4.4 Taxi, Samlor, Silor and Hired Motorcycle

1) Outline

The registered numbers of taxi, samlor, and silor are shown in Table 4.4.1. The numbers of taxi and samlor have remained constant in the recent years, because DLT (Department of Land Transport) has set limits for the number of registered units by each at 13,500 and 7,500 units, respectively.

The number of registered silor units, for which the upper limit is set at 8,000 units, has been increasing from 3,400 to 7,900 in the past four years (1985 - 1988). In any case, taxis including samlor and silor may reach the upper limit of 29,000 units within a few years, without any changes in the DLT policy.

Table 4.4.1 Registered Numbers of Taxi, Samlor, Silor

Type	1985	1986	1987	1988
Taxi	13,500	13,500	13,500	13,493
Samlor	7,404	7,406	7,406	7,406
Silor	3,382	6,542	7,215	7,874
Total	24,286	27,448	28,121	28,773

Source : The Royal Police Department

No statistical data are available on hired motorcycles which have kept increasing in number due to the road characteristics in Bangkok and the increased road traffic congestion. According to the DLT survey, however, 16,000 hired motorcycles were in operation on 830 sois as of 1988.

(1) Taxi

According to the DLT, taxis in Bangkok are basically classified into the following two categories:

A. Public taxi with yellow number plates, which can pick up passengers at any place. Approximately 13,500 units are currently in operation.

B. Taxi with green number plates operated on contract basis at limited facilities, such as hotels, etc. Approximately 1,300 units are currently in operation.

(Note: "Taxi" as used in this report represents category "A", and description will be given mainly on this.)

Taxi service in Bangkok, at present is operated by 13 associations and 7 companies. Approximately 10,400 units, equivalent to 77% of the total number, belong to associations. In general, one taxi business owner has approximately 20 taxis on average, and one association is composed of 40 owners. The DLT grants taxi business licenses to these associations and companies.

More than half of the total taxis are operated on 24-hour basis with two shifts.

In Bangkok there are no metered taxis, and each passenger must negotiate the taxi fare with the taxi driver before starting the trip.

According to the taxi driver interview survey, the taxi fare per trip is approximately 40 Baht on average.

Estimated daily taxi passengers are approximately 470,000.

(2) Silor

The silor is a 6-seat public transport vehicle converted from a light truck. As of 1988, approximately 7,900 units are in operation mainly in the suburbs of Bangkok. Basically, silor is not allowed to drive on trunk roads; therefore, they are mainly used for service on sois.

Most silors are driven by their owners. Therefore, unlike taxi, no service is available late at night. As in the case of taxi, a number of owners form an association to be eligible for obtaining a business operation license from the DLT.

The silor does not have a fare meter, and fare negotiation is necessary before the trip. According to the study's silor driver interview survey, each passenger pays approximately 20 Baht per ride on the average.

Estimated number of daily silor passengers is approximately 350,000.

(3) Samlor

The samlor, with 3 wheels and 3-seat capacity, is a typical omnibus type taxi in Bangkok. Samlors are operated on any road in the inner area like taxi.

As in the case of taxi, a number of samlor owners having about 30 units per owner form an association to obtain DLT licensing for business operation, and some samlors operate on a 24-hour basis with two shifts.

Since samlor has no meter, advance fare negotiation is necessary. Each passenger pays about 20 Baht per ride on the average.

Estimated samlor passengers are approximately 320,000 per day.

(4) Hired motorcycle

Hired motorcycles line the entrances of sois, which are too narrow or difficult for cars to enter and too long to walk, waiting for passengers. Basically, hired motorcycles are allowed to operate only in sois. Depending on requests of passengers, however, hired motorcycles are sometimes used on trunk roads, causing more traffic congestion on trunk roads in Bangkok.

Each passenger has to negotiate with the driver for the fare before embarking on the trip. According to a driver interview survey and DLT's information, approximate figures for the average fare and estimated passenger number are 7 Baht per ride and 580,000 passengers per day respectively. This number of passengers is larger than the corresponding numbers for each of taxi, samlor and silor.

The hired motorcycle has increased rapidly due to its low fares and flexible service, unattainable by other vehicles. However, no laws and acts are available to control hired motorcycles as a consequence of which the following problems have surfaced.

a. The unstable body structure can cause many traffic accidents. Besides, passengers are not fully covered by insurance in the case of accidents due to the lack of an insurance system for hired motorcycle.

b. Hired motorcycles may interfere with traffic on trunk roads.

c. Hired motorcycle service may have an effect on bus service, resulting in a decreased benefit for bus service.

Figure 4.4.1 shows the locations of sois where hired motorcycle service is operated. Entrance of sois served by hired motorcycles, are located along trunk roads with bus routes and so hired motorcycles provide a feeder service for buses.

2) Operational characteristics

The operational characteristics of taxi, samlor, silor, and hired motorcycle, derived from the results of the study's driver interview survey, are shown in Table 4.4.2.

The average age of drivers is about 35 years old for taxi, samlor and silor, while it is 25 years old for drivers of hired motorcycle. Hired motorcycle drivers have a comparatively higher educational background, and a smaller number of hired motorcycle drivers come from the countryside. On the other hand, approximately 80% of taxi, samlor, and silor drivers come from the countryside.

As to driving experience, taxi, samlor, and silor drivers have been driving for 5.5 to 7 years, while hired motorcycle drivers have only 2 years of driving experience.

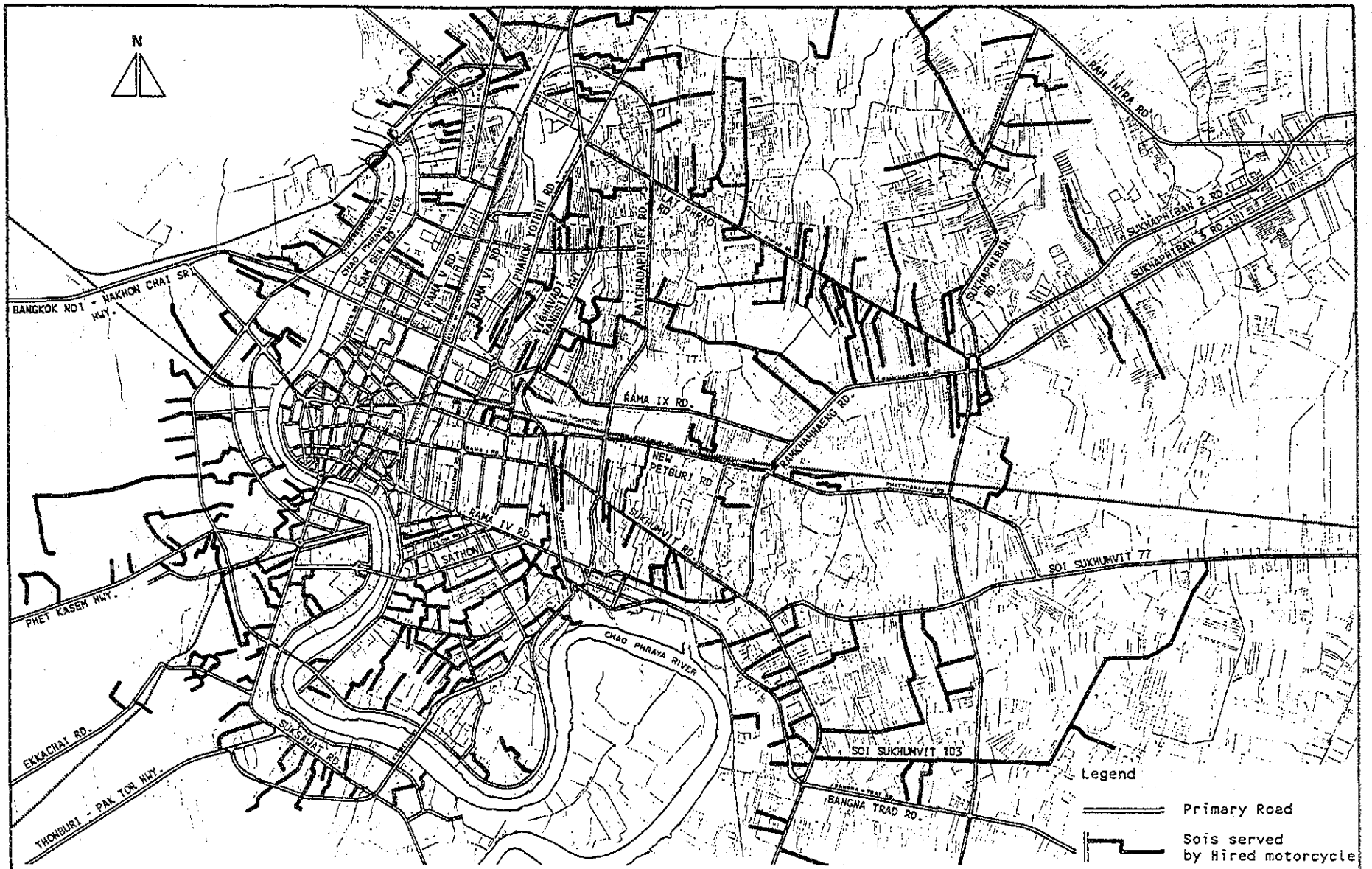


Figure 4.4.1 Location of Sois served by Hired Motorcycle

Taxi and silor, having no terminals or turning points, pick up passengers mainly on roads or at theaters, etc., while silor and hired motorcycle, having some limited service areas and routes, pick up passengers at turning points or soi entrances.
The average number of trips per day is 15.6 for taxi, 23.2 for samlor, 18.1 for silor, and 33.8 for hired motorcycle.

The average number of passengers per trip is less than 3 for taxi and samlor, 4.4 for silor, and 1 for hired motorcycle. Most of the drivers work more than 6 days per week, and 11 to 14 hours a day on average.

The percentage of insurance coverage is 100% for taxi, 90% for samlor, a little less than 80% for silor, and only 23% for hired motorcycle which is extremely low compared with the other modes.

The percentage of accident occurrence is over 50% for taxi and hired motorcycle. The probability of experiencing 2 or more accidents is 38% for hired motorcycle which is relatively high compared with other modes while it is 31% for samlor and 18% for silor. Consequently, it can be said that the silor is the safest of the four modes.

The drivers consider traffic congestion to be the most serious problem they face during their working hours.

Table 4.4.2 Operational Conditions of Taxi, Samlor, Silor and Hired Motorcycle

Items		Taxi	Samlor	Silor	Hired Motorcycle
Operational Characteristics	Average age of driver	37.2	32.6	37.2	24.4
	Educational Background*1	26.7	10.7	17.1	33.3
	Province of driver*2	79.5	80.0	76.7	53.4
	Driving experience (year)	6.8	7.0	5.4	2.0
	Major waiting point of passengers	on-road	on-road	Turning Point	Entrance of Soi
	No. of Trips/Day	15.6	23.2	18.1	33.8
	Total No. of Pass./Day	38.5	60.0	58.3	35.5
	Average Pass./Unit-Trip	2.9	2.8	4.4	1.1
Working Conditions	Total Working Days/Week	6.8	6.4	6.6	6.8
	Total Working Hours/Day	11.2	10.7	13.3	13.7
	Insurance (%)*3	100.0	89.3	77.1	23.1
	Accident (%)*4	53.1	30.9	18.2	52.1

Note : *1 The percentage of drivers with an educational background above high school
*2 The percentage of drivers from provinces outside Bangkok
*3 The percentage of interviewees having at least one insurance coverage
*4 The probability of more than one traffic accident within a year

3) Financial Conditions of Public Transportation

The financial status was also analyzed based on the results of the interview survey. The analysis is as shown in Table 4.4.3. The daily average revenue is 650 Baht for taxi, 460 Baht for samlor, 340 Baht for silor, and 250 Baht for hired motorcycle. On the other hand, the daily average expenses are 435 Baht for taxi, 320 Baht for Samlor, 195 Baht for Silor and 110 Baht for hired motorcycle. The taxi has the highest revenue and expense as well as the largest operating income of 210 Baht. Operating incomes for the other modes are similar at 140 to 150 Baht.

Table 4.4.3 Financial Conditions of Taxi, Samlor, Silor and Hired Motorcycle

Unit : Baht

Items	Taxi	Samlor	Silor	Hired Motorcycle
1. Average Operating Revenue/Day	646.3	457.9	342.7	250.8
2. Average Operating Expenses/Day	434.9	319.8	194.1	112.3
3. Fuel Expenses	159.3	85.3	96.6	52.3
4. Others(Rental, Repair etc.)	289.7	217.4	137.3	66.0
5. Operating Income = 1 - 2 Excluding Personnel Expenses	211.4	138.1	148.6	138.5

4) Assessment of Taxi, Samlor, Silor and Hired Motorcycle

Based on the public transport user opinion survey, the assessment of taxi, samlor, silor and hired motorcycle by users is as follows:

(a) 75.0% of total interviewees consider that taxi, samlor, silor and hired motorcycle are not always necessary. However, the necessity for taxi, samlor, silor and hired motorcycle is relatively higher for interviewees in the western area than in other areas. Taxis are increasingly considered necessary as the proximity to the inner city becomes closer.

(b) In general, the availability of the taxi, samlor, silor and hired motorcycle services in Bangkok is considered good. However, the availability in the northern area is conceived to be poor. On the other hand, the interviewees feel the taxi fare is high.

Table 4.4.4 Assessment of Taxi, Samlor, Silor and Hired Motorcycle by Users

Item	yes very	yes	not always	not at all
Do you need them?				
Hired Motorcycle	7.8	18.2	51.5	23.3
Samlor/Silor	3.4	19.7	62.4	14.5
Taxi	2.3	14.6	66.7	16.5
Are they available?				
Hired Motorcycle	11.8	47.7	27.9	12.6
Samlor/Silor	9.7	49.3	32.8	8.2
Taxi	11.0	49.5	31.7	7.8
Are they expensive?				
Hired Motorcycle	7.4	27.0	43.9	21.7
Samlor/Silor	6.8	32.4	49.0	11.8
Taxi	18.3	35.2	40.0	6.5

4.5 Rail Transportation

1) Railway Network

The railway system in Thailand which is managed and operated by SRT, radiates from Bangkok and extends along the northern line, northeastern line, eastern line and southern line. SRT has 3,726 route kilometers of rail track open to traffic.

Most of the lines are single track and the total length of double track sections is only 90 km (2.4% of total SRT track), from Bangkok to Ban Phachi.

The railway network functioning as an urban transport system serves a 30-km radius area from Bangkok CBD. As shown in Figure 4.5.1, the Northern Line serves up to Chiang Rak, the Eastern Line up to Hua Takhe, and the Southern Line up to Sala Ya.

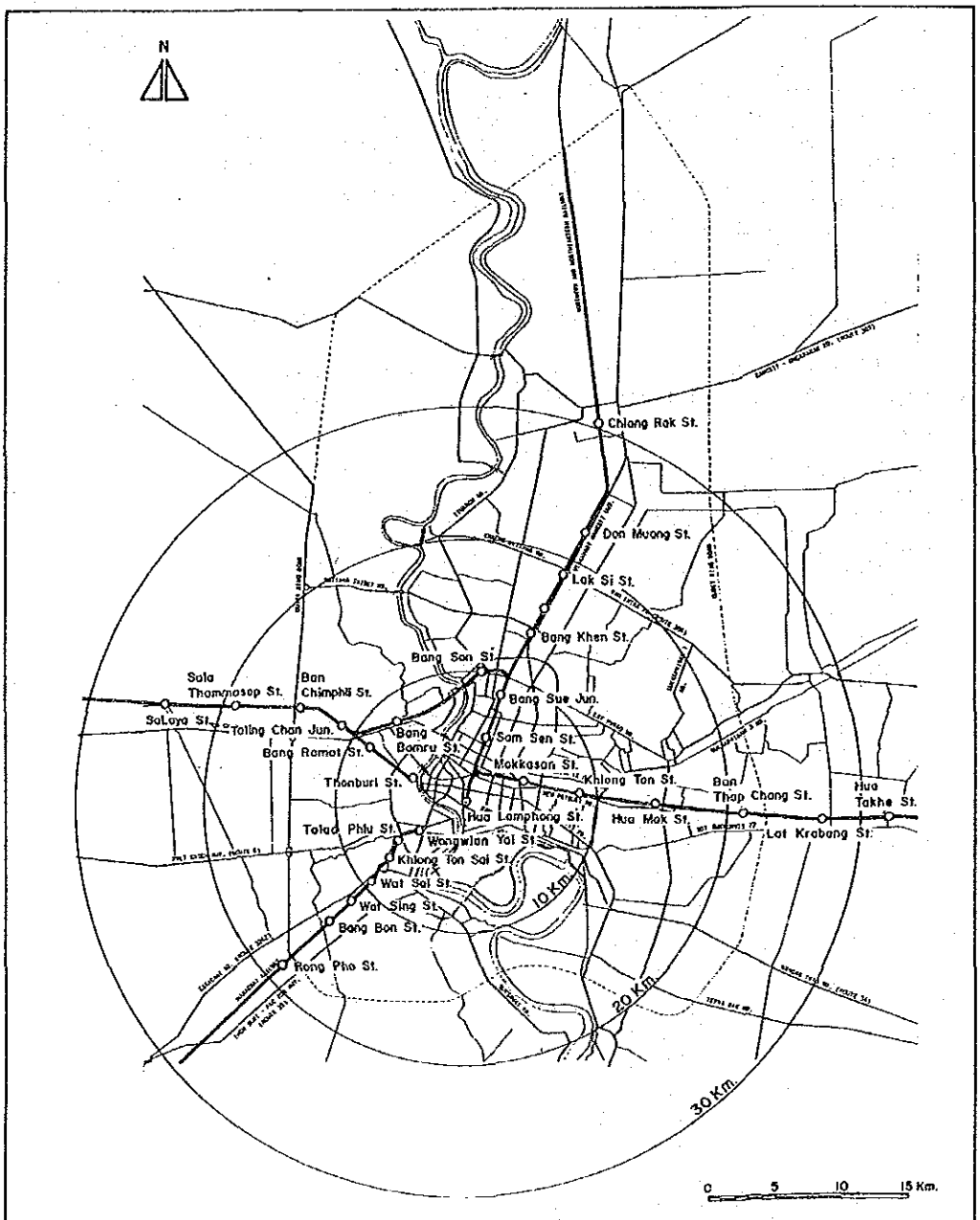


Figure 4.5.1 Railway Network in Bangkok

2) Passengers

Passengers carried by SRT in the year 1987 were 77,931 thousand (214 thousand/day), at an increase of 1,200 thousand over the previous year.

The number of passengers has decreased from a peak of 81,498 thousand in 1984. However, the passengers in 1987 increased over the previous year. Figures for the average distance/passenger and operating revenue have slightly increased.

The number of intra-city rail passengers in Bangkok in 1985 was only 7,151 thousand because the time schedule of SRT is mainly composed of long distance trains.

However, in the case of the Eastern line, the load factor during the morning peak hour is almost 200% due to the following two reasons:

a. Cheap fare (2 Baht for 10 km, 5 Baht for 15 km)

b. The line runs parallel to Sukhumvit Road which is one of the most congested transport corridors.

Trend of SRT passenger service is shown in Table 4.5.1.

Table 4.5.1 Trend of SRT Passenger Service

Year	Passenger (X1000 Pass.)	Passenger/Day (X1000 Pass.)	Ave.Distance/ Passenger(Km)	Operating Revenue (Million Baht)
1975	61,570	169	92	-
1981	78,824	216	120	1,573
1982	80,036	220	115	1,816
1983	81,404	223	119	1,954
1984	81,498	223	118	2,042
1985	78,031	214	117	1,971
1986	78,702	210	121	2,051
1987	77,931	214	123	2,114

Source: SRT

3) Rolling Stock

In 1987, the number of locomotives and passenger cars, as shown in Table 4.5.2, were 473 and 1,102, respectively. The average proportions of total rolling stock in service of locomotives and passenger cars were 85.0% and 83.5%, respectively.

Table 4.5.2 Existing Rolling Stock of SRT

	Locomotives			Passenger Cars		
Year	A Units	B In Service	B / A X 100	A Units	B In Service	B / A X 100
1983	341	277	81.2%	1,119	978	87.4%
1984	343	257	74.9	1,123	898	80.0
1985	488	391	80.1	1,111	822	74.0
1986	490	406	82.9	1,098	921	83.9
1987	473	402	85.0	1,102	920	83.5

Source: SRT

4) Finance

In 1987, operating revenues, expenses and operating loss were 3,310.4 million Baht, 3,897.9 million Baht and 587.5 million Baht, respectively. The largest share of operating expenses was personnel expenses, totaling 2,051.1 million Baht or 53% of the total expenses in that year. (Refer to Table 4.5.3)

Table 4.5.3 Operating Revenues and Expenses

Fiscal Year	Operating Revenues Baht '000	Operating Expenses Baht '000	Operating Ratio %
1983	3,141,231	3,470,821	110.49
1984	3,308,462	3,585,401	108.37
1985	3,238,387	3,621,155	111.82
1986	3,235,757	3,840,678	118.69
1987	3,310,433	3,897,855	117.74

Source: SRT

5) SRT Organization and staff

SRT is composed of 6 Departments, 9 Bureaus and 1 Division and the total number of staff is 25,546 as of 1987.

The formulation of policies and the supervision of the general affairs of SRT are entrusted to the Board of Commissioners consisting of a chairman and four to six other members appointed by the cabinet. The general manager, chief executive of SRT, is an ex-official member of the Board. The Minister of Transport and Communications has general supervisory power and may call upon SRT to give statements or opinions or to submit reports or suspend SRT's actions.

The total number of staff is 25,546 as stated above and the number of staff by organization is as follows:

Civil Engineering Department	8,012	(31.4%)
Mechanical Engineering Department	7,441	(29.1%)
Traffic Department	6,792	(26.6%)

The number of temporary staff is 1,485, 6% of the total staff. Between 1983 and 1987, the total number of staff decreased by approximately 4,000 persons.

Table 4.5.4 Number of SRT Employees Classified by Organization as of September 30, 1987

Item	Permanent	Temporary	Total
Personnel Administration Dept.	95	-	95
Traffic Dept.	6,395	379	6,792
Marketing Dept.	72	-	72
Accounting & Finance .	466	2	468
Mechanical Engineering Dept.	7,441	-	7,441
Civil Engineering Dept.	7,190	822	8,021
Legal Bureau	51	-	51
Medical Bureau	271	-	271
Stores Bureau	272	1	273
Railway Training Centre	68	-	68
General Manager Bureau	117	-	117
Railway Police Div.	764	-	764
Signaling and Telecommunication	730	263	993
Information System Bureau	65	-	65
Property Management and Development Bureau	46	-	46
Total	24,061	1,485	5,546

Fiscal Year	Permanent	Temporary	Total
1983	27,126	2,460	29,586
1984	26,375	1,446	27,821
1985	25,445	1,729	27,174
1986	24,754	2,314	27,068
1987	24,061	1,485	25,546

Source: SRT

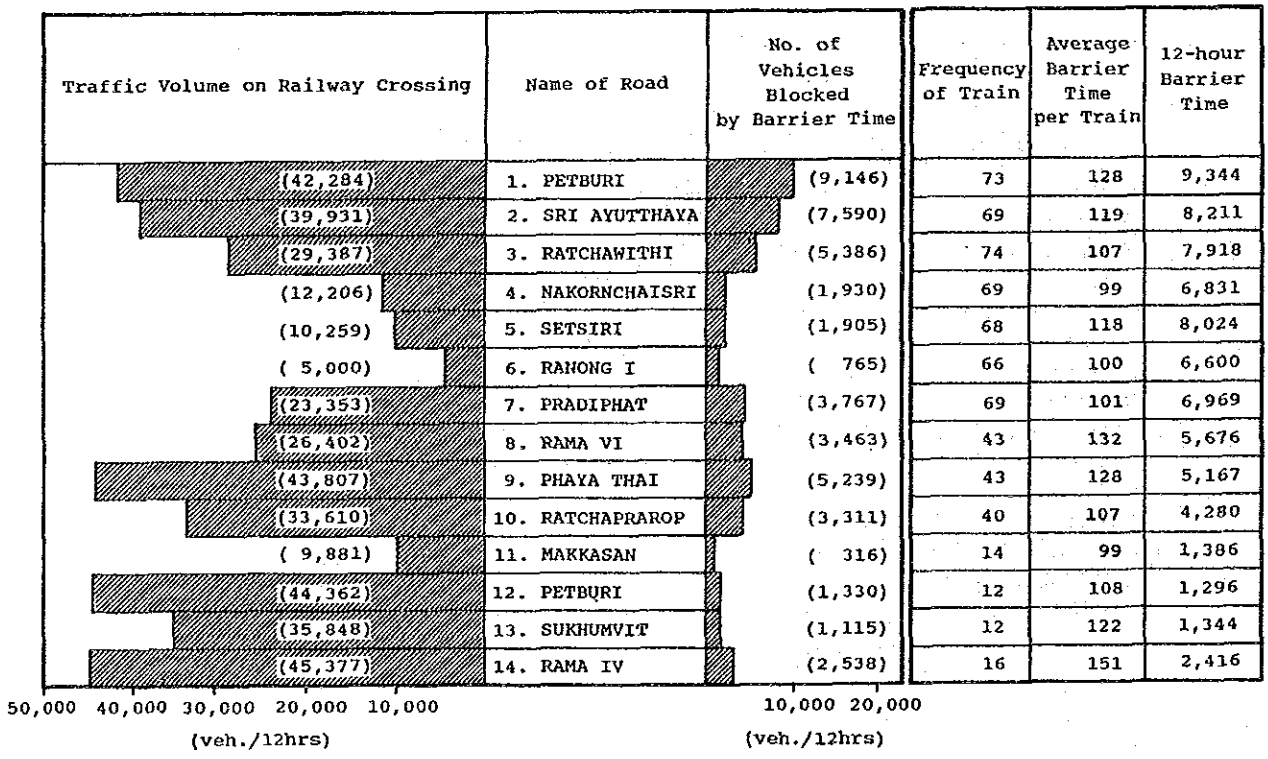
6) Influence of SRT level crossing on the urban road traffic in Bangkok

In the "Plan of Elevated Railway of SRT in Bangkok (JICA, July, 1984)", the volume of traffic at level crossing and the volume of blocked traffic by crossing barrier were surveyed at 14 level crossings with SRT tracks inside the area where elevated railways were planned.

According to the survey result, the volume of traffic at railroad crossing in the survey area was 401,700 veh./12 hrs. The volume of traffic blocked by crossing barrier assumed from the frequency of train and the barrier time (average daily frequency of train is 47.7, and average barrier time is 116 seconds) was 47,800 veh./12 hrs. Thus, 12% of the total traffic on the trunk roads in the inner area was blocked by crossing barrier due to passing of trains.

The SRT crossings with heavy volume of blocked vehicle traffic are found on the Phet Buri, Sri Ayutthaya, Rajavithi, and Phayathai. Blockage of vehicle traffic in the urban area causes serious congestion particularly during the morning and evening rush hours.

Figure 4.5.2 and Figure 4.5.3 show the locations of the surveyed crossings, and the survey result, respectively.



Traffic Volume on Railway Crossing	Name of Road	No. of Vehicles Blocked by Barrier Time	Frequency of Train	Average Barrier Time per Train	12-hour Barrier Time
(42,284)	1. PETBURI	(9,146)	73	128	9,344
(39,931)	2. SRI AYUTTHAYA	(7,590)	69	119	8,211
(29,387)	3. RATCHAWITHI	(5,386)	74	107	7,918
(12,206)	4. NAKORNCHAISRI	(1,930)	69	99	6,831
(10,259)	5. SETSIRI	(1,905)	68	118	8,024
(5,000)	6. RANONG I	(765)	66	100	6,600
(23,353)	7. PRADIPHAT	(3,767)	69	101	6,969
(26,402)	8. RAMA VI	(3,463)	43	132	5,676
(43,807)	9. PHAYA THAI	(5,239)	43	128	5,167
(33,610)	10. RATCHAPRAROP	(3,311)	40	107	4,280
(9,881)	11. MAKKASAN	(316)	14	99	1,386
(44,362)	12. PETBURI	(1,330)	12	108	1,296
(35,848)	13. SUKHUMVIT	(1,115)	12	122	1,344
(45,377)	14. RAMA IV	(2,538)	16	151	2,416

Figure 4.5.3 Survey Result

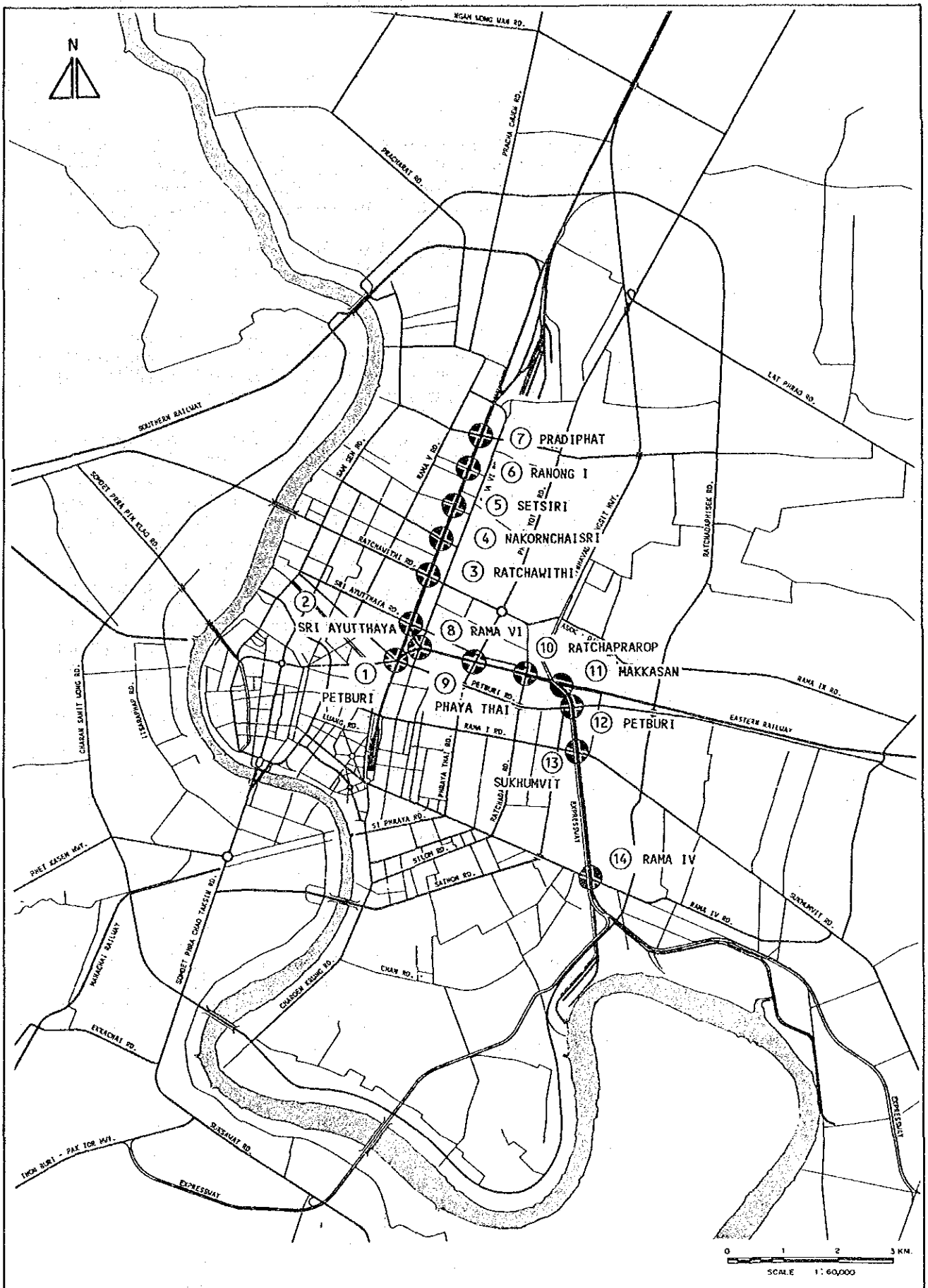


Figure 4.5.2 Location of Level Crossing of SRT

4.6 River Transport

Much of the river transport has been converted to road transport with the growth of motorization in Bangkok; however, river transport is still an important mode of transport to the people who live along the Chao Phraya River and in the Thonburi Area.

Basically, river transport along the Chao Phraya River is operated by the private sector and classified into the following three categories.

Ferry	Ferry has routes crossing the Chao Phraya River and mainly connects the Bangkok and Thonburi areas. This mode has the largest number of boat stops and passengers.
Express Boat	This mode has longitudinal routes along the Chao Phraya River served at high speeds. According to the survey result of "Role of Chao Phraya Express Boat as Public Transportation in Bangkok Metropolitan Area-Phase I (AIT and International Development Research Centre-Canada)", the travel speed of the Express Boat between Nontha Buri and Bangkok along the Chao Phraya River is approximately 16 Km/h. This speed is higher than that of a roughly parallel BMTA bus route.
Long-Tail Boat	This is the oldest mode of river transport in Bangkok and operates mainly along Khlongs.

The total number of river transport passengers is 313,200 per day, broken down as follows.

Ferry	259,400 (83%)
Express Boat	12,800 (4%)
Long-tail Boat	41,000 (13%)

Many Khlongs have been filled as a result of the growth of motorization, however some still remain active river transport lanes. Compared with the Khlongs in the Thonburi side, those in the Bangkok side are not fully used for river transportation. Khlong Saen Saep and Khlong Sam Saeng, for example, east and west of the CBD and having important locations, are not fully used. Figure 4.6.1 shows the current Khlong network in Bangkok.

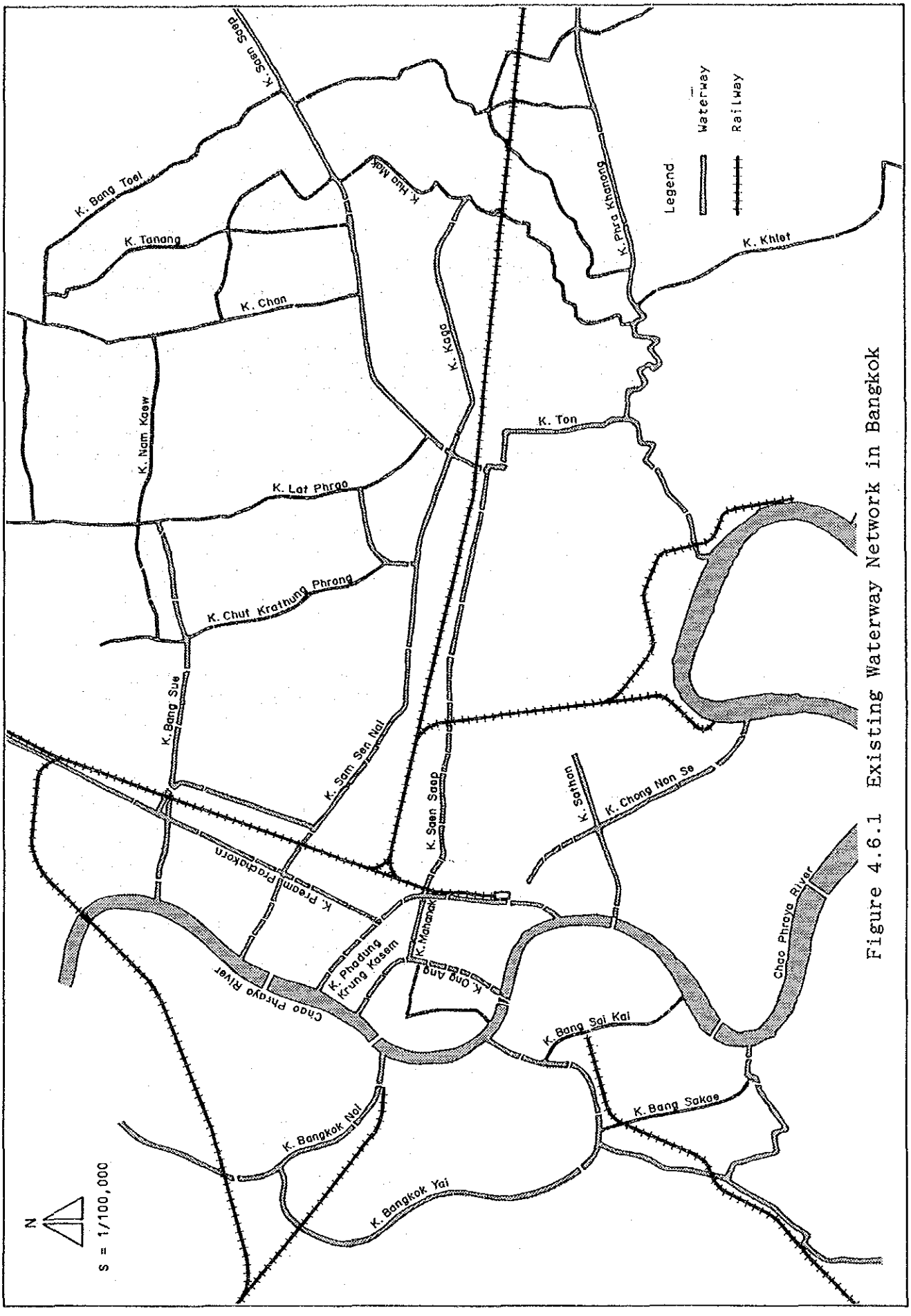


Figure 4.6.1 Existing Waterway Network in Bangkok

4.7 Main Issues

1) Demand structure of public transportation and balance of demand and supply

The public transportation demand on the Chao Phraya screen line is 653,100 trips/day. Out of this, 74% or 540,000 trips, are concentrated inside the Middle Ring Road. On the other hand, based on the bus network and frequency, the supply of public transportation is 1,537,200 passengers/day. The load factor is 42% on a daily base.

However, 18% of the daily passengers are concentrated in the peak period (7:00 - 8:00), while only 7% of daily bus traffic is available during peak period due to the restrictions of the road traffic conditions. As a result, the load factor at the peak hour is 110%. In addition, since more than 99% of the bus frequency is concentrated within the Middle Ring Road, the demand is extremely larger than supply on the north and south sides of the Middle Ring Road.

Figure 4.7.2 shows the public transportation demand on the screen line along the Middle Ring Road by direction. The largest demand (381,500 trips/day) is found on the Lat Phrao - New Phet Buri corridor in the northwest direction, followed by the demand on the Phahon Yothin - Wiphawadi Rangsit corridor in the north direction.

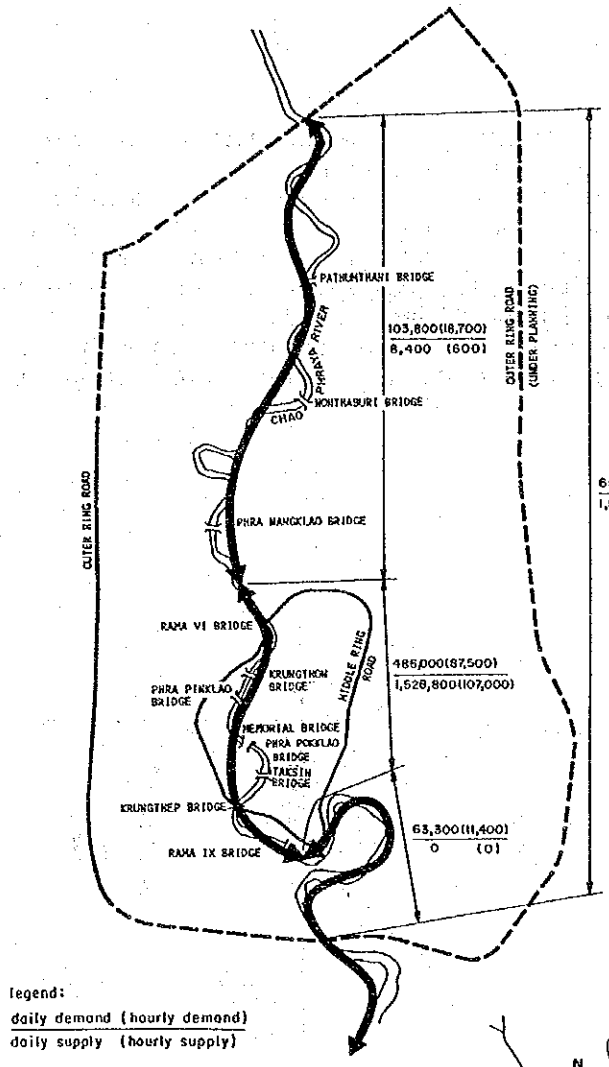
The demand of the southwest - west direction is 184,000 to 205,000 trips/day. The smallest public transportation demand, 85,000 trips/day, is found on the Tiwanon - Pracha Chuen corridor in the northwest direction.

As to the supply, a high level of service is available in the north direction including the northwest. The supply of public transportation by direction from the south to the west, especially the Thonburi side, is poor. The load factor during peak period on the Phet Kasem - Thonburi - Nakon Chaisri corridor reaches more than 140%.

In any case, observing the public transportation demand and supply crossing the screen lines on the Chao Phraya River and along the Middle Ring Road at the peak period, the load factor is over 100%, that is, the demand is slightly greater than the supply.

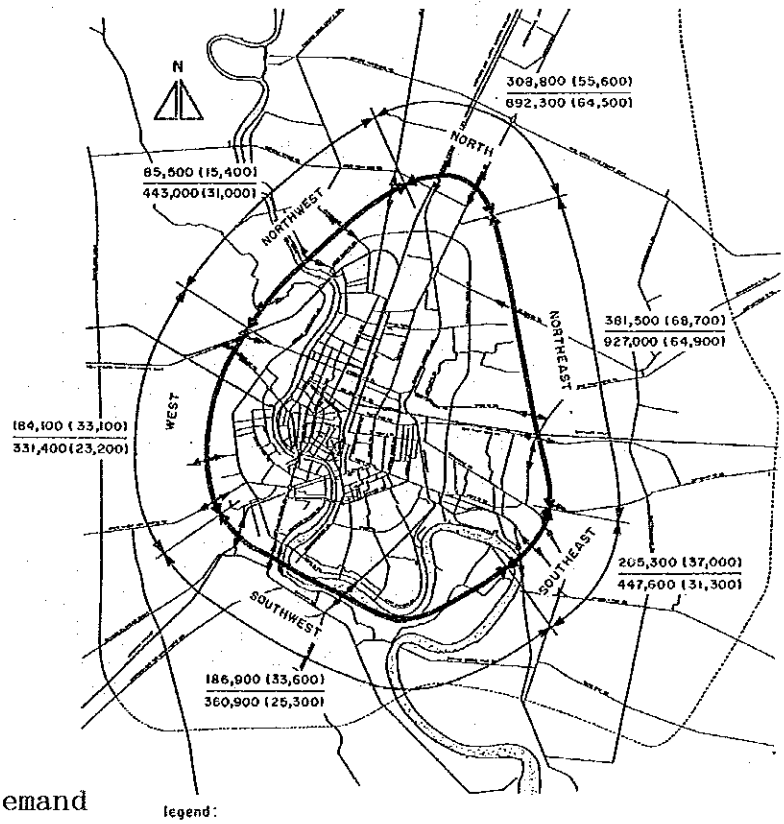
Table 4.7.1 Peak Time Demand and Supply on Screen Lines

Screen Line	Demand (A) (trips/hour)	Supply (B) (persons/hour)	Load Factor (A)/(B) x 100 (%)
Chao Phraya	117,600	107,600	109
MRR	243,400	240,200	101



legend:
daily demand (hourly demand)
daily supply (hourly supply)

Figure 4.7.1
Relationship between Demand and Supply of Public Transport on the Chao Phraya Screen Line



legend:
daily demand (peak hour demand) 243,400
daily supply (peak hour supply) 240,200

Figure 4.7.2
Relationship between Demand and Supply of Public Transport by Direction

To cope with the future increase of public transportation demand, it may be possible to introduce new bus routes on the newly constructed roads outside the Middle Ring Road. However, without any changes in the demand structure in the inner area, the traffic congestion may grow more serious due to the limit of the at-grade road construction. In other words, only the current bus system, where bus service is provided together with other modes on the same road, cannot cope with the future growth in demand for public transportation, especially in the inner area in Bangkok.

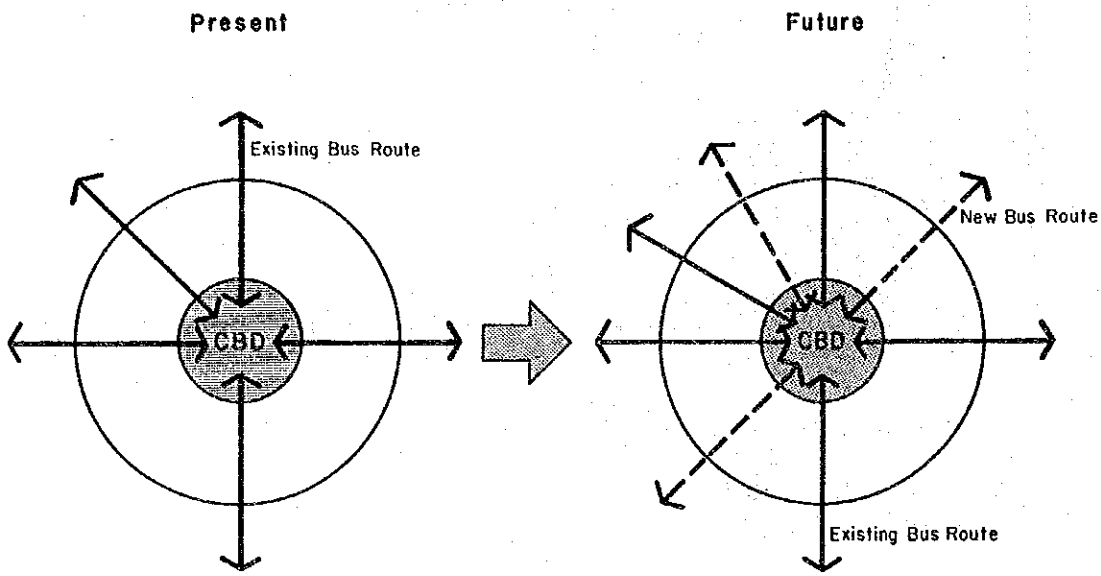


Figure 4.7.3 Future Growth in Demand for Public Transportation and Current Bus System

2) Bus fare system

A bus flat fare system (basically 2 Baht) is adopted for the bus service in Bangkok, except in certain areas. Table 4.7.2 shows leading indices on public transportation service available in Bangkok and other Asian cities. The table shows that the bus fare in Bangkok is the lowest compared with those in other cities.

Comparing the revenue and expenses of BMTA based on the financial conditions, against a revenue value of 100 the expenses are 130, showing a serious deficit, as described in Section 3. This is caused by the low fare level. This deficit makes it difficult to improve various services for bus passengers such as, purchase of new buses, and improvement of bus maintenance service facilities and bus stop facilities.

Table 4.7.2 Bus Services in Asian Cities

City	1985 Population (million)	Type of Vehicle	Capacity of Vehicle	Capital Cost of Vehicle (US$)	Ownership	Name or Type of Undertaking	Fleet	Fleet Utilization	Per Operating Vehicle: Staff	Km/day	Passengers per Day	Total Pass/Day (million)	Fare for 5 Km (US $)	Cost per Operat. Pass.-Km (US cents)	Revenue/ Total Costs
ANKARA	2.3	large buses	100	65,000	Public	EGO	900	0.65	6.0	197	1,150	0.67	0.12(F)	2.5	0.67
		large buses	100	65,000	Private	Individual	200	0.95	2.6	171	1,300	0.25	0.12(F)	1.2	1.70
		minibuses	15		Private	Individual	2,000	0.90				0.72	0.15(G)		
BANGKOK	8.2	large buses	100		Public	BMTA	4,400	0.81	6.2	230	1,250	4.50	0.07(F)	1.9	0.74
		large buses	100		Private	Individual	550	0.80			1,250	0.55	0.07(F)	1.2	1.0 to 1.2
		minibuses	15-30		Private	Individual	12,000					2.50	0.07(F)		1.1 to 1.3
HONG KONG	5.6	DD buses	120	75,000	Private	KMB	2,400	0.82	4.96	250	1,475	2.92	0.13(G)	2.2	1.0 to 1.1
		DD buses	120	75,000	Private	CMB	1,080	0.80		175	1,090	0.99	0.13(G)		1.0 to 1.1
		minibuses	14		Private	Individual	4,350	0.90		230	330	1.30	0.2 - 0.4(G)	3.0	1.1 to 1.3
ISTANBUL	5.7	large buses	100	65,000(reg) 140,000(art)	Public	IETT	1,500	0.60	7.5	235	1,200	1.10	0.14(F)	2.0	0.88
		large buses	100	50,000	Private	route associations	960					1.00	0.14(F)	1.7	1.0 to 1.2
		minibuses	20	20,000	Private	route associations	3,800	0.78		215	335	1.00	0.20(G)	2.2	1.4
		shared taxis	7	7,000	Private	Individual	715	0.86		110	100	0.60	0.40(G)	4.0	1.2
JAKARTA	8.0	large SD and DD buses	100-130	30,000(SD) 80,000(DD)	Public	PPD	1,940	0.59	14.5	225	1,135	1.30	0.13(F)	1.8	0.50
		large buses	100	30,000	Private	Mayasari	550	0.76	7.25	300	1,200	0.50	0.13(F)	0.9	1.1 to 1.3
		minibuses	30	16,000	Private	2 assoc. of owners	3,365	0.80	5.5	250	480	1.30	0.13(F)	1.2	1.3 to 1.6
		vans	15	12,000	Private	1 assoc. of owners	2,000	0.50	5.5	250	125	0.20	0.13(F)	1.3	1.2
KUALA LUMPHUR	1.1	large buses	80	50,000	Private	8 companies	950	0.80	4.2	280	820	0.62	0.17	2.3	1.0 to 1.1
		minibuses	20		Private	Individual							0.30		
MANILA	6.8	large buses	100		Public	MMTC	503	0.94					0.08(G)		
		small buses	60		Private	Individual	3,000						0.06(G)		
		jeepneys	14-16		Private	Individual	28,000						0.06(G)		
SEOUL	9.9	large buses	100	30,000	Private	90 companies	8,300	0.97	3.2	340	1,290	10.40	0.15(F)	3.0	1.0
SINGAPORE	2.6	large SD and DD buses	100-120	50,000(SD) 75,000(DD)	Private	SBS	3,030	0.90	3.9	245	910	2.50	0.24(G)	3.0	1.0

* F = Flat Rate ; G = Graduated

Source : World Bank survey, studies and field mission reports.

3) Financial Analysis of Public Transport

The financial conditions of BMTA public bus transport based on the BMTA 1987 financial data are as follows: (Figures in Table 4.7.3 show per staff per day, considering the total number of staff - 20,481 and 310 working days a year - 6 working days per week).

(a) Fare revenue, operating expenses and operating index are 498.0 Baht, 546.6 Baht and 0.91, respectively. As compared with corresponding figures for other public transport modes, the fare revenue of BMTA bus falls between those of taxi and samlor but operating expenses are the highest among all the public transport modes.

(b) The breakdown of operating expenses is 113.4 Baht for fuel, 208.6 Baht for others (maintenance fee, rental of land for depot, etc.) and 224.6 Baht for personnel expenses. These figures do not differ greatly from those for other public transport modes. (BMTA personnel expenses include salaries of managers)

(c) Operating income and operating index, excluding personnel expenses, are 176.0 Baht and 1.55, respectively.

Assuming that the level of operating expenses is roughly reasonable compared with the other public transport modes, it can be concluded that BMTA's financial deficit is caused by the low level of its fare system.

A suitable BMTA fare system is briefly explained as follows:

(a) 1987 settlement of BMTA finance is summarized in Table 4.7.4.

Table 4.7.4 The Summary of BMTA Finance

Items	Thousand Baht
A) Revenue	3,217,527
B) Ticket	3,059,937
C) Others	157,590
D) Operating Expenses	3,531,275
E) Total Expenses (Including paid interest etc.)	4,138,246

(b) The fare level (L1) which would achieve a balance between operating revenue and expenses (A and D) is expressed by the following formula:

$$B \times L1 + C = D \qquad L1 = 1.10$$

On the other hand, the fare level (L2) which would achieve a balance between operating revenue and total expenses (A and E) is shown in the following formula:

$$B \times L2 + C = E \qquad L2 = 1.30$$

(c) Therefore, assuming that the level of operating expenses is roughly reasonable compared with other transport modes, the level of BMTA bus fare which would balance operating revenue and expenses is the existing fare plus 10%. On the other hand, considering the total BMTA expenses (including depreciation and paid interest etc.), it is necessary to increase the existing fare by 30%.

The financial conditions of the public transport modes in Bangkok are shown in Table 4.7.3. The present financial conditions of modes other than BMTA bus are summarized as follows:

(a) The Taxi service has the largest fare revenue and operating expenses, followed, in order, by samlor, silor and hired motorcycle.

(b) The Taxi mode has the largest operating income (fare revenue minus operating expenses) at approximately 210 Baht, and the smallest is approximately 140 Baht in the cases of samlor and hired motorcycle. The operating income of silor drivers is approximately 150 Baht, in between those of taxi and samlor/hired motorcycle drivers.

(c) The largest operating index, (operating income divided by operating expenses), which expresses cost performance, is 2.23 for hired motorcycle mode, and the smallest is 1.43 for samlor.

Rows 13, 14 and 15 in Table 4.7.3 show the monthly income, average monthly working hours, and hourly income of transport sector drivers compared with the corresponding average figures for Bangkok basic industries workers in 1986.

The monthly income of those working in public transport, excluding bus and taxi modes, is less than the average monthly income in Bangkok. The hourly income, excluding that of BMTA bus, is only 60% of the average in Bangkok. This is due to the long working hours monthly, more than 1.5 times the Bangkok average. Especially, monthly working hours of hired motorcycle drivers is more than 400 hours, equivalent to 1.9 times the average in Bangkok.

Table 4.7.3 Operational Characteristics and Financial Conditions of Public Transport in Bangkok

Items		BMTA Bus (Regular+Air-con.)	Taxi	Samlor	Silor	Hired Motorcycle	
Operational Characteristics	① No. of Trips/Day	8.4	14.4	20.5	16.0	28.8	
	② Total No. of Pass./Day	784.4	29.9	42.0	26.1	34.3	
	③ Avarage Pass./Unit-Trip	100.2	2.9	2.6	4.0	1.0	
Working Conditions	④ Total Working Days/Week	6.0	6.7	6.5	6.7	6.7	
	⑤ Total Working Hours/Day	8.0	10.8	10.2	11.7	12.1	
Financial Conditions (Baht)	⑥ Average Operating Revenue/Day	498.0	615.3	439.3	316.2	231.3	
	⑦ Average Operating Expenses/Day	546.6	413.3	310.7	161.4	82.4	
	⑧ Fuel Expenses	113.4	149.7	82.6	79.3	45.3	
	⑨ Others(Rental, Repair etc.)	208.6	282.7	207.7	96.9	50.9	
	⑩ Personnel Expenses	224.6	-	-	-	-	
	⑪ Operating Income = ⑥-⑦ Excluding Personal Expenses	176.0	202.0	128.6	154.8	148.9	
	⑫ Revenue/Expenses Index = ⑥/⑦ <⑥/(⑧+⑨)> ---> Excluding ⑩	0.91 <1.55>	1.49	1.41	1.96	2.81	Bangkok-1986 Average
⑬ Monthly Income (Baht) = ⑫or⑪×④×4.345Weeks		5,856.0	5,861.0	3,744.0	4,507.0	4,335.0	4,690.0
⑭ Working Hours/Month = ④×⑤×4.345Weeks		260.7	314.4	292.5	340.6	352.3	216.0
⑮ Income/Hour (Baht) = ⑬/⑭		22.5	18.7	12.8	13.2	12.3	21.7

Source: BMTA Bus ----------> BMTA Data
Other Modes ----------> Paratransit Operator/Driver's Survey, 1989 JICA Study
Bangkok(1986)Average---> Ministry of Interior
Note : 1.Unit of Operational Characteristics
BMTA Bus ------> Per Bus Fleet (Total No. of Fleet = 4,650)
Other Modes ---> Per Driver
2.Unit of Working and Financial Conditions
BMTA Bus ------> Per Staff (Total No. of Staff = 20,841)
Other Modes ---> Per Driver

4) Brief Review of Past Transport Planning Studies on Public Transport

Several transport planning studies have been conducted since the 1960's when the transport conditions of Bangkok began to worsen.

Table 4.7.5 summarizes the problems identified and policy measures recommended by three transport planning studies such as BTS, STTR, and BTSS (Feasibility Study for Mass Transit System in Bangkok). The problems identified by those studies are summarized as follows:

1. Poor conditions of bus fleet and low operational rates due to insufficient maintenance

2. Inadequate fare system, in particular, low fares and the flat fare system

3. Structural problems of BMTA, namely its accumulated deficit due to inflexibility of its large organization, low fares, and increasing personnel costs

4. Deterioration of the level of services due to traffic congestion in the CBD

As regards recommended policy measures, the Bangkok Transportation Study (BTS) in 1975 pointed out that 26 private bus companies should be merged into only one undertaking. This recommendation was implemented in 1976. BTS also made other recommendations such as increasing the number of bus stop shelters and introducing monthly/weekly tickets. Some of these recommendations have been implemented and adjusted by the bus system in their own way. BTS also recommended an elevated public transport system as a core of the mid to long-term recommendations. The concept of this system is such that buses should be operated on elevated roads as a first step but the system should be changed to rail mass transit with the increase in transport demand.

The Short Term Urban Transport Review (STTR) in 1985 recommended improvement measures for BMTA, which suffered from increasing problems, including the change of fare systems as well as extensive bus priority measures, such as bus exclusive flyovers at major intersections, and semi-express bus service utilizing the Second Stage Expressway System.

The Bangkok Transit System Study (BTSS) in 1986 examined the feasibility of a rail mass transit system. BTSS pointed out that, instead of buses, the rail mass transit should play the primary role in the public transport systems of Bangkok in the future. BTSS also reviewed the elevated busways proposed by BTS and concluded that it was not feasible for the following reasons:

- The demand growth is going to be very fast, and thus the life period of the busway will be too short;

- The operationally untested system has many potential problem areas;

- Substantial cost escalation will incur to accommodate the buses on the otherwise narrower guideway, as well as to provide access ramps; and

- Special rolling stock is required to match station platforms.

BTSS summarized the results of the case study of segregated bus-way in Rama IV Road proposed by STTR as follows:

The Rama IV bus-way service level was expected to be poor, only marginally better than the current reserved lane bus operation. The total cost in the long run would be much higher than the RRTS (Rapid Rail Transit System) cost and the impact on the other traffic would be very severe. The system's reliability would be low and the noise and air pollution impacts very pronounced.

The review discussed above indicates that there has been a consistent goal in the thinking of the public transport studies since 1970's which is the need to segregate the public transport system from general traffic, in order to improve the level of services of public transport in Bangkok.

Table 4.7.5 The Problems Identified and Policy Measures Recommended by Past Transport Planning Studies

Year			1972	1976	1984	1985	1988
Status of Bus Operation			26 Private Companies		BMTA		
Traffic Management in Major Road						Introduction of One-Way System for Major Road	
Bus Operational Characteristics		No. of Bus Routes	90		155		223
		No. of Bus in Operation	2,800		4,470		8,182
		Daily Mileage per Bus	500,000		877,732		1,530,742
		Average Length of Route	16.4 km		23.0		23.0
		Daily Passengers	3.5 millions		5.1 (BMTA only, including 700,000 free riders)		6.1 BMTA+Private, excluding free riders
		Daily Passengers per Route	38,900		32,900		27,400
Study	Name		BTS		STTR	BTSS	STMR
	Objectives		Comprehensive Transportation Master Plan in Bangkok for the year 1990		To develop an agreed 5-year (1988-1991) capital investments programme for urban transport in Bangkok, and to resolve a number of transport policy issues	Feasibility study for Mass Transit System in Bangkok	To formulate medium (1996) to long-term (2006) improvement plan for road network and road transport, etc.
	Identified Problems of Bus System	Routes	. The lack of sufficient diameter lines, e.g., connecting Thonburi with the eastern and northern parts of the central area			. Short Routes	. Few diameter routes compare with radial routes with old CBD in the center . Northbound bus routes and trips concentrate on Phahon Yothin Road
		Operation	. High percentage of buses out of operation (30 %)		. The capacity of bus fleet is substantially too low to meet the public demand without gross overcrowding	. The average proportions of total fleet in daily operation is 82 % because of poor condition of depot . Many free riders . Low productivity due to exceptionally low operational speeds, thus reducing the daily mileage per bus and the number of passengers served . Intersection delays . Insufficiency of the bus lanes	. The average proportion in daily operation is 90 % of schedule, because of absence of driver and traffic congestion . There is no discrepancy between flat fare of the short and long distances of routes
		Fleet/ Facility			. The bus fleet is old and is in poor condition	. Very high maintenance costs associated with the poor quality of rolling stock and the almost total dependence on contracted maintenance	. Poor condition of bus fleet due to the insufficient maintenance depot . High maintenance costs associated with the 90% out of total bus fleet under private maintenance . No off-road terminal facilities except for long distance bus
		Management	. Average staff per bus of Bangkok is surprisingly low . Bus companies aim at maximum profit, not level of service . Drivers get a low basic salary, but bonus is granted for each trip, bad driving manners and excessively long working hours		. BMTA loses money continually, has no revenues, very small assets and is heavily indebted. This is often attributed to the low level of fares	. High personnel costs for BMTA staff	. The share of personnel costs out of total expense is increasing for the last 3 years (34.4-39.4%)
	Policy Measures		. The merging of bus companies into one public company (Recommendation of working group of the NOC in 1973) . Rerouting (Pairs of radial routes should be connected to Diameter Routes) . Construction of off-street Terminals to the inner core area . Various bus service improvements (Bus Maps, Shelter, Signboard, New type of bus) . Construction of exclusive bus lanes . Introduction of the elevated mass transit system (Bus operation --> Train operation)		. Introduction of segregated busways . Introduction of engineered buslanes delineated by studs or kerbs . Junction improvement for bus priority . Construction of bus only flyover . Recommendation for improvement of BMTA and fare system . Proposal for introduction of semi-express bus service after Completion of Second Stage Expressway System	. Introduction of Rapid Rail Transit System with rerouting of conventional buses for feeder service	

Note: BTS -Bangkok Transportation Study 1975
STTR-Short Term Urban Transport Review 1985
BTSS-Bangkok Transit System Study 1986
STMR-The Study on Medium to Long-term Improvement/Management Plan of Road and Road Transport in Bangkok 1988

CHAPTER 5

EXISTING PLANS AND PROJECTS

5. EXISTING PLANS AND PROJECTS

5.1 Current Urban Transport Development

The 6-th Plan explains that the development of the urban sector, in particular of the Bangkok Metropolitan Region (BMR), is critical. It lays emphasis on appropriate public investment and spatial development policies to guide the growth of the city. Towards the overall plan objective, the 6th Plan delineates the following guidelines for the development of infrastructure services:

(a) to make full use of existing basic services;
(b) to complete networks and raise service quality to international standards;
(c) to encourage and increase the role of the private sector in investment;
(d) to improve the efficiency of public administration and management;
(e) to adjust the pricing structure of basic services to ensure cost recovery and financial self-sufficiency;
(f) to adjust laws, rules, and regulations and to remove obstacles to the development and utilization of the infrastructure.

These guidelines are more specifically broken down into the following points;

(a) Development of Main Routes; including ETA expressway system, DOH highways, BMA main roads, and PWD/MOI bridges;
(b) Development of Auxiliary Road System; including roads linking "Soi";
(c) Expansion and Strengthening of Public Transport System; including BMTA bus system, Skytrain (LRT or Light Rail Transit) system, SRT Suburban services, and elevation of SRT tracks;
(d) Expansion of Traffic Management; including traffic lights, one-way circulation, pedestrian crossings, and facilities;
(e) Expansion of Traffic Demand Control; including parking control, traffic restraints such as cordon pricing, Area Licensing Scheme, etc.;
(f) Structural Adjustment of the Administration System and Related Rules and Regulations.

Summary of the transport investment projects committed in the 6th Plan is shown in Table 5.1.1. The overall progress of the projects is summarised as follows:

- Main and trunk roads are being implemented relatively smoothly, while the auxiliary roads have implementation difficulties.

- Public transport improvements are behind schedule.

- Much remains to be done on traffic demand control, traffic management and structural adjustment of the administrative system and related rules and regulations.

Adjustments recommended by the BMR Transport Investment Programme Review include the following:

(a) Finance and management measures
(b) Expressway traffic dispersal system
(c) Skytrain access and bus system improvement
(d) Traffic organization and control measures
(e) Suburban infrastructure provision
(f) Additional regional transport capacity

Of the above, the most urgent requirements are considered to be:

(a) Short-term assistance to TPD, BMA, and BMTA for operational traffic matters;
(b) Measures to ensure that major expressways and Skytrain function as effectively as possible;
(c) A BMR Transport Plan to guide the "second generation" of infrastructure investments; and
(d) Finance to speed up selected public sector investments.

Table 5.1.1 Transportation Investments Included in Sixth Plan

(million Baht)

Category	Investment		Agency
	Whole Project	During 6th Plan	
1. Main Roads/Trunk Roads			
(1) Expressway System	22,460	9,842	ETA
(2) Highway System	4,932	4,441	DOH
(3) Main Roads	2,930	1,696	BMA
(4) Bridges	5,543	2,138	PWD/MOI
Sub Total	35,865	18,117	
2. Auxiliary Roads	4,692	2,511	BMA
3. Public Transport System			
(1) Improvement to BMTA	4,510	2,980	BMTA
(2) Skytrain Stage I	17,000	3,500	ETA
(3) SRT Track Elevation and Suburban Rail Investments	3,000	2,000	SRT
Sub Total	24,510	8,480	
4. Bus/Truck Terminals	245	245	DLT
5. Traffic Management 1/	-	-	
6. Traffic Demand Control	-	-	
TOTAL	65,312	29,353	

Source: BMR Transport Investment Programme Review, NESDB
1/ ATC project is currently promoted by BMA

5.2 Plans/Projects of Relevant Agencies

This section gives an inventory of existing plans and projects of relevant agencies which will form a component of the proposed future transport network of this study. Main agencies responsible for the implementation of transport infrastructure include BMA, ETA, DOH, PWD and SRT. The identified plans/projects are summarised as shown in Table 5.2.1. The total investment cost of these projects/plans is approximately 105 billion Baht of which about 60% is of ETA.

Table 5.2.1 Summary of Investment Costs of Existing Projects/Plans by Agency

Agency	Project Type	No. of Projects	Estimated Budget (B/ million)
BMA	1) Roads	28	9,775
	2) Intersection/Flyover/Viaduct	18	1,874
	3) Local roads	L.Sum	2,100
	4) Traffic management	L.Sum	650
	5) Bus priority	L.Sum	242
	Sub Total		14,641
DOH	1) Roads	58	22,238
	2) Road (concession)	1	-
ETA	1) Second Stage Expressway	L.Sum	29,500
	2) Ekamai/Ram Intra	L.Sum	9,000
	3) Rail Mass Transit (Stage I)	L.Sum	22,553
	4) Busways	7	1,370
	Sub Total		62,423
PWD	1) Bridges and Approaches	3	5,460
	TOTAL		104,762

Source: prepared based on the Information shown in Table 5.2.2

The existing projects/plans are shown in Figures 5.2.1, 5.2.2 and 5.2.3 and Table 5.2.2. Main features of the projects/plans are described by agency as follows:

1) BMA Projects

BMA projects/plans are composed of various auxiliary roads, flyover and viaduct, intersection improvement, traffic management and bus priority. Priority projects expected to alleviate traffic congestion in the short-term (by 1992) include:

- 16 intersection improvements (mainly flyovers) including Rama IV viaduct along Rama IV Road and Soi Asok elevated road.

- A computerized traffic control system.

Bus priority projects included in the Sixth Plan have not been committed yet by BMA. Similarly, there has been no further action on trip tolls proposed by STTR.

2) ETA Projects

ETA is undertaking the implementation of expressways and a rail mass transit system under the BOT scheme. The former has been contracted out and construction started recently, while the latter is currently being negotiated with investor groups. No significant action has been taken on the bus-ways yet.

3) DOH Projects

A fairly large number of road projects are being implemented by DOH. They include those of inter-city links and main roads between the Middle Ring Road and Outer Ring Road. The projects comprise new construction, reconstruction and upgrading. Most of these DOH roads have wide right-of-way; say 60 to 100 meters.

Moreover, the projects to be implemented on concession basis or on toll scheme are as follows:

Concession Road

a. Northeast Connection (Rangsit - Saraburi Road)

b. Vibahavadi-Rangsit Toll Road (ESS - Don Muan)

DOH Toll Road

a. Krungthep - Chonburi Highway/Expressway

b. Thon Buri - Pak Tho Highway

c. Outer Ring Road

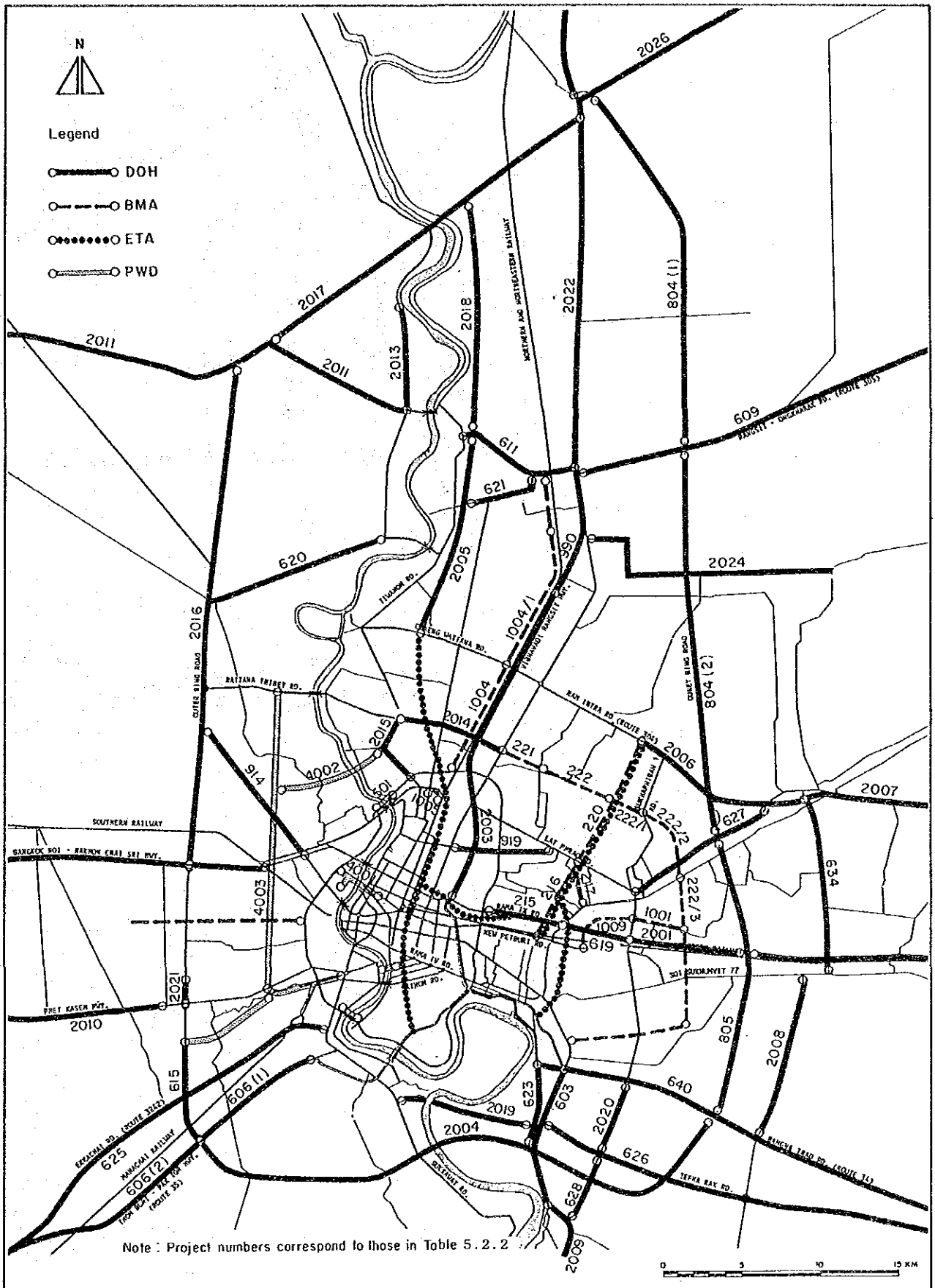
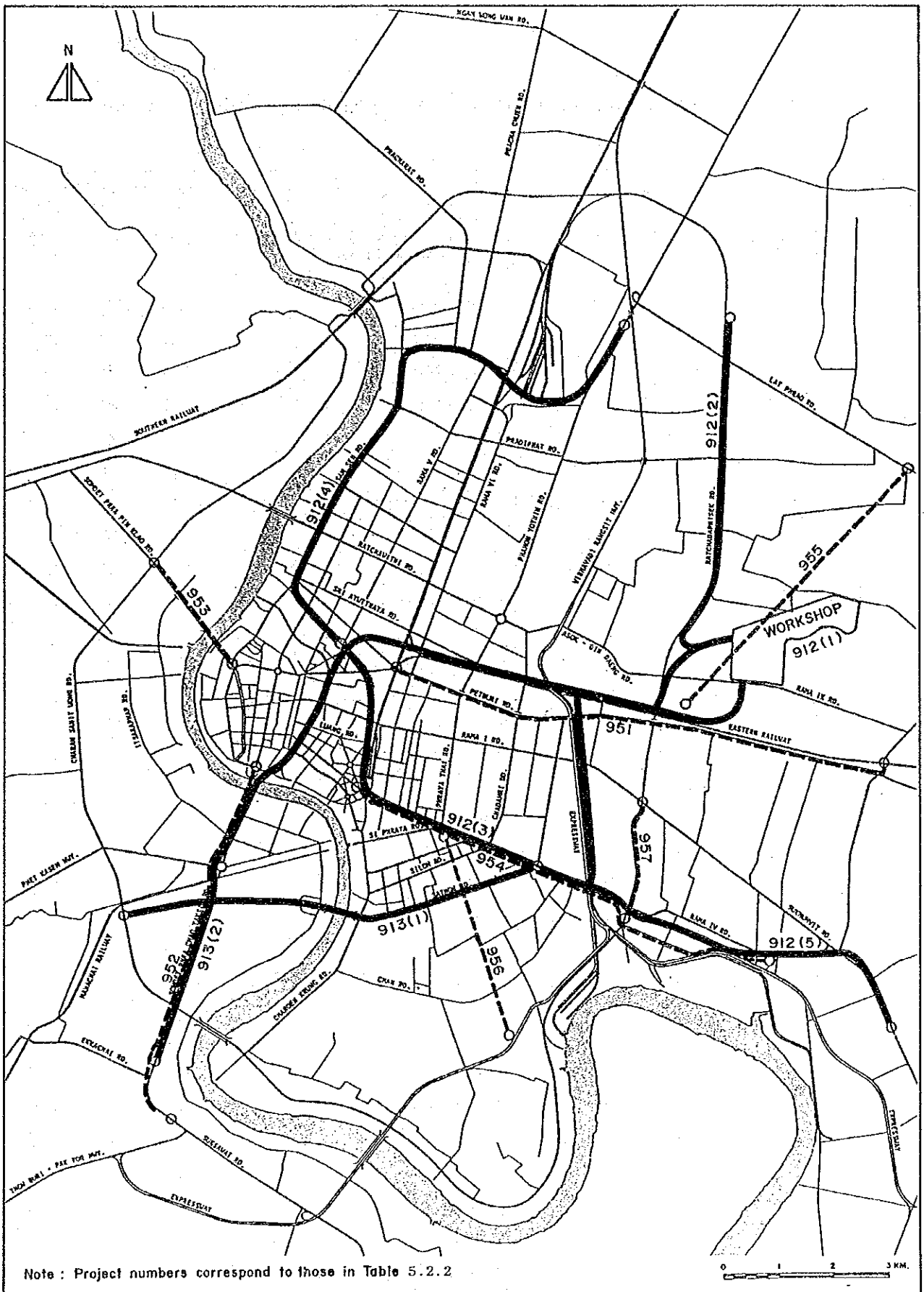


Figure 5.2.1 Existing Transportation Project/Plans (Roads and Bridges) for the Study Area

Figure 5.2.2 Existing Transportation Projects/Plans (Roads and Bridges) for Inner Area



Note : Project numbers correspond to those in Table 5.2.2

Figure 5.2.3 Existing Transportation Projects/Plans (Sky Train and Busways)

Table 5.2.2 Existing Transportation Projects/Plans by Agency

BMA

Project No.	Project Name	Description	Length (km)	Budget (B mill)	Scheduled Completion
213	Rathada Phisek : Route 31 - Prame Prachakorn	Interchange : elevated over Khlong and railway at Wiphawadi Rangsit Highway, dual 3	1.50	660	1993
214	Ratchad Phisek : Sukhumvit - Rama IV	New Road, dual 4	2.40	90	1989
215	Rama IX	New Road, dual 3	4.50	254	1988
216	Ekamai - Lat Phrao	New Road, dual 3	6.00	344	1992
220	Lat Phrao - Ram Indra	New Road, dual 3	8.70	504	1995
224	Rama VI : Siphaya - Suriwong	New Road, dual 2	0.75	48	1991
224/1	Rama VI : Sathorn - Chao Phya River	New Road, dual 3	4.00	150	1995
226	Khlong Chong Nonsi : Siphya - Rachada Phisek	New Road, segregated 2 lanes busway betwee Riverside Rd and Suriwong Rd, dual 4	4.00	1352	1993
226/1	Khlong Chong Nonsi : Rachada Phisek	New Road, dual 4	1.50	148	1994
918	Din Daeng - Ratchaprarop	New Road, underneath First Stage Expressway, dual 2	0.80	30	1989
921	Charan Sanitwong - Issaraphap	New Road: junction improvements at adjointing roads, single 4	1.20	114	1991
924	New Phetburi - Rama IX	New Road: at-grade railway crossing, single 4	0.90	100	1991
925	Extension of Sukhumvit Soi 55	New bridge over khlong San Saeb, single 4	0.15	28	1991
933	Chan Road Access	Improvement of two junctions - Road widening to 4 lanes, dual 2	1.00	100	1990
221-222	Ngam Wong Wan - Sukhumvit				
221/222	: Ngam Wong Wan - Ekkamai Ram Indra	New Road	5.8	554	1992
222/1	: Ekkamai Ram Indra - Sukhaphiban 1	New Road	3.0	286	1993
222/2	: Sukhaphiban 1 - Sukhaphiban 3	New Road	4.4	335	1994
222/3	: Sukhaphiban 3 - Krungthep kreetha	New Road	2.2	168	1996
222/4	: Krungthep Kreetha - Suhkumvit 103	New Road	6.6	503	2006
1004	Prame prachakorn : Ratchada Phisek - Chang Wattana	New Road, dual 2	7.0	560	1994
1004/1	: Chang Wattana - BMA Boundary	New Road, dual 2	7.0	525	1994
1005	Therdamri - Pracha Cheun - Pracharat 1	New Road, dual 1	3.5	237	1992
1006	Phrannok - Puttamonton IV	New Road, dual 1	15.0	360	1996
1007	Arunammarin	New Road		509	1990
1008	Rama II - Chao Phya River	New Road, dual 3	4.5	201	1994
1009	Ram Khamhaeng II	New Road, under prelim design, dual 2		451	1995

BMA (Continued)

Project No.	Project Name	Description	Length (km)	Budget (B mill)	Scheduled Completion
1011	Krungthep Kreetha - Rom Klao	New Road, dual New Road : under prelim design, dual 3	8.0	364	1995
1002	Soi Asoke Elevated Road	Elevated New Road : Concession basis, dual 2	2.0	800	1991
1001	Rama IV Viaduct	Continuous flyover over 3 intersection, dual 1-2	1.4	600	1991
1003	Intersection Improvement				
	(1) Din Daeng - Rajprarop	Flyover and tunnel, single 3	1.0	120	1991
	(2) Prachachuen - Ngarmwongwan	Flyover : Semi-Turnkey, dual 2	0.5	80	1990
	(3) Ratchada - Krungthep Nonthaburi	Flyover : Semi-Turnkey, dual 2	0.5	75	1990
	(4) Rama IV - Kasemraj	Additional entrance lane to Soi Ari, dual 2	0.7	40	1991
	(5) Sukhumvit - Rama IV	Extension of existing bridge over Klong Phrakanong through 2 intersections on Sukhumvit Rd., dual 2	1.0	70	1991
	(6) Sri Ayutthaya - Rajprarop	Flyover : under expressway over Rajprarop Road, dual 2	0.5	80	1991
	(7) Ratchada - Lard Prao	Flyover, dual 2	0.5	75	1991
	(8) Ratchada - Rama IV	Flyover, dual 2	0.5	70	1991
	(9) Ratchada - Prachachuen	Flyover, Semi-Turnkey, dual 2	0.5	80	1990
	(10) Prachachuen - Pracharaj	Additional lane, dual 2	0.7	24	1991
	(11) Petchburi - Ram Khamhaeng	Flyover : Semi-Turnkey, dual 2	0.5	120	1991
	(12) Charan Sanitwong - Phra Pin Klao	Flyover : Semi-Turnkey, dual 2	0.5	75	1990
	(13) Ratchada Phisek - Phetkasem	Flyover : Semi-Turnkey, dual 2	0.5	75	1990
	(14) Ratchada Phisek - Phahonyothin	Flyover : Semi-Turnkey, dual 2	0.5	75	1990
	(15) Pradipat - Paholyothin	Flyover : reversible 3	0.5	70	1990
	(16) Ratdamnean Klang - Ratdamneon Nai	Underpass, single 3	0.5	130	1991
930	Charoen Muang road Area Improvement	Junction & traffic control improvements in relation to interchange between SSE and BMA roads	-	15	1991
937	Local Roads Program	Identification, design and implementation of small and medium scale road improvements in most areas of the City to serve as new distributor and access roads	-	2,100	beyond 2007
1010	Area Traffic Control	-	-	500	1991
948	Traffic Management Program	Identify, evaluate, design and implement low-cost traffic management measures; continuing work carried out in the Bangkok Traffic Management Project	-	100	1990

BMA (Continued)

Project No.	Project Name	Description	Length (km)	Budget (B mill)	Scheduled Completion
970	Trip Tolls	Installation and operation of control points on a cordon around the central area	-	50	No Action
	Bus Priority Projects				
938	Ploenchit / Sukhumvit Road Bus Priority	Integrated program of bus priority measures along 16 km route; extensive buslanes, bus priority signals at Sukhumvit Rd. junction and First Stage Expressway, ATC and traffic regulations required	-	47	No Action
939	Phahonyothin / Phayathai Road Bus Priority	Integrated program of bus priority measures along 8 km route; extensive with and contra-flow buslanes, ATC and traffic regulations required	-	23	
940	Rama VI Road Bus Priority	Integrated program of bus priority measures along 8 km route; buslanes or segregated bus road, ATC and traffic regulations required	-	22	
941	Central Area Bus Priority Measures	Bus priority measures in central area to connect with busway schemes; upgrading existing bus lanes, adding new and contra-flow lanes, ATC and traffic regulations required	-	58	
942	Rama IV / Krung Kasem Bus Priority	Junction improvement; traffic signals and bus channelization, ATC required	-	9	
943	Rama I / Krung Kasem Bus Priority	Junction improvement; bus priority signal, traffic flows channelization, ATC required	-	5	
944	Ratchadamnoen Khlong / Lan Luang Bus Priority	Junction improvement : channelization and traffic signals for buses; ATC required	-	9	
945	Phitsanulok / Lan Luang bus Priority	Junction improvement : integrated design of busway, bus lanes, existing roads and SES ramps required after construction of Second Stage Expressway Ramp and demolition of existing Phetburi flyover	-	5	
946	Phrapinklao Bridge Bus Priority	Junction improvement : bus priority access (signals & channelization) - Bus only lanes F/S on bridge - ATC required	-	9	
947	Memorial Bridge Bus Priority	Junction improvement : Old Memorial Bridge to be used exclusively by buses - Segregated bus lanes around King Rama VI statue - ATC required	-	5	

PWD

Project No.	Project Name	Description	Length (km)	Budget (B mill)	Scheduled Completion
501	Rama VI Bridge and Approaches	New dual 3 lane bridge and approaches (Span Length : 120 m) Bridge to form part of Middle Ring Road	2.0	1,362 m	1992
502	New Krungthep Bridge	New dual 2 lane bridge and approaches (Span Length : 220 m) Replacement of existing bridge and immediate approach roads	2.0	1,917 m	1994
503	Taksin - Phet Kasem Road - ORR (West)	New road : dual 4 lanes 2 grade separated interchanges and 2 flyovers	10.5	3,081 m	1995
902	Siphaya Bridge	New bridge and approaches : dual 3 lanes, major traffic management and soi widening required	F/S commenced		
4001	Tavaes Bridge and Approaches				
4002	Nakorn-In Bridge and Approaches	F/S commence in 1990			
4003	Phet Kasem - Tiwanon road - Rattana Thibet				

DOH

Project No.	Project Name	Description	Length (km)	Budget (B mill)	Scheduled Completion
217	Ram Khamhaeng - Lat Phrao	New road; single 4 (No Jurisdiction of DOH)	2.5	173	-
218	Lat Phrao - Ram Inthra (South)	New road; single 4 lanes with 2 lanes service roads at either side	4.5	540	No action
219	Lat Phrao - Ram Inthra (North)	New road; single 4 lanes with 2 lanes service roads at either side	4.5	370	No action
222	Phahonyothin - Sukhaphiban 1 (Center)	New road; dual 2	3.4	165	No action
221	Phahonyothin - Sukhaphiban 1 (West)	New road; dual 2 with 30 m row (No Jurisdiction of DOH)	2.4	130	-
601	Rangsit Interchange : Route 1 / Route 305	Interchange		120	1989
603	Route 3 : Bang Na to Samut Prakan	Widening from 4 to 8 lanes plus footpath	9.0	105	1990
609	Route 305 : Rangsit to Ongkharak	New dual 2 lanes (14 km) and reconstruction of existing single 2 lanes road (29 km)	44.0	50	1988
611	Route 306 : Rangsit Interchange to Bang Phun	New dual 2 lanes highway plus overpass (2 km) reconstruct existing road to single 2 lanes (8 km)	10.0	60	1987
628	Route 3344 : Route 3268 to Route 3	New road; Single 2	4.2	49	1990

DOH (Continued)

Project No.	Project Name	Description	Length (km)	Budget (B mill)	Scheduled Completion
913	Din Daeng - Bang Khlong Song	New road; dual 2, parallel 2 lanes service roads and 2 lanes central bysway (Proj. 955) (No Jurisdiction of DOH)	15.4	1,100	-
914	Bangkok Noi - Nonthaburi	New road; 4 lanes (No Jurisdiction of DOH)	8.2	480	-
919	Khlong Bang Sue Rd	New road; 4 lanes (No Jurisdiction of DOH)	4.0	400	-
619	Route 343 : Route 3107 - Route 3344 (Ram Khamhaeng - Phathanakan Rd)	New road; upper for responsibility of ETA (4 lanes), lower for responsibility of DOH (6 lanes), part of New Bangkok-Chonburi Highway	4.0	120	1992
	Bangkok - Chonburi New Highway			5,000	
2001	: Phathanakan - Outer Ring Road	New road; 4 lanes			1993
2002	: Outer Ring Road - Chonburi	New road; 4 lanes			n.a.
2003	Route 31 : FSE - Airport	New Elevated Road : dual 3 (Concession)			1993
2005	Route 304 - Route 306	New road (missing link) : planning stage			-
2018	Bangpun - Bang Pa-In Vocational Centre	New road	9.0	208	1991
615	Route 340 : Route 4 to Route 35	New section of Outer Ring Road; dual 2	7.0	240	1987
804(1)	Outer Ring Road; Northeast Section (I)	New road; 4 lanes		4,000	1993
804(2)	: Northeast Section (II)	New road; 4 lanes			1994
805	: Southeast Section	New road; 4 lanes		550	1995
2004	: South Section	New road; 4 lanes			1996
2016	Outer Ring Road : Talingchan - Bangbuothong	Increase Standard	12.0	240	1992
2017	Outer Ring Road : Route 345 - Route 1	New road	21.0	1,000	1994
606	Route 35				
606(1)	: Thonburi - Route 340	Upgrading; 4 lanes + frontage	9.0	330	1992
606(2)	: R340 - Pak Tho	Upgrading; 4 lanes + frontage	76.0	2,500	1992
620	Route 345 : Route 340 to Route 307	Reconstruction to single 2 lanes	10.0	170	1990
621	Route 3100 : Route 306 (Tiwanon Rd.) - Route 346	Reconstruction to single 2 lanes	5.3	54	1988
622	Route 3102 : Sanphawut - Bang Na	Widening from existing 2 to 4 lanes (No Jurisdiction)	2.0	41	-
623	Route 3109 : Klong Toey to Chalakea Noi	Reconstruction of existing road to 2 lanes	4.2	128	No action
625	Route 3242 : Bang Khun Thian - Samut Sakhon	Reconstruction of existing road to 2 lanes	17.2	186	1989

DOH (Continued)

Project No.	Project Name	Description	Length (km)	Budget (B mill)	Scheduled Completion
626	Route 3268 : Sam Rong to Route 3344	Widening from 2 to 4 lanes (4 km) and reconstruction to single 2 lanes (8 km) (design stage)	12.0	100	-
627	Route 3278 : Bangkapi to Minburi	Widening from 2 to 4 lanes	8.8	232	1989
990	Route 1 / Route 31 : Don Muang - Rangsit	Upgrading	5.3	30	1991
640	Route 34 : Bangna - Bang Pakong	Upgrading (design stage)	40.0	400	-
631	Route 3 : Bang Tumru - Bang Pakong	Upgrading		186	1991
634	Route 3119 : Minburi - Lat Kabang	Upgrading	10.6	128	1987
2006/2007	Route 304				
2006	: Route 3202 - Minburi	Upgrading	7.1	211	1989
2007	: Minburi - Romklao	Upgrading (design stage)	2.2		-
2008	Route 3256 : Oonnuch (Lad-Krabung) - Amphoe Bangplee		13.5		1991
2009	Route 3 : Samut Prakarn - Bangpakong Section Samut Prakarn - Bangturu Part II	Upgrading Upgrading	13.3	163	1990
2010	Route 4 : Bangkok - Nakornpratom (Out bound)	Reconstruction (design stage)	32.0	150	-
2011	Route 3112 : Patumtani - Lat-Lhumkaeo	Reconstruction	14.0		1991
2012	Route 3035 : Amphoe Lad-Lhumkaeo - Banglane	Reconstruction (design stage)	21.0		-
2013	Route 3111 : Patumtani - Samkok	Improvement	6.2	24	1989
2014	Route 302 : Kaset Sart - Kaerai	Upgrading	5.0		1993
2015	Route 306 : Nonburi - Pakkred	Upgrading	10.0	300	1992
2016	Talingchan - Banbuatong	Upgrading	12.0	240	1992
2017	ORR ; eastern portion	New link	21.8	1,000	1994
2018	Bangpun - Bang Pa-in Vocational Centre	New link	9.8	208	1991
2019	Route 3113 : Sumrong - Thahin	Upgrading	6.0	140	1992
2020	Route 3344 : Route 34 - Samut Prakarn	Upgrading	9.0	220	1992
2021	Outer Ring Road : different level, Puttamontol Part II			120	1992
2022	Route 1 : Rangsit - Bang Pa-In	Upgrading	19.0	1,000	1993
2023	Route 303 : Bangprakod - Pomphrachun	Improvement	8.0	100	1992
2024	Route 3312 : Bangkwun - Khlong Luang Broadcasting	Improvement	11.0	60	1992
2025	Route 3242 : Route 35 - Samut Sakhon	Improvement	7.0		1992
2026	Route 1 : Wongnoi - Lumlukka		36.0	165	1992

ETA (Continued)

Project No.	Project Name	Description	Length (km)	Budget (B mill)	Scheduled Completion
301	First Stage Expressway ; Third Section	New cable stayed bridge along Chao Phraya River ; dual 3 lanes	10.3	915	
	Second Stage Expressway System		38.3	29,500	
3001	Sector-A	Elevated new road : dual 3 lanes	14.8	7,704	1993
3002	Sector-B	Elevated new road : dual 3	9.0	7,215	1996
3003	Sector-C1	Elevated new road : dual 2	8.0	3,516	1993
3004	Second Stage Expressway System	Withdrawn			
3005	Sector-D	Elevated new road : dual 3	6.5	5,778	
3008	Third Stage Expressway System	Conceptual Stage only	-	-	
3008(1) 3008(2) 3008(3)	Silom-Phet Kasem Phet Kasem-Bangkok Noi-Nakorn Chaisri Bang Kapi-Nonthaburi Bang Na-Samut Prakarn				
3006	Ekamai - Ram Indra Expressway	Elevated new road : dual 3 / dual 2		9,000	
	Rail Mass Transit (Stage I)	- Rama IV Line- 24 km, 24 stations - Sathon Line- 20 km, 19 stations - Memorial Line- 16 km, 17 stations	60.0	22,553	
912	Part I	L=35.93 km, 37 stations			1994
912(1)	Workshop	L=2.2 km(Yard Access)			
912(2)	Sathorn Line	L=12.46 km, 12 stations			
912(3)	Rama Center	L=6.35 km, 7 stations			
912(4)	Rama North	L=10,19 km, 11 stations			
912(5)	Rama South	L=6.94 km, 7 stations			
913	Part II	L=24.07 km, 23 stations			
913(1) 913(2)	Sathorn Line Memorial Line	L=8.07 km, 6 stations L=16 km, 17 stations			
951	Phetburi / New Phetburi Road Busway	Segregated busway ; Centrally located 2 lane, staggered bus stops, 2 new bus only flyover and concersion of 2 existing flyovers to bus only flyovers. Upgrading of 2 khlong bridges, ATC and busway priority signals required	9.1	400	No action
952	Taksin Road Busway	Centrally located 2 lane, Segregated, Staggered bus stop, upgrading of 3 Khlong bridges, ATC required	6.0	250	
953	Arun Amarin / Phrapinklao Bridge Busway	2 with-flow lanes ; segregated from other traffic, existing bus stops, 2 new bus only flyovers, bus priority signals, ATC required	2.2	35	

ETA (Continued)

Project No.	Project Name	Description	Length (km)	Budget (B mill)	Scheduled Completion
954	Rama IV Road Busway	Segregated busway ; Centrally located 2 lane staggered bus stops, 2 new bus only flyovers, bus priority signals, ATC required	8.75	450	
955	Din Daeng / Ban Khlong Song Busway	Segregated busway ; Centrally located 2 lane, ATC required	5.0	180	
956	Rama IV / Chan Road Busway	Segregated busway ; Centrally located 2 lane, ATC required	5.0	35	
957	Middle Ring road Busway	Segregated busway ; Centrally located 2 lane, ATC required	2.5	20	

5.3 Description of Selected Major Projects

This section describes major transport projects selected from the list shown in Table 5.2.2.

1) Regional Highways and Expressways

Krungthep - Chonburi Highway: The existing 4-lane Bang Na-Trat Highway is already congested and is clearly inadequate as the main link between Bangkok and the Eastern Seaboard. DOH plans to enlarge the existing highway to 6 lanes over the next two years and then would like to build a new toll highway between Krungthep and Chonburi, on an alignment to the north of the existing highway. The new 58 km highway, which would cost on the order of 5,000 million Baht, would connect via the planned Outer Ring Road to the rest of Thailand. ETA, however, has a competing suggestion which is to extend the expressway system to provide a tolled facility in the Bangkok-Chonburi corridor; this suggestion would be studied as part of the Third Stage Expressway Study, which ETA plans to launch shortly.

Outer Ring Road: Approximately 70km of a planned 170km Outer Ring Road have been constructed. DOH intends to bring forward construction of the eastern section of Outer Ring Road in view of the need to provide a by-pass to Bangkok, particularly for future traffic between the Eastern Seaboard and the rest of the country. The eastern section of Outer Ring Road would cost on the order of 7,000 million Baht.

Northeast Connections: Both DOH and ETA have suggestions for highways/expressways to link Bangkok and the northeast. DOH plans a 73km 6-lane highway between Rangsit and Saraburi, at a cost of approximately 4,000 million Baht; in addition, there is a proposal for a new highway to link Saraburi with Chachangsao. There is also a suggestion for an expressway to link Nakorn Nayok with Nakorn Ratchasima. The concession on the first project has been awarded to a local investor group.

Thon Buri - Pak Tho Highway: The existing 85km 2-lane road will be widened to 4 lanes plus frontage road, which then will be converted to toll road. The cost is approximately 2,830 million Baht.

2) Urban Roads and Expressways

Vibahavadi - Rangsit Highway: DOH has negotiated a 25-year concession with a German-Thai consortium to construct a 16 km elevated 6-lane highway over the existing 10-lane Viphawadi - Rangsit Highway, between Ding Daeng and Don Muang, at an approximate cost of 7,000 million Baht. Construction is expected to commence soon and last about three years.

Second Stage Expressway System (SES): ETA signed a contract in December 1988 with Bangkok Expressway Company Limited for SES construction and operation. Land acquisition is now under way, the construction will commence in 1990. SES will be opened for traffic partially by 1993 and fully by 1995. A total of 38.3 km elevated dual 3 lane (of which 8 km is dual 2 lane) toll road

will cost about 29.5 billion Baht, including land acquisition of 11 billion Baht.

Ekkamai/Ram Intra Expressway: Implementation of this ETA project has recently been approved by the Cabinet as a BOT scheme. A 26 km long elevated new toll road will be constructed at 9 billion Baht mostly on a new BMA at-grade road which is constructed simultaneously.

Third Stage Expressway System (TSES): ETA is undertaking feasibility study and detailed design of the project which covers the following corridors; Silom - Phet Kasem, Phet Kasem - Bangkok Noi - Nakorn Chaisri, Bang Kapi - Nonthaburi, and Bang Na - Samut Prakan.

Elevated Toll Road above Khlong Saen Saep (KSS): This project is being studied by the Special Task Committee organized under the Prime Ministers Office.

3) Rail Mass Transit System

The Mass Transit System Project (Stage-I): The project has been negotiated with investor groups. The Stage-I system comprises the following three lines:

- Rama IV Line	:	24 km	24 stations
- Sathorn Line	:	20 km	19 stations
- Memorial Line	:	16 km	17 stations
Total		60 km	60 stations

The system will be elevated except for a 1 km underground section. Six-car (maximum) trains with passenger capacity of about 200 per car will be operated at 4 minute and 15 minute intervals during peak hours and off-peak hours, respectively, with scheduled speed of 37 km/hr or maximum speed of 80 km/hr. It is expected that the system will carry about 3 million passengers a day. It is estimated that the construction will cost 22.5 billion Baht and require eight years, including land acquisition.

4) PWD Projects

PWD is solely responsible for the bridges across Chao Phraya River including approaches. Rama VI Bridge and New Krungthep have been committed, while Siphaya Bridge, Tavaes Bridge and Nakorn-In Bridge are being studied.

5) SRT Projects

SRT has a number of different proposals for the improvement of the existing facilities and utilization of SRT owned land for effective urban development. Investors have been called for international tender on the project of elevation of existing tracks and associated urban/commercial development of the SRT properties.

CHAPTER 6

URBAN GROWTH AND SOCIO-ECONOMIC FRAMEWORK

6. URBAN GROWTH AND SOCIO-ECONOMIC FRAMEWORK

6.1 Socio-economic Perspective of the BMR

This section presents the future perspective of economic activity, population, and employment in the BMR at large as a basis for forecasting the demographic framework of the study area.

1) Economic Activity

As described in Chapter 1, the BMR has been prominent leader of the national economic growth. In this sense, the future of the BMR economy depends on the target set for the development of the entire Thai economy.

In turn, the future scale of population and employment as the premise of the transportation planning in the study area is largely affected by how the economy of the BMR will grow.

Accordingly, this section will look at the economic growth of the BMR from the national point of view.

Based on the growth trend of the Thai economy and various economic prospects published by many institutions, this study makes the following assumptions about the growth process of the Thai national economy through the year 2006:

1. The heated growth of the national economy, after experiencing a boom in recent years, will gradually subside and the BMR's gross regional product (GRP) will slow down. Between 2001 and 2006, the annual growth will level off at an average rate of 5% per year throughout the country.

2. The Sixth Plan period will maintain the recent high growth. And the growth rate between now and 1996 will continue at an annual average of 7%, a level comparable to that achieved in 1987.

3. Regional development outside the BMR will take time. The success of regional development will, to a great extent, hinge on the successful dispersion of economic activity into local areas from the BMR. This study assumes that the average annual regional growth rate during the Sixth Plan period (1986-1991) will be equal to the average growth rate between 1980 and 1987, and that the growth will rise gradually from this year (1989) through 1996 to achieve an annual growth level of 4%. At the start of the 21st century, the regional growth will attain a level of 5%, which is comparable to the average national growth.

4. The BMR will lead the nation's economic growth, maintaining an average annual growth rate of 11.8% for the period from this year to 1996 on the same level as in 1987.

In summary, the BMR's regional economic growth rate, in contrast to the national economy, will be as shown in Table 6.1.1.

Table 6.1.1 Forecast of GRP Growth Rate, 1989-2006

(in %)

	1989-1996	1996-2001	2001-2006
BMR	11.8	6.8	5.0
Other provinces	4.0	4.6	5.0
Whole Kingdom	7.0	6.0	5.0

2) Population

For the purpose of plan formulation, policy making, and investment program selection, a number of estimations have been made about future population size. Of such estimates, the forecast made in the Bangkok Metropolitan Regional Development Proposals (hereinafter referred to as BMRDP) prepared by NESDB in 1986 is used as the basis of this study.

It should be noted, however, that the growth rate of the BMR's GRP was 9.64% per year in 1985-1987; that is, nearly twice as large as the 5.5% annual growth for the Sixth Plan period (1986 through 1991), on which NESDB based its population estimation in BMRDP.

If the economic growth in the BMR is accelerated, there will be a significant increase in incoming population into the BMR, where the labor force participation rate has already reached its maximum allowable limit (BMRDP 2.3.5 Labor Force).

This study revises its estimation of the population in proportion to the increase of GRP in excess of the NESDB estimation.

The future population increase as estimated by NESDB may be classified into two types, i.e., natural increase and net migration (Table 6.1.2).

The net migration rate is re-estimated in proportion to the increase in growth rate of the BMR's GRP, and the corrected net migration rate is employed to revise part of the NESDB population estimation.

The growth rate of a regional economy may be represented roughly as the sum of the growth rate of employed population and the growth rate of labor productivity. The growth of employed population can be classified into two groups; residents entering into the labor market and population incoming from outside. The increase due to residents entering into the labor market is realized by an increased labor force due to change in age structure and rise in labor force participation rate on one hand, and by a decreased unemployment rate on the other.

For the economic growth rate to rise by n percentage points, the product of the growth rates of employed population and labor productivity must be n times the expected value. If the forecast value of working age population does not change, then what matters is how high the increased labor force participation rate and decreased unemployment rate will boost the growth rate of resident employed population. Another important factor is how much productivity increase can be attained. These factors will determine the required rate of increase in net migration.

Table 6.1.2 Annual Rate of Population Increase by Natural Growth and Migration by NESDB

(in %)

	1989-1996	1996-2001
Increase by natural growth	1.3	1.2
Increase by migration	1.0	1.0
Total increase	2.3	2.2

Table 6.1.3 Comparison of Annual Growth Rate of GRP in BMR, NESDB and JICA Study

(in %)

	1989-1996	1996-2001
Forecast by NESDB	5.3	5.2
Forecast by JICA Study	11.8	6.8
Difference	6.5	1.6

The annual rate of GRP growth expected by NESDB is 5.5% for the period of 1986 through 1991, 5.2% for 1991 through 1996, and 5.3% for 1989 through 1996. This study, on the other hand, estimates the growth of GRP for the period of 1989 through 1996 at a level of 11.8%, a difference of 6.5 percentage points from the estimate of NESDB (Table 6.1.3).

As stated above, there are four factors to fill this gap: increased labor force participation (for example, through the conversion of non-labor force such as housewives into labor force), decreased unemployment, increased productivity, and increased net migration.

Supposing that about one-half of the above 6.5 percentage points is filled by the first three factors, the gap to be covered by the increased net migration is 3.3 percentage points. From the fact that the ratio of employed population to the total population is about one-half, the population increase rate caused by the migration should be raised by about 1.65 percentage points.

Similarly, difference in the rate of GRP growth between NESDB and this study is viewed for the period of 1996 through 2001. The growth forecast by the former is 5.2% per year while that of the latter is 6.8% per year, showing a gap of 1.6 percentage points. Assuming that 1 percentage point of this gap is filled by increased labor participation, decreased unemployment, and increased productivity, the remaining 0.6 percentage point will be covered by increased net migration. As a result, the rise in the population increase rate caused by migration will be 0.3 percentage point.

For the period of 2001 through 2006, the rate of natural population growth is assumed to be 1.2% and the rate of increase of migration 1.0%, making the rate of total growth 2.2%.

The above can be summarized as shown in Table 6.1.4.

Table 6.1.4 Revised Rate of Population Increase

(in %)

	1989-1996	1996-2001	2001-2006
Increase by natural growth	1.3	1.2	1.2
Increase by migration	2.65	1.3	1.0
Total increase	3.95	2.5	2.2

On the basis of the rate of increase in Table 6.1.4, the BMR population can be forecast as shown in Table 6.1.5.

Table 6.1.5 Forecast of BMR Population, 1989-2006

(in thousand)

	1989	1996	2001	2006
Population	8,513	11,164	12,631	14,083

3) Employment

The scale of future employment in the BMR is determined by the growth of GRP and the rise of labor productivity, both on a sector-by-sector basis. In this regard, the scale of future employment by sector is forecast, based on the following perspective of each sector on the premises of the BMR economic growth process through the year 2006 described previously.

1. Primary Industry

In the primary industry, production has demonstrated a significant increase in recent years, particularly during the period 1985 through 1987. In the long term, however, the increase will slow down to an extremely low level after 1996 due to decreasing farm land area because of urbanization.

In addition to the farming deterioration, labor productivity will rise at an annual rate of 5%, with the result that this industry's employment, now rated a little over 6% of the total employment, will appreciably shrink to a level of 2% in the year 2006.

2. Secondary Industry

The recent boom in the economy has helped the secondary industry achieve extraordinary growth, which will continue to act as a driving force to develop the economy of the BMR and Thailand through 1996.

After 1996, the growth of this industry will return to the state of pre-boom days, relinquishing its role as the engine of economic development to the tertiary industry.

Contribution to expanded production is equally shared by increased labor productivity and increased employment. By 1996, employment by the secondary industry will account for about one-third of the total employment, and this ratio will continue thereafter.

3. Tertiary Industry

Together with the secondary industry, this industry will continue to grow at a high level next to the secondary industry through 1996. After 1996, though gradually reducing its rate of growth, it will replace the secondary industry as the leader of economic development.

Its production expansion will, similar to the secondary industry, depend equally on increased labor productivity and increased employment.

Consequently, its share of employment, though slightly reduced by the pressure of growing secondary industry through 1996, will recover in the year 2006.

The employment forecast is shown in Table 6.1.6.

Table 6.1.6 Forecast of Employment by Sector

(in thousand %)

Section	Employment				Composition			
	1989	1996	2001	2006	1989	1996	2001	2006
Primary	199	166	152	127	6.2	3.3	2.6	1.9
Secondary	811	1,642	1,901	2,164	25.3	32.5	32.5	32.5
Tertiary	2,196	3,241	3,792	4,367	68.5	64.2	64.9	65.6
Total	3,206	5,049	5,850	6,658	100.0	100.0	100.0	100.0

6.2 Land Use Plan of the Study Area

1) Trend of Urban Development and Development Pattern

The present urban development policy of the government fails to provide a clear vision for the future development configuration of the BMR urban area. Under strong development pressure and lacking any effective means of control, this area is completely left alone to take its own course without guidance. Specifically, urban development in the belts along trunk roads is interwoven with unused vacant land. While high-rise building construction booms within the city's central district and on its periphery, the surrounding suburbs are eroded by a hodgepodge of random urban development operations. Thus, a chaotic mixture of various disordered urbanization movements are presented.

For the future of the BMR, the following points should be given due consideration from the socio-economic point of view:

1. The tertiary industry, especially management, finance, government administration, and professional services that are expected to develop along with the internationalization of Thailand and the capital, is likely to be located in the center of Bangkok. Accordingly, its related employment of workers (office workers called white-collar workers) will concentrate on the CBD.

2. Of the manufacturing industry, medium- and small-scale enterprises will evolve within Bangkok while the export-oriented industries that are awarded promotional privileges will be located in the five surrounding provinces to assume a leading role in each province for the development of the local economy.

3. The exploitation of unused land is in no way an easy job because of minutely segmented holding rights, lack of

accessibility to trunk roads, and various other reasons. In addition, many government-owned land lots within the central city or on its periphery will not be readily available for new development.

4. In comparison with peripheral areas, land prices go up toward the center of the city. Accordingly, residential development and business location tend to move outward.

5. Traffic congestion in the central city and on its periphery will cause the bases of various activities to move outward but, at the same time, will somewhat restrict the outward extension of urban belts from the handicap of long and time-consuming travel between their location and the central city.

In conclusion, the above urbanization trend suggests that the typical urban development for the future of the BMR will be based on the following three patterns:

1. Corridor Development Pattern

Allowing the formation of ribbon-type urban areas, appropriate communication facilities and other infrastructure will be constructed for more efficient and effective development of the urban corridor.

2. Concentric Pattern

Urban activities will be contained generally within the 30 km range. In order to build a high-density urban area, this pattern requires effective land-use regulations and the building of an intensive and efficient urban infrastructure.

3. Poly-centric Pattern

This will organize dispersed development operations into an organic system and build up the infrastructure required to promote the evolution of sub-centers.

Of these three, the concentric and poly-centric patterns require substantial socio-economic and urban-planning efforts for their materialization. Compared with these two, the corridor pattern is basically in line with the trend of urbanization and requires less, though substantial, efforts for guiding urbanization to the proper direction and for appropriate setting and evolution of urban activities.

Development patterns provide a basis for the forecast of future population and employment by zone as described later. The population and employment of each zone will be a premise for the forecast of its traffic demand. Since the purpose of this study is to establish a transportation plan, it is questionable to base such a plan on premises heavily dependent on administrative actions. In view of this, this study will adopt the concept of corridor-type development for the assumption of the socio-economic framework.

Figure 6.2.1 shows a conceptual view of the urban development pattern adopted.

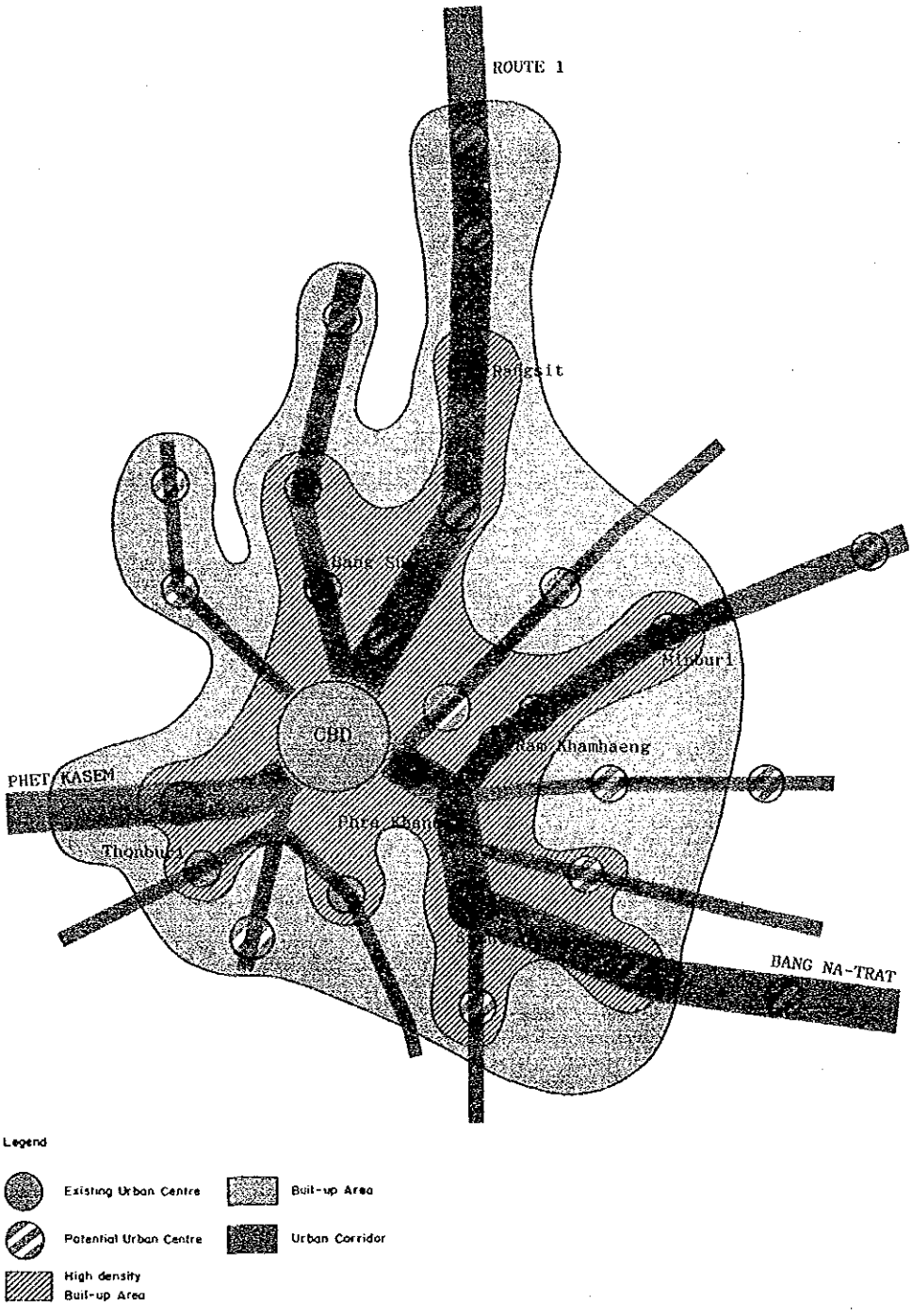


Figure 6.2.1 Urban Development Pattern

2) General Plan of the Study Area

The study area includes four general plan areas: BMA, Samut Prakan, Nonthaburi, and Pathum Thani, for which the land use plans as shown integratedly in Figure 6.2.2 are prepared by DTCP. Of these plans, the general plan for the BMA is now going through formalities for enforcement and will become effective in 1990.

An area of 104,600 ha, accounting for 64% of the total study area of 164,000 ha, is designated as the urban land-use area. One-half of this area, 52,100 ha, is the low-density residential area. The total residential area, including a 22,000 ha (21%) medium-density area and a 10,100 ha (10%) high-density area, is 84,200 ha, accounting for 80% of the total area. The high-density residential area is designated only in the BMR.

An area of 4,900 ha in total is designated as the industrial area, of which Samut Prakan and Pathum Thani with an area of 1,900 ha and 2,000 ha, respectively, jointly account for 80%.

For the commercial area, the BMA occupies 3,800 ha or 66% of the total of 5,800 ha.

The location pattern of land use designation indicates low-density residential area all over the eastern area and medium-density residential area and non-residential use area along the trunk roads.

The assumption of socio-economic framework by traffic zone is based on this land use plan.

Table 6.2.1 Area by Urban Land Use Category Designated by general Plans in the Study Area

(in hectare)

	Residential Area			Commercial Area	Industrial Area	Warehouse Area	Institutional Area	Total
	High	Medium	Low					
BMA	10,089	14,018	35,779	3,820	583	702	6,525	71,516
Samut Prakan	-	3,811	2,620	808	1,915	-	185	9,339
Nonthaburi	-	2,456	4,980	739	426	-	1,178	9,779
Pathum Thani	-	1,700	8,684	441	2,006	-	1,130	13,961
Total	10,089	21,985	52,063	5,808	4,930	702	9,018	104,595

Source: Calculated by Study Team based on the General Plan Maps prepared by DTCP

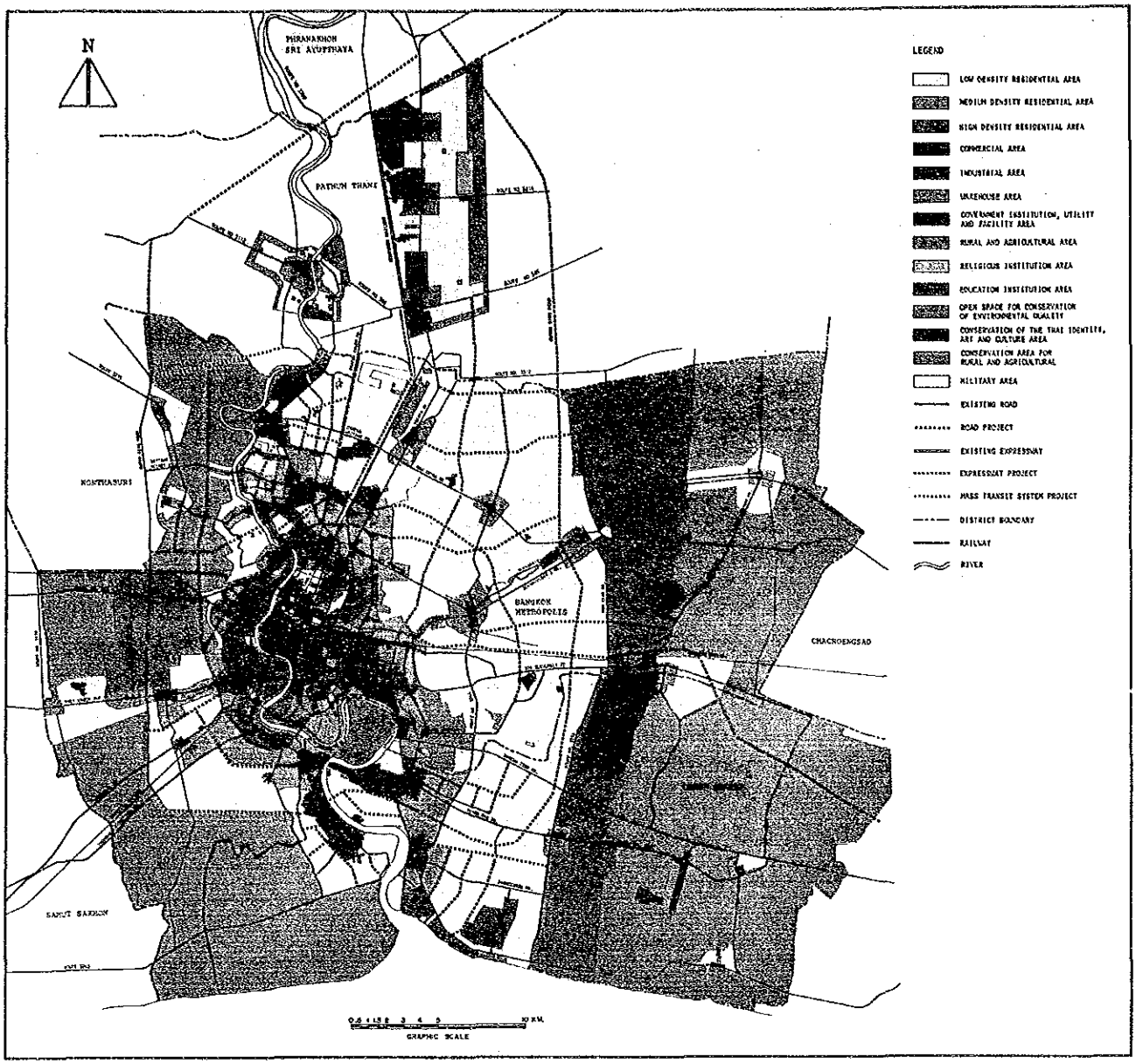


Figure 6.2.2 Land Use Plan Based on General Plans

6.3 Demographic Framework

Based on the urban development pattern in the BMR and the general plans for the BMA and others, this section will make a forecast of population, employment, and the number of students in the target year (2006) by zone in the study area. It should be noted here that the zonal forecast is made on 59 zones in the study area but, for the sake of convenience, is presented by province as shown in Figure 6.3.1.

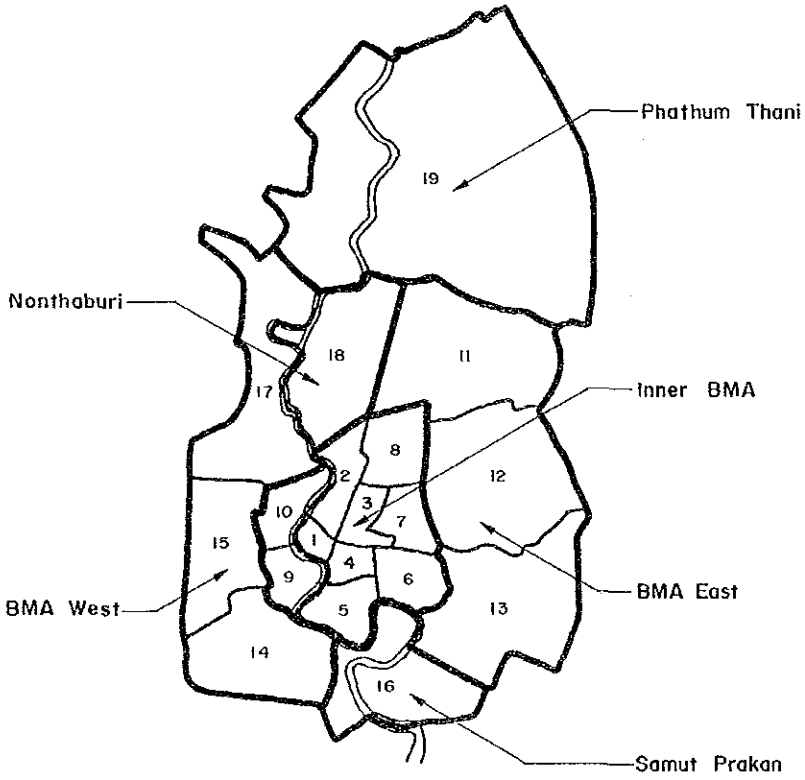


Figure 6.3.1 Provincial Division of the Study Area

1) Population

The population of the study area in 1989 is 6,357,000, accounting for 75% of the total BMR population of 8,513,000. The population of the study area in 2006, when the total BMR population will reach 14,083,000, is forecast based on the following conditions:

1. The rate of population increase in areas other than the study area is virtually equal to the rate of population increase in the total BMR in the 1980's.

2. Planned population by zone for the year 2001 provided in the general plan for BMA is regarded as a basis.

3. Population is distributed as heavily as possible in zones located along major trunk roads.

4. Referring to the general plans for BMA and others, a maximum limit of accommodation (or minimum limit for decreasing population zones) is computed for each zone to distribute population within the limit.

Table 6.3.1 Summary of Population by Zone, 1989 and 2006

(in thousand)

	1989	2006	2006/1989
BMA	5,365	9,101	1.70
Inner	3,707	4,773	1.29
East	1,182	2,957	2.50
West	476	1,371	2.88
Samut Prakan	321	547	1.70
Nonthaburi	454	692	1.52
Pathum Thani	216	512	2.37
Study Area	6,357	10,852	1.71

2) Employment

For the zone distribution of employment, the provincial trend of growth in each industrial sector is taken into consideration as follows:

1. Primary Industry

Although the annual production of each province may vary year-by-year, the long-term production growth for the period of 1970 to 1987 is extrapolated to obtain the production in the year 2006. In addition, the production is adjusted in consideration of possible decrease in farm land due to progressing urbanization in each province.

2. Secondary Industry

The significant growth of the manufacturing industry which has supported the recent economic boom is supposed to continue for some time in all the provinces. In addition, taken into consideration are the expansion of Lat Krabang Industrial Estate in the BMA, Samut Sakon Industrial Estate in Samut Sakon, Nawanakorn Industrial Estate in Pathum Thani, and other private industrial estates as well as the location trend of industrial factories to benefit from incentive measures taken by BOI.

It is also anticipated that, after 1996, some of the manufacturing industries located in BMA will be dispersed into the five neighboring provinces.

3. Tertiary Industry

The tertiary industry in each province will keep growing for some time to come. In addition, Samut Prakan and Samut Sakon situated along the corridor roads will raise their tertiary industrial employment per unit population to the level presently enjoyed by Nonthaburi, changing their industrial structure into one similar to the urban industrial structure. Pathum Thani will also raise its employment up to, though perhaps a little short of, that level. Nakon Pathom will see approximately the same employment growth as the population growth.

Next, the distribution to each zone is made by working out sectorial location models as shown below:

1. Primary Industry

The total number of employees in the primary industry is small, and an insignificant influence on the traffic demand estimation may be expected as the result of distribution by zone. Therefore, distribution was executed on the assumption that the future value of the employment in primary industry in each zone would decrease in proportion to the degree of decrease of the employment in primary industry by province. (Refer to Appendix F: Primary Sector Location Model for Economic Activity)

2. Secondary Industry

The employment in secondary industry was calculated in two separate fields: the construction industry and the manufacturing industry. The same percentage for the current employment in secondary industry by the PT survey was taken for the percentage of the future total of construction industry employment in the study area.

In the distribution of the construction industry employment by zone, house construction to cope with population increase and shop and office construction to cope with the tertiary industry employment are considered to have a significant influence. Therefore, half of the expected construction industry employment increase during the period 1989 through 2006 was allotted to the population increase, and the other half was distributed in proportion to the tertiary industry employment increase.

The manufacturing industry employment increase is attributable to the expansion of the current manufacturing industry concentration, and to the increase of local-service-type industries which are increasing in urban areas depending on local employees. In this Study, the product of the manufacturing industry's concentration (manufacturing industry employment by zone) multiplied by the population increase was taken as the locational potential of the manufacturing industry. Distribution was made in proportion to the relative ratio of the potential index of each zone.

The distribution model of employment in secondary industry according to the above-mentioned concept is presented in Appendix F: Secondary Sector Location Model for Economic Activity.

3. Tertiary Industry

The employment in tertiary industry has a 70% share. Its distribution, like the population distribution, has a significant influence over trip production. Because of the major significance, study was made on the location function to explain the current distribution of tertiary industry.

Consequently, the following linear expression was obtained.

$$Ei = 2272.3\ X_{1i} + 5132.1X_{2i} + 13212.5X_{3i} + 40318.0X_{4i} + 11937.3 \quad (R = 0.92)$$

where

Ei : Tertiary industry employment in zone 'i'
X1i : Tertiary industry locational potential (Relative magnitude of surrounding population discounted by distance from zone 'i')
X2i : Trunk road density (km/km2)
X3i : Commerce specialization factor (-1 to 2)
X4i : Special zone dummy variable (e.g., zone "31" having the airport will get 1, and other zones 0.)

The above relationship was applied to the increased portion of the employment in tertiary industry to calculate the future value by zone. For details of the model, refer to Appendix F: Tertiary Sector Location Model for Economic Activity.

The result of such distribution can be summarized as shown in Table 6.3.2.

Table 6.3.2 Summary of Employment by Sector and by Zone, 1989 and 2006

(in thousand)

	1989				2006			
	Primary	Secondary	Tertiary	Total	Primary	Secondary	Tertiary	Total
BMA	18	487	1,724	2,229	11	1,206	3,319	4,535
Inner	11	331	1,346	1,688	7	683	2,350	3,039
East	3	103	282	388	2	331	695	1,028
West	4	53	96	153	2	192	274	468
Samut Prakan	2	47	70	118	1	132	175	308
Nonthaburi	15	35	102	152	7	95	231	333
Pathum Thani	7	40	43	90	3	121	106	230
Study Area	42	609	1,939	2,590	22	1,553	3,831	5,406

3) Number of Students

The term "student" in this section applies to high school students, vocational school students, and university students, all aged 15 or over for the sake of convenience, students in the age group 15 to 18 are classified as high school students and those aged 19 or over as university students.

The living place basis distribution of students can be estimated based on the population distribution. On the other hand, the zone-wise student numbers are estimated in the following procedure.

The zone distribution of students is based on zones where the schools and universities are located.

In the first place, the total number of students in the study area is forecast on the following assumptions:

1. The future ratio of school attendance to the total population of the same age group is assumed to rise from the present level of 77.5% to 83.5% for high school students and from the present level of 34% to 37% for university students.

2. The ratio of the corresponding age-group population to the total population will drop from the present level of 7% to 6.5% for high school students and from the present level of 12.3% to 11% for university students.

3. The number of students coming to study in the study area from outside areas will increase from the present number of 13,300 to 19,800.

Then, the future number of high school students is distributed in proportion to the future population in each zone, and the number of university students is distributed in proportion to the existing number of university students in each zone.

The result is summarized in Table 6.3.3.

Table 6.3.3 Summary of Students by Zone, 1989 and 2006

(in thousand)

	1989	2006	2006/1989
BMA	578	977	1.69
Inner	360	623	1.73
East	189	293	1.55
West	29	61	2.10
Samut Prakan	12	22	1.83
Nonthaburi	23	42	1.83
Pathum Thani	19	37	1.95
Study Area	633	1,078	1.70

CHAPTER 7

FUTURE TRAFFIC DEMAND

7. FUTURE TRAFFIC DEMAND

7.1 Forecasting Method

A demand forecast model aims at describing universal relationships in mathematical forms between trip data and socio-economic data, which are considered to be unchanging in the future. Future traffic demand is forecast in the following normative procedure, which is called the "four-step method."

First-step : Trip generation/attraction forecast
Second-step: Trip distribution forecast
Third-step : Modal split
Fourth-step: Traffic assignment

Main input and output of each step are shown in Figure 7.1.1.

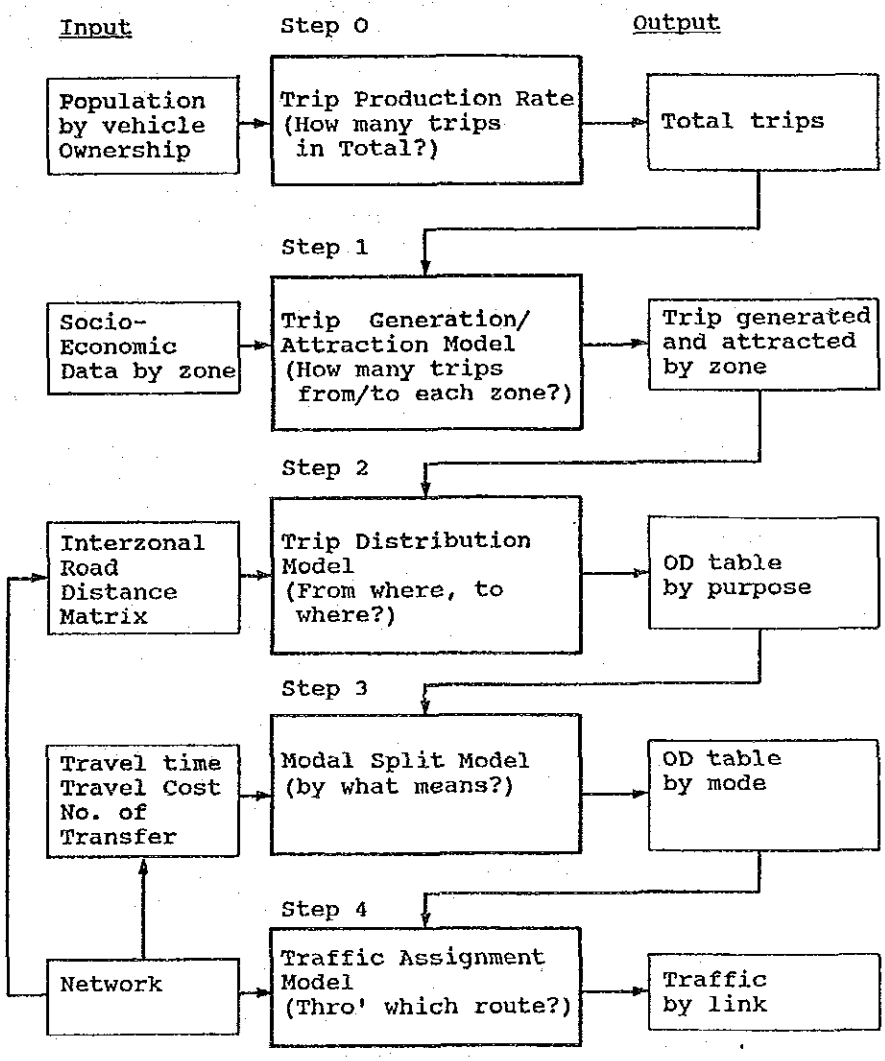


Figure 7.1.1 Procedure of Transportation Demand Forecast

Prior to the estimation of the generated and attracted trips, future car-ownership was estimated by zone using the logistic type models which are explained in the next section. In addition, trips by public transportation were split into those by bus and those by rail transit, not by a model but as the result of traffic assignment onto the network.

The four-step method is applied only to the trips made by the inhabitants in the study area. The future traffic by those living outside the study area and the traffic volume outside the area are estimated by a simple estimation method using the growth-rate. The four-step method is not used for the traffic volume outside the study area, because it is not covered by the person trip survey and no sufficient information for the estimation is available. Also, the traffic volume to/from outside the study area is as low as 6% of the total traffic, and is thereby considered to have insignificant influence on the total estimation accuracy.

For the business-use truck traffic, an aggregate growth rate was estimated in relation with the regional economic growth, and to estimate each OD traffic, average growth factors of passenger car trips at the origin and destination zones were applied.

1) Trip Generation and Attraction

The present trip production rates by car ownership are considered as an unchanging factor in the future and are used to forecast the total number of trips as a control total.

According to the person trip survey results, trip production rates are:

Non-vehicle-owning family member	1.57 trips/day
Motorcycle-owning family member	2.55 trips/day
Car-owning family member	2.97 trips/day
Motorcycle- and car-owning family member	3.21 trips/day

Zone-wise, generated and attracted trips are forecast by car ownership and by trip purpose. Generated trips going back home ("home" trip) are not estimated but considered as the sum of attracted trips with purposes other than business purpose. In the same way, attracted "home trips" are the sum of generated trips with other purposes.

Linear type regression models are developed to estimate generated and attracted trips, using socio-economic data as explanatory variables.

$$Gi = K + \alpha iXi1 + \beta iXi2 + \cdots\cdots$$
$$Aj = K + \alpha jXj1 + \beta jXj2 + \cdots\cdots$$

where;

Gi : Generated trip from Zone i
Aj : Attracted trip to Zone j
Xn : Socio-economic data
K, α, β : Parameters

In the case of trips with private purpose, there are some zones with significant gaps between estimators and actual values. In such zones, dummy variables are used. Parameters of models and zones with dummy variables are shown in Table 7.1.1.

Table 7.1.1 Trip Generation and Attraction Models

Y Purpose	Y=a+b1.X1+b2.X2					
	a	b1	b2	X1	X2 Dummy	r
1) Non-Motorized Trip Generation						
To Work	2549.44	0.456		Worker		0.885
To School	1052.65	1.586		Student-Home		0.829
Business	856.19	0.150		Tertiary		0.851
Private	2903.21	0.145	9230.58	Populat	1	0.855
Trip Attraction						
To Work	462.59	0.365		Tertiary		0.905
To School	4694.34	0.425		Student-School		0.899
Business	-31.02	0.174		Tertiary		0.863
Private	-109.74	0.312	16667.20	Tertiary	1	0.824
2) Motorized Trip Generation						
To Work	817.01	1.256		Worker		0.943
To School	877.85	2.198		Student-Home		0.915
Business	-630.70	0.656		Tertiary		0.924
Private	2884.59	0.326	13934.75	Populat	1	0.841
Trip Attraction						
To Work	-5221.16	1.009		Tertiary		0.950
To School	5992.28	0.604		Student-School		0.887
Business	-2614.63	0.708		Tertiary		0.932
Private	-1400.11	0.577	23917.98	Tertiary	1	0.929

Zone with dummy variable = 1

1) Non-Motorized
Trip Generation 1,5,9,11,20,21,24,31,35,36,42,54
Trip Attraction 24,32,34,55,59

2) Motorized
Trip Generation 1,5,9,11,20,21,24,36,51
Trip Attraction 10,24,32,34,36

2) Trip Distribution Model

Voorhees-type gravity models were developed to estimate interzonal trips by car ownership and by trip purposes. "Home" trips are estimated in the same way as generated and attracted "home" trips, explained by trips with other purposes.

(1) Interzonal Trips

$$Tij = Gi \frac{Aj \cdot Dij^{\alpha}}{\sum Aj \cdot Dij^{\alpha}}$$

where;

Tij	:	OD trips between zone i and j
Gi	:	Generated trips from zone i
Aj	:	Attracted trips to zone j
Dij	:	Road distance between zone i and j (km)
α	:	Parameter

Table 7.1.2 Parameters of Trip Distribution Models

Trip Purpose / Car-ownership	Work	School	Business	Others
Car-owning family member	-0.867	-1.067	-0.317	-1.467
Non-car-owning family member	-1.341	-0.867	-0.167	-1.163

(2) Intrazonal Trip Model

$$Tii = K \times Gi^{\alpha} \times Ai^{\beta}$$

where;

Tii	:	OD trips within zone i
Gi	:	Generated trips from zone i
Ai	:	Attracted trips to zone i
K, α, β	:	Parameters

Table 7.1.3 Parameters of Intrazonal Models

Trip Purpose	Car-owning family member			Non-car-owning family member		
	K	α	β	K	α	β
Work	0.0036	1.1610	0.2545	1.7774	0.3806	0.3796
School	0.0190	0.9381	0.3600	0.1491	0.6429	0.4243
Business	0.7748	0.0488	0.7275	0.1962	0.3897	0.5315
Private	0.5187	0.3938	0.5439	6.9068	0.0060	0.6737

3) Modal Split

The OD trips by purpose were converted into the OD traffic volume by mode following the binary choice method shown in Figure 7.1.2. However, each modal split of public traffic demand is determined not by the modal split model but as the result of traffic assignment mentioned on the following page.

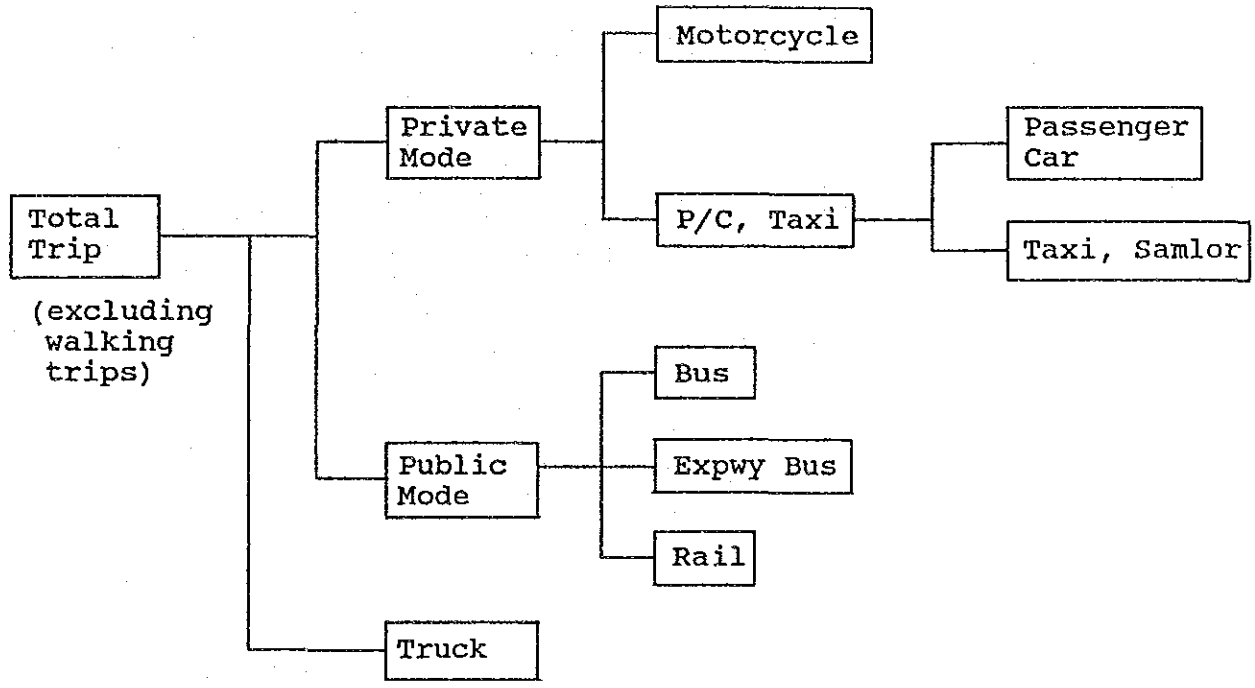


Figure 7.1.2 Order of Binary Choice for Modal Split

(1) Private Mode vs. Public Mode

The model to classify the total OD trip volume into private mode and public mode was prepared for each category of trip purpose and by vehicle ownership and non-ownership. In this classification, taxi and samlor, though public modes, are classified as private mode, since they are operated as private in their nature as passenger cars. Conversely, company and school buses, though private modes, are classified as public buses for convenience.

The model used is the Logit model, which can explain the share of private mode with three variables such as time difference, cost difference, and number of transfers in the public modes are used. This can be expressed in the following formula.

$$p = 1/ (1 + \exp (A + B \Delta T + C \Delta C + D \cdot N))$$

where;

- p : Share of private mode
- ΔT : Travel time difference (public-private in minutes)
- ΔC : Travel cost difference (public-private in Baht)
- N : Times of public mode transfer
- A, B, C, D : Parameters

Table 7.1.4 Parameters of Private and Public Modal Split Model

Vehicle Owning	A	B	C	D
Work	-1.689	-0.073	-0.120	-0.215
School	-0.703	-0.162	-0.382	
Business	-2.601	-0.008	-0.169	-0.701
Private	-1.103	-0.093	-0.302	-0.254
Non-Vehicle Owning	**A**	**B**	**C**	**D**
Work	1.148	-0.092	-0.284	-
School	2.264	-0.056	-0.366	-
Business	-1.101	-0.010	-0.165	-
Private	1.378	-0.046	-0.114	-

(2) Other Split Ratios

The split ratio of motorcycle and passenger car (including pick-up and taxi) has currently proved nearly equal to the ratio of the number of units owned in the origin zone multiplied by the average number of passengers. It was presumed, therefore, that each split ratio would be the same as the ratio of the said product in the future. For business trips, however, the ratio of attracted trip ends of commuting trips to a zone by motorcycle and car was used as the ratio of business trip ends generated from the zone.

For the ratio of passenger car (including pick-up) and taxi (including samlor), the current split ratios by zone were applied for the future.

4) Traffic Assignments

The OD tables to be assigned to a network were prepared for five transport mode types: motorcycle, passenger car, taxi, truck, and public transportation passengers. As mentioned above, the public mode demand can consequently be split into bus, express bus, and rail transit system after assignment work.

The assignment of the OD traffic volume of each mode to the transportation networks is done by the multi-step shortest path method. This method distributes the OD traffic volume part-by-part in several times considering the relationship among the capacity, traffic volume, and speed in each link (section) of traffic networks. (In this study, assignment was made five times, and the OD traffic volume split ratio was made as follows: 30%, 30%, 20%, 20%, 10%).

Prior to the assignment, all the OD traffic volume of various modes was converted into passenger car units (pcu). The average number of passengers of each mode and the passenger car equivalent (pce) used for the conversion are shown in Table 7.1.5.

Table 7.1.5 Average Number of Passengers and Passenger Car Equivalent

Vehicle Type	Avg. Number of Passenger	PCE
Motorcycle	0.25	1.36
Passenger Car	1.00	2.08
Taxi	1.00	1.21
Samlor	0.60	1.21
Heavy Truck	2.50	2.20
Bus, Mini-bus	2.00	21.00

As the necessary input for making the assignment, each road link is identified by nodes at both ends (intersections), length and Q-V curve. The Q-V curve shows the relationship between the traffic volume (Q) and the speed (V) of vehicle under such a traffic volume. Basically, in this study, the Q-V curves determined by the STTR were used. Figure 7.1.3 represents a general Q-V curve, while Table 7.1.6 shows types of Q-V curves.

As shown in Figure 7.1.4, the assignment work was made five times each for motorcycle, public mode, passenger car, taxi, and truck. (For motorcycle, however, 50% each was distributed in the first and the second assignment.) For each step and mode, both the shortest route search in the network consisting only of ordinary roads and the shortest route search in the network including toll expressways were performed. Comparing both results, and judging whether the time difference can justify payment for toll expressway charges, total OD traffic volume was assigned to the favorable route. The toll express facilities taken into consideration are expressway, express bus road, and rail transit.

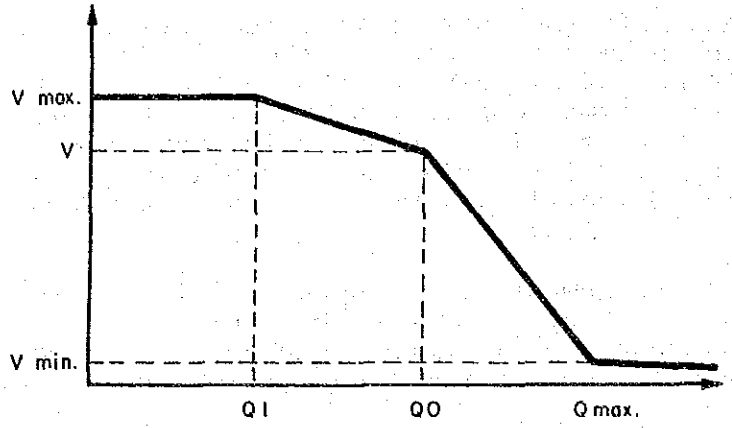


Figure 7.1.3 Q-V Curve (Traffic Volume and Velocity)

Table 7.1.6 Speed - Flow Curves

Model No.	Type of Road	Location	No. of Lanes	Free-Flow		Capacity		Cut-Off Point	
				V max (km/hr)	Ql (veh/day)	V (km/hr)	Qo (veh/day)	V min (km/hr)	Q max (veh/day)
1	Ordinary Road	Chinatown	2	30	6,400	10	16,000	10	19,200
2			4	35	19,200	10	48,000	10	57,600
3			6	35	28,800	10	72,000	10	86,400
4			8	35	38,400	10	96,000	10	115,200
5			10	35	67,200	10	168,000	10	201,600
6			one-way 2	35	9,600	10	24,000	10	28,800
7			one-way 4	35	19,200	10	48,000	10	57,600
8		Central Area	2	35	6,400	20	16,000	2	19,200
9			4	40	19,200	20	48,000	2	57,600
10			6	40	28,800	25	72,000	2	86,400
11			8	40	38,400	25	96,000	2	115,200
12			10	40	48,000	25	120,000	2	144,000
13			one-way 2	40	9,600	20	24,000	2	28,800
14			one-way 4	40	19,200	20	48,000	2	57,600
15			one-way 6	50	28,800	25	72,000	2	86,400
16			one-way 8	50	38,400	25	96,000	2	115,200
17		Rural Area	2	45	6,800	30	17,000	5	20,400
18			4	50	27,200	40	68,000	5	81,600
19			6	60	40,800	45	102,000	5	122,400
20			8	60	54,400	45	136,000	5	163,200
21	Expressway	Urban	6	80	48,000	70	120,000	0	150,000
22		Ramp	2	20	6,400	10	16,000	5	19,200
23	Super Highway		10	70	48,000	30	120,000	0	144,000

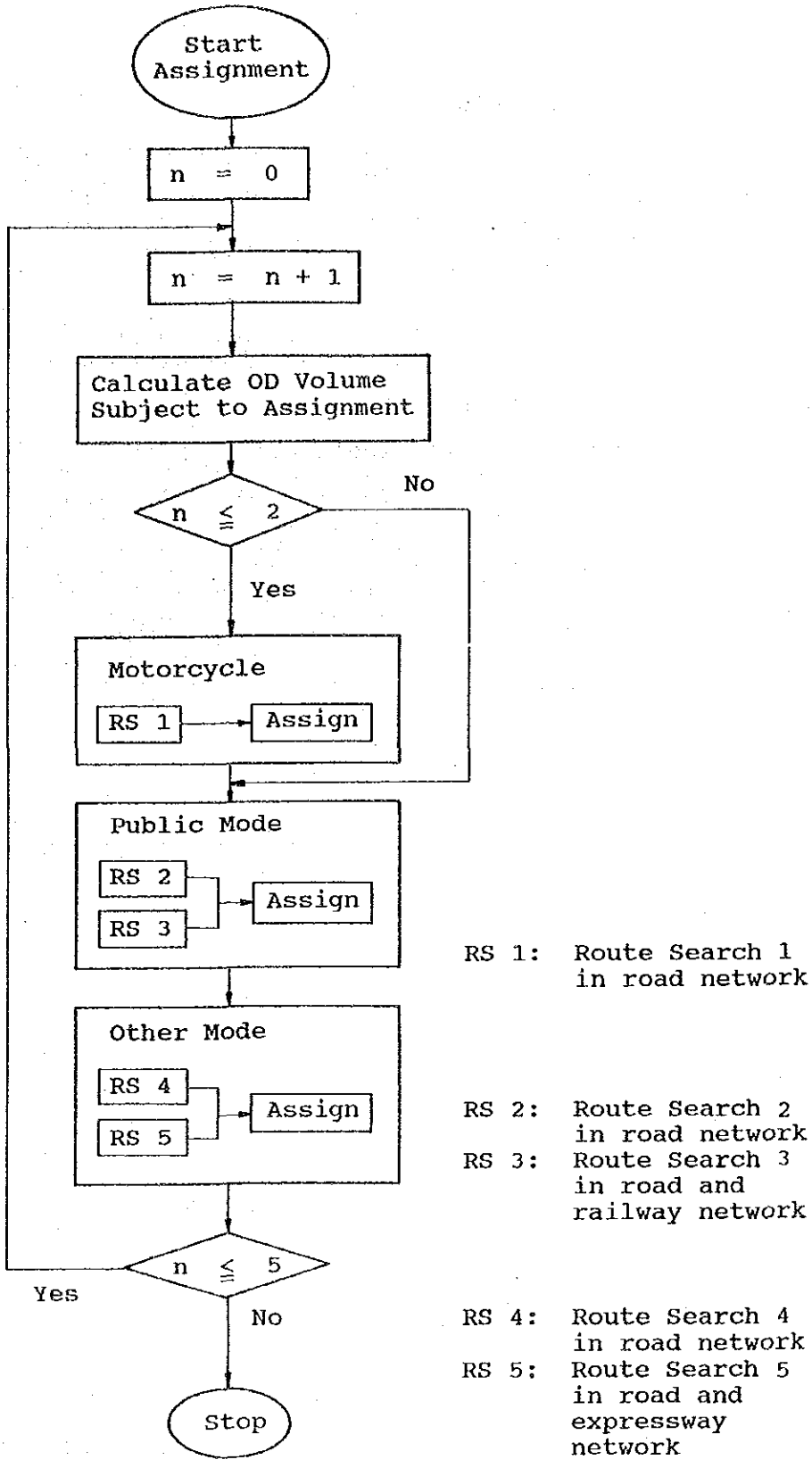


Figure 7.1.4 Traffic Assignment Procedure

7.2 Future Vehicle Ownership

Through analysis of the current demand structure, it has been clarified that the trip generation ratio is greatly affected by vehicle ownership. To project the future traffic volume, therefore, it will be necessary to project the future vehicle ownership by zone. This projection is made in the following three steps by the household unit.

a. Projection of total number of vehicles
b. Projection of total vehicle-owning households
c. Projection of vehicle-owning households by zone

1) Projection of Total Number of Vehicles

The number of passenger cars (including pick-up vans) and that of motorcycles registered in the study area have increased in the past 10 years as shown in Figure 7.2.1. Motorization in Bangkok has gradually developed from the mid 1970s, and has drastically accelerated in the 1980s. Passenger cars, which numbered 327,000 in 1979, reached 979,000 in 1988. The average increase rate during this period was 11.6%, while the population increase rate was about 2%. Consequently, the ownership ratio of passenger cars has achieved a rapid growth. Motorcycles have made an even more rapid increase, from 154,000 to 830,000 in the 10 year period, growing 5.4 times (annual average 18.4% growth).

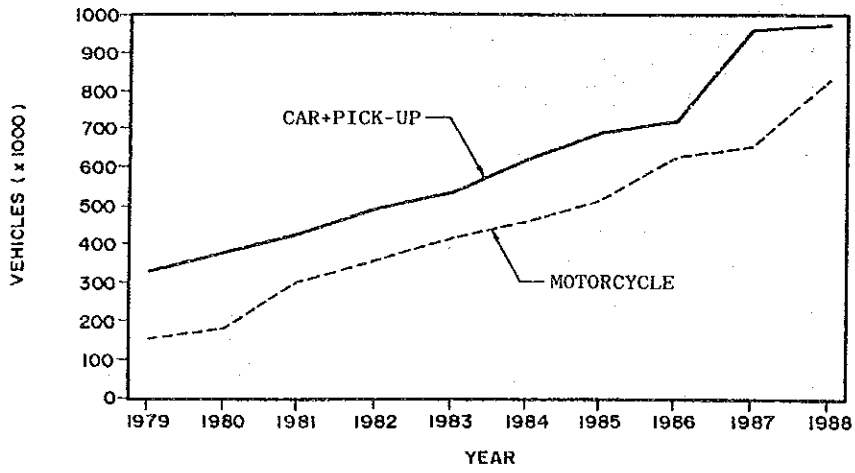


Figure 7.2.1 Number of Registered Vehicles in the Study Area

As the result of examining the suitability using various models as to the above trend, the logistic curve to explain the ownership per 1,000 persons was employed. The total number of passenger cars and motorcycles can be obtained by multiplying the total population by M, calculated in the following formula. Figure 7.2.2 shows the result of applying this curve to the time-base change of the ownership ratio.

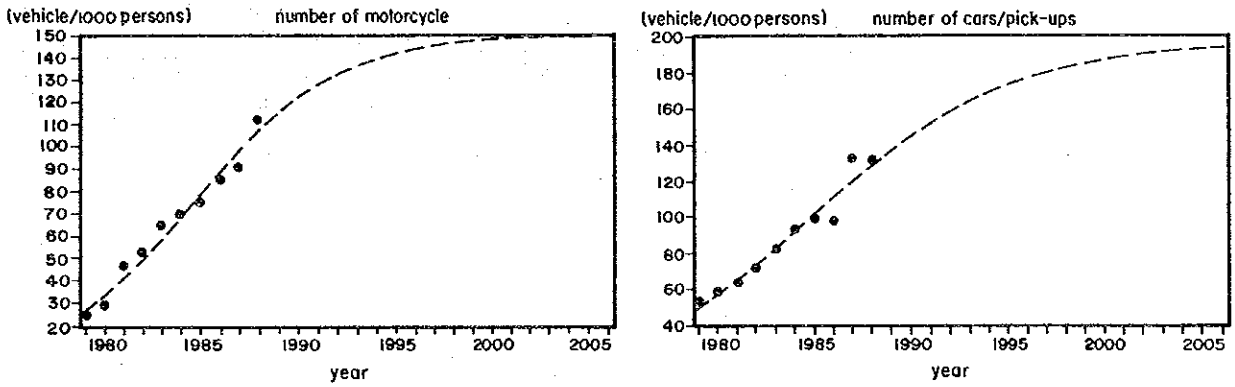
$$M = S / (1 + K e^{-at})$$

where;

M : Ownership per 1,000 persons
t : Year (1979 is taken as 0)
S, k, a : Parameters (See Table 1.1.)

Table 7.2.1 Parameters of Vehicle-Ownership Ratio Trend Regression Curve

	S	k	a
Motorcycle	150.0	6.12	0.27
Passenger car	200.0	3.65	0.19



(1) Motorcycle (2) Car/Pick-up

Figure 7.2.2 Logistic Curve adapted to Vehicle-Ownership Trend

The projection result is shown in Table 7.2.2. Motorcycles and passenger cars are expected to increase to 2.0 and 2.2 times the current figures, respectively, by the year 2006. The current passenger-car-ownership ratio is 153 per 1,000 persons. It is expected to reach approx. 200 in 2006. At present, 47% of the total number of passenger cars in Thailand are registered in the study area, but the percentage will slightly decrease to 44% by 2006.

Provided that the above growth rates are achieved, the GRDP in 2006 will become 3.87 times the current product. Since the expected population increase during this period is 1.71 times, the household income increase will be 2.26 times.

From the above, the ratio of households owning more than two vehicles to the total number of households in the study area can be calculated by the following formula.

$$Mc = \sum_{i} ni \cdot f(Pi)$$

where;

Mc : Ratio of households owning more than two vehicles
ni : Ratio of households of income level i
f(Pi) : Ratio of households owning two vehicles of income level Pi

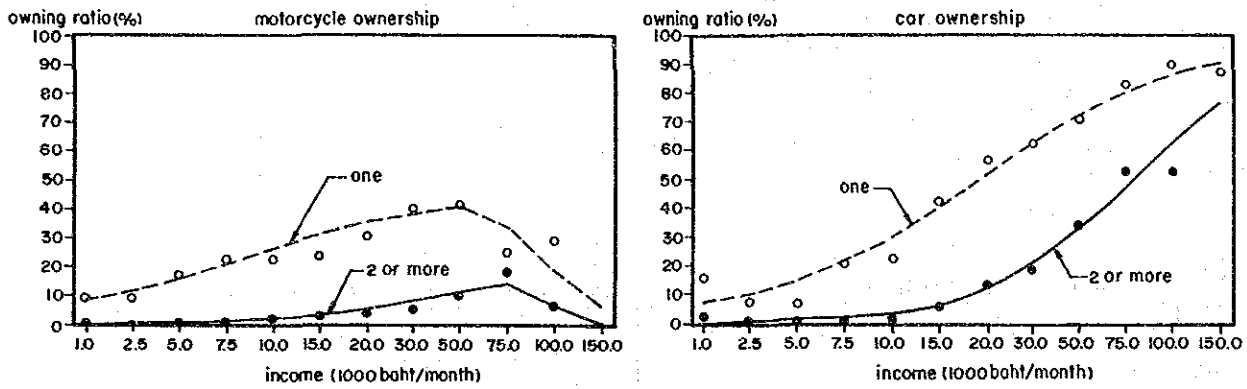


Figure 7.2.3 Multi-vehicle-owning Household Ratio by Income Level

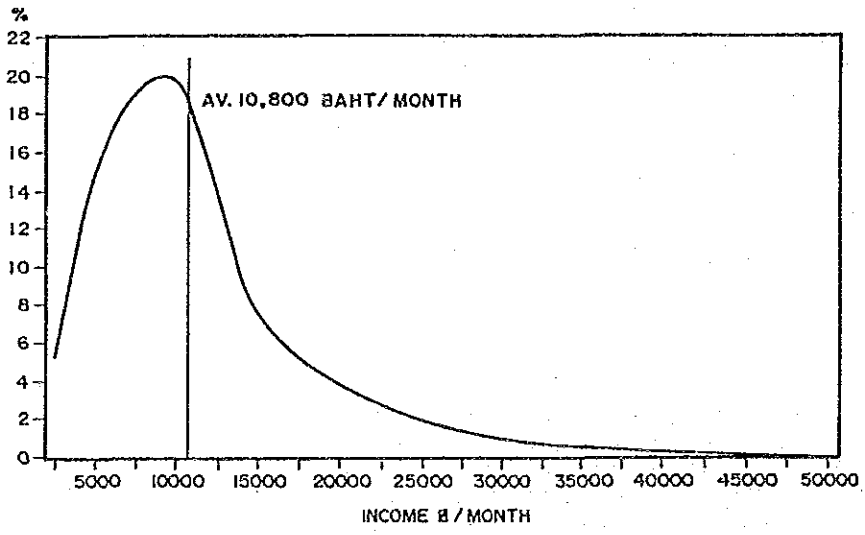


Figure 7.2.4 Household Income Distribution, 1989

Table 7.2.2 Projection of Vehicles in the Study Area

(1000 vehicles)

	1988	1996	2006
Motorcycle	821.5	1,087.0	1,627.9
Passenger Car	972.1	1,353.2	2,170.5

The number of owned vehicles obtained as a result of the PT survey is limited to the vehicles owned by the general households located in the study area. Therefore, there is some difference between this number and the number of vehicles of the previously mentioned registration base: The number of vehicles counted in the PT survey stands for 55.1% of the registered motorcycles and 66.2% of the registered passenger cars. The rest are expected to be vehicles owned by companies and governmental bodies or those registered in the study area but owned by households in areas other than the study area. In the future projection shown below, vehicles owned only by the general households in the study area are considered, and the ratio of the vehicles owned by household to the total is assumed to be the same as the current one.

2) Projection of Total Number of Vehicle-owning Households

From the analysis of the current status of the vehicle ownership and the household attributes in the PT survey, it has been clarified that the vehicle ownership ratio is closely related to the household income. Therefore, a regression model has been structured as follows in order to explain the number of vehicle-owning households using the future average income.

(1) Projection of Multi-vehicle-owning Household Ratio

The multi-vehicle-owning household ratio by income level for motorcycles and passenger cars is shown in Figure 7.2.3. It is assumed that this ratio will not change in the future.

The household income distribution as of 1989 in the study area is as shown in Figure 7.2.4 based on the result of the PT survey. As to the future, gross product per capita is calculated based on the GRDP of BMR assumed within the population frame in the previous chapter, and it is further assumed that the household income will increase at the same growth rate. In this calculation, it is assumed that the same household income growth rate is uniformly applicable to any income level.

GRDP Annual Growth Rate

1989 - 1996	11.1%
1997 - 2001	6.8%
2002 - 2006	5.0%

(2) Projection of Number of Vehicle-owning Households

From the above result, the number of vehicle-owning households in the whole study area can be projected as follows.

* Number of households owning two or more vehicles

$$F_{2M} = F.M_{CM}$$
$$F_{2C} = F.M_{CC}$$

where;

F_{2M}, F_{2C} : Number of households owning two or more motorcycles or passenger cars

M_{CM}, M_{CC} : Ratio of households owning two or more motorcycles or passenger cars

F : Total number of households

* Number of households owning one vehicle

$$F_M = V_M - 2.14F_{2M}$$
$$F_C = V_C - 2.21F_{2C}$$

where;

F_M, F_C : Number of households owning one motorcycle or passenger car

V_M, V_C : Total corrected number of motorcycles or passenger cars owned by individuals

Parameters: Average number of owned vehicles

* Number of multi-vehicle-owning households

$$F_{MC} = 0.158(F_{2C} + F_C)$$

* Number of households owning no vehicle

$$F_N = F - (F_{2C} + F_C + F_{2M} + F_M - F_{MC})$$

Table 7.2.3 shows the results of the projection. The motorcycle-owning household ratio grows from the current 23.8% to 27.8%, and the passenger-car-owning household rate from 30.7% to 36.2%.

Table 7.2.3 Projection of Households by Car-ownership

(1000 households)

	1989 households (%)	2006 households (%)
Motorcycle	326.0 (19.0)	646.3 (22.1)
Car	443.4 (25.9)	891.6 (30.5)
M/C and Car	83.1 (4.8)	167.1 (5.7)
Non-owning	862.1 (50.3)	1,221.2 (41.7)
Total	1,714.7(100.0)	2,926.4(100.0)

3) Vehicle-ownership by Zone

In the same manner as stated in the case of total number of vehicle-owning households, the number of vehicle-owning households by zone can be calculated. This was adjusted so that the total of the vehicle-owning-households of all zones was equivalent to the total number of vehicle-owning households. The future average income by zone is calculated basically by referring to the current income differential by zone. For a zone where the land use may greatly change, determination was made referring to the future average income level in other zones having a similar image to that expected in the future for the zone.

Projection of households owning both motorcycle and passenger-car is performed using the following formula. Figure 7.2.5 shows the basis of the formula.

$$R_{MC} = 0.7(R_M \times R_C)$$

where;

R_{MC} : Multi-type-vehicle-owning household ratio
R_M : Motorcycle-owning household ratio
R_C : Passenger-car-owning household ratio

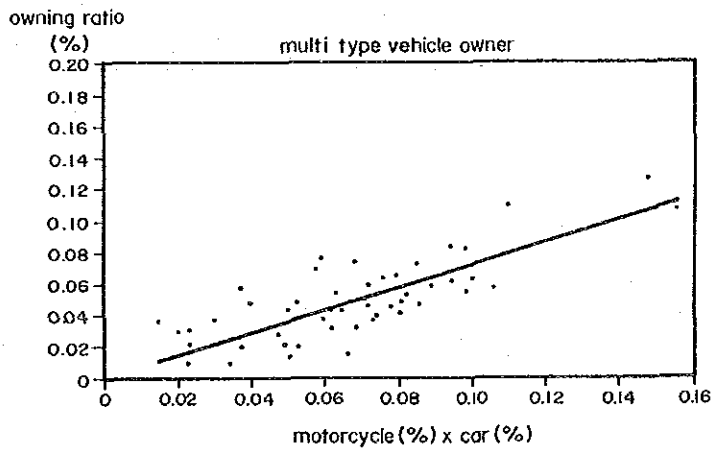


Figure 7.2.5 Multi-type Vehicle Ownership

Table 7.2.4 and Figure 7.2.5 show the number of vehicle-owning households by zone, and Figure 7.2.6 shows the vehicle-owning household ratio. In the center of the city, the vehicle number maintains the same level or decreases, reflecting the trend of population decrease, while a sharp increase is observed in the zone between the Middle Ring Road and the Outer Ring Road. The growth rate is remarkable particularly in the zones located on the urban corridor described in the previous chapter.

Table 7.2.4 Vehicle-Owning Household by Zone, 1989 and 2006

Zone	The Year of 1989					The Year of 2006				
	M/C Only	Car+Pic Only	Mo+Car/p	No-veh	Total	M/C Only	Car Only	M/C+Car	No-Veh	Total
1	19232	20962	8031	35683	83908	8188	21405	8131	38594	76318
2	23402	38599	5782	65602	133385	32572	45274	6842	65228	149916
3	16709	31138	4308	52000	104155	21442	31495	4347	40989	98273
4	22232	31331	6273	40373	100209	19691	27640	6843	23297	77470
5	23835	28681	7625	52554	112695	22931	30351	8088	42011	103381
6	9772	30938	3184	34098	77992	33147	72481	7412	59216	172255
7	10809	20251	3121	32711	66892	23400	36867	5625	41609	107501
8	8477	16643	2301	29611	57032	37881	60262	7788	78119	184049
9	38385	29126	6508	71677	145696	54860	58726	12126	65357	191070
10	33470	26780	3075	59879	123204	39574	41083	7353	39542	127553
11	17051	27807	3941	44707	93506	65846	96842	13914	110500	287102
12	16430	41807	7023	63018	128278	47189	76884	12641	100389	237102
13	12574	27175	3567	50957	94273	50946	86255	13752	122487	273441
14	13482	13457	3868	35692	66499	51184	60667	17866	92648	222365
15	10257	12538	2248	35150	60193	32366	38431	8135	67979	146911
16	17346	9948	3228	57559	88081	36644	24860	6593	78156	146252
17	10934	11050	3101	42220	67305	13929	15357	4013	42473	75772
18	7678	16890	3071	26212	53851	21965	37856	7003	46020	112844
19	13960	8309	2861	32420	57550	32614	28913	8660	66639	136825
Total	326035	443430	83116	862123	1714704	646367	891650	167129	1221254	2926400

SOURCE: JICA Study Team

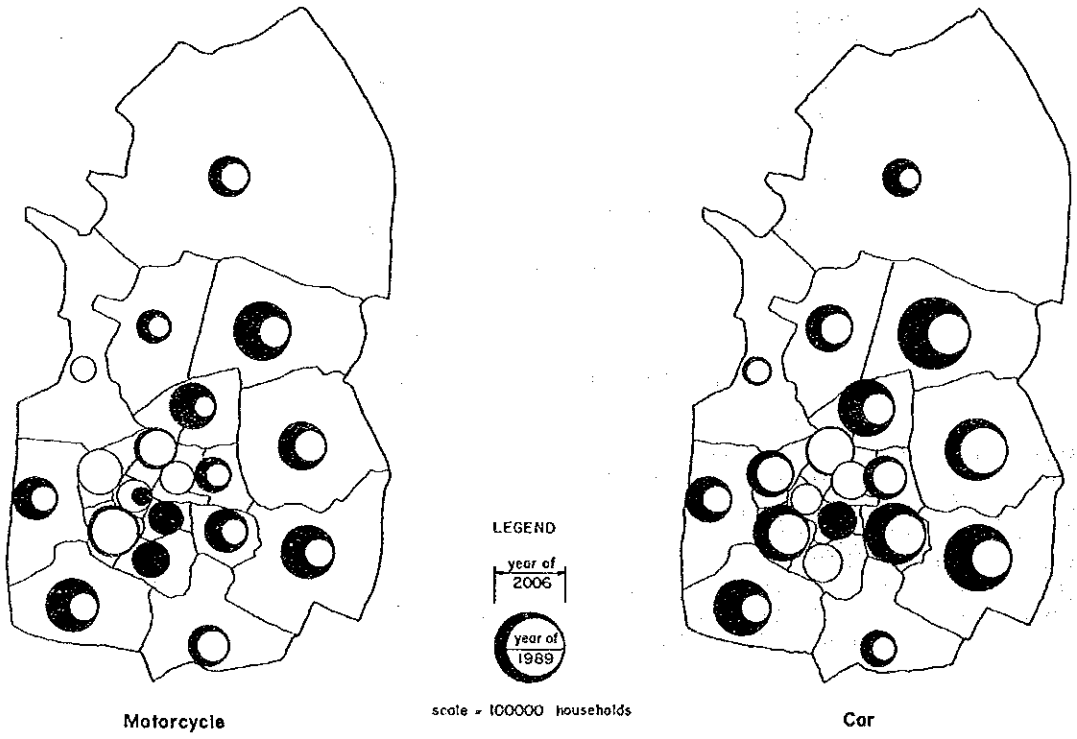


Figure 7.2.5 Vehicle-Owning-Household by Zone in 2006

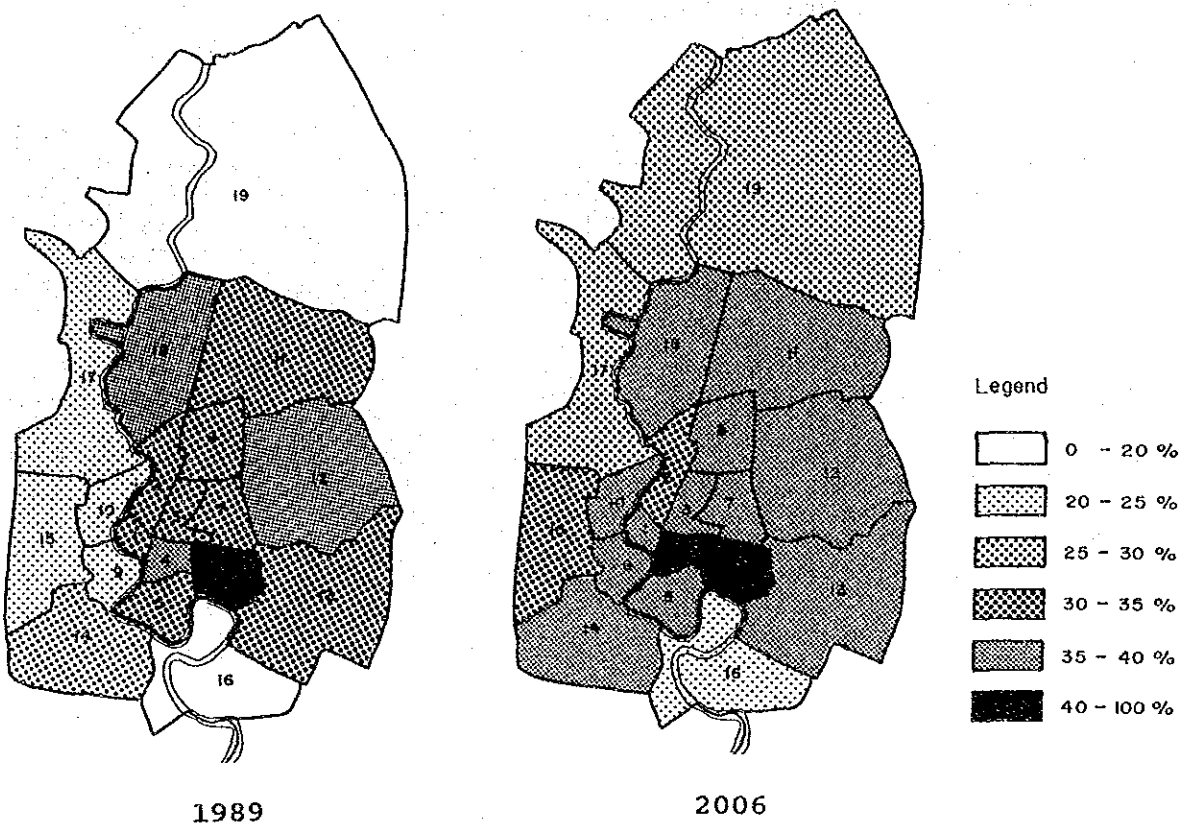


Figure 7.2.6 Car Ownership Ratio by Zone in 1989 and 2006

7.3 Projection of Total Number of Trips

1) Total Number of Trips

Provided that trip production rates by car ownership category described in the previous section remain unchanged in the future, the average rate will rise slightly from 2.20 trips/day in 1989 to 2.31 trips/day in 2006, due to the future motorization progress. On the other hand, the study area population is envisaged to grow by 1.70 times during the same period. Consequently, the total number of trips made by residents in the study area will increase by approximately 1.8 times.

Trips originating and ending in the study area will increase from 11.5 million per day in 1989 to 21.5 million in 2006. At the same time, trips originating or ending outside the study area and through trips will increase by 1.9 times and 2.0 times respectively (Figure7.3.1, Table 7.3.1). (Here, trips made by truck are excluded, hence the numbers of present trips do not correspond to the figures in Chapter 2).

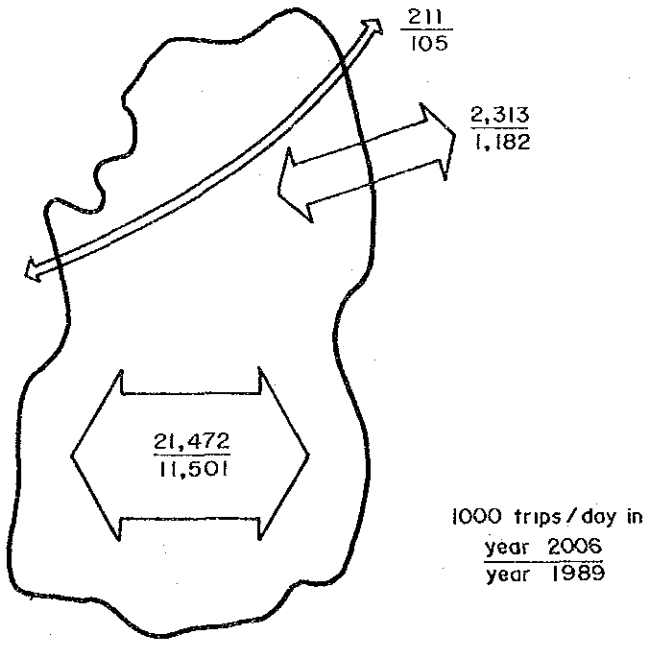


Figure 7.3.1 Total Trips in 1989 and 2006

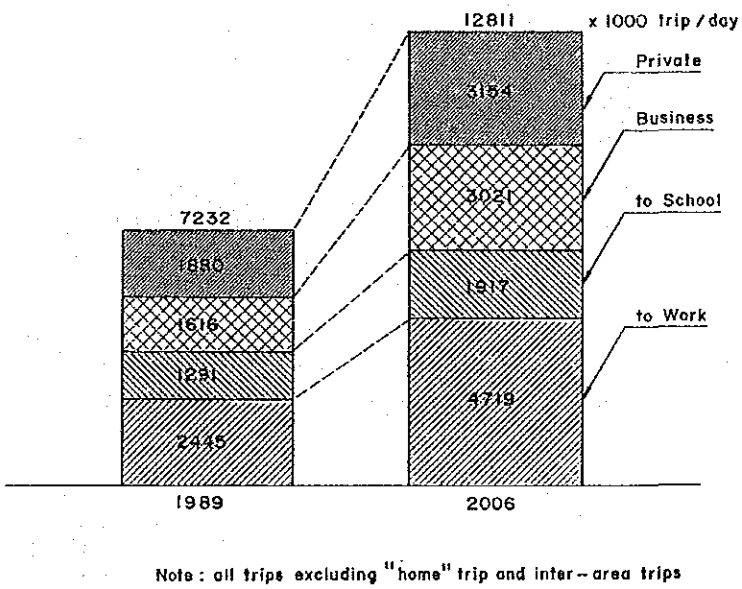
Table 7.3.1 Major Indicators Concerning Transportation Demand in the Study Area

Indicator/Year	(A) 1989	(B) 2006	(B)/(A)
1. Population (1000)	6,357	10,852	1.70
2. GRDP/capita* (1000 Baht at 1989 price)	92.0	251.8	2.34
3. Passenger Car			
Motorcycle (1000)	821.5	1,627.9	1.98
Passenger Car (1000)	972.1	2,170.5	2.23
4. Car Owning Family Ratio (%)			
Motorcycle	23.8	27.8	1.17
Passenger Car	30.7	36.2	1.18
5. Daily Trip			
Trip Rate (trip/person)	2.19	2.31	1.05
Total Trip (1000/day)	11,501	21,472	1.87

Note : * per capita GRDP in BMR

2) Trip by purpose

By trip purpose, the largest share of internal trips in the year 2006 will be accounted for by returning-home trips, 46% of the total which remains almost in the same level as at present. The trip composition by purpose other than "returning home" is shown in Figure 7.3.2.



Note : all trips excluding "home" trip and inter-area trips

Figure 7.3.2 Trip Increase by Purpose in 1989 and 2006

"Commuting-to-work" trip has the second largest share, 20% of the total, followed by "private (social, leisure, shopping and other purposes)" trips (13.3%), business trip (12.7%) and "commuting-to-school" trip (8.1%). The order will thus remain the same as in 1989, but a significant change will be the rise in the share of commuting-to-work trips from 18.6% to 20.0%. These trips will occur mostly during peak hours and constitute the most critical element in transportation planning. It should be noted that the increased share of such trips in the future will create a major burden on the transport network.

7.4 Trip Generation and Attraction

The generated and attracted trips forecast for the year 2006 are shown in Table 7.4.1 and they are compared with those of 1989 in Figure 7.4.1. In order to emphasize the generation/attraction characteristics of the zones, returning-home trips are not included in the figure. If returning-home trips were included, generation and attraction in a given zone would be more or less equal and would be close to the sum of generated and attracted trips of the zone.

Table 7.4.1 Future Trip Generation and Attraction in 2006

(1000 Trips/day)

Zone	Generation						Attraction					
	Work	School	Business	Private	Home	Total	Work	School	Sus	Private	Home	Total
1 Phranakhon-Pomprap	115701	56218	224904	93134	662107	1152064	354817	112414	226473	230556	228417	1152677
2 Dusit	241558	115812	181421	167326	532783	1238900	276361	113955	177289	186108	485612	1239323
3 Phaya Thai	164094	72323	244537	127311	693517	1301782	376684	113611	241503	246436	324151	1302365
4 Pathum Wan-Bang Rak	131529	49676	249787	114526	710260	1255758	392468	102786	250934	254047	256340	1258575
5 Yanava	169059	63260	91687	119035	255209	698250	126124	78917	82146	79048	332490	698725
6 Sukhumvit	290968	123084	232626	194022	650216	1490916	356212	111319	228518	234116	561080	1491245
7 Huai Khwang	188895	69997	105895	129684	332165	826636	154365	94295	99702	114996	363405	826763
8 Chatu Chak	274412	144309	166391	202563	517307	1304982	256237	120531	163900	186130	577836	1304634
9 Thon Buri	299054	105874	200973	189209	553528	1348638	309444	105696	198199	184969	550870	1349178
10 Bangkok Noi	206170	81745	150765	125433	405674	969787	233319	66119	149308	139131	382071	969948
11 Bang Khen	434014	191094	165072	283079	461360	1534619	256611	71677	164134	186840	854631	1533893
12 Bang Kapi	382923	202639	204409	280959	728200	1799130	298841	262660	192541	234812	809007	1797861
13 Phra Khanong	428511	132043	180497	269548	503094	1513693	265972	110930	171614	182678	781534	1512728
14 Ratburana	371456	111179	123667	210912	320879	1138093	189889	57973	121701	113733	654856	1138152
15 Taling Chun	238185	84292	92341	141431	246023	802272	138082	54065	88741	83355	437520	801763
16 Muang Samut Prakan	228763	88931	138056	149538	360574	963862	203101	69284	131136	124174	435884	963579
17 Bang Kruai	145469	58835	43428	97512	111077	456319	53352	42484	35328	35208	288414	454786
18 Muang Nontha Buri	186317	85392	140217	114673	408194	934793	216485	60063	138573	163410	355897	934408
19 Pathum Thani	221969	82279	84545	144194	250788	783775	113658	84232	74217	85027	424441	781575
Total	4719047	1916982	3021196	3154089	8702955	21514269	4571982	1833011	2935957	3064772	9104456	21510178

Since overall trip generation in a zone is more or less proportionate to the zone's population, those zones where a sharp increase in population is forecast, also expect to have a sharp increase in the number of trips generated.

Zones where generated trips will increase by more than two times in the year 2006 are: Ratburana (3.51 times), Taling Chun (2.82), Patong Thani (2.76), Phra Khanong (2.70), Chatu Chak (2.61), Bang Khen (2.51), Muang Samut Prakan (2.13), and Muang Nontha Buri (2.09). All of these zones are located in the suburban areas.

Conversely, zones located in the central part of the city where resident population will decrease or remain unchanged will have a comparatively moderate increase in trip generation by 1.0 to 1.2 times.

Trip attraction will show a large increase in zones with a steep rise in population, zones where a new urban core will be established and zones where industrial development is planned. Zones where trip attraction will increase by more than two times are: Ratburana (3.33 times), Taling Chun (3.26), Bang Kruai (3.15), Phra Khanong (2.78), Muang Nontha Buri (2.42), and Muang Samut Prakang (2.19).

The ratio of trip attraction to trip generation is defined as the trip satisfaction rate within a zone. Even if a zone has a trip satisfaction rate of 1.0, there will actually be a large number of vehicles moving out of the zone and an equal number of vehicles flowing into the zone. However, if the achievement of "closed" zones in terms of traffic demand is considered desirable for mitigating traffic congestion, it would at least be necessary to secure a trip satisfaction rate in the range of 0.9 to 1.1.

In 1989, 6 out of 19 integrated zones in the study area had a trip satisfaction rate of over 1.0. All these zones contain commercial, business or industrial centers. They are Phranakhon-Pomprap (1), Phaya Thai (3), Phathum Wan-Bang Rak (4), Sukhumvit (6), Chat Chak (8), and Bang Kapi (12).

In the year 2006, in addition to the above 6 zones, the following 4 zones will have a trip satisfaction rate of over 1.0: Dusit (2), Thong Buri (9), Bangkok Noi (10), and Muang Nontha Buri (18).

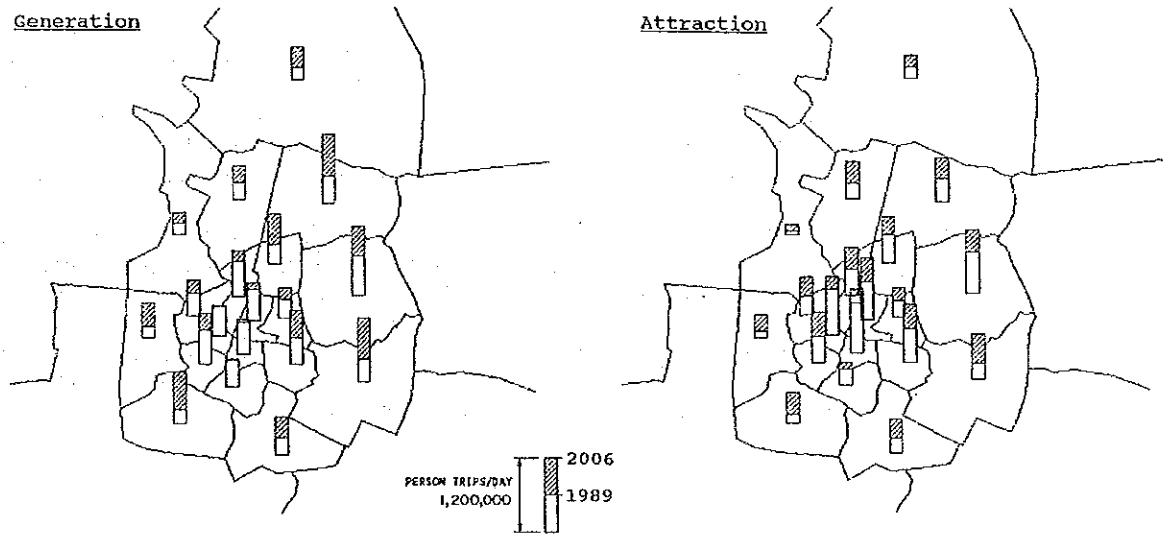


Figure 7.4.1 Trip Generation and Attraction in 2006

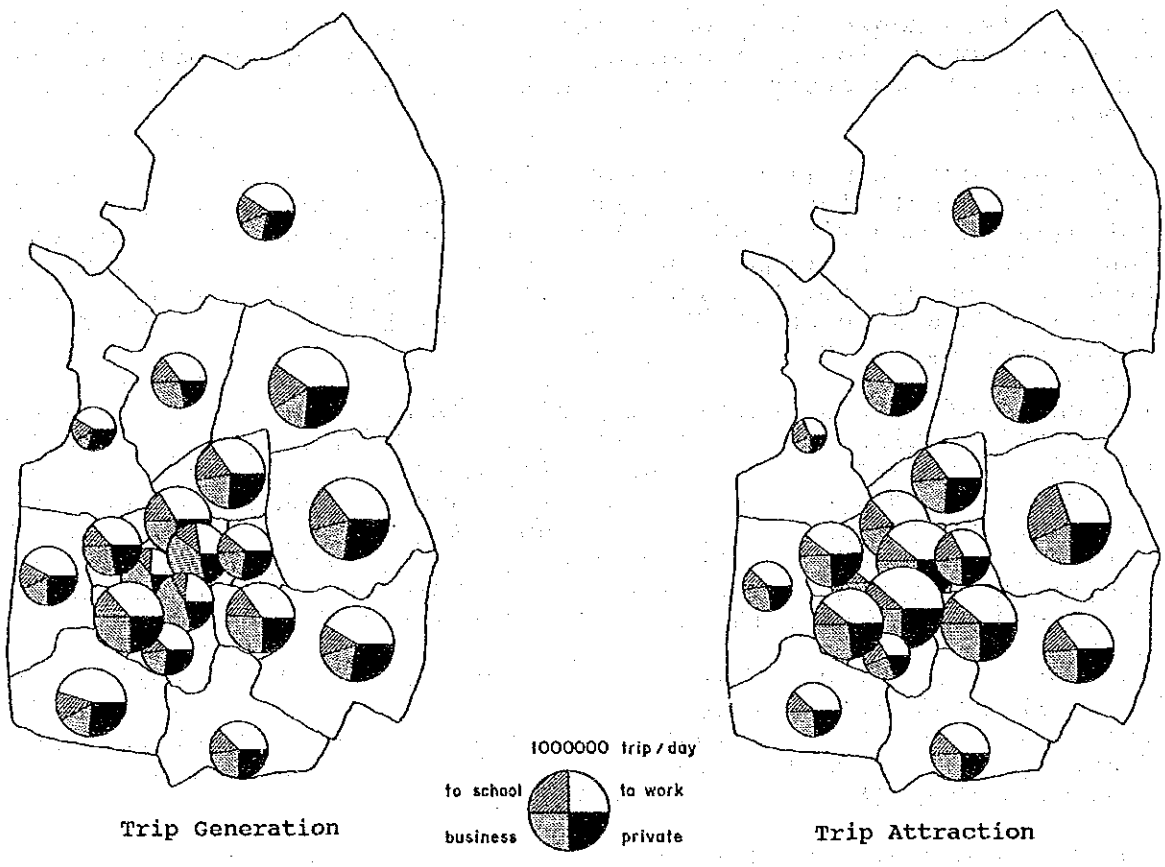


Figure 7.4.2 Trip Generation and Attraction by Purpose in 2006

Figure 7.4.2 shows trip generation and attraction by purpose in the year 2006 (returning-home trips are again excluded). The proportion of trips generated for "commuting to work" is nearly the same in all zones as are trips for "commuting to school". The share of business trip is large in the CBD area, especially in Phra Nakhon (1), Phaya Thai (3), and Pathum Wan-Bang Rak (4).

On the attraction side, the ratio of "commuting to work" trips is higher in the CBD area than in the suburban areas, even though new urban centers were planned in the suburbs in the future framework study, to decentralize working opportunities. Therefore, without enforcing such a decentralization policy, much heavier concentration of "commuting to work" trips to the central area will occur making traffic conditions worse.