail Trade	23.9	23.1	5.5	25.1	24.4	5.3	18.3	17.7	8.4
Banking, insurance and real estate	3.6	4.0	7.7	4.2	4.5	7.4	1.2	1.6	11.9
Ownership of dwelling	3.2	3.1	5.3	3.4	3.3	5.3	2.4	2.2	4.9
Public administration and defence	3.8	3.2	3.4	4.1	3.5	3.2	2.2	2.0	5.6
Services	13.8	14.5	6.9	14.5	14.8	6.2	10.6	13.0	10.7
Total	100	100	6.0	100	100	5.8	100	100	7.0

Source: National Account Division; NESDB



## 1.2 Socio-economic Characteristics of the Study Area

### 1) Coverage and Zone Division of the Study Area

As shown in Figure 1.2.1, the study area covers 1,640 km<sup>2</sup> in the central part of the BMR. Administratively it consists of parts of the four provinces of BMA, Samut Prakan, Nonthaburi, and Pathum Thani.

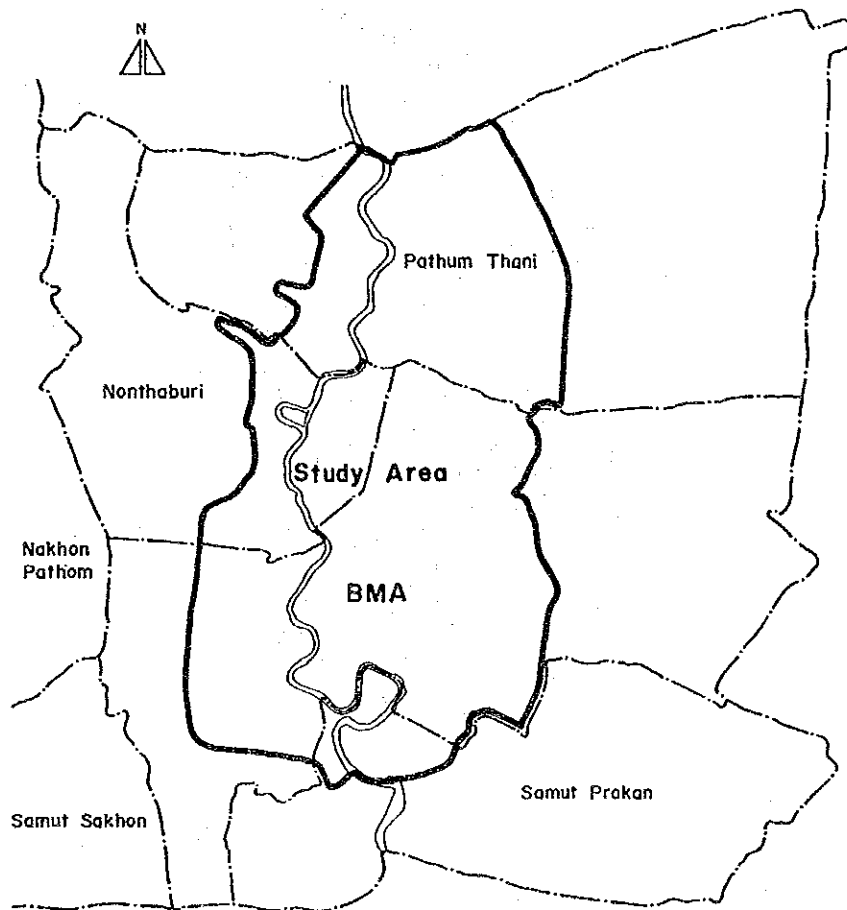


Figure 1.2.1 Location of Study Area in BMR

The population in 1989 is 6,357 thousand, which is equivalent to 75% of the total population of the BMR. In order to describe the characteristics by zone, the study area is divided into 19 zones as shown in Figure 1.2.2. Zones 1 - 10 are located in central BMA.

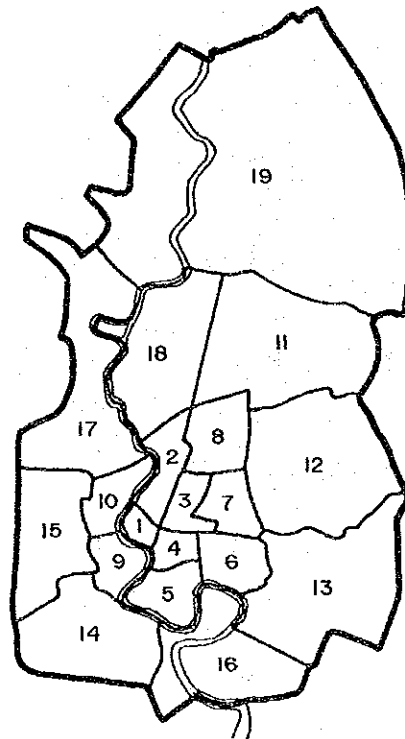


Figure 1.2.2 Zone Division inside the Study Area

## 2) Population Distribution and Density

Table 1.2.1 shows the population distribution and density by zone. The central BMA (zones 1 - 10) covers only 13.5% of the total area (221 km<sup>2</sup>), but 3,707 thousand persons, equivalent to 58.3% of the total population, live there. Therefore, the population density is as high as 16,800 persons/km<sup>2</sup> in central BMA (20,000-30,000 persons/km<sup>2</sup> in some zones), although it is 3,900 persons/km<sup>2</sup> on average in the entire study area.

Table 1.2.1 Population Distribution and Density by Zone

Zone	Area (Km <sup>2</sup> )	Population	Population Density (Persons/Km <sup>2</sup> )
1	8.9	322,497	36,236
2	22.2	528,268	23,796
3	16.7	399,657	23,932
4	13.9	345,082	24,826
5	36.8	430,482	11,698
6	22.8	285,475	12,521
7	22.7	251,239	11,068
8	32.9	221,748	6,740
9	20.8	522,722	25,131
10	23.3	400,156	17,174
11	136.4	355,940	2,610
12	149.3	472,447	3,164
13	120.7	353,858	2,932
14	106.8	249,259	2,334
15	75.1	226,169	3,012
16	121.2	321,053	2,649
17	121.6	249,428	2,051
18	82.7	204,880	2,477
19	505.2	216,325	428
Entire Study Area	1,640.0	6,356,683	3,876

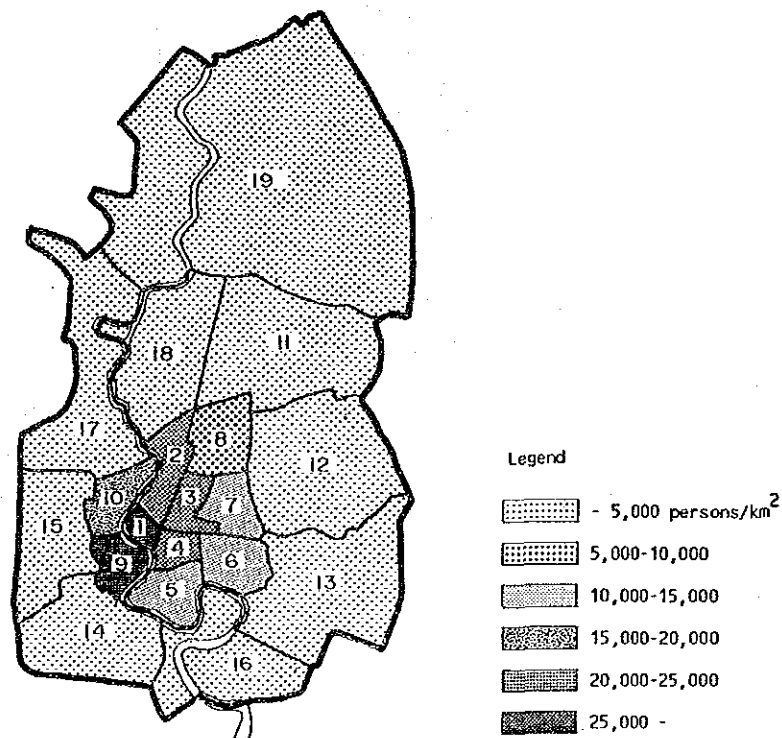


Figure 1.2.3 Population Density by Zone

### 3) Population Characteristics

The following is a description of the population aged six years and above, of 5,638 thousand persons obtained as a result of the PT survey.

The demographic data by zone are shown in Table 1.2.2.

#### (1) Population Composition by Sex and Age Group

The population composition by sex and age group is shown in Figure 1.2.4. Females make up 51.7%, or a little more than half of the population.

By age group, those 25 - 29 years old have the largest share of 700 thousand. Young people ranging from 15 - 34 years old are more than 2,600 thousand, or nearly 50 percent.

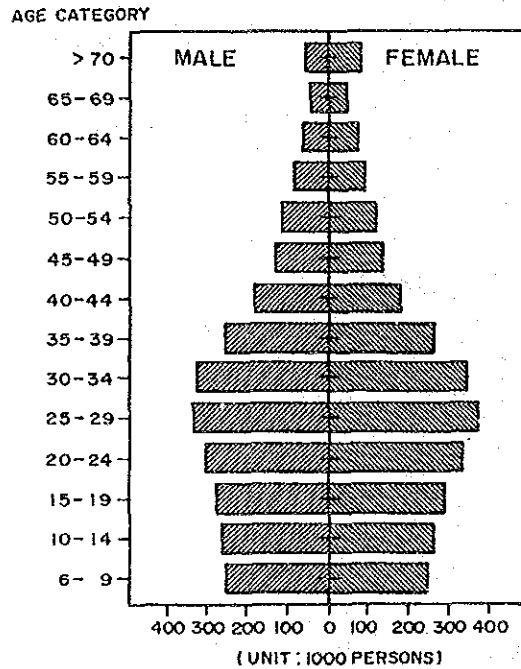


Figure 1.2.4 Population Composition by Sex and Age Group

Table 1.2.2 Demographic Data of the Study Area as of 1989

Zone	Population			Type of Economic Activity						
	Male	Female	Total	Employed				Student	Housewife	Others
				Primary	Secondary	Tertiary	Total			
1	138,904	147,174	286,078	636	27,629	99,931	128,196	87,699	37,012	33,171
2	227,110	242,168	469,278	432	36,558	178,079	215,069	146,927	56,240	51,042
3	170,499	183,889	354,388	1,019	22,605	144,002	167,626	108,649	43,557	34,556
4	147,230	158,630	305,860	1,211	25,828	116,709	143,748	87,763	35,615	38,734
5	183,862	198,020	381,882	2,979	49,949	119,433	172,361	108,233	50,522	50,776
6	121,776	131,337	253,113	404	24,042	95,116	119,562	76,608	32,625	24,318
7	107,418	115,750	223,168	465	17,246	90,560	108,271	64,291	29,363	21,243
8	95,309	101,344	196,653	399	12,573	74,802	87,774	63,482	20,469	24,928
9	223,919	239,850	463,769	2,177	61,711	159,630	223,518	130,826	54,626	54,799
10	170,429	183,991	354,420	3,119	33,380	132,823	169,122	104,281	42,051	38,966
11	153,018	162,564	315,582	2,433	33,846	105,196	141,475	95,573	41,193	37,341
12	201,618	217,521	419,139	462	34,976	160,570	196,008	137,373	44,856	40,902
13	150,708	163,093	313,801	1,246	42,755	103,353	147,354	86,926	41,617	37,904
14	106,615	114,195	220,810	1,231	31,764	75,357	108,352	60,760	26,068	25,630
15	96,684	103,648	200,332	3,297	26,423	70,376	100,096	57,590	25,388	17,258
16	138,322	143,800	282,122	1,766	50,486	84,127	136,379	82,772	27,868	35,103
17	108,094	115,413	223,507	14,740	22,842	77,253	114,835	66,032	23,231	19,409
18	88,778	94,941	183,719	0	17,493	70,233	87,726	57,855	19,847	18,291
19	93,170	96,923	190,093	6,822	38,330	44,508	89,660	57,827	20,239	22,367
Total	2,723,463	2,914,251	5,637,714	44,838	610,436	2,001,858	2,657,132	1,681,467	672,387	626,728

### (2) Type of Economic Activity

As shown in Table 1.2.2, the employed population is 2,657 thousand, or 47% of the total population. Under the classification of non-employed, there are 1,681 thousand students and pupils, 30% of the total population, while housewives number only 672 thousand (12%), showing a high employment rate.

### (3) Employed Population by Occupation

The employed population by occupation is shown in Table 1.2.3. Production workers have the largest share of 23%, while administrative workers (including government officials) and shop owners have relatively large shares of 22% and 16%, respectively.

Table 1.2.3 Employed Population by Occupation

Occupation	Number (1000 persons)	Percentage
Professional	220	8.3
Administrative	582	21.9
Shop Owner	434	16.3
Clerical	195	7.3
Sales Worker	218	8.2
Agricultural	38	1.5
Transport Worker	96	3.6
Production Worker	616	23.2
Service Worker	258	9.7
Total	2,657	100.0

Table 1.2.4 shows the values obtained by dividing composition of employed population by occupation of each zone by the corresponding composition of employed population by occupation of the total area. If the percentage of employed population of a certain occupation in a zone is greater than the percentage of employed population of that occupation in the total area, it can be said that the zone is specialized for that occupation. Regarding the values in the table as the specialization index of each zone as to employed population by occupation, the greater an index value is, the higher the degree of specialization.

Figure 1.2.5 shows the most specialized occupation of the employed population by zone. Based on this figure, the following outline of the distribution of employed population by occupation can be seen.

1. Zones specializing in shop owners or sales and service workers are zones 1, 3, 5, 6 and 9, which are located in the CBD and its surrounding commercial area inside the central BMA.
2. Zones specializing in office workers engaged in professional work, administrative work, and clerical work are zones 2, 7, 8, 10, 11, 12 and 18, which are located in the northern part of the BMA center, the northeastern suburbs of BMA, and the suburban residential area in Nonthaburi.
3. Zones specializing in transportation laborers and production workers are zones 13, 14, 15, 16, 17 and 19, which are located in the peripheral area except for the northeastern part of BMA.

Table 1.2.4 Specialization of Composition of Employed Population by Occupation  
(Ratios of Percentage Distribution to the Average)

Zone	Professional & Administrative	Shop Owner	Clerical	Sales & Service Worker	Transport & Production Worker
1	0.67	1.98	1.07	1.17	0.66
2	1.35	0.73	1.22	0.99	0.73
3	1.09	1.00	0.87	1.29	0.75
4	0.93	1.28	1.16	1.19	0.74
5	0.79	1.13	0.83	1.23	1.05
6	1.05	1.05	1.10	1.12	0.81
7	1.22	0.89	0.78	1.18	0.78
8	1.13	0.82	1.53	1.24	0.68
9	1.03	1.13	0.66	1.12	0.90
10	1.19	1.08	0.97	1.05	0.73
11	1.20	0.56	1.38	0.79	1.08
12	1.10	0.83	1.50	1.06	0.82
13	0.80	0.94	1.20	0.80	1.32
14	0.73	1.33	0.62	0.70	1.39
15	0.90	1.13	0.46	0.89	1.24
16	0.74	0.93	0.64	0.62	1.65
17	0.94	0.67	0.94	0.70	1.47
18	1.16	0.83	1.11	0.95	0.92
19	0.64	0.59	0.78	0.50	1.99
Whole Study Area	1.00	1.00	1.00	1.00	1.00

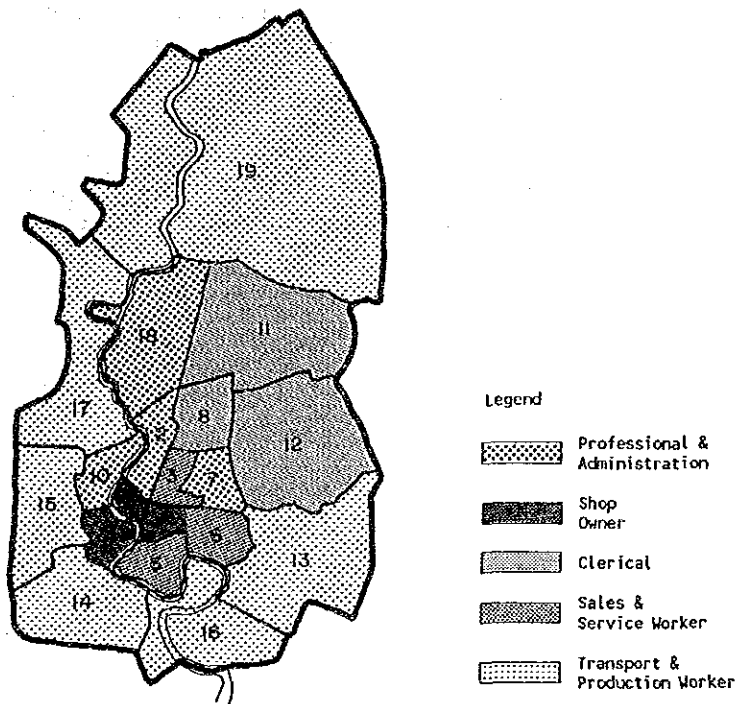


Figure 1.2.5 Most Specialized Occupation of Employed Population by Zone

#### (4) Employed Population by Industry and Place of Employment

The employment composition by industry is shown in Figure 1.2.6, where the share of tertiary industry is 75%, and that of the primary industry is very low at less than 2%.

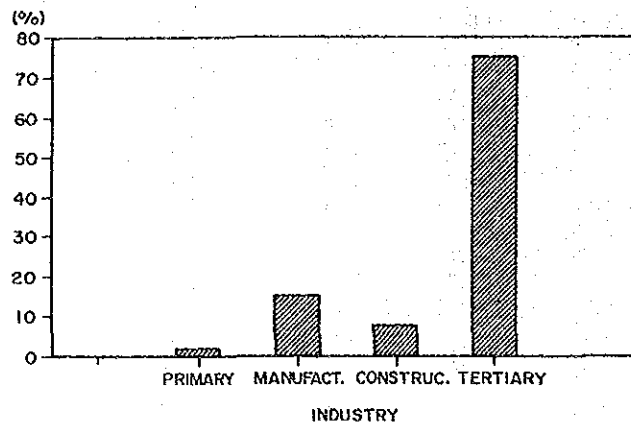


Figure 1.2.6 Employed Population by Industry

The distribution of the place of employment by industry reflects the distribution of the economic activities by industry. Namely, it indicates the distribution of the employment by industry produced by the economic activities.

Figure 1.2.7 shows the zonal distribution of the employed population by industry comparing the home base (where the employees reside) and the work place base (where the employees work). As shown in the figure, the central part has a larger employed population of work place base than that of the home base, while the situation is opposite in the suburban area having a large employed population commuting to the central part.



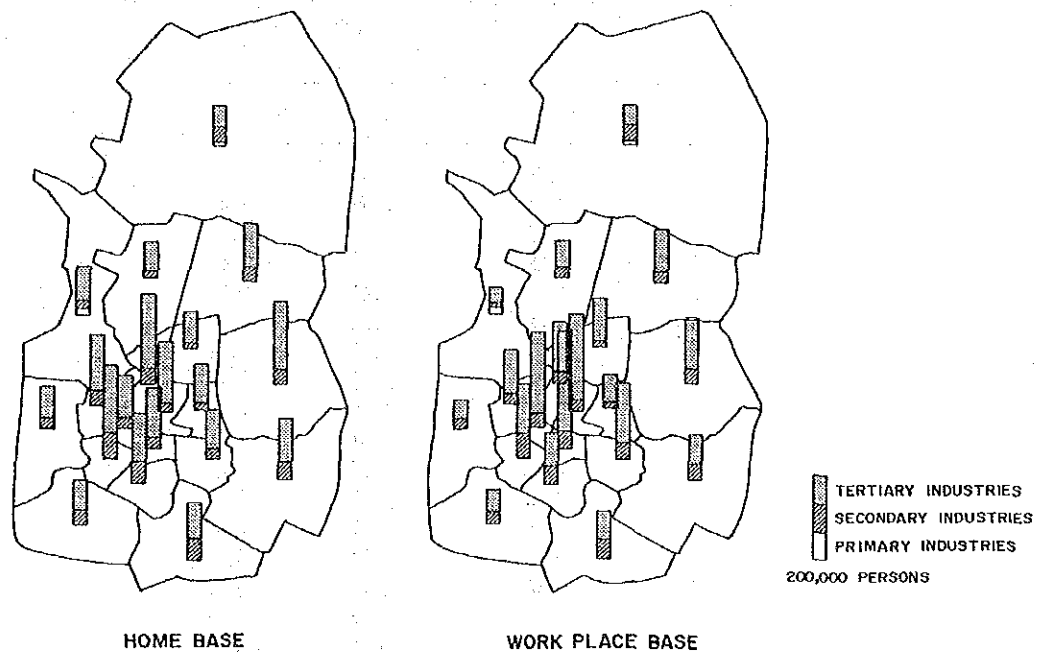


Figure 1.2.7 Zonal Distribution of Employed Population, Home Base and Work Place Base

Table 1.2.5 shows the specialization index by industry of work place base employed population. Table 1.2.6 shows the zonal share of employment by industry of the work place base employed population. Based on these two tables, the following facts can be discerned concerning the employment distribution by industry in the area.

1. The primary industry has a considerably large share of employment in the area ranging from the suburban area of Nonthaburi (zone 17) to Pathum Thani (zone 19).
2. The secondary industry is highly specialized in areas such as zones 5 and 9 in the center of BMA, southern zones 13, 14, 15 and 16 in the suburbs, and Pathum Thani in the north. In the central BMA, however, there is a considerably high accumulation in areas other than zones 5 and 9, although the degree of specialization is low.
3. The tertiary industry has a concentrated employment in central BMA, especially zones 1, 3 and 4 in the CBD, while the development is slow in the suburban areas.

Table 1.2.5 Ratio of Employment Composition by Industry to the Average

Zone	Primary	Secondary	Tertiary
1	0.29	0.64	1.12
2	0.04	0.86	1.06
3	0.17	0.51	1.17
4	0.29	0.65	1.12
5	1.21	1.44	0.86
6	0.49	0.98	1.02
7	0.13	0.71	1.11
8	0.73	0.55	1.14
9	0.54	1.40	0.89
10	0.82	0.87	1.04
11	0.79	0.92	1.03
12	0.26	0.97	1.02
13	0.25	1.57	0.85
14	0.65	1.51	0.85
15	2.48	1.48	0.82
16	0.84	1.73	0.78
17	14.00	0.73	0.80
18	0.36	1.15	0.97
19	4.87	1.91	0.64
Total	1.00	1.00	1.00

Table 1.2.6 Zonal Share of Employment by Industry

Zone	Primary	Secondary	Tertiary
1	2.60	5.66	9.93
2	0.22	4.80	5.93
3	1.47	4.56	10.39
4	3.15	6.97	12.03
5	5.88	7.00	4.19
6	3.41	6.88	7.11
7	0.40	2.20	3.42
8	3.31	2.49	5.17
9	3.69	9.49	6.05
10	4.12	4.37	5.24
11	3.79	4.43	4.92
12	1.53	5.80	6.11
13	1.01	6.45	3.48
14	2.11	4.90	2.77
15	6.45	3.86	2.14
16	3.81	7.82	3.55
17	34.86	1.82	2.00
18	1.20	3.87	3.27
19	16.98	6.64	2.25
Total	100.00	100.00	100.00

(5) School Location for Students and Pupils

Figure 1.2.8 shows the distribution of students of high schools and universities and pupils by school location. The fact that there is a heavy concentration of students in zone 12, where the Ramkhamhaeng University is located, draws particular attention. Generally, the share of pupils is larger in the suburbs, while that of students is a little larger in in the zones where there are universities.

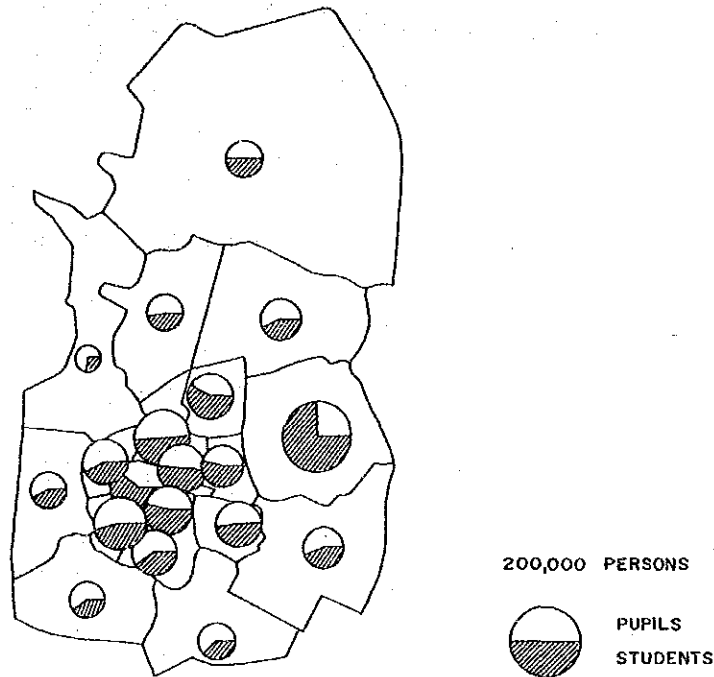


Figure 1.2.8 Distribution of Students and Pupils at School Location

(6) Individual Income

The average individual income is 5,600 baht/month. The administrative workers earn 9,600 baht/month, which is remarkably high. This is followed by professional workers and shop owners, who earn approximately 6,000 baht/month. These persons form a high income earning group.

Clerks earn close to the average individual income, while workers of other occupations earn 3,000 - 4,000 baht/month (See Figure 1.2.9).

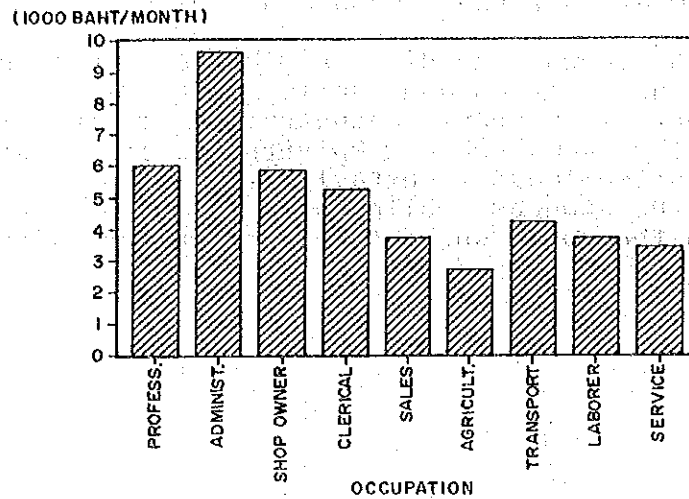


Figure 1.2.9 Individual Income Distribution by Occupation

#### 4) Household Characteristics

The main household indicators by zone are shown in Table 1.2.7.

Table 1.2.7 Main Household Indicators by Zone

Zone	Number of Households			Vehicle- Owning Ratio (%)	Number of Vehicles					Average Household Income (baht/ month)
	Vehicle- Owning	Non Vehicle- Owning	Total		Motor- Cycle	Pass. Car	Pick-Up	Others	Total	
1	29,966	53,942	82,908	35.7	31,368	19,843	14,242	1,316	66,769	10,336
2	47,779	85,606	131,385	35.8	32,145	38,222	18,425	5,098	93,890	11,665
3	37,174	66,981	104,155	35.7	23,928	30,555	17,112	2,156	73,751	10,902
4	38,696	61,513	100,209	38.6	31,512	30,702	16,767	1,217	80,198	10,594
5	38,955	73,740	112,695	34.6	36,497	28,829	15,329	4,750	85,405	10,289
6	36,907	41,085	77,992	47.3	13,916	32,327	13,843	2,997	63,083	11,448
7	24,645	42,247	66,892	36.8	14,675	18,748	10,064	1,576	45,063	11,453
8	22,244	34,788	57,032	39.0	11,857	16,291	6,896	3,734	38,778	10,731
9	40,308	105,388	145,696	27.7	52,004	26,081	17,972	6,098	102,155	11,105
10	31,698	91,506	123,204	25.7	38,546	22,712	10,724	2,129	74,111	11,212
11	35,219	58,287	93,506	37.7	24,202	23,403	14,362	4,903	66,870	11,096
12	52,797	75,481	128,278	41.2	24,973	36,733	22,613	4,842	89,161	11,058
13	33,659	60,614	94,273	35.7	17,875	22,744	12,709	3,065	56,393	10,973
14	19,716	46,873	66,499	29.6	18,811	12,964	8,366	3,068	43,209	10,389
15	16,346	43,847	60,193	27.2	13,495	10,174	8,395	2,068	34,132	10,336
16	16,855	71,226	88,081	19.1	22,891	8,424	6,479	4,664	42,458	9,839
17	18,378	48,927	67,305	27.3	15,188	7,793	9,285	5,333	37,599	9,849
18	20,844	33,007	53,851	38.7	11,561	13,126	8,468	883	34,056	11,147
19	13,188	44,362	57,550	22.9	17,641	2,504	9,356	3,096	32,597	9,593
Total	575,374	1,139,330	1,714,704	33.6	453,085	402,175	241,425	62,993	1,159,678	10,810

(1) Number of Households

The total number of households in 1989 is 1.7 million.

(2) Number of Households by Income Level

Figure 1.2.10 shows the number of households by income level. The number of households within the income range of 7,500-15,000 baht/month is the largest. The share of households earning between 2,500 and 15,000 baht/month is 76% of the total. The average household income is 10,800 baht/month. The zonal average household income is comparatively high for zones 2, 6 and 7.

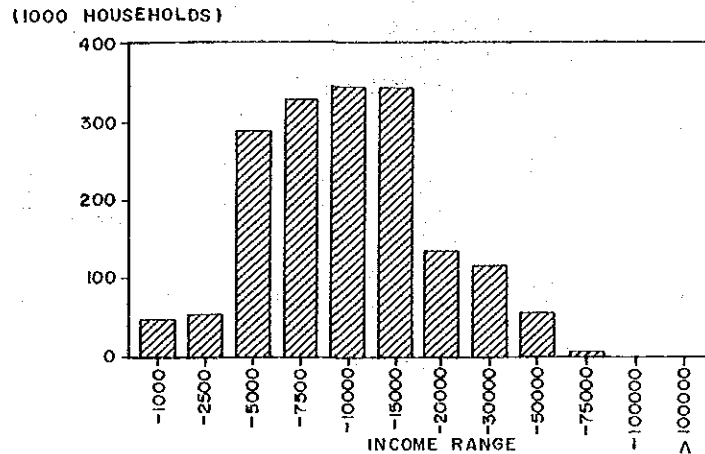


Figure 1.2.10 Household Distribution by Income Level

(3) Vehicle Ownership

The total number of vehicles owned by the households in the study area is 1,160,000: motorcycles, 450,000; passenger cars, 400,000; and pick-ups, 240,000, as shown in Table 1.2.7. The percentage of vehicle-owning households shows a high level of 33.6%. These numbers do not include company and government vehicles, and therefore are lower than registration figures.

Figure 1.2.11 shows the vehicle-owning/non-vehicle-owning households by zone. Figure 1.2.12 shows the distribution of vehicles by type and by zone. These figures show that in the zones where the ratio of vehicle-owning household is high, the average household income is also high. There is a close relationship between vehicle ownership and household income.

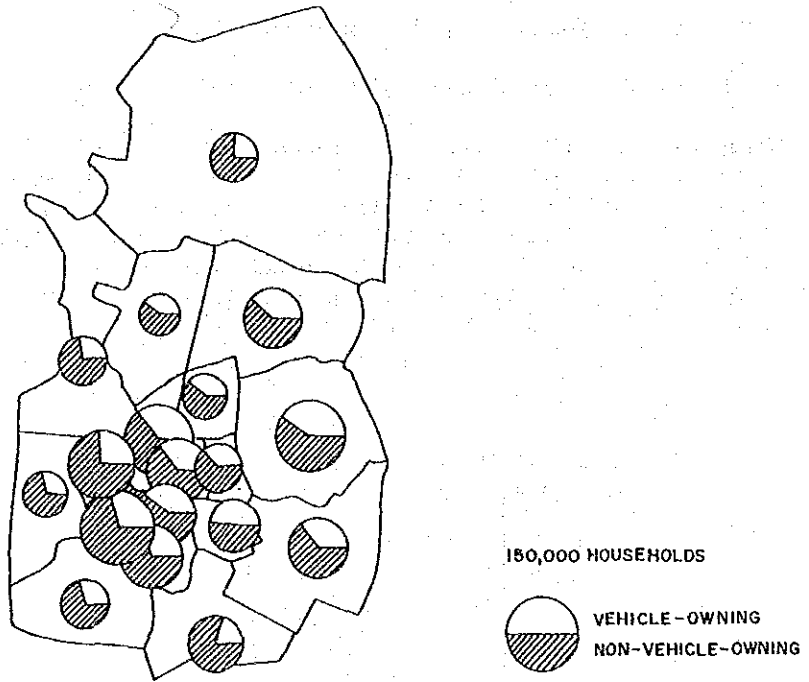


Figure 1.2.11 Vehicle Ownership by Zone

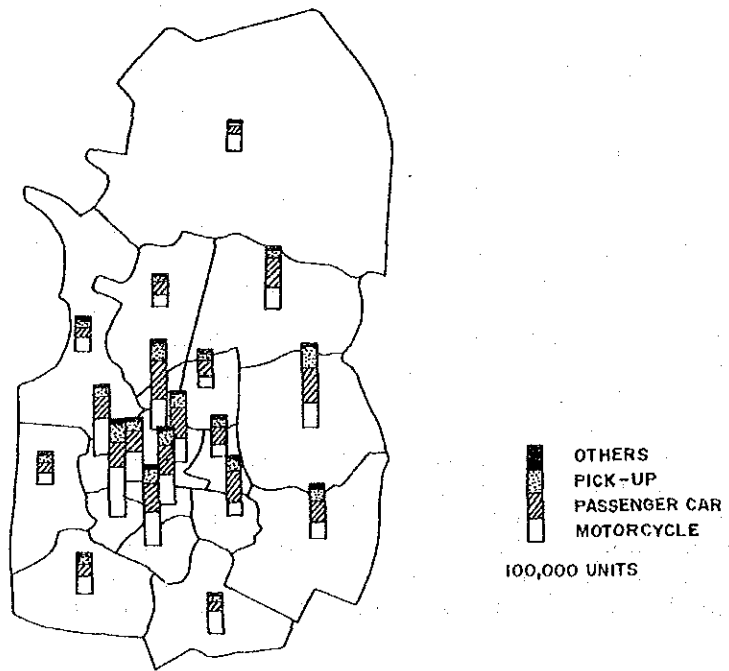


Figure 1.2.12 Vehicle Distribution by Type and by Zone

The percentage of multiple-car-owning households (passenger car and pick-up) is 18% of the total car-owning households.

The period of vehicle ownership by type is shown in Figure 1.2.13. Approximately 70% of passenger cars and pick-ups are kept for less than five years, and 50% of motorcycles for less than two years. In general the ownership period for privately-owned vehicles is short in the study area. On the other hand, 60-70% of commercial vehicles (except taxis) are kept for more than five years.

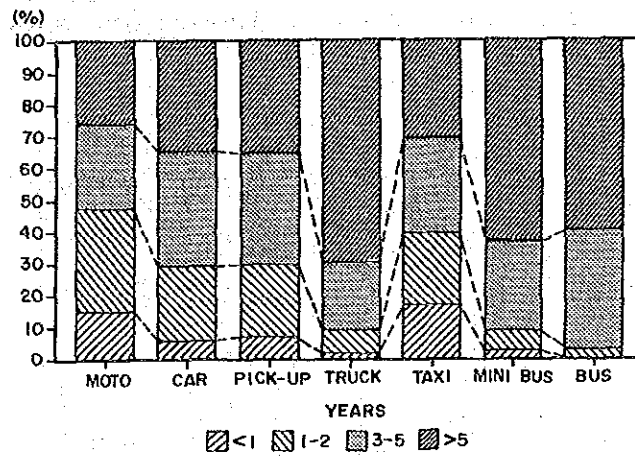


Figure 1.2.13 Ownership Period by Vehicle Type

An analysis of the motivations to own a vehicle reveals that approximately 50% of the owners purchased their vehicles for commuting or attending school. Approximately 80% of purchased vehicles are intended for daily use including business purpose. A high ratio of pick-ups and motorcycles are purchased for business trips and private trips, respectively.

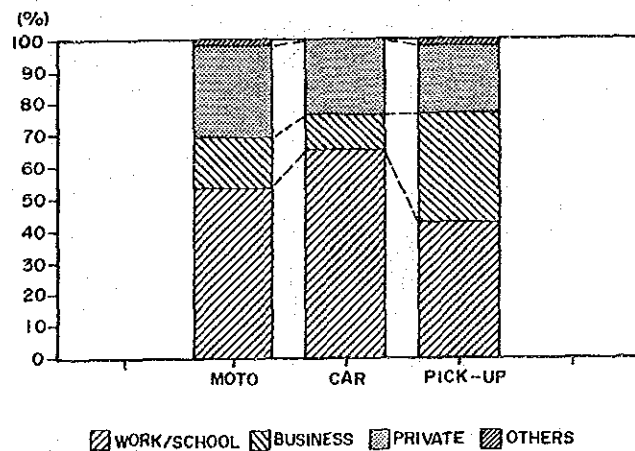


Figure 1.2.14 Motivation of Vehicle Ownership

The relation between household income and ownership of cars and motorcycles is shown in Figures 1.2.15 and 1.2.16, respectively. The car ownership increases as household income increases. The motorcycle ownership, however, increases as the income increases up to approximately 30,000 baht/month, but decreases over this income level. This may indicate that high income households favour car ownership over motorcycle ownership to car ownership. Multiple-vehicle ownership increases for both motorcycle and car in proportion to the increase of income.

These tendencies pertaining to the relationship between vehicle ownership and household income are shown in Figures 1.2.17 and 1.2.18.

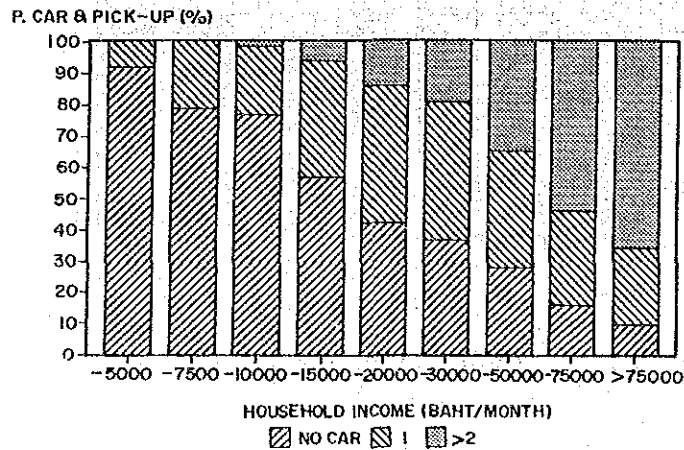


Figure 1.2.15 Car Ownership by Household Income

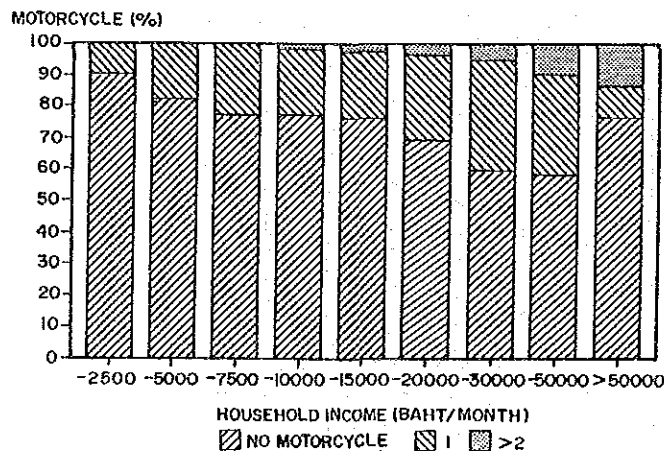


Figure 1.2.16 Motorcycle Ownership by Household Income



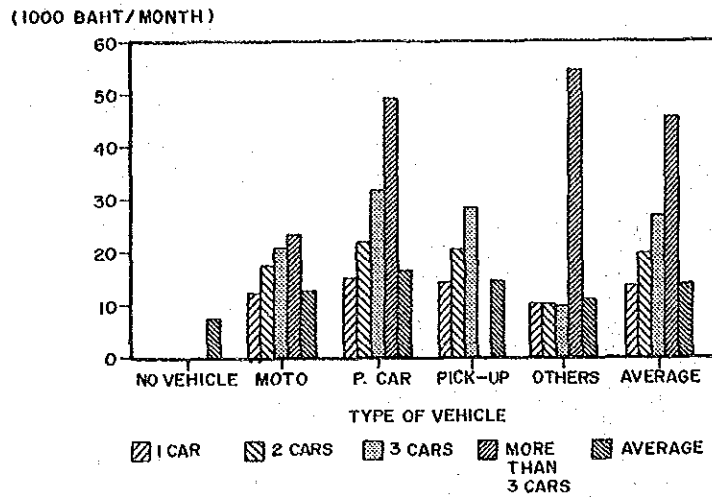


Figure 1.2.17 Average Household Income by Number of Vehicles Owned

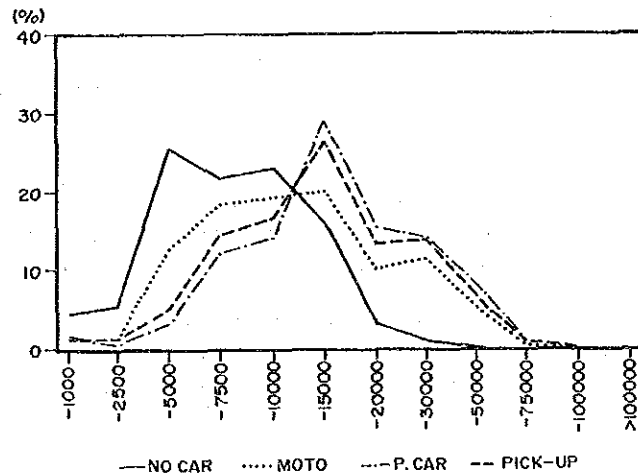


Figure 1.2.18 Household Income Distribution by Vehicle Ownership

#### (4) Residence Ownership

Approximately 66% of the houses are owned by residents. The distribution of residence ownership is shown in Figure 1.2.19. There are many home owners in the peripheral areas, while many rented houses are found in the inner area.

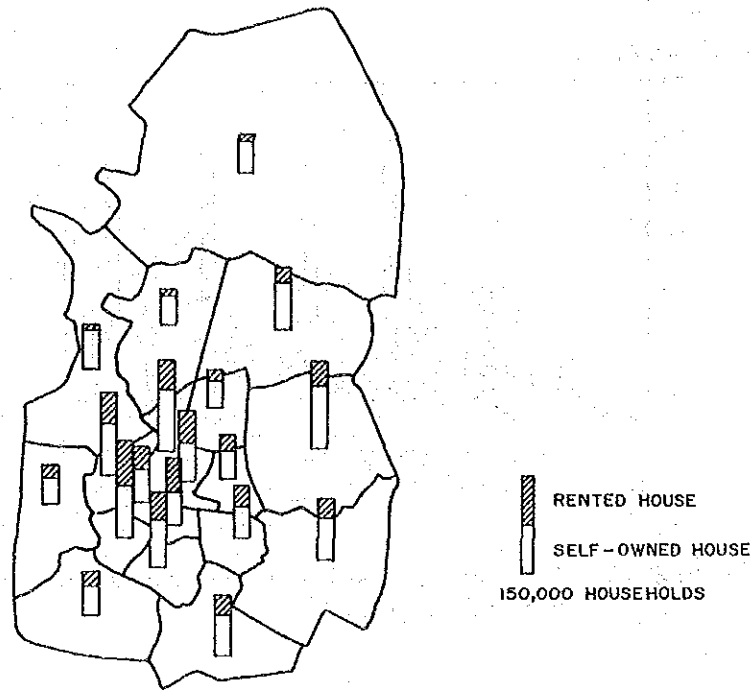


Figure 1.2.19 Residence Ownership by Zone

The number of households by years of residence is shown in Figure 1.2.20. Most study area residents have lived in their current places of residence for a period of between 5 and 10 years; that is, for a relatively short period of time.

Household income by type of residence is shown in Figure 1.2.21. Those who stay in dormitories have the lowest income, while those living in detached houses have the highest income. Residents of townhouses have fairly high income.

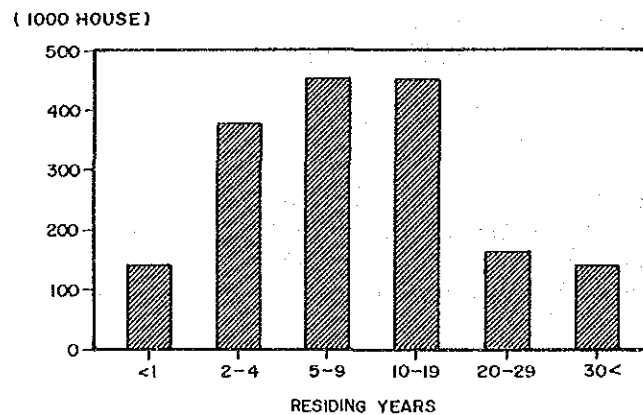


Figure 1.2.20 Household Distribution by Years of Residence

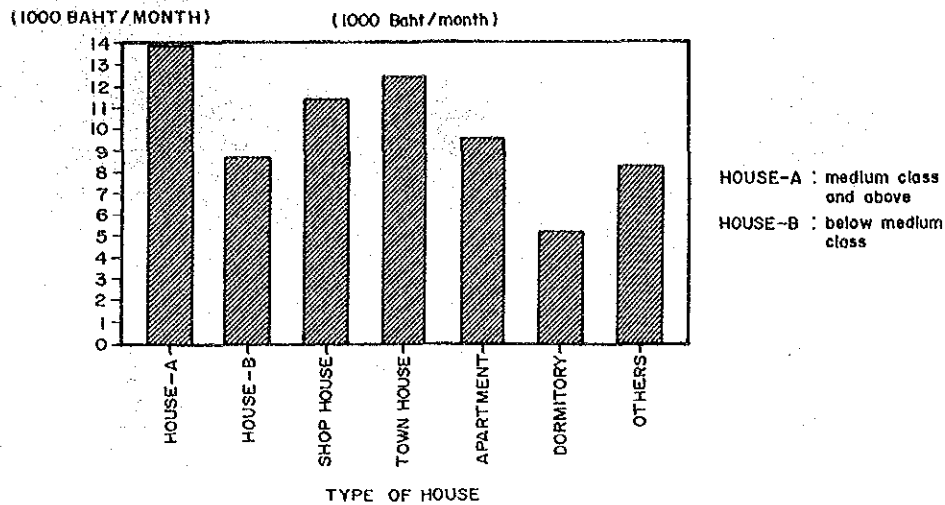


Figure 1.2.21 Average Household Income by Type of Residence

### 1.3 Urban Structure and Land Use

#### 1) Spatial Urban Growth

A small town along the Chao Phraya river has continued to expand its built-up area outward developing into a mega-city with a population of 5.7 million (Figure 1.3.1). The edges of the built-up areas extend to a range of about 30 km radius from the heart of the city, intruding into the neighboring provinces.

One of the prominent features of the Bangkok urban area is the narrow strips of built-up areas along the arterial roads radiating from the central area of Bangkok, with vacant tracts being left between the strips within the city. This contributes to another characteristic of Bangkok; low average population density.

NESDB classified areas in terms of changes in population, namely Saturated Urban, Slow Growing Urban, Fast Growing Urban, and Transitional Urban (Figure 1.3.2). This denotes the progressive urban structure. In the core area of Bangkok such as the Saturated Urban area, population is decreasing, and the Slow Growing area is following the same pattern. Urbanization is rampant in the Fast Growing Urban area, and further expansion of urbanization is turning the agricultural land into urban land in the Transitional Urban area (suburbanization in the fringe area).

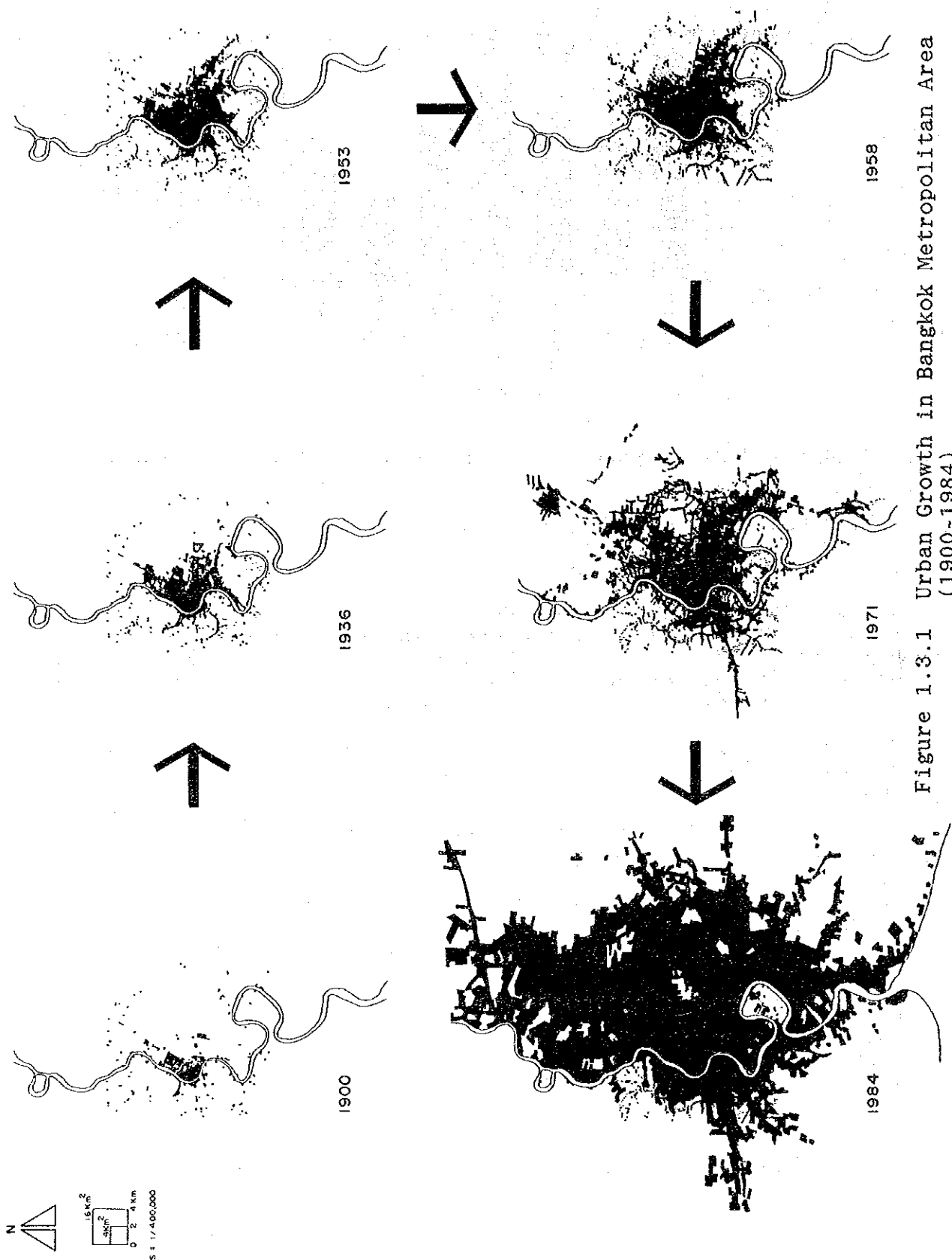
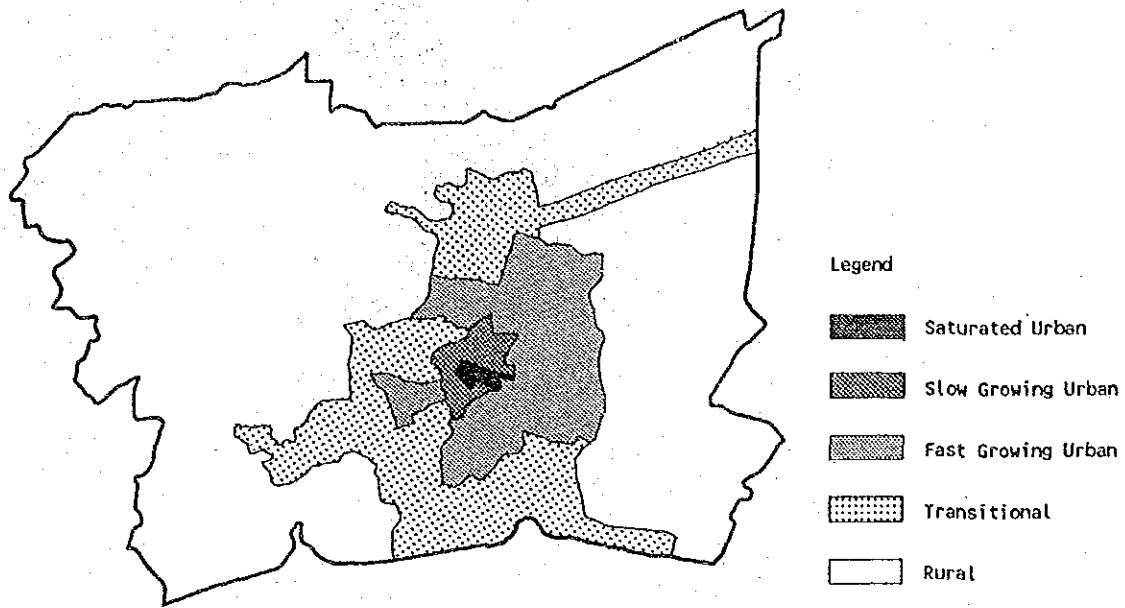


Figure 1.3.1 Urban Growth in Bangkok Metropolitan Area (1900-1984)



Source: NESDB

Figure 1.3.2 Area Classification by Population Growth

The urban area has developed mainly in the southeastern direction and the northeastern direction.

The leading factors of the urbanization in the southeastern direction are National Roads No. 3 and No. 34. Establishment of factories and development of residential areas are underway along the roads, and urban areas are being formed between the east coast prefectures and Bangkok.

To the northeastern direction, along National Road No. 1, on the other hand, the development of industrial estates and residential areas and transfer of universities have made progress.

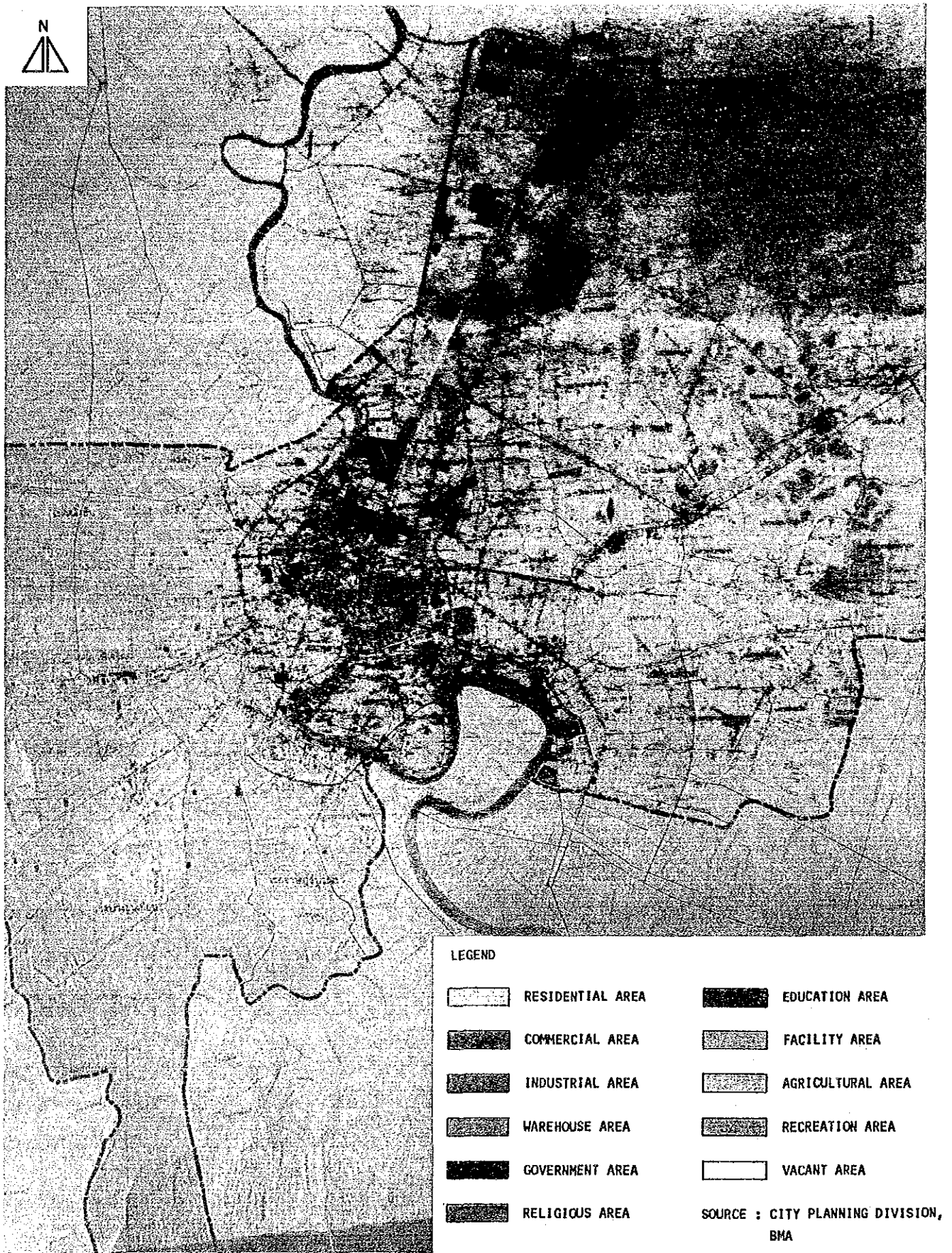


Figure 1.3.3 Existing Land Use in Bangkok 1986

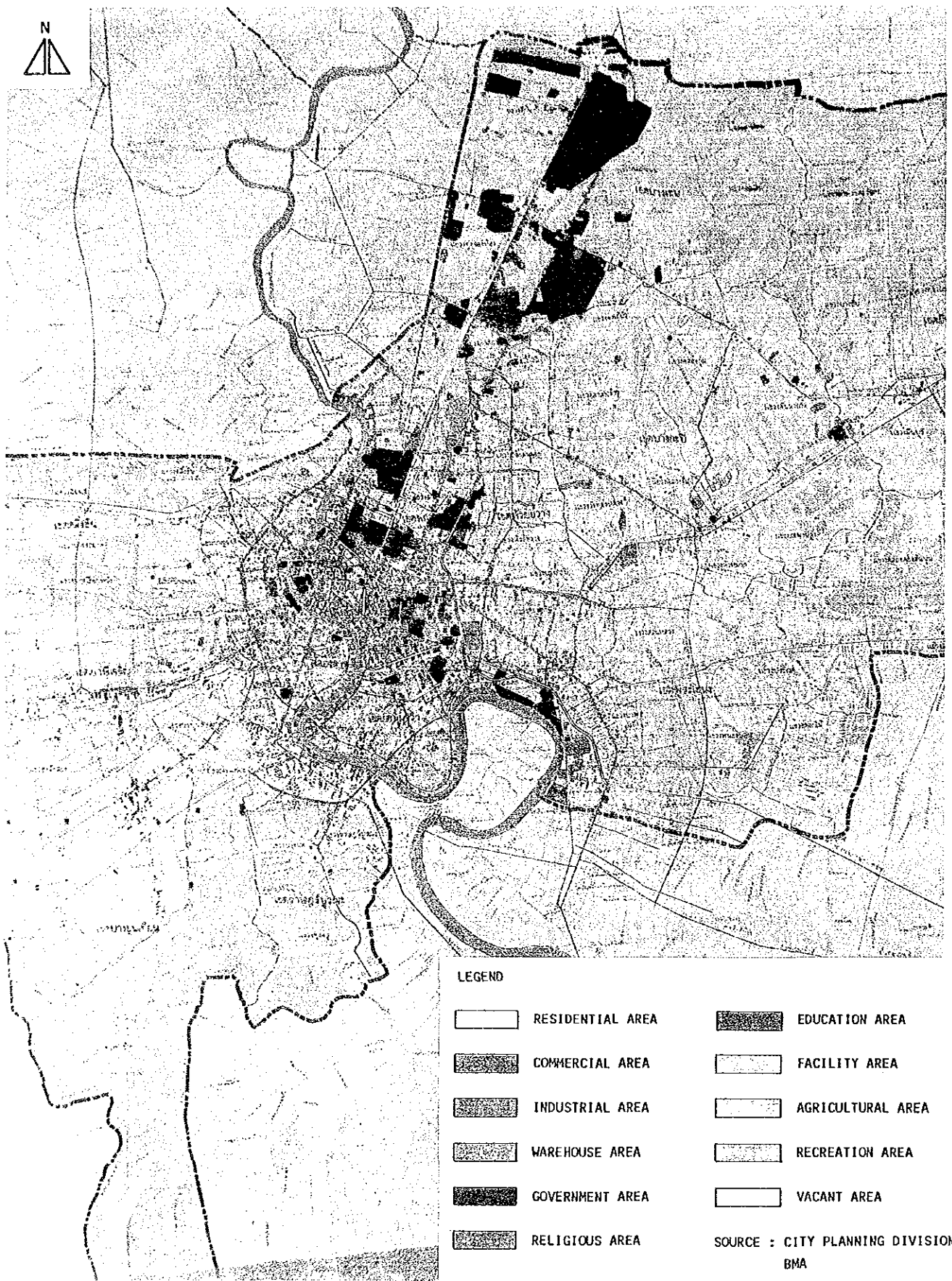


Figure 1.3.3 Existing Land Use in Bangkok 1986

## 2) Land Use

Existing Land Use is shown in Figure 1.3.3. District classification made by NESDB is of much help to understand the existing land use (Figure 1.3.4).

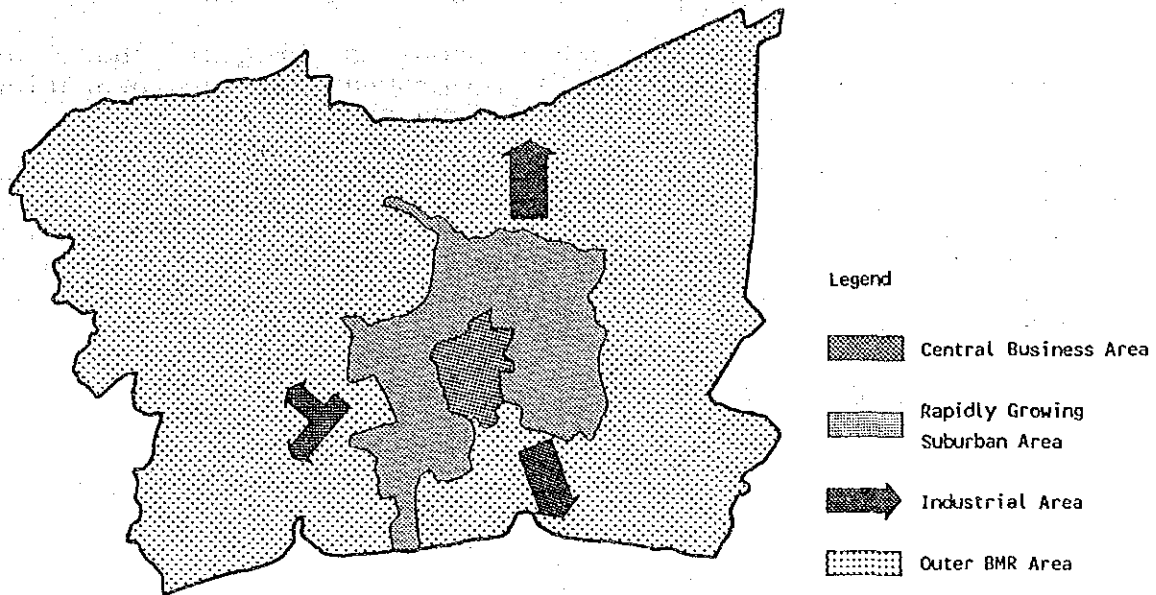


Figure 1.3.4 Strategic Area for BMR Development

The central business area consists of old and new business districts. As the center of business, services, and government administration, it is the major employment area within the BMA. But buildings are decaying, especially in the old business district where proper maintenance is lacking.

The rapidly growing suburban area surrounding the Central Business Area has been experiencing the rapid urban growth resulting from the spill-over of housing and economic activities from the central area.

The industrial area, which is out of the BMA, consists of the old industrial areas of Samut Prakan and new industrial areas of Pathum Thani, Thanyaburi, and Samut Sakhon.

Bangkok has never experienced land use or architectural controls (zoning). This has led to the mixture of types of land use, represented by;

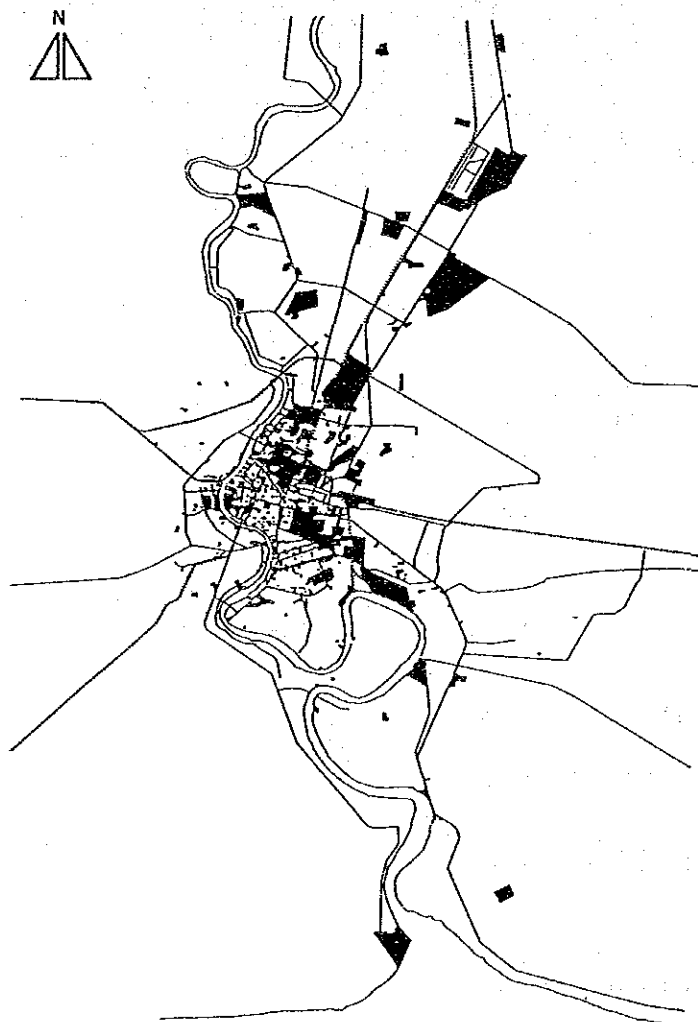
- a. High population density in the commercial areas, especially in the inner city (Old Town).
- b. Small-scale industries scattered and mixed up with other types of land use.



- c. One of the prevalent types of buildings in Bangkok is the "shophouse," which accommodates small-scale commercial/ industrial activities on the ground floor and families on the second or higher floors.
- d. Skyscrapers (hotels, offices and condominiums) located in the residential areas or low density areas.

In order to cope with the urban problems brought about by uncontrolled urban development, the Government has been preparing the enforcement of the General Plan of Bangkok.

Another major feature of the existing land use lies in the presence of a great deal of open land and government lands (Figure 1.3.5). This is one of the reasons for the low-density spread of built-up areas or the trends of pushing the location of housing and urban industries outward in the suburban area of Bangkok.



SOURCE : INFORMATION BMA

Figure 1.3.5 Government Land Ownership, 1972

### 3) Buildings and Housing

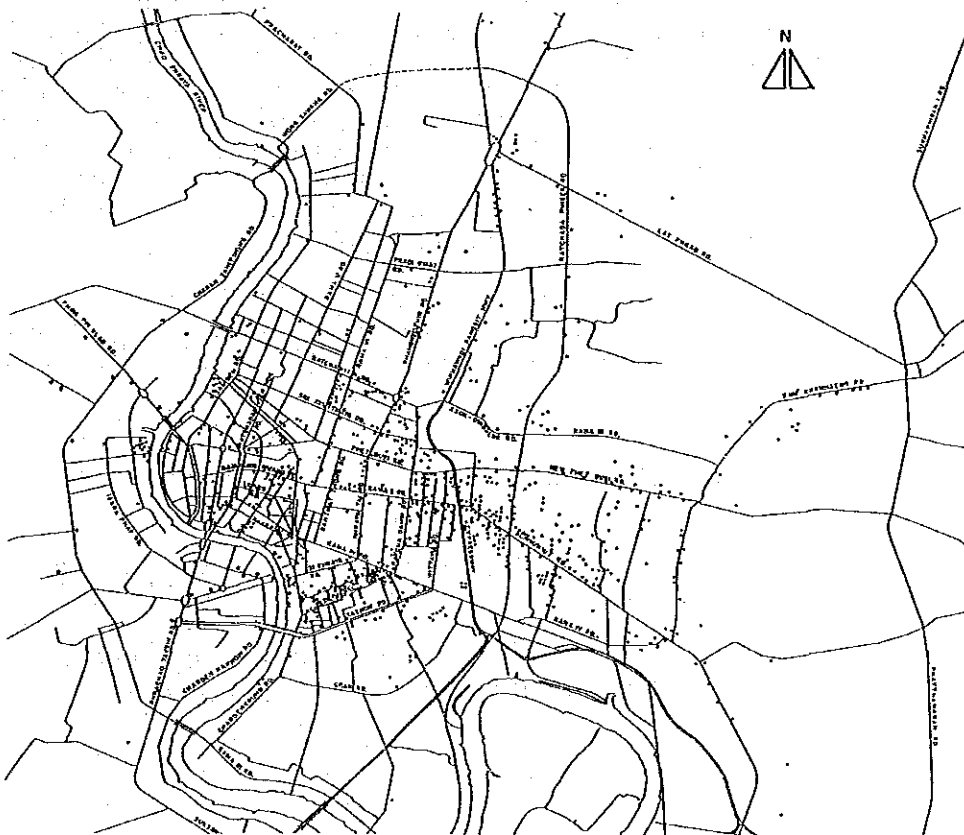
#### (1) Recent Development of Major Buildings/Complexes (Construction Rush)

The recent economic boom of Thailand triggered a construction rush of office buildings, hotels, and condominiums in Bangkok.

Although the new constructions of major buildings seem to be indiscriminately located, those urban development activities are taking the initiative to reshape the urban structure of the BMA.

Figure 1.3.6 shows the location of new construction of buildings with 6 or more floors in recent years. According to the data, the distribution pattern of new development can be summarized as follows:

- a. Recent development has been taking place in the fringe area of the central district of Bangkok. Due to the heavy traffic congestion in the central area, new buildings are likely to avoid that area, instead transferring to the fringe area (the area along the middle ring road).



SOURCE : BANGKOK LAND MANAGEMENT STUDY, 1987

Figure 1.3.6 Location of Recent Construction of Major Buildings/Complexes with Different Uses

- b. New development through new construction of buildings appears to proceed still southeast- and northeastward, as described in the preceding section.

Formerly, a major business district was located along Charoen Krung and Yaowaraj Road, but its relative importance has declined. This business district became congested and could not accommodate the rapidly expanding metropolis. The small nucleus at Prathunam, where open spaces are available, began replacing the old business community in importance. The Prathunam area started to grow with the extension of Petchaburi Road and annexed Raja Prasong and Siam Square into its sphere. Meanwhile, the improvement of Silom and Suriwong Roads contributed to the growth of business communities in these areas, which are adjacent to the Prathunam district. Therefore, the present central business district of Bangkok includes Prathunam, Raja Prasong, Siam Square, Silom, and Suriwong.

At present, the total floor area of first class office buildings amounts to 109.0 ha (99 buildings), of which 15% is in the Silom Road area, 12% in the Sarthon area, 12% in Ploenchit, and 10% in Suriwong.

Under the current construction rush, new construction of office buildings by the private sector is very pronounced. The total floor area is estimated at 149.0 ha in the year 1992, including the planned construction of new buildings. The share of each district in the floor areas is 13.8% at Silom, 9.4% at Asoke, 8.7% at Sarthon, 8.6% at Ploenchit, 7.6% at Ratchadamri, 7.4% at Suriwong, 6.5% at Ratchada and 0.1% at Sukhumvit. (Business Center and Office Space Requirement in Bangkok, December 1988).

Those current movements in office building construction signal the dispersion of office spaces and the creation of multiple business centers throughout the built-up areas.

## (2) Housing

Housing in the BMA totaled around 1.0 million units in 1984 (Table 1.3.1).

The 3 major types of housing are shop houses, accounting for 24.8%, individual buildings, 27.2%, and slum housing, 16%.

Most of the additional units constructed between 1974 and 1984 are shop houses and developer housing (private land and housing projects).

Table 1.3.1 Housing Stock by Type of Housing Project  
Bangkok Metropolitan Administration, 1970-1984

Type of Housing Project	Number of Units				Abs. Chg. 1974-84	Share Increase	Percent Increase 1974-84
	1974	Percent	1984	Percent			
Shop House	134,766	23.0	247,553	24.8	112,787	27.3	83.7
Developer Housing	20,193	3.5	113,755	11.4	93,562	22.6	463.3
Land Subdivisions	31,393	5.4	70,466	7.1	39,073	9.5	124.5
Individual Building	209,084	35.7	271,266	27.2	62,182	15.0	29.7
Public Housing							
NHA	9,377	1.6	47,882	4.8	38,505	9.3	410.6
Non-NHA	n.a.	n.a.	26,826	2.7	n.a.	n.a.	n.a.
Slum Housing	139,326	23.8	160,145	16.0	20,819	5.0	14.9
Canal Housing	21,868	3.7	21,592	2.2	-276	-0.1	-1.3
Other Housing	19,156	3.3	38,951	3.9	19,795	4.8	103.3
<b>Total</b>	<b>585,163</b>	<b>100.0</b>	<b>998,436</b>	<b>100.0</b>	<b>413,273</b>	<b>100.0</b>	<b>70.6</b>

Source: National Housing Authority and Bangkok Land Management Study, 1987

Table 1.3.2 shows the increases in housing stock by distance from the CBD and type of housing. The outstanding characteristics of the housing pattern of Bangkok are as follows:

Shop houses, which appear most common in the built-up areas, have been developed at distances of 6-10 km from the CBD. A large part of developer housing concentrates on the 11-20 km range. In the 21-30 km range, land subdivision aimed at high income households occupies 20% of the total housing realized in the belt.

Thus, there seems to be a locational tendency of housing in accordance with distance away from the CBD.

Table 1.3.2 Increase in Housing Stock by Distance and Type of Housing, 1974-1984  
(in housing units)

Type	Distance from CBD (km)					Total
	0-5	6-10	11-20	21-30	Over 30	
Developer Housing	2,406	15,054	61,424	12,096	2,582	93,562
Land Subdivision	- 450	2,754	24,662	9,823	2,284	39,073
Individual Units	-2,795	7,134	31,395	14,395	12,114	62,182
Slum and Squatter	716	3,281	12,165	3,526	1,131	20,819
Shop House	32,825	40,731	25,929	6,489	6,813	112,787
Institutional	2,569	-2,451	12,730	2,813	4,134	19,795
<b>Total Housing</b>	<b>35,271</b>	<b>66,503</b>	<b>168,244</b>	<b>49,142</b>	<b>29,058</b>	<b>348,218</b>

Source: Bangkok Land Management Study, 1987

Slum and squatter settlement, while continuing to grow, is expanding at a much slower rate than in the past. While the residential sector grew by a total of 62.9% in the 1974-1984 period, slum and squatter settlements grew by only 14.9%. This pattern of growth suggests that the private, formal market is beginning to respond to the needs of Bangkok's lower income residents.

There were approximately 890 slums in Bangkok in 1974. The number increased to 1,020 by 1984.

The average distance of slum communities from the city center increased from 7.5 km in 1974 to 8.4 km in 1984. New slums are located further away from the city center, at an average distance of 14.9 kms. Most new slum communities are smaller in size. Average community size was 205 households per community in the slums. Newly created slum communities have an average of 114 households per community, bringing down the average to 180 by 1984.

#### 4) Changing Trends of Urban Structure

As shown, the land use of Bangkok is very vague since it is not clearly articulated over the urban areas. Under this circumstance, locational tendencies of population and industries were seen as follows:

- a. The population density of the region is "flattening out" as population in the center of the city declines while that in the suburban areas increases. Most of the population growth has concentrated in the eastern and northern sides of the region.

Most of the urbanization pressures are focused in the ring around the city between 11 to 20 kilometers from the center, accounting for nearly 80% of the population growth of the region between 1974 and 1984.

The land conversion data and urbanization information during the same period reveal that the bulk of land conversion has taken place in this ring.

- b. Although there are signs that large firms have been decentralizing, small firms stay closer to the central area where they can access business and professional services.

Since service firms are the key growth sector in Bangkok, and because they tend to be small, the pattern of employment decentralization may be slow. The activity in the region's land and housing markets will be greater in the close-in urban areas, and along transportation corridors providing good access to the center of the city.

In regard to the recent urban development activities, 3 major trends are summarized as follow:

- a. Several narrow strips of built-up areas are extending outward and infiltrating the rural area along the main arterial roads in the suburban area of the BMR. They are reaching the area of the 30 km-range from the heart of Bangkok.
- b. Vacant and unused tracts of land have been left inside the 30 km-range area (especially the vacant areas held undeveloped between the strips of built-up areas), while sporadic urban development and building construction (especially factories, industrial estates and housing for them) have been rampant outside the area.

There is much potential for infill development (of the vacant land in the built-up area). If a policy of urban infill was adopted and close-in plots were developed with housing, much of Bangkok's future housing needs could be met without converting outlying agricultural lands. For example, by developing infill plots at 11 dwelling units per rai, approximately 600,000 units could be built, enough to accommodate Bangkok's housing needs until the year 2000.

- c. New urban development has been represented by the recent construction rush of office buildings, hotels, condominiums in/around the central district area, and some supermarket/department stores in the fringe area, which have been increasing the density of built-up area and reshaping the urban structure of BMR.

The future urban structure of Bangkok, which is to integrate all the development trends as stated above, shall be established either by developing the selected strips of built-up areas into growth corridors, intensifying existing built-up areas without expanding, or further enhancing the urbanization to create some satellite communities out of the built-up areas.



**CHAPTER 2**

**TRAFFIC DEMAND STRUCTURE  
BY PERSON TRIP**





## 2. TRAFFIC DEMAND STRUCTURE BY PERSON TRIP

### 2.1 Outline of Person Trip Survey

For a general understanding of the daily trips of the people living in BMA, the person trip (PT) survey, a vehicle origin/destination (OD) survey, and supplemental surveys such as cordon line survey and screen line survey were performed in the early stage of this study. Since a vehicle OD survey was previously made in 1985 for the area within the Middle Ring road as a part of the "Study on Road Improvement, Rehabilitation, and Traffic Safety in Bangkok", this vehicle OD survey was made for the area located between the Middle Ring road and the Outer Ring road. A master file was developed based on these two vehicle OD surveys, and the vehicle traffic characteristics were analyzed. Appendix A details the contents and methods of various surveys and an outline is given in this section.

#### 1) Person Trip Survey

The person trip survey (PT survey) was made by visiting 15,000 households in the study area and asking family members older than 6 years of age about their traffic behavior in a specified day. Effective replies were given by 48,553 persons, which is equivalent to 0.86% of the total study area population of 5,640,000 persons.

The PT survey was conducted in January and February, 1989. Although home visits were made even on weekends, the recorded trip information is for weekdays. The selection of the sample households was made by dividing the study area into 87 zones (dividing the total country area into 108 zones). Fundamentally, this is based on the zoning used for the STTR in 1986, but some zones were additionally sub-divided by the Outer Ring Road.

The contents of the survey were as follows. Household size, vehicle ownership, household income, and type of house ownership were checked. For each individual family member; sex, age, occupation, work place (or school place), individual income, and availability of driving license were checked. For the trip; origin and destination zones (OD zones), departure/arrival time, trip purpose, and type of traffic facility used were checked.

#### 2) Vehicle OD Survey

The vehicle OD survey was made to clarify the actual status of vehicle use and to correct the PT survey results. Vehicles were classified into seven categories: motorcycle, passenger car, pick-up/van, taxi/samlor/silor, truck, mini-bus, and bus. A 10% lot was extracted at random from the vehicle registration list of the Department of Land Transport of Ministry of Communication. Then, interviews were made with the owners of vehicles registered in the area located between the Middle Ring road and the Outer Ring road to ask them of the status of use of vehicles on a day

of the week. The survey period was January and February, 1989.

Since no analysis was made on motorcycles in the 1985 survey, the 1989 survey included motorcycles in the total area inside the Outer Ring road. The lot size, however, was limited to 1%, since as many as 821 thousand motorcycles were registered. Effective replies totaled 5,100 for motorcycles and approximately 27,000 for the other vehicles.

Among the survey items concerning household information, there were PT survey items as well as the frequency of use and maintenance cost of the vehicle. For the vehicle trip; the survey covered the OD zones, purpose of trip, departure/arrival time, number of passengers, and types of parking area.

### 3) Cordon Line Survey

The cordon line survey is to supplement the PT survey and to determine the trip behavior within the survey area by the people living outside the survey area. The cordon line of this survey was the Outer Ring road (including sections to be constructed). At 20 cordon line - road crossings and 4 cordon line - railway crossings, 24 hour or 14 hour surveys were conducted (Figure 2.1.1).

In the survey, the driver's place of residence (or passenger's place of residence in the case of bus and taxi), origin and destination of trip, and purpose of trip were checked as to the sampled vehicles for the survey. The number of interviewed passengers totaled 44,200 in this sample. At the same time traffic volume and average number of passengers were counted.

### 4) Screen Line Survey

In the screen line survey, an imaginary line was drawn to divide the survey area, and observation was made on the traffic crossing such a line. The result was used to check the reliability of the PT survey and the vehicle OD survey and to improve the accuracy of the surveys. In this survey, the Chao Praya River was used as the screen line, and the survey was made at 11 road bridges, one railway bridge, and nine ferry terminals (Figure 2.1.1).

The survey was made by counting the traffic volume by type of vehicle and counting of the number of passengers. For bus and train, percentage of seat occupancy (100% taken for full seat occupancy) was checked first, then converted into numbers of passengers after the survey. The percentage of seat occupancy in the train was checked at the nearest station and not on the screen line.

### 5) Data Processing and Preparation of Data Base

All the actual records of various surveys were converted into numeric values and input into a computer. After expanding the sample information into the universe information, data of people living outside the survey area were added to prepare the preliminary data file.



Prior to the expansion work, the population by zone of the universe and the percentage of vehicle ownership in 1989 were estimated. The estimation of population was made by expanding the population in 1986 checked by the STTR at the rate of increase of the registered population by district. The sample data expansion was made by zone, sex, age, and vehicle ownership. After expansion, various computations were made using the data file. The result was compared with more reliable data to correct the data file as necessary. The most important correction works are the screen correction and the business trip correction. In the screen correction, the volume of traffic crossing over the Chao Praya River was computed from the data file first, the result was compared with the actual traffic volume checked by the screen line survey, and the data file was corrected so that the former would match the latter.

Using the data file after screen correction, the trip composition by purpose was totaled. It was found that business trips had less than 3% share in the total trips. In the meantime, at the road side of various places in BMA, interview surveys were made of approximately 7,700 passengers in passenger cars and buses. The result shows business trips had approximately 33% share during off-peak (10:00-16:00) hours and approximately 10% on the whole day average. Therefore, judging that the PT survey and the vehicle OD survey captured only a small percentage of business trip, the data file was corrected based on the road side interview result.

The data file after various corrections was called the "master file". It served as basic analysis data mentioned in the next and later chapters, and it provided the most important information for the future traffic forecast.

#### 6) Representative Traffic Mode for Trip

Generally, one trip is counted for one purpose. Suppose, for example, that someone drops into a restaurant to dine on the way home from the office, and then goes home. The journey from the office to the restaurant is counted as a private-purpose trip (dining), and the journey from the restaurant to home is counted as a home-coming trip; thus, two trips are counted. (A trip counted corresponding to a certain purpose is called a "linked trip".)

If a trip is counted from the viewpoint of traffic facilities (mode) used (a trip counted in this manner is called an "unlinked trip"), on the other hand, one trip may be divided into sections of different modes. Therefore, in order to pair one linked trip with one mode, it is necessary to predetermine the priority for selecting a representative mode. For this study, it was presumed that the following modes were ranked from the highest to less significant degrees of priority!

Train, Public Bus, Public Minibus, School/Private Bus, Soi Minibus, Silor, Taxi, Samlor, Soi Motorcycle, Water Transport, passenger Car, Pick-up/Van, Truck, Others, Motorcycle, Bicycle, Walking.

## 2.2 Total Number of Trips and Trip Production Rate

### 1) Total Number of Trips

#### (1) Total Number of Trips

Of the total number of 15.64 million trips per day in the study area in 1989, 2.24 million trips (14.3%) are made by walking and bicycle. Unless otherwise specified, trips by mode of transport other than walking and bicycle are adopted for consideration in the analysis. Of the total number of 13.40 million trips, 12.55 million trips were made by residents in the study area and 850,000 trips by non-residents. Since trips by residents in the study area have a 93.7% share, it may be judged that the study area is closed in the view point of traffic.

A classification of trips shows 90.1% for trips within the study area, 9.1% for trips to/from study area, and 0.8% for trips passing through the study area. (Figure 2.2.1)

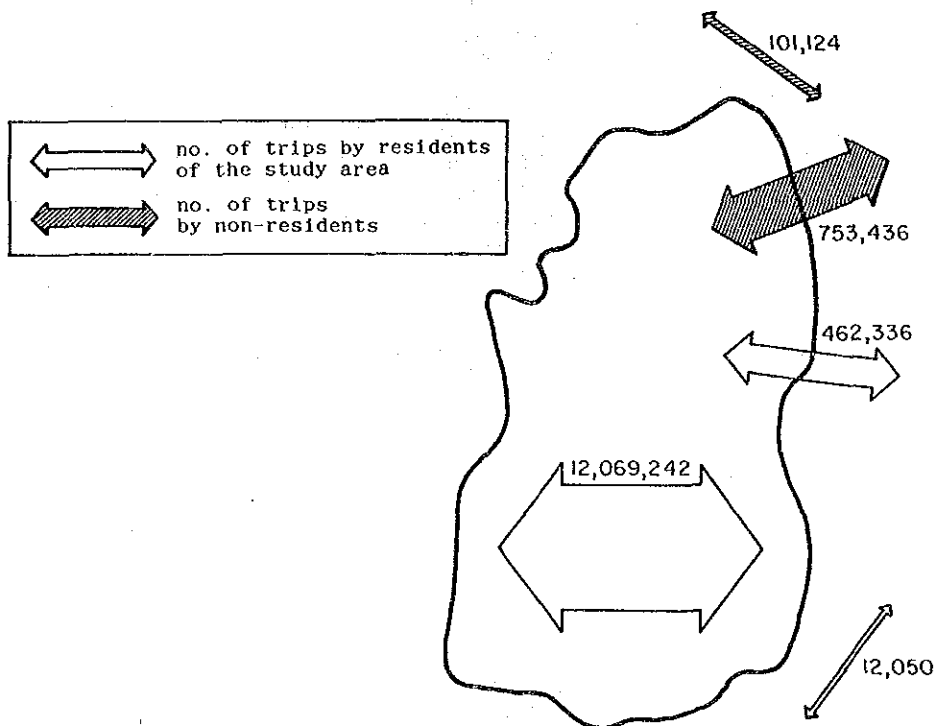


Figure 2.2.1 Aggregated Number of Person Trips

(2) Trip Composition by Purpose

As shown in Figure 2.2.2, the purposes of trips are "to home" (43%), "to work" (19%), "private" (16%), "to school" (12%), and "business" (11%).

As shown in Figure 2.2.3, in terms of the composition by purpose of mode of road transportation (excluding walking, bicycle, railway and water transportation), the share of school and private trips is smaller than the composition by purpose of all modes, while the share of business trips is larger. This may indicate that transportation modes are used for business, while people on private and school trips often walk.

Almost half of the trips are "to home" which means that there are many home-based trips, and that there are many outgoing trips with one destination.

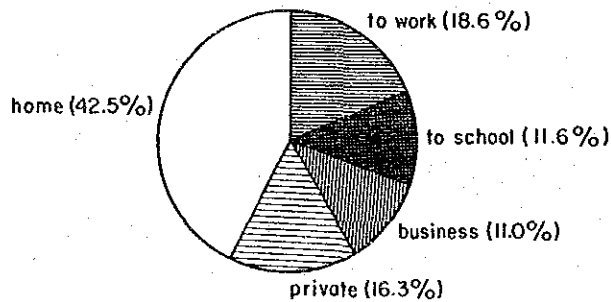


Figure 2.2.2 Trip Purpose Composition (All Modes)

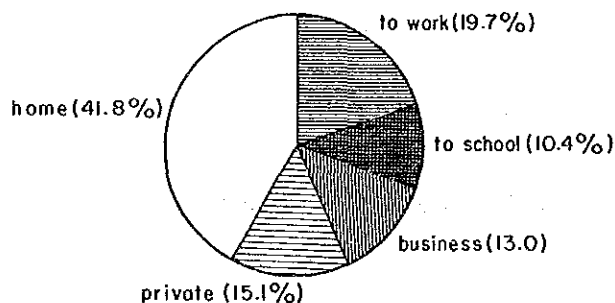


Figure 2.2.3 Trip Purpose Composition (Trips by Vehicle Only, Excluding Trips by Walking and Bicycle)

(3) Trip Composition by Mode

Figure 2.2.4 shows trip composition by mode. According to the figure, bus has the highest share (33%), followed by 27% for passenger car, 16% for motorcycle, and 15% for walking. While the trip composition of road transportation (Figure 2.2.5) excluding walking and bicycle is 39% by bus, 33% by passenger car, and 19% by motorcycle. The share by taxi is as low as 10%.

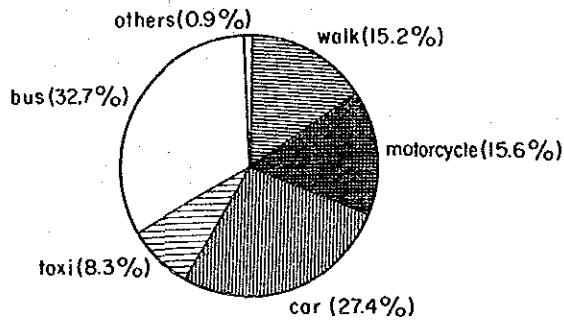


Figure 2.2.4 Trip Mode Composition (All Modes)

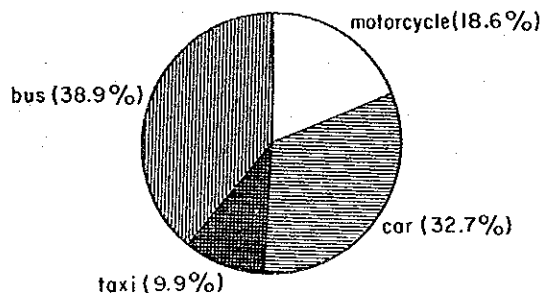


Figure 2.2.5 Trip Mode Composition (Trips by Vehicle Only, Excluding Trips by Walking and Bicycle)



## 2) Trip Production Rate

There are two types of trip production rate: gross rate for the population (consisting of those age 6 and above), and net rate only for people going out. Unless otherwise specified, gross rate is taken as the trip production rate in this report. Because walking and bicycles do not affect the road transportation facilities, and because they are not assigned in the traffic assignment, they are not considered in the analysis. They are not included as items, either, in the composition for the future traffic assignment model.

The trip production rate in the study area is 2.22, and the outgoing rate is 82%.

### (1) Trip Production Rate by Age Group, by Sex and by Purpose

The trip production rate by sex is 2.71 for males, and 1.77 for females. This fact is shown in Figure 2.26, which shows the trip production rate by age group and by sex. Up to high-school age, there is no remarkable difference between males and females, and the purposes mainly are to school and to home. Above age 25 or so, however, the production rate by males shows a sharp increase, while the rate by females achieves only a slight increase. In trip production by purpose, to work and business are popular for males, while private (shopping, etc.) purposes are popular for females. Consequently, the high mobility of males can be observed.

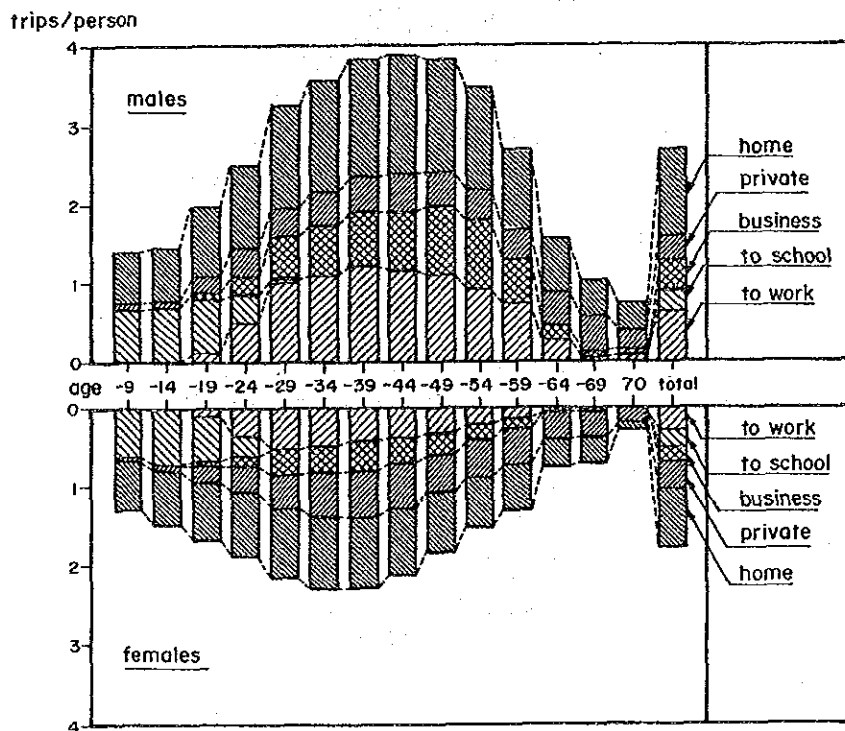


Figure 2.2.6 Trip Production Rate by Gender and by Age Group

(2) Trip Production Rate by Occupation and by Purpose

The trip production rate by occupation shown in Figure 2.2.7 reveals that more than 3.0 trips are made by administrative personnel, professionals and transportation workers per day, and that a low rate is found among housewives, agricultural workers and students.

The characteristics of the trip production rate by occupation are a low rate to work by shop-owners and agricultural workers, a high rate by administrative personnel and professionals, and a high rate of private purposes by housewives.

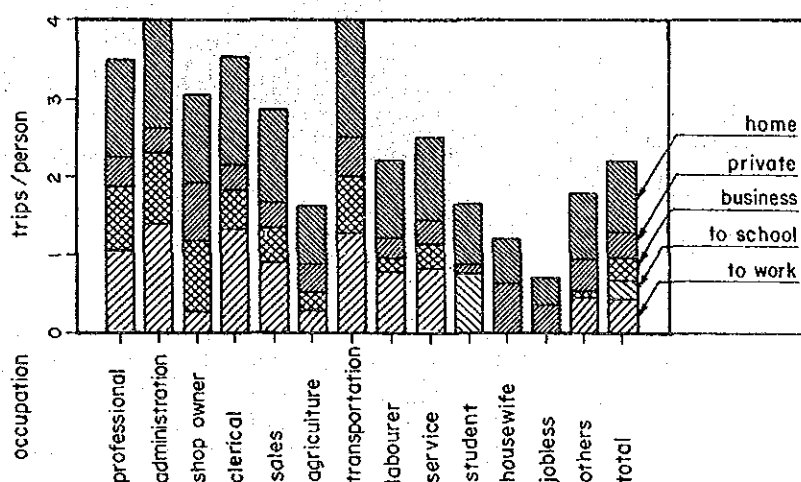


Figure 2.2.7 Trip Production Rate by Occupation and By Purpose

(3) Trip Production by Industry and by Purpose

The trip production rate by industry as per Figure 2.2.8 shows a high trip production rate for tertiary industries and a low rate for primary industries. There are many business trips for the tertiary industries.

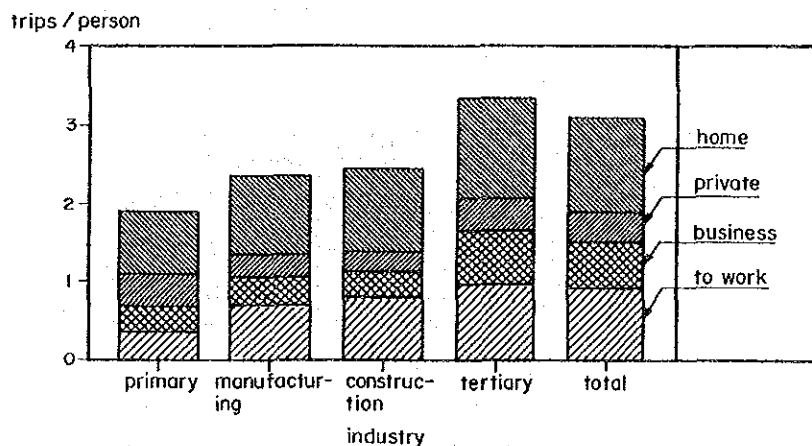


Figure 2.2.8 Trip Production by Industrial Sector and by Purpose

(4) Trip Production Rate by Household Income Level and by Purpose

Figure 2.2.9 shows the trip production rate by household income level. The trend is that high income earners have a high trip production rate. The purpose composition shows that the higher the income, the higher the trip production rate to work, business, and for private purposes.

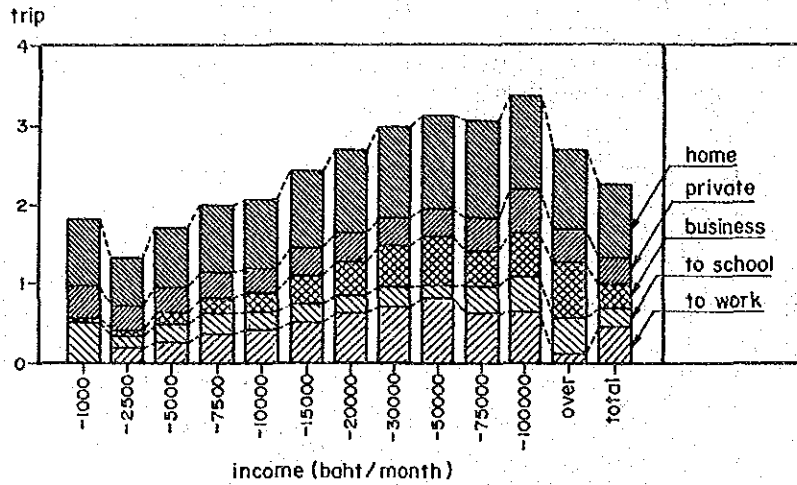


Figure 2.2.9 Trip Production Rate by Income Level and by Purpose

(5) Trip Production by Vehicle Ownership and by Purpose

Figure 2.2.10 compares trip production rate by vehicle owning households with that for non-vehicle owning households. The trip production rate is 3.21 for households owning both car and motorcycle, while it is 1.57 for non-vehicle owning households. This shows that the possibility of using transportation such as cars and motorcycles is closely related to the rate of outgoing trips. Here, the term "cars" includes both passenger cars and pick-ups.

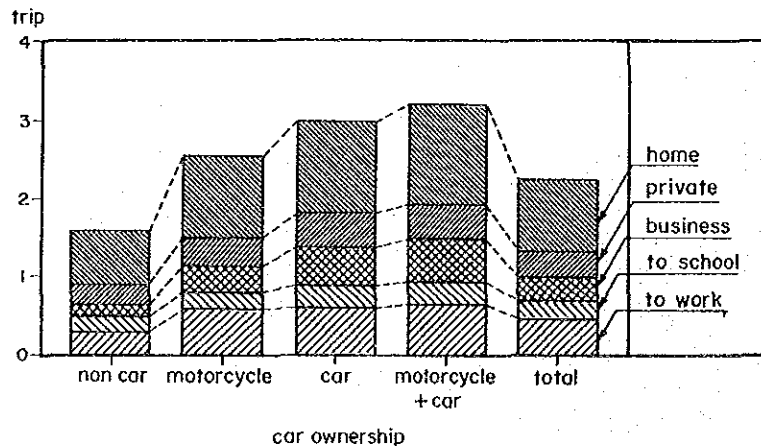


Figure 2.2.10 Trip Production Rate by Car Ownership and by Purpose

### 3) Household Characteristics and Modal Share

#### (1) Modal Share by Car Ownership

Figure 2.2.11 shows the trip distribution by car ownership and by mode. Based on this, all household types have a constant rate of bus use. Looking at the use of transportation modes other than bus, almost 100% of car owning households use their own cars. On the other hand, non car owning households use almost no transportation modes other than bus.

#### (2) Trip Production Rate by Mode and by Household Income Level

Figure 2.2.12 shows the trip production rate by household income and by mode. Use of passenger car increases as the income increases. Use of motorcycle increases to a certain degree as the income increases, but declines for higher income earners. This trend is based on the relationship between the household income and car ownership.

The trip production rate of taxi and bus appears to maintain a constant level regardless of the income level.

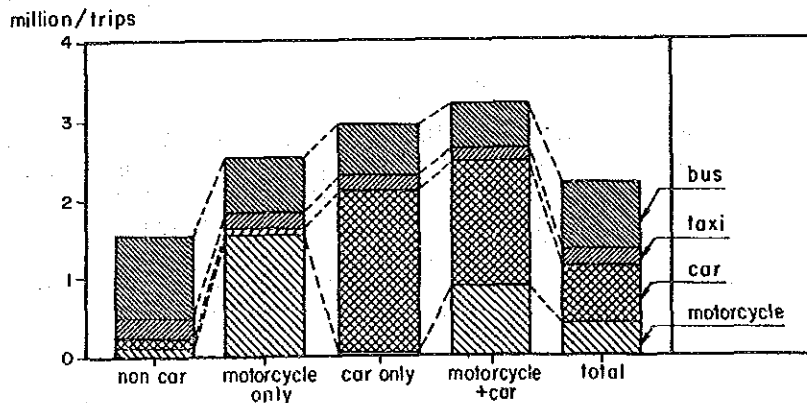


Figure 2.2.11 Modal Share by Car Ownership

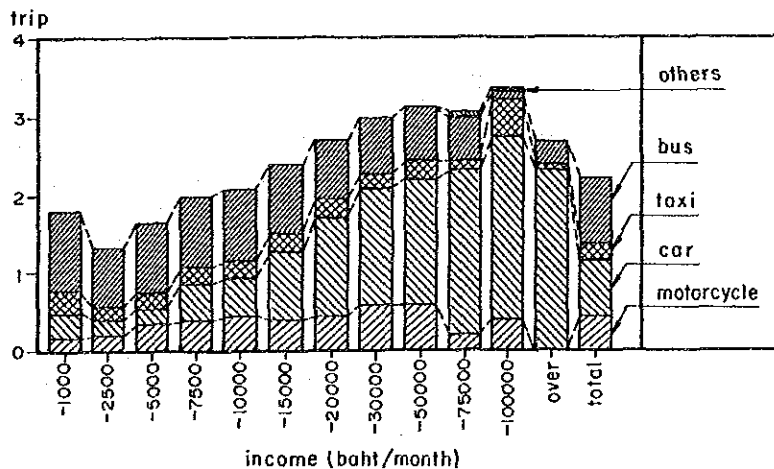


Figure 2.2.12 Trip Production Rate by Mode and by Household Income Level

## 2.3 Trip Generation and Attraction

### 1) Generated and Attracted Trips by Purpose and Zone

Figure 2.3.1 and Figure 2.3.2 show generated and attracted trips by integrated zone and purpose. ("to home" trips are excluded, since their volume is proportional to the total trips.)

The zones with a large number of generated trips are 2, 9, and 12, which have large populations, and 3, 4, and 6, which are business activity centers. The zones with a large number of attracted trips are 1, 3, and 4, which are business activity centers, and 12, which contains many large schools.

Characteristics of trip generation and attraction by purpose are as follows:

#### (1) "To Work" Purpose

Many trips with "to work" purposes generate from residential areas because they are proportional to the population size. Many of them are attracted to the business areas.

#### (2) "To School" Purpose

As in the case of "to work" purpose, "to school" trip generation is proportional to the population size. The attraction shows almost the same pattern with the generation, because trips are made largely by school children who attend schools within the areas. An exception is zone 12 with a significant concentration of students.

#### (3) "Business" Purpose

For business trips, both generation and attraction are heavy in zones 1, 3, and 4.

#### (4) "Private" Purpose

Private trip generation is nearly proportional to the population size, but relatively heavy concentration is found in zones 1, 4, 8, and 12 where there are many shops.

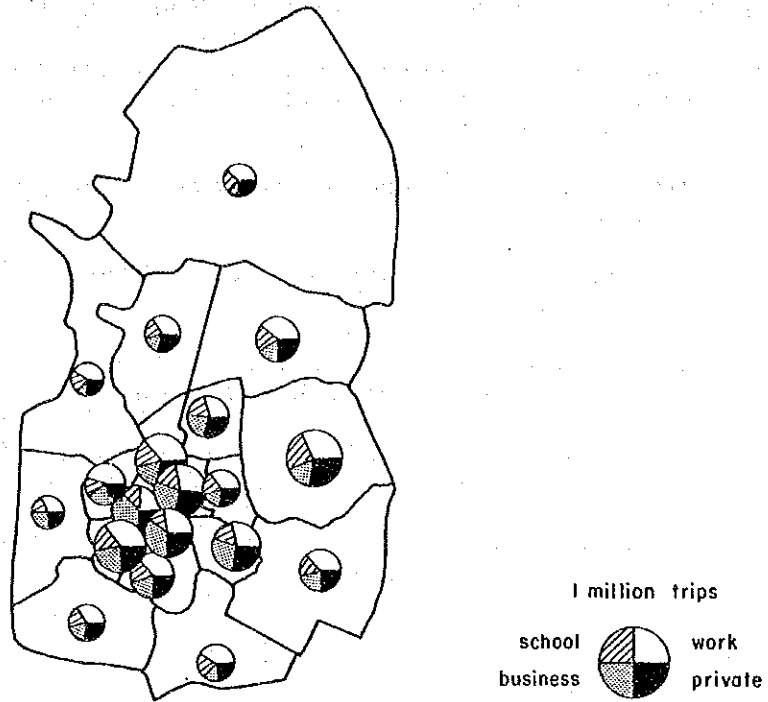


Figure 2.3.1 Zone-Wise Distribution of Generated Trips by Purpose

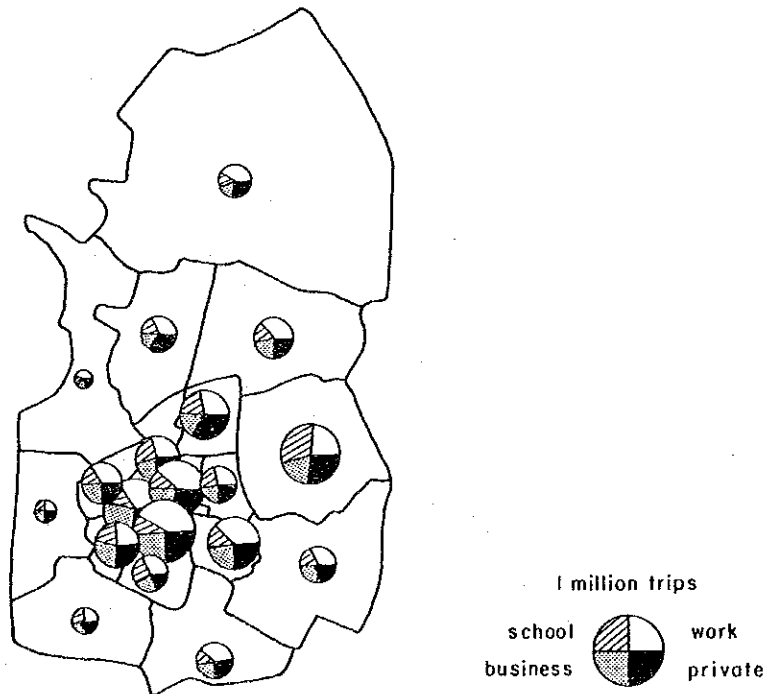


Figure 2.3.2 Zone-Wise Distribution of Attracted Trips by Purpose

## 2) Trip Generation and Attraction by Zone and Mode

Figure 2.3.3 shows trip generation and attraction by zone and mode of transportation. The characteristics are summarized as follows;

- (1) Motorcycle trips are nearly proportional to total trip generation.
- (2) The number of passenger car trips is large in the business areas.
- (3) The number of taxi trips is large in the business areas, but not in peripheral areas.
- (4) The number of bus trips is large in the business areas, but the percentage in total traffic is low.
- (5) Bus trips constitute a large share of the total traffic in the peripheral areas.

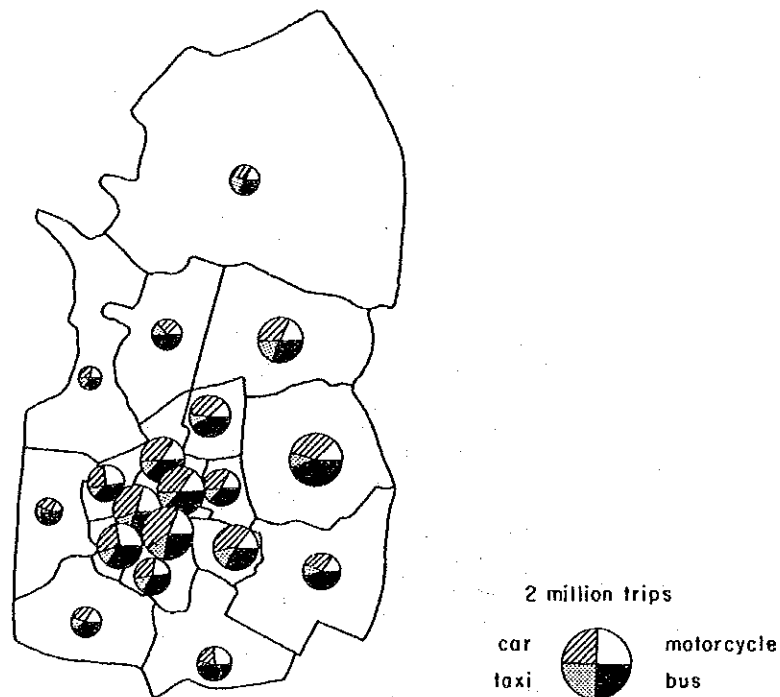


Figure 2.3.3 Zone-Wise Distribution of Generated and Attracted Trips by Mode

### 3) Number of Trips by Time

Figure 2.3.4 shows the number of trips by purpose and trip starting time, while Figure 2.35 shows the number of trips by purpose and time period (trips are counted in the entire time period from departure to arrival).

Figure 2.3.4 shows that the peak of trip generation is during 7:00 - 8:00 in the morning largely due to "to work" and "to school" trips (approximately 2.3 million trips; and peak hour factor of 18.2%). Evening peak is found during a three-hour period between 15:00 - 18:00, mainly due to "to home" trips. From 8:00 to 15:00, in between the peaks, trip generation is relatively even.

"To work" has its peak during 6:00 - 9:00, while "to school" trips during 6:00 - 8:00. "Business" starts around 7:00 and ends around 16:00. Although "to home" trip starts in the morning, its peak is around 15:00 - 18:00. There is no significant peak time for "private" trip.

Figure 2.3.5 indicates that there are many trips around 8 o'clock in the morning and 6 o'clock in the evening. This implies trips lasting a long time are made during the peak time.

Figure 2.3.6 shows the number of trips by traveling time and mode. With the exception that the share of bus increases a little at the peak time, the shares of other modes are nearly constant throughout the day.

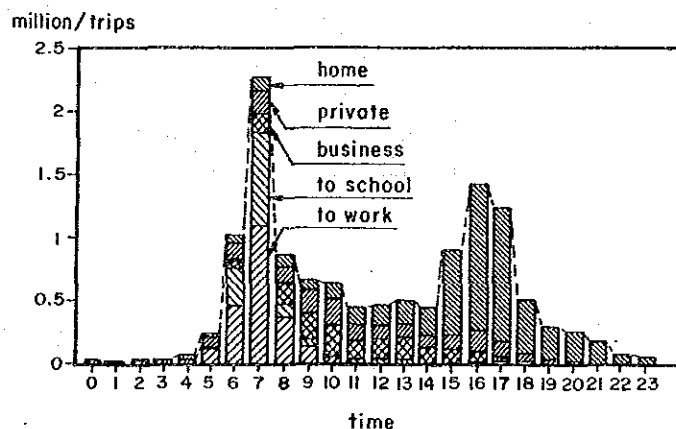


Figure 2.3.4 Hourly Distribution of Generated Trips by Purpose (Counted at Starting Time)



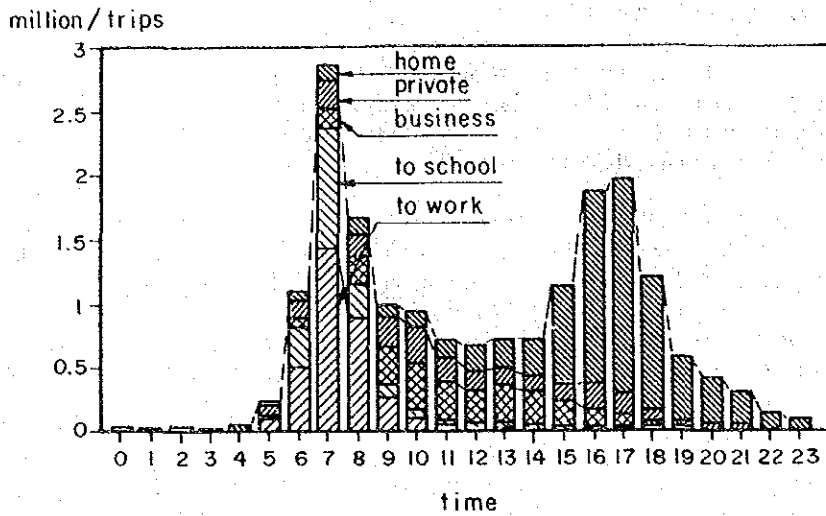


Figure 2.3.5 Hourly Distribution of Moving Trips by Purpose (Counted at Traveling Time)

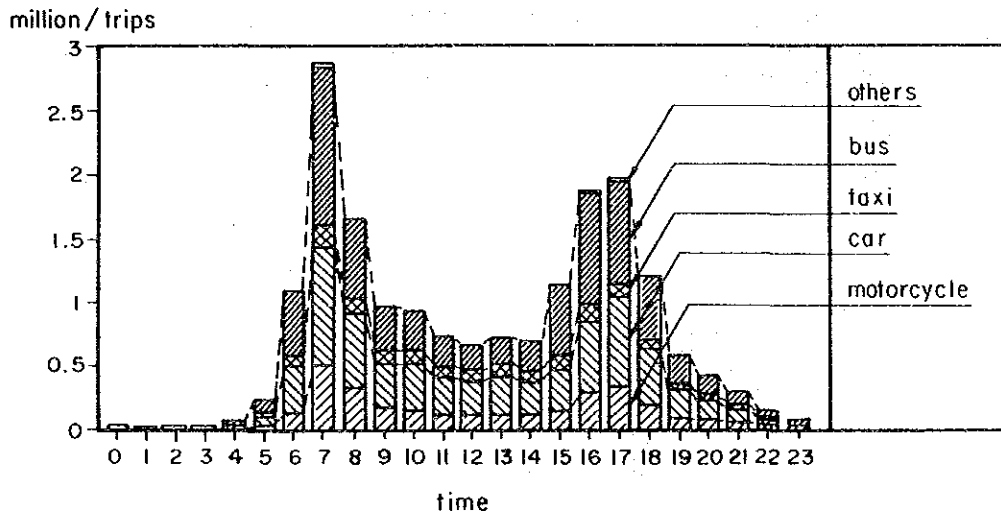


Figure 2.3.6 Hourly Distribution of Moving Trips by Mode (Counted at Traveling Time)

## 2.4 Trip Distribution by Purpose

Distribution of trips made by residents for all purposes and by all modes is shown in Figure 2.4.1. There is a large movement within the center and between the center and the east. Uniform movement is found not only in the adjoining zones but between fairly remote zones.

Figure 2.4.1 to 2.4.5 show desire lines by trip purpose on integrated zones. The characteristics are as follows;

### (1) "To Work" Trip

The desire lines for "to work" trips shows that there is heavy traffic between heavily populated areas and business centers, especially between the east and the center. The work places and residential areas do not appear to be located close to each other, therefore trip length seems to be fairly long.

### (2) "To School" Trip

"To school" trips shown by desire lines can be considered as the movement of students of high school or higher level. Compared with "to work" trips the distance between residences and schools is shorter.

### (3) "Business" Trips

Overwhelmingly, business trips are made around zones 1, 3, 4, and 6. No heavy connection between remote zones is found.

### (4) "Private" Trips

Private trips can be considered mainly as those for shopping and eating-out. Therefore, the trips are significant among zones with many shops and restaurants.

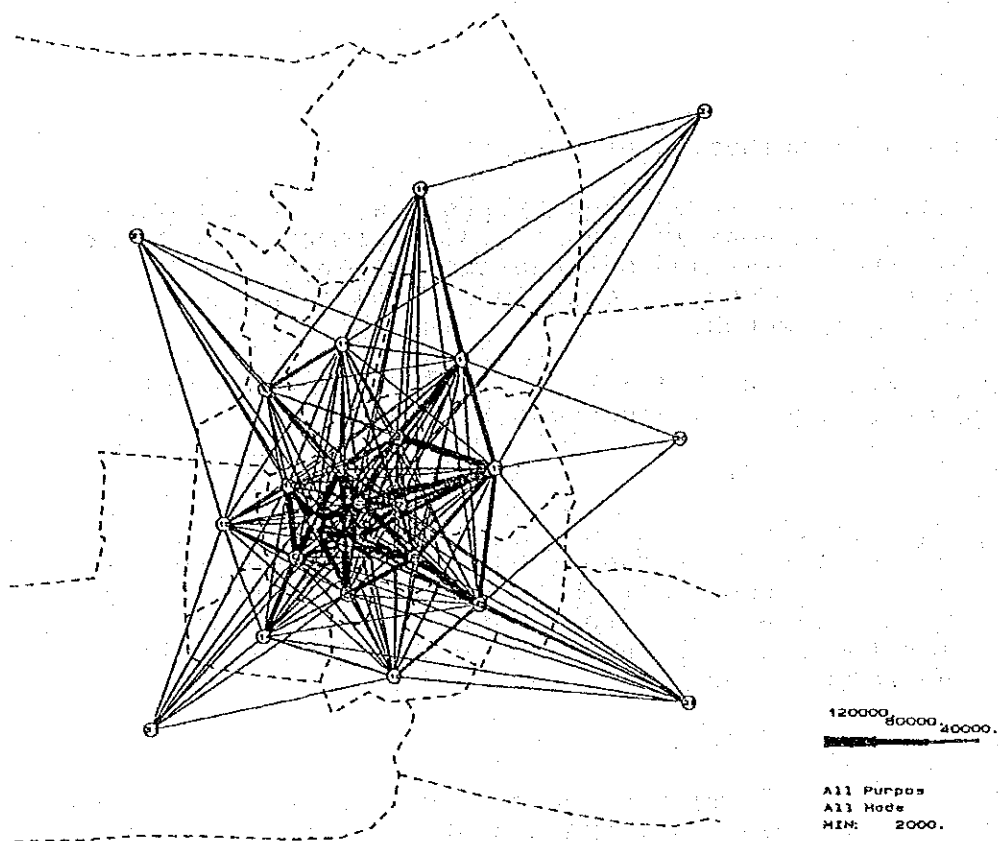


Figure 2.4.1 Trip Distribution shown in Desire Line Chart (All Purpose, All Mode)

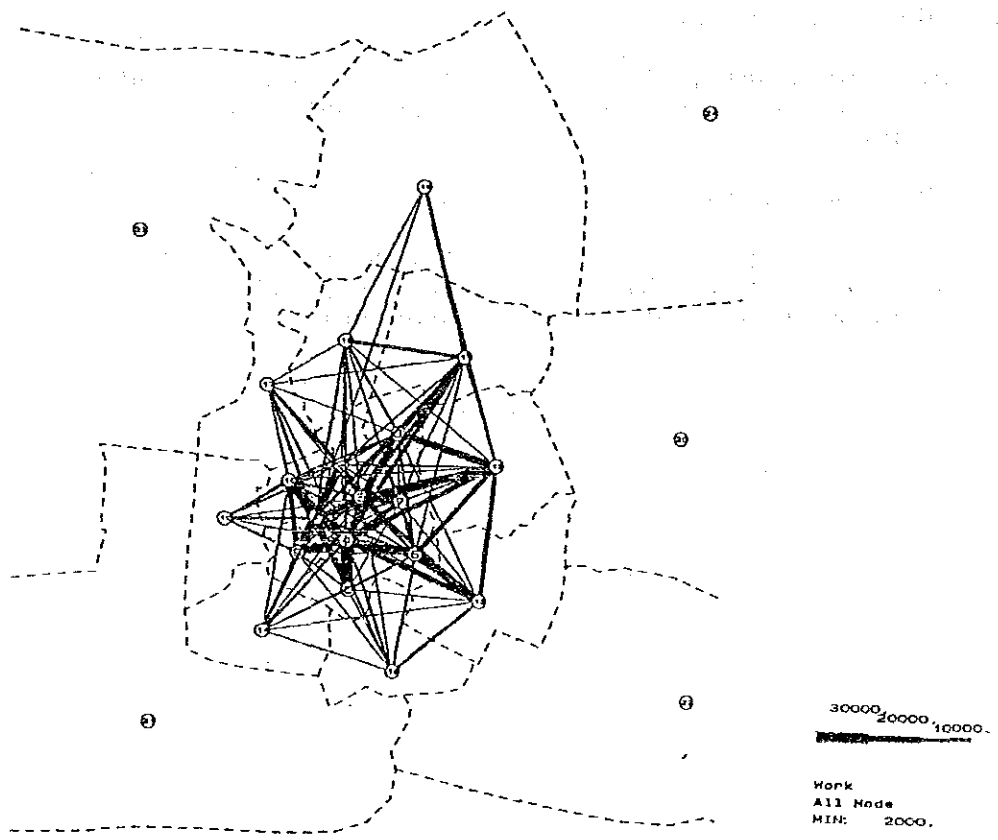


Figure 2.4.2 Trip Distribution shown in Desire Line Chart (To Work Trips)



Figure 2.4.3 Trip Distribution shown in  
Desire Line Chart (To School Trips)

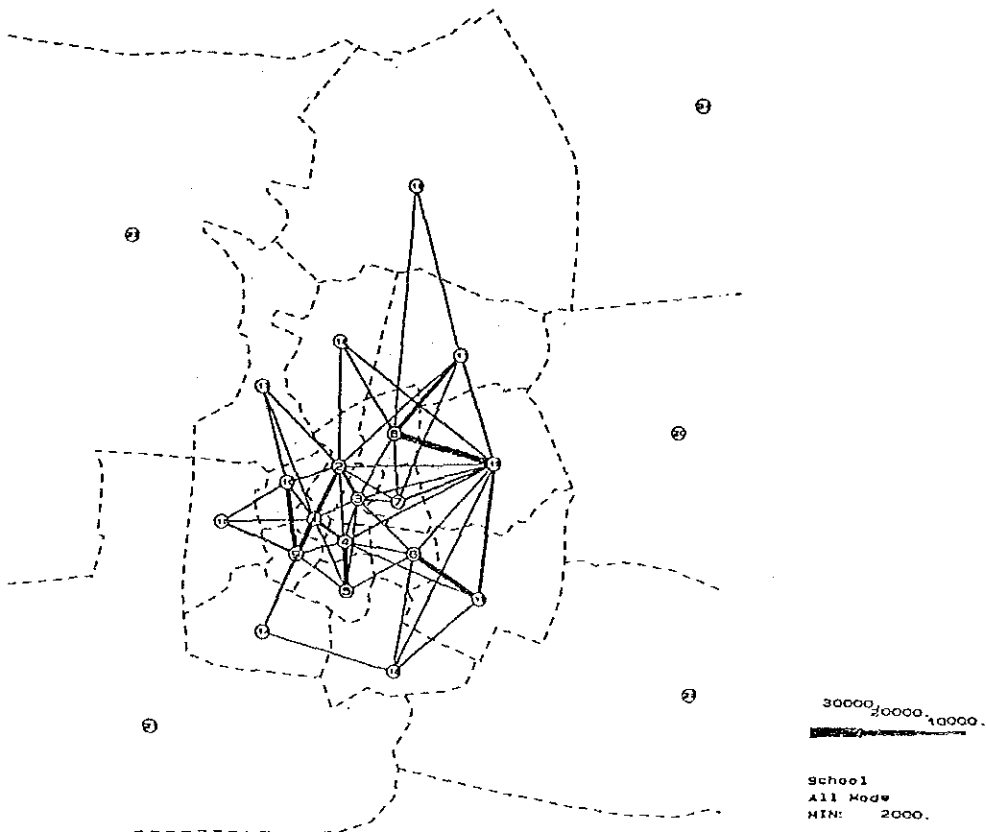


Figure 2.4.4 Trip Distribution shown in  
Desire Line Chart (Business Trips)

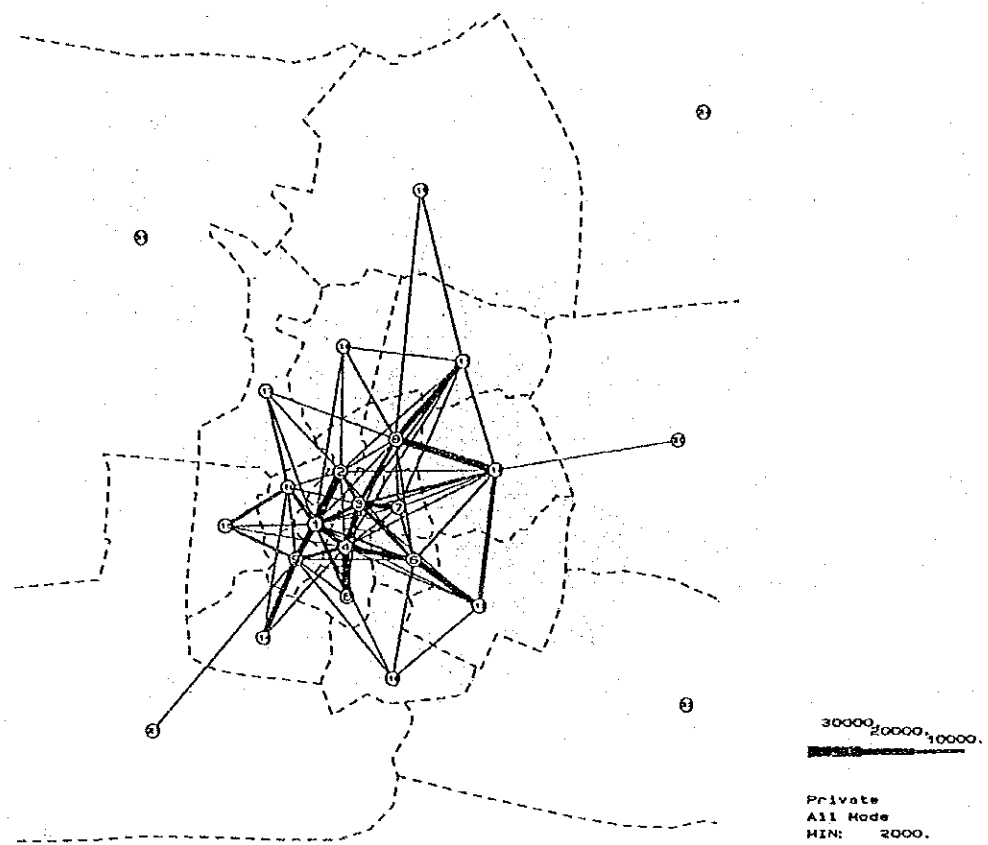


Figure 2.4.5 Trip Distribution shown in  
Desire Line Chart (Private Trips)

## 2.5 Trip Production and Distribution by Mode

### 1) Modal Share of Trips by Purpose

Figure 2.5.1 shows the modal share of trips by purpose. Many passenger cars and buses are used for commuting to work, and motorcycles are also used for commuting to work at the rate of 20%. Walking and buses are used as major modes to school. For business, passenger cars play a main role. Taxis are frequently used for business and private trips and rarely used for daily trips such as to work and to school.

### 2) Trip Production by Mode

Figures 2.5.2 to 2.5.5 show desire lines by mode and by integrated zones.

Basically, motorcycles are used for short trips, but they may also be used for fairly long trips. Many trips by motorcycle are produced around the business areas.

Passenger cars are frequently used among the business areas. Complicated desire lines of passenger cars connect all zones, and no distinct directional patterns are is apparent.

Taxis are used for trips within small areas. Major trips are made within the inner area. Taxis are also used for trips among the peripheral areas.

Buses are used for trips that radiate from the inner area and for south-to-north connection in the eastern part. Frequency of trips by bus does not always match the demand because of the fixed bus routes. The pattern of the trip distribution of bus is therefore different from that of the passenger car, and the former is close to the pattern of the motorcycle.

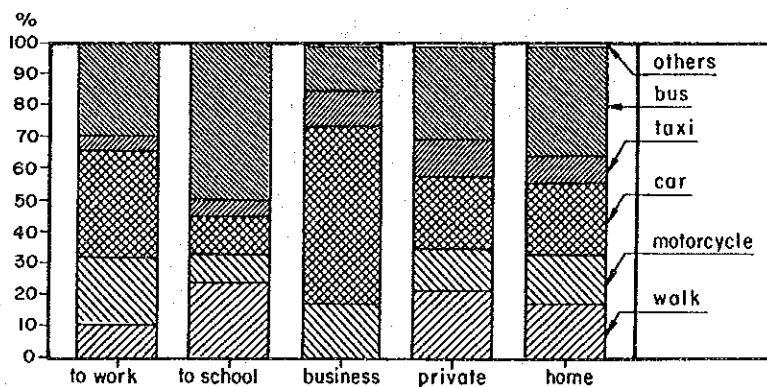


Figure 2.5.1 Modal Share of Trips by Purpose

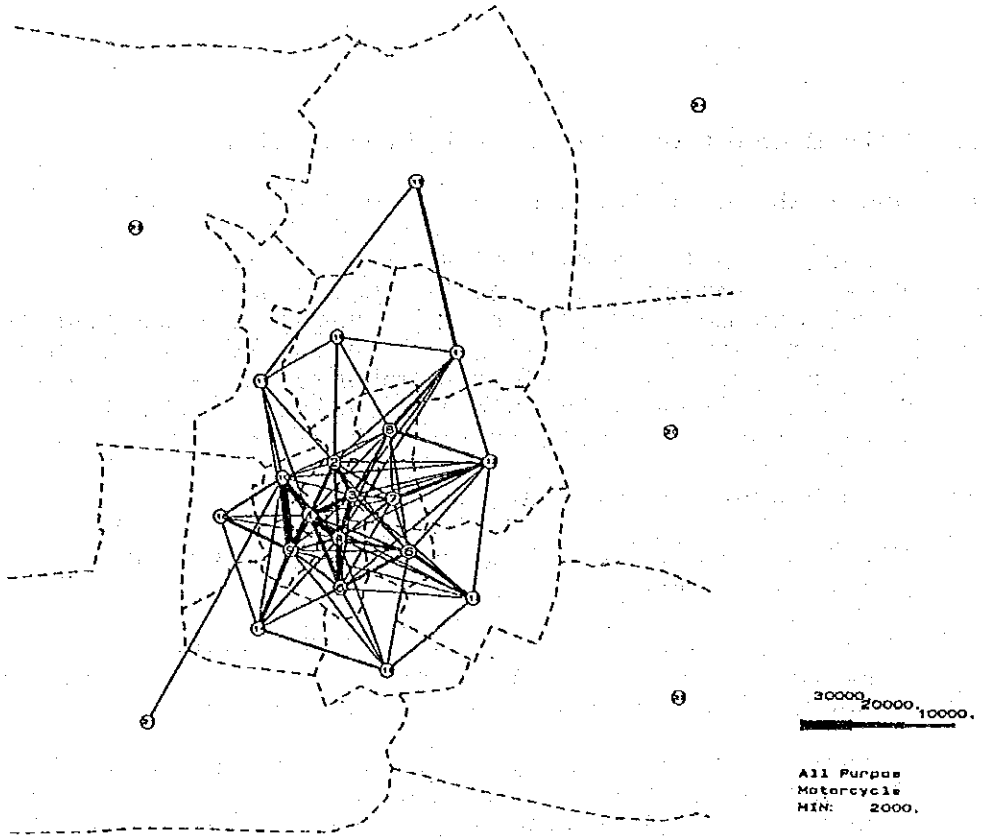


Figure 2.5.2 Trip Distribution (Motorcycle)

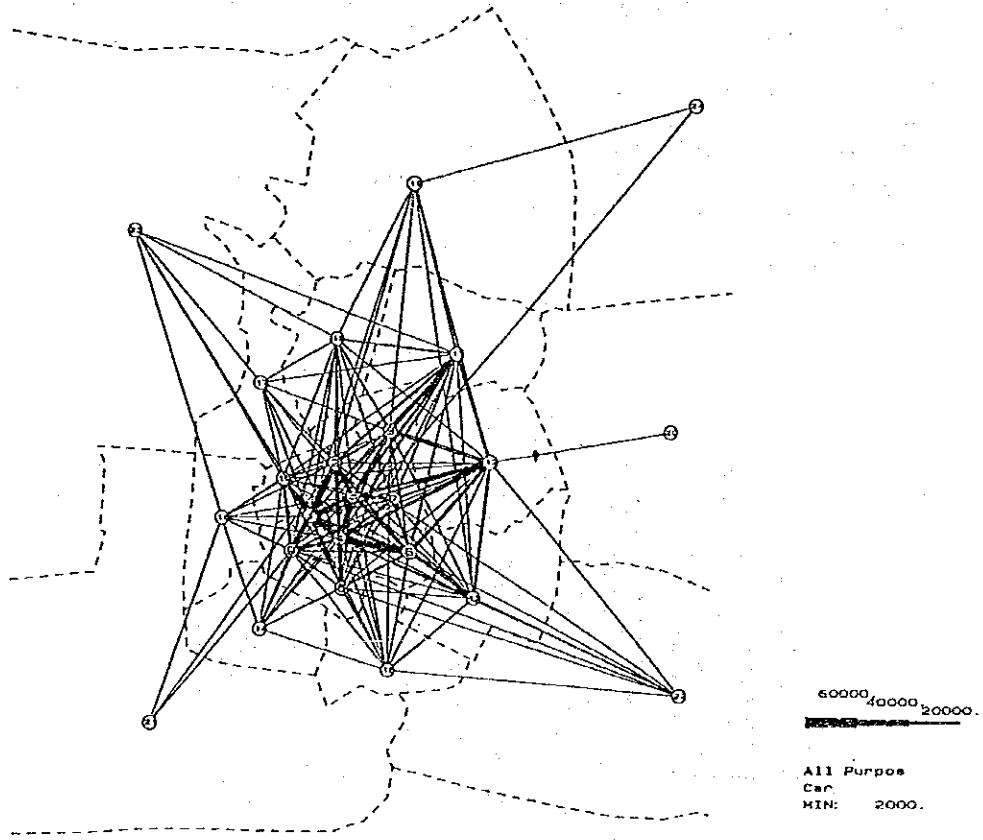


Figure 2.5.3 Trip Distribution (Car)

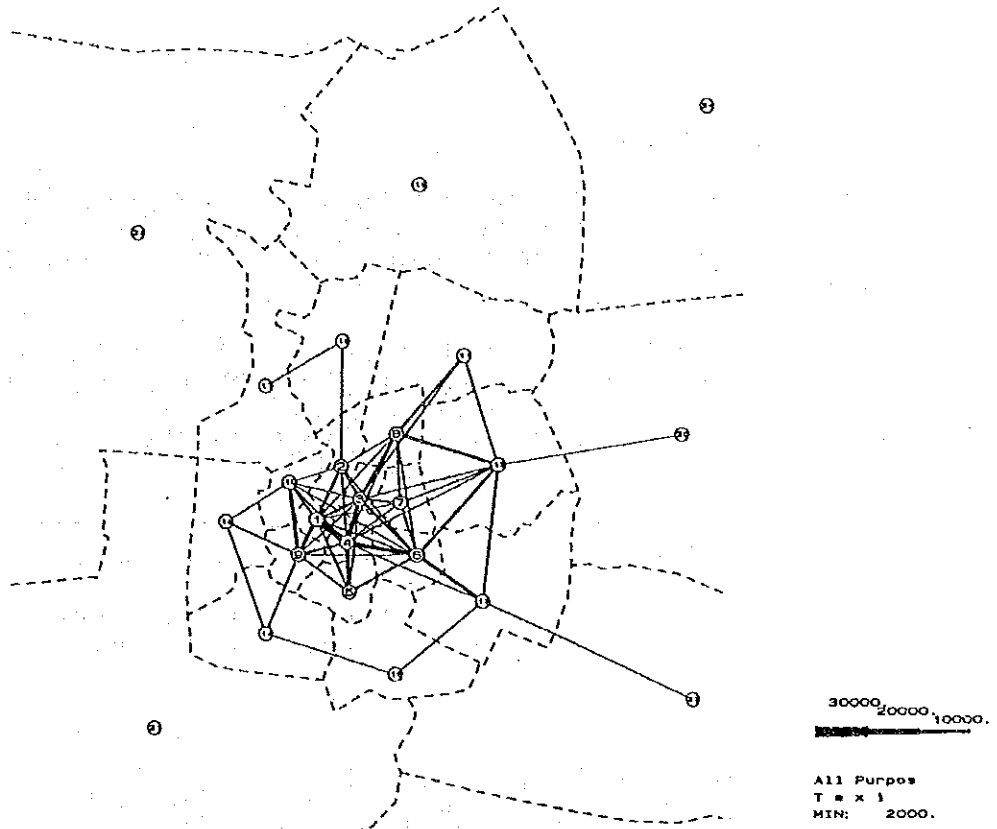


Figure 2.5.4 Trip Distribution (Taxi)

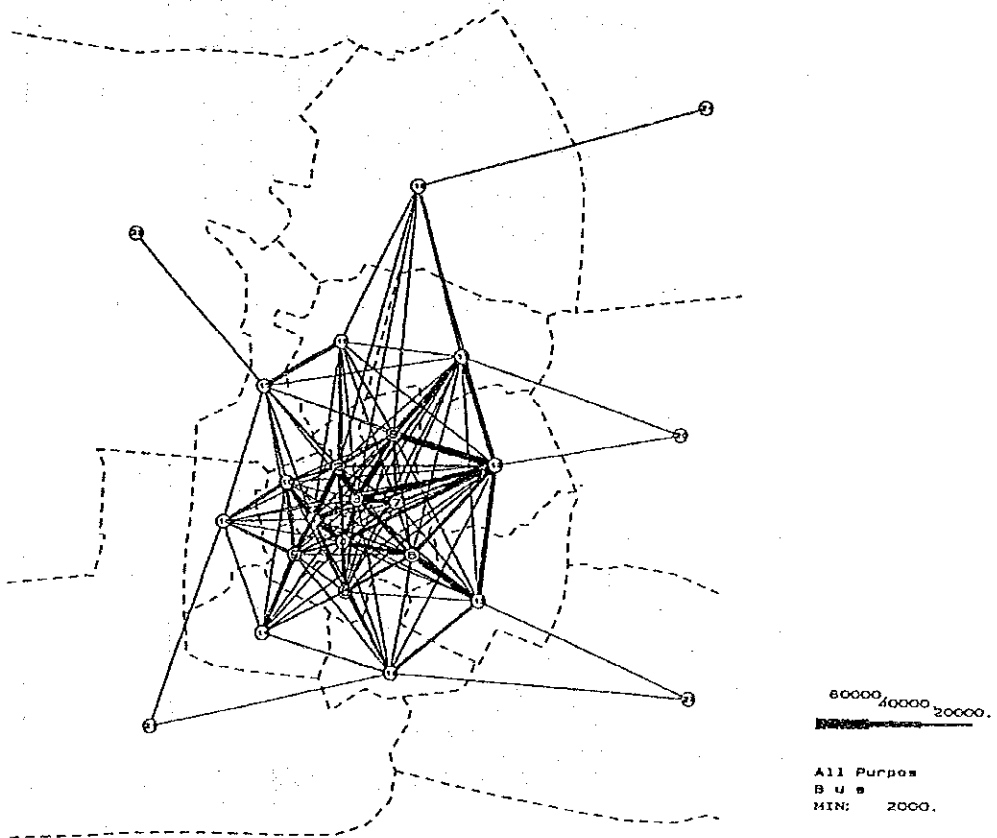


Figure 2.5.5 Trip Distribution (Bus)



### 3) Trip Length by Mode

Based on the travel time obtained from the interview survey and the assumed average travel speed by mode, the modal share of trips by length was calculated as shown in Figure 2.5.6.

- (1) Motorcycle is a transportation mode used for trips within 15 km. Its share is in inverse proportion to the distance.
- (2) The share of passenger car is in proportion to the trip distance.
- (3) Taxi is used within 15 km distances. No remarkable change is found in the share regardless of the distance.
- (4) Bus keeps a nearly constant share but decreases significantly for distances longer than 20 km.

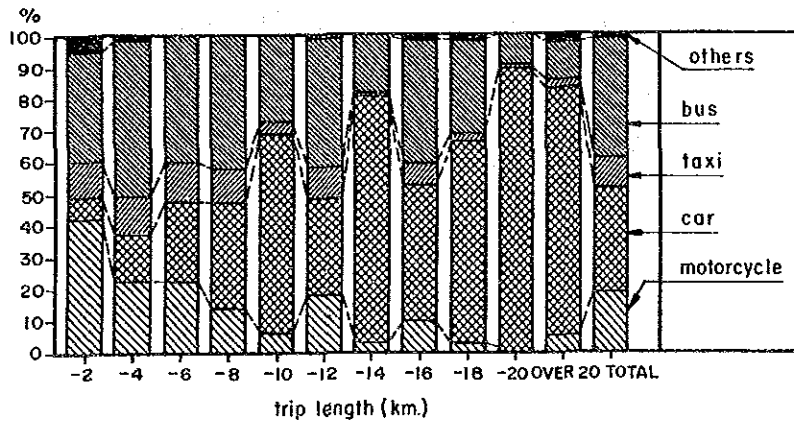


Figure 2.5.6 Modal Share of Trips by Length

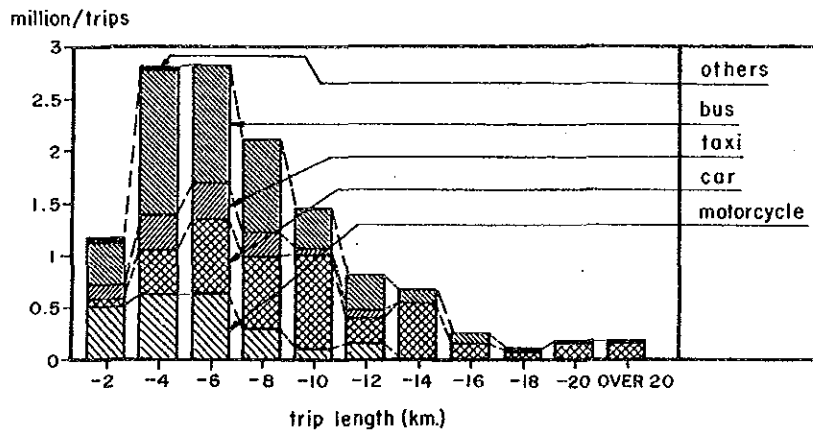


Figure 2.5.7 Trip Distribution by Length

## **CHAPTER 3**

### **ROAD NETWORK AND TRAFFIC**



### 3. ROAD NETWORK AND TRAFFIC

#### 3.1 Road and Transportation Development in Bangkok

##### 1) Historical Background

Since the founding of Bangkok in 1782, the only means of transportation was by boat. A pedestrian network was provided only within the palace walls. The population was about 170,000 and grew to approximately 350,000 at the end of the reign of King Rama III (around 1832). City planning during this period was confined to the area within the city wall, which was divided into two sections: the inner Khlong (Khlong Ku-Muang) and the outer Khlong (Khlong Banglumpu). The King's palace formed the center of the inner area while the outer area was the residential district with rice fields.

The first land communication was constructed by King Rama IV in 1857. This was called "Trong Road" and later changed to "Rama IV Road". This road was built to link the water coast way of Paknam and the city, and was constructed by compacting piles of dirt. The second road was "New Road" or "Charoeng Krung", the first paved street built after complaints from the people who wanted to ride horses and operate automobiles in the city.

Then, many other roads were built. During the reign of King Rama V, Bangkok developed into truly a city and had a population of about 600,000 in 1900. More streets were paved and motorcars, trams, trains, public utilities, and even western architectural styles were introduced. Many bridges were built, and the city expanded across the waterways into the northern and eastern sections of Bangkok. Thonburi, the old capital, remained unchanged and could be reached from Bangkok only by boat; many Bangkok residents still lived along the river and khlong.

Developments in Bangkok continued during the reigns of Kings Rama VI, VII and VIII. The land transportation network was extended towards suburban areas, and schools, universities, city halls and other institutions were built. It was during this period that transportation by water began to decline. A bridge connecting Bangkok and Thonburi, which was named the Rama I Memorial Bridge was also built in 1931.

In 1960, when Bangkok had approximately 1.6 million population, the first master plan was prepared and presented to the government by the Litchfield group, an American team of consultants. The Litchfield Plan proposed the concept of an automobile-oriented city to accommodate an estimated 4.5 million people in 1980. More than thirty highways were proposed to form the "Ring Road" and the "Star Shape" networks over-laying the existing water network. Although the plan was never officially accepted, many of the proposals were implemented. Many khlongs were filled in to built many roads. The "Ring Road" and "Corridor Road" systems of connecting regional cities were implemented.

## 2) Administration

There are various organizations related to urban transportation in Bangkok, comprising government agencies, statutory committees, ad-hoc inter-agency committees, and transportation associations. There are 37 official agencies responsible for various aspects of planning, evaluation, approval, implementation, operation, maintenance or control of urban transport in Bangkok. Their formal relationship within the Government organization is shown in Figure 3.1.1, while their functions at different stages of activities are summarized in Figure 3.1.2. Responsibilities of selected urban transportation agencies are briefly as follows:

### (a) BMA (Bangkok Metropolitan Administration)

PWD : Planning, design, construction and maintenance of roads in Metropolitan Bangkok

CPD : Preparing land use plans, including transportation networks for BMA

TED : Design and implementation of road improvement/traffic engineering schemes in Metropolitan Bangkok

### (b) NESDB (National Economic and Social Development Board): Preparation of 5-year Development Plans for Thailand, including policies for Bangkok within the national context.

(c) DTCP : Preparation of land use plans, including transportation networks for all major cities in Thailand

(d) DOH : Planning, design, construction, and maintenance of major highways in Thailand

(e) DPW : Planning, design, construction, and maintenance of major bridges across Chao Phraya River

(f) ETA : State Enterprise responsible for planning, constructing, and operating expressways (toll roads) and rail mass transit in Thailand

(g) SRT : State Enterprise responsible for planning, implementing, and operating national railway

(h) OCMRT: Conducting traffic analysis, preparing traffic policies, and designing traffic management schemes for major cities in Thailand

(i) TPD : Enforcement of traffic laws and regulations

(j) DLT : Regulation of bus and truck operations

(k) BMTA : State Enterprise operating bus services in Greater Bangkok (includes Nonthaburi, Samut Prakan, and Pathumthani)

(l) ETO : State Enterprise operating trucks

(m) HD : Planning and regulation of inland waterway and coastal transportation including ferry services

There are 3 statutory committees with specific responsibilities for urban transportation. They are;

(a) Land Transport Policy Committee (LTPC)

(b) Land Transport Control Board (LTCB)

(c) Committee for the Management of Road Traffic (CMRT)

In view of the worsening traffic situation of Bangkok, a number of ad-hoc committees have also been created. The principal ones are:

- (a) Bangkok Metropolitan Region Development Committee (BMR)
- (b) Traffic Solving and Illegal Vehicles Management Committee
- (c) Rattanakosin Island Committee
- (d) Special Task Committee to Consider the Construction of Elevated Roads above the Canals and Public Lands

Existing associations for urban transport operation in Bangkok are:

- (a) Associations for minibus
- (b) Associations for Taxi
- (c) Association for tuk-tuk owners and drivers

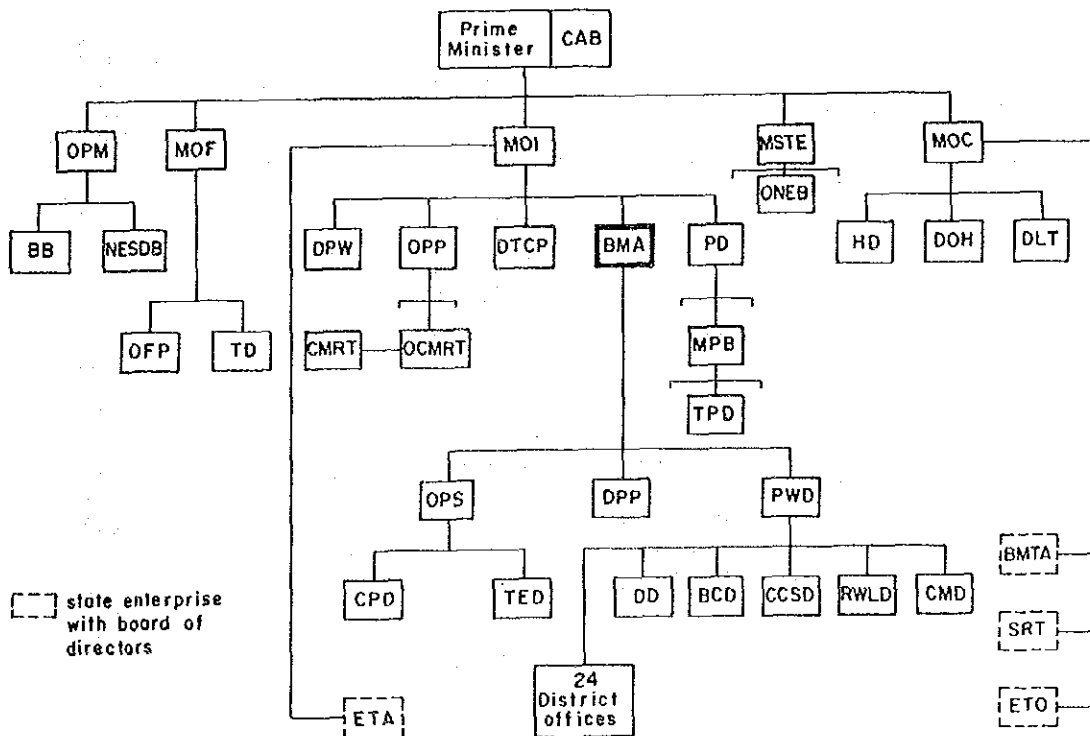


Figure 3.1.1 Organization Chart of Transportation Agencies

Abbreviations are as follows:

<u>Abbreviation</u>	<u>Agency Name</u>	<u>Reporting To</u>
BB	Budget Bureau	OPM
BCD	Building Control Division	BMA
BMA	Bangkok Metropolitan Administration	MOI
BMTA	Bangkok Mass Transit Authority	MOC
CAB	Cabinet	
CCSD	Construction Control & Supervision Division	BMA
CMD	Construction & Maintenance Division	BMA
CPD	City Planning Division	BMA
DD	Design Division	BMA
DOH	Department of Highways	MOC
DLT	Department of Land Transport	MOC
DPP	Department of Policy and Planning	BMA
DPW	Department of Public Works	MOI
DTCP	Department of Town and Country Planning	MOI
ETA	Expressway and Rapid Transit Authority of Thailand	MOI
ETO	Express Transportation Organization of Thailand	MOC
HD	Harbor Department	MOC
MOC	Ministry of Communications	CAB
MOF	Ministry of Finance	CAB
MOI	Ministry of Interior	CAB
MPB	Metropolitan Police Bureau	MOI
MSTE	Ministry of Science, Technology and Energy	CAB
NESDB	National Economic & Social Development Board	OPM
NSC	National Safety Council	OPM
OCMRT	Office of the Committee for the Management of Road Traffic	MOI
OFFP	Office of Fiscal Policy	MOF
ONEB	Office of the National Environmental Board	MSTE
OPM	Office of the Prime Minister	CAB
OPP	Office of Policy and Planning	MOI
OPS	Office of Permanent Secretary (BMA)	BMA
PD	Police Department	MOI
PWD	Public Works Department	BMA
RWLD	Right of Way and Land Division	BMA
SRT	State Railway of Thailand	MOC
TD	Treasury Department	MOF
TED	Traffic Engineering Division	BMA
TPD	Traffic Police Division	MOI

Function Agency			Planning					Implementation										
			National Plan	Strategic Plan	General Plan	Specific Plan	Regulation	Bridge	Roads				Rail Mass Transit	Railway	Bus	Bus Terminal	Land Acquisition	
National	Provincial	BMA/Municipal							Expressway									
Central Government	OPM	NESDB	★	★														
	MOI	DTCP		★	★	★												★
		OCMRT		★	★	★												
		FWD					★	★		★								★
	MOC	DLT															★	
		DOM							★									★
State Enterprise	ETA (MOI)										★	★					★	
	SRT (MOC)											★					★	
	BMTA (MOC)													★				
Local Authority	BMA					★	★	★			★						★	
	Municipality					★	★				★						★	
Private Sector	Private Company								★			★	★		★	★		

Figure 3.1.2 Functions of Urban Transportation Related Agencies



### 3) Finance

One of the critical constraints to the transportation system development is the financial capabilities of both public and private sectors. While most of the transportation infrastructures have been implemented by the public sector, a number of projects are currently being implemented and planned under the BOT (build, operate and transfer) scheme. The objective of the BOT scheme is to have users shoulder the investment cost and lessen the financial commitments of the Government.

The transportation investment and expenditures made by various agencies in the past is approximately 2.4 billion Baht per year during 1977 and 1981, and 3.2 billion Baht per year during 1980 and 1984 as shown in Table 3.1.1. The latter figure becomes roughly 4.6 billion Baht at 1989 prices.

The first transportation investment based on BOT scheme is ETA's Second Stage Expressway, which is being implemented. The project requires approximately 29.5 billion Baht in 6 years between 1990 and 1995.

Table 3.1.1 Transportation Investments in Bangkok Area

Item	Agency	Million Baht (Oct. 1984)	
		1980-1984 Total	Annual Average
A. Investment <sup>1/</sup>	OCMRT	84	17
	BMA	3,103	621
	ETA	2,790	558
	DPW	1,536	307
	DOH	2,867	573
	SRT	157	31
S. Total		10,537	2,107
B. Subsidy <sup>1/</sup>	SRT	256	51
	BMTA	5,393	1,079
	S. Total	5,649	1,130
TOTAL	Expenditure	16,186	3,237

Source: STTR Working Paper No. 4 March 1985

<sup>1/</sup> The figures refer to investment in physical works or to public transport operating losses that require public sector finance. They do not include the administrative costs of the agencies.

In order to expand the financial sources, the BMRT Regional Transport Sector Study delineates various measures including user and beneficiary charges and local taxes. These are more specifically shown in Table 3.1.2.

Table 3.1.2 Source of Finance

Source	Nature of administrative-procedural-policy-institutional change	Indicative feasibility of change 2	Comments
<b>1. LOCAL GOVERNMENT</b>			
1) Utilise regular revenue regulatory surplus	No change required		
2) Reduce collection expenses from surcharge (new)	Requires regulatory change	AAA	Under active consideration by Ministry of Finance
3) Restructure Surcharge taxes	Requires regulatory change	AA	Continuation of present trend in changes to local government finance
4) Improve collection efficiency of . Land development tax . House and rent tax	Significant, both require administrative changes	D	Require wide ranging changes to existing system
5) Revoke owner-occupier exemption from house and rent tax	Significant, requires regulatory change	D	Present exemptions not founded on taxation principles
6) Increase vehicle registration fee	Significant, requires regulatory change	A	Various schemes under consideration by Ministries of Communication and Finance
<b>2. CENTRAL GOVERNMENT</b>			
1) Reallocate fee on property sales	Significant, requires regulatory changes and new administrative procedures	A	Results in loss of revenue to central government
<b>3. USER CHARGE</b>			
1) Introduce special fee (land or property development tax) (new)	Substantial, requires specification of a new charge and administrative procedures	DD	Has proved difficult to operate in other countries
2) Introduce road and bridge tolls (new)	Few changes required	AA	Requires extension of expressway toll concept
3) Introduce trip toll for access to inner city area (new)	Substantial, requires specification of a new charge and administrative procedures	D	Expressway toll provides local conceptual precedent. Users pay
4) Introduce flood control annual property surcharge (new)	Substantial, requires specification of a new charge	A	Approved in principle by local and central government. Beneficiaries pay

Source: BMRT Regional Transport Sector Study, NESDB

1 (new) indicates new source of finance

2. Symbols are as follows; AAA (assured), AA (very feasible), A (feasible), D (difficult) and DD (very difficult)