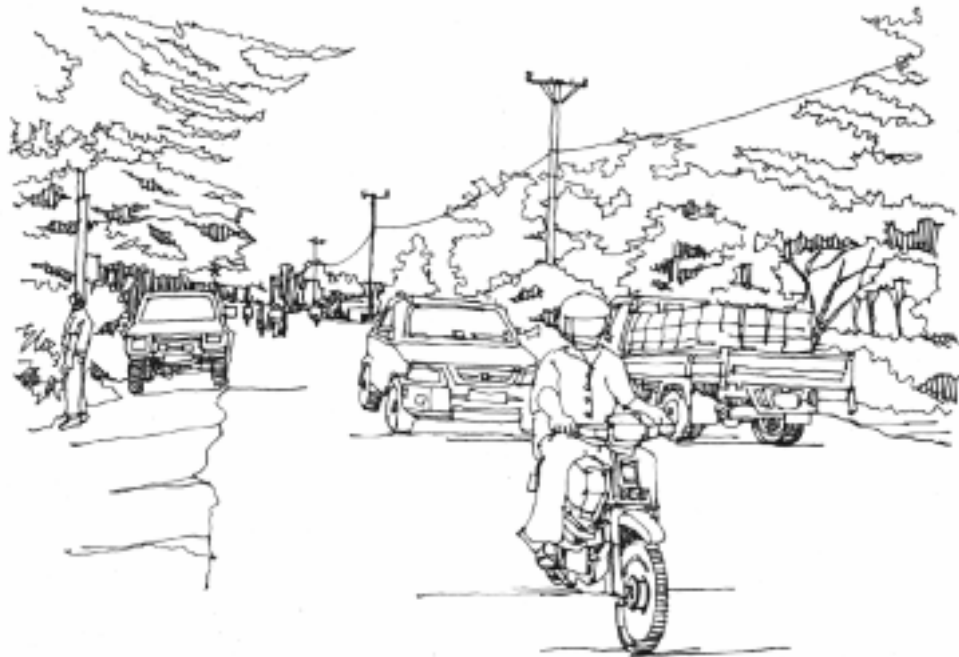# CHAPTER 2   CURRENT ROAD AND TRAFFIC CONDITIONS

CHAPTER 2   CURRENT ROAD AND TRAFFIC CONDITIONS

2.1   Current Road Condition

2.1.1   Road and Road Transport in Cambodia

Road and inland water transport play important roles in the transport sector although rail transport shares a portion but it is negligible.   The inland water transport has shared more than a half of cargo transport in the past due to very often interruption of road transport by flood.   However, the road transport increases the share of passenger and cargo rapidly as the road improvement progressed.   It is reported that two third of passenger and more than a half of cargo are transported by road.

Roads in Cambodia comprise 44 National Roads (4,756 km), 124 Provincial Roads (5,700 km) and other Local Roads, totaling 35,700 km in length.   National Roads consist of seven single digit primary roads (2,002 km) and 37 double digit secondary roads of No. 11 to 78a (2,754 km), while Provincial Roads consist of 124 triple digit roads of No. 101 to 339.   Fig. 2-1-1 shows the present road network.

Roads under jurisdiction of MPWT are of 12,156 km in length and they are administratively classified into two categories as follows:

- National Road: National roads are intended to connect the capital to the provincial center, important population centers and important border crossings.
- Provincial Road: Provincial roads are intended to connect provincial centers to district centers to the extent these are not connected by National Roads.

There are two international road networks, namely Asian Highway and ASEAN Highway. The former aims to assist member countries in developing road transport infrastructure in Asia and link Asia with Europe, thereby promoting regional and international cooperation for economic and social development, as well as opening up new potentials for international trade and tourism.   The latter is to intensify cooperation in the development of trans-ASEAN transportation network as the trunkline or main corridor for the movement of goods and passengers in ASEAN.

National Roads No. 1 and No. 5 are designated as Asian Highway No. A-1 as well as ASEAN Highway No.1, while National Roads No. 4, No. 6 and No. 7 are designated as Asian Highway No. A-11.   Accordingly, the cross-border on NR-1, Bavet is designated as the main gate between Cambodia and Vietnam.

The road inventory and its condition in Cambodia are summarized by the study "Strengthening the Maintenance Planning and Management Capabilities at the MPWT" funded by ADB in July 2002.   Based on the final report, the inventory of road is as shown in Table 2-1-1.

Fig. 2-1-1 Present National Road Network

Table 2-1-1   Road Length under MPWT

Type of Road		Length (Km)	
		Kandal	National
N1	Primary National Roads	165	2,002
N2	Secondary National Roads	111	2,754
N3-1	Provincial Roads	238	5,700
N3-2	Urban Roads under MPWT	0	1,700
Total		514	12,156

Notes: N1 Roads are the primary national roads with single digit.
N2 Roads are the secondary national roads with double digit.
N3-1 Roads are the provincial roads.
N3-2 Roads are the urban roads under the jurisdiction of MPWT.

The condition of roads under jurisdiction of MPWT is as shown in Table 2-1-2, and Table 2-1-3 shows structures pertaining to the roads.

Table 2-1-2　Road Inventory and Condition by Type of Pavement

Type of Road	Kandal Province							National						
	Length (Km)	Excellent	Good	Fair	Poor	Bad	Under Construction	Length (Km)	Excellent	Good	Fair	Poor	Bad	Under Construction
N1　Primary National Roads														
Asphalt Concrete Surface	17.4	2.4	6.5	8.2	0.3			392	45	123	177	40	6	1
Surface Treatment	5.6						5.6	604						604
Penetration Macadam	138.0		7.1	77.2	41.6	12.1		933		34	328	363	200	8
Laterite/Gravel	4.3				2.5	1.8		73		1	20	41	11	
Earth	0.0							0						
Total	165.3	2.4	13.6	85.4	44.4	13.9	5.6	2,002	45	158	525	444	217	613
N2　Secondary National Roads														
Asphalt Concrete Surface	0.0							0						
Surface Treatment	0.0							90						90
Penetration Macadam	26.8			1.2	11.9	13.7		1,605			245	698	662	
Laterite/Gravel	84.4		3.4	15.8	19.5	45.7		1,059		121	257	362	319	
Earth	0.0							0						
Total	111.2		3.4	17.0	31.4	59.4		2,754	0	121	502	1060	981	90
N3　Provincial Roads & Urban Roads														
Asphalt Concrete Surface	5.6		0.8	3.1	1.7			50		5	20	18	7	
Surface Treatment	0.0							50			15	25	10	
Penetration Macadam	21.9			0.3	7.6	14.0		1,476			272	497	488	219
Laterite/Gravel	36.7			6.9	21.1	8.7		4,153		112	1,652	1,406	863	120
Earth	173.6			0.8	90.3	82.5		1,671			20	791	831	29
Total	237.8		0.8	11.1	120.7	105.2		7,400	0	117	1,979	2,737	2,199	368
All Roads under MPWT														
Asphalt Concrete Surface	23.0	2.4	7.3	11.3	2.0	0	0	442	45	128	197	58	13	1
Surface Treatment	5.6	0	0	0	0	0	5.6	744	0	0	15	25	10	694
Penetration Macadam	186.7	0	7.1	78.7	61.1	39.8	0	4,014	0	34	845	1,558	1,350	227
Laterite/Gravel	125.4	0	3.4	22.7	43.1	56.2	0	5,285	0	234	1,929	1,809	1,193	120
Earth	173.6	0	0	0.8	90.3	82.5	0	1,671	0	0	20	791	831	29
Total	514.3	2.4	17.8	113.5	196.5	178.5	5.6	12,156	45	396	3,006	4,241	3,397	1,071

Table 2-1-3   Structure Inventory by Type of Road

Type of Road		Kandal Province					
		Road Length (Km)	Pipe Culvert Location	Box Culvert Location	Bridge		
					Location	Length (m)	Area (m^2)
N1	Primary National Roads	165.3	62	10	55	2,075	15,133
N2	Secondary National Roads	111.2	47	19	71	1,411	6,543
N3	Provincial Roads & Urban Roads	237.8	91	22	110	2,296	10,013
	All Roads under MPWT	514.3	200	51	236	5,782	31,689
Type of Road		National					
		Road Length (Km)	Pipe Culvert Location	Box Culvert Location	Bridge		
					Location	Length (m)	Area (m^2)
N1	Primary National Roads	2,002	1,012	161	735	27,989	221,100
N2	Secondary National Roads	2,754	1,817	587	673	13,056	63,041
N3	Provincial Roads & Urban Roads	7,400	8,998	1,361	2,029	34,759	155,335
	All Roads under MPWT	12,156	11,827	2,109	3,437	75,804	439,476

2.1.2   Roads in the Study Area

As shown in Fig. 2-1-2, the arterial road network in the study area comprises National Roads of No.1, No.6 and No.7 as the primary national road and that of No.11 and No. 21 as secondary national road.
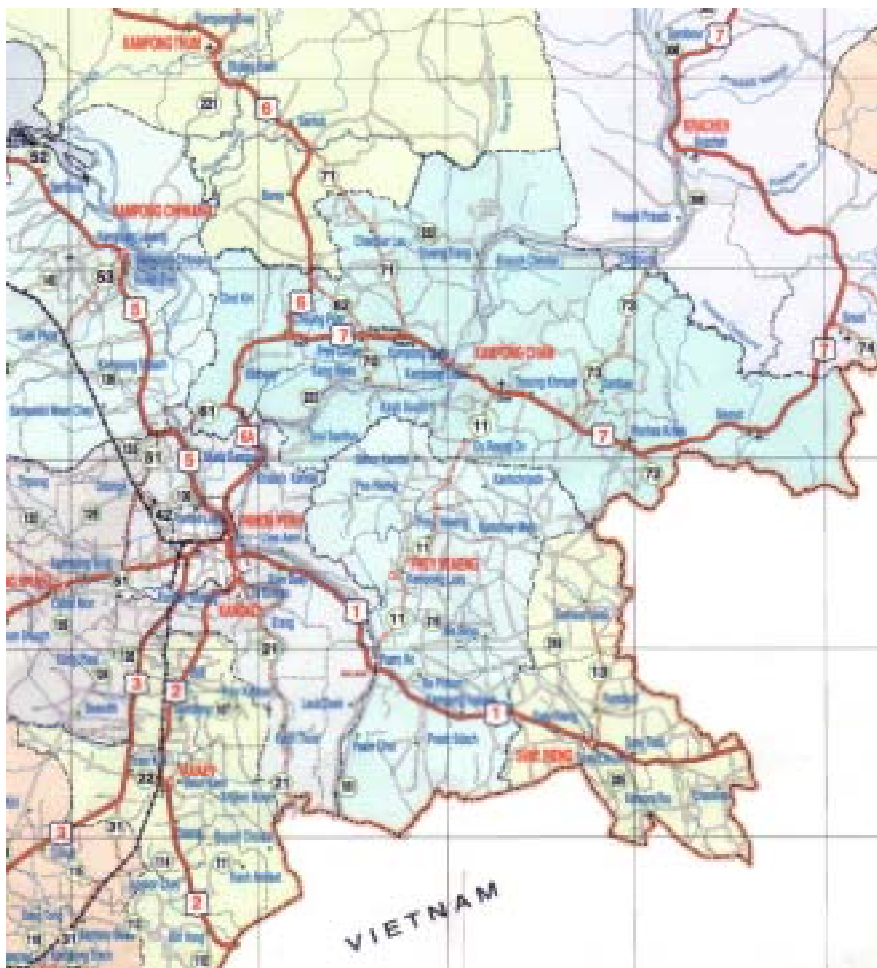

Fig. 2-1-2   Arterial Road Network in the Study Area

In the international context, there are three route to connect Phnom Penh to Ho Chi Minh as shown in Fig. 2-1-3, which the travel distance is 246 km on NR-1, 355 km on NR-6/7 and 421 km on NR-2 respectively.

Fig. 2-1-3   Existing Routes to Ho Chi Minh City

According to the cross-border agreement between Cambodia and Vietnam, the main cross-borders are located on NR-1 and NR-2.   However, the cross-border gate on NR-6/7 exists but it is not always open.

The salient feature of the road network in the study area is pointed out that it is so difficult to find an alternative route that the communication by road is disrupted once the flood cause to interrupt the road traffic.   The main reasons are as follows:

(1) The road network is very coarse.
(2) The Mekong River and its tributaries sever the communication by road because of only on bridge across the Mekong River.

2.2   Existing Traffic Characteristics

2.2.1   Traffic Survey and Interviews

a.   Contents

As shown in Table 2-2-1, seven different types of traffic surveys and interviews were conducted from mid May to mid June 2002.

Table 2-2-1   Contents of Traffic Surveys and Interviews

#	Name of Traffic Surveys & Interviews	No. of Stations, Route, or Interviewed Companies	Duration	Remarks
1.	Roadside Traffic Counts	15	1-day (14-hr)	Traffic Counts
2.	Cordon Line Survey	8	1-day (24-hr) 1-day (12-hr)	Traffic Counts OD Interviews
3.	Intersection Traffic Movement Counts	6	1-day (14-hr)	Traffic Counts
4.	Travel Speed Survey	1 (Both Directions)	3-days	Time Recording
5.	Cargo Transport Interviews	100	1-week	OD Interviews
6.	Public Transport Interviews	5	1-week	OD Interviews
7.	Axle Load Survey	1	1-day (12-hr)	Weight Scaling

b.   Locations

Location of traffic surveys and interviews are shown in Fig. 2-2-1.

c.   Zones

As shown in Fig. 2-2-2, traffic zone numbers are assigned to the study area.

d.   Forms

Field counting and interview forms as well as data input forms are designed as shown in Appendix-E.
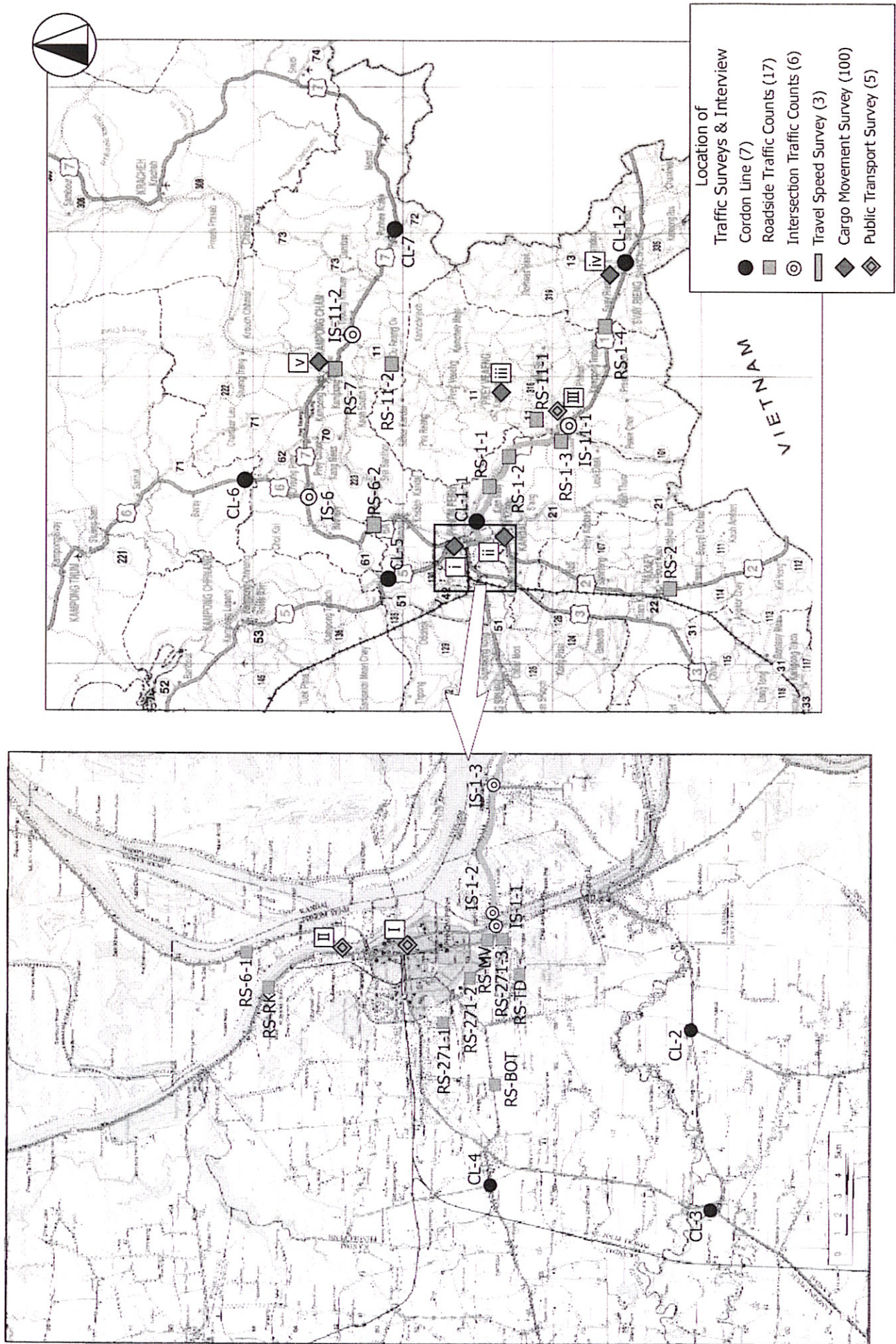
Figure 2-2-1   Location of Traffic Surveys and Interviews
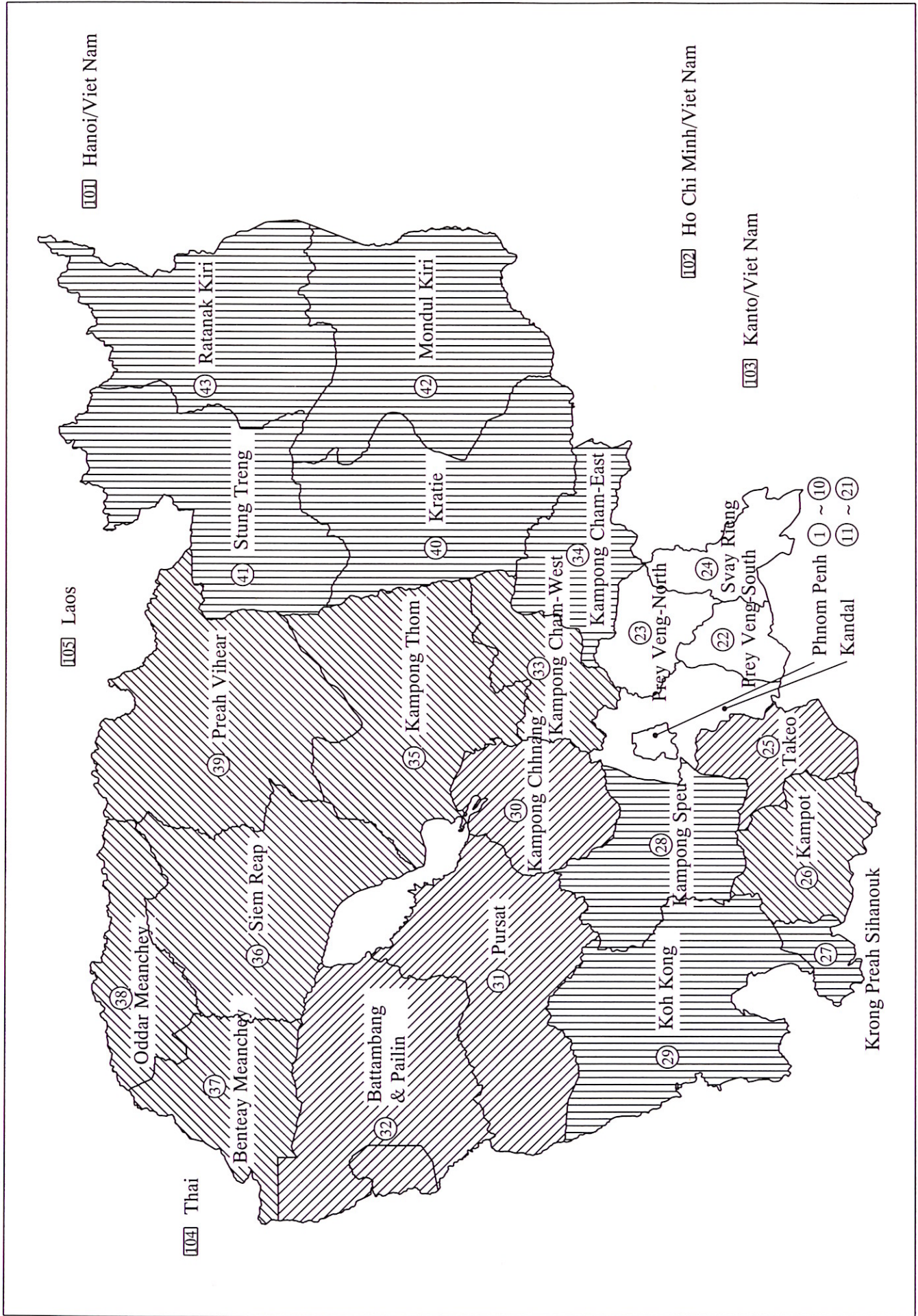
Figure 2-2-2 Traffic Zone and Code No. (Cambodia) (1/2)

101 Hanoi/Viet Nam

102 Ho Chi Minh/Viet Nam

103 Kanto/Viet Nam

105 Laos

104 Thai

43 Ratanak Kiri

42 Mondul Kiri

41 Stung Treng

40 Kratie

39 Preah Vihear

38 Oddar Meanchey

37 Benteay Meanchey

36 Siem Reap

35 Kampong Thom

34 Kampong Cham-East

33 Kampong Cham-West

32 Battambang & Pailin

31 Pursat

30 Kampong Chhnang

29 Koh Kong

28 Kampong Speu

27 Krong Preah Sihanouk

26 Kampot

25 Takeo

24 Svay Rieng

23 Prey Veng-North

22 Prey Veng-South

Phnom Penh 1 ~ 10
Kandal 11 ~ 21

2 - 9

Legend:

① Phnom Penh-Central (4-Districts)
② Phnom Penh-Mean Chey-East (Chbar Ampov)
③ Phnom Penh-Mean Chey-Middle (Chak Angrae)
④ Phnom Penh-Mean Chey-West (Stueng Mean Chey)
⑤ Phnom Penh-Russei Kaev-South (Tuek Thla/Thmei)
⑥ Phnom Penh-Russei Kaev-Middle (Russei Kaev)
⑦ Phnom Penh-Russei Kaev-North (Preak Lieb)
⑧ Phnom Penh-Dangkao-South (Prey Veaeng)
⑨ Phnom Penh-Dangkao-Middle (Pochengton)
⑩ Phnom Penh-Dangkao-North (Kouk Roka)

⑪ Kandal-Takhmau (KD-2)
⑫ Kandal-Kien Svey (KD-1)
⑬ Kandal-Leuk Daek (KD-1)
⑭ Kandal-S'ang (KD-2)
⑮ Kandal-Kaoh Thom (KD-2)
⑯ Kandal-Kandal Stung (KD-3)
⑰ Kandal-Angk Snuol (KD-4)
⑱ Kandal-Prek Kdam (KD-5)
⑲ Kandal-Mukh Kampul (KD-6)
⑳ Kandal-Khsach Kandal (KD-6)
㉑ Kandal-Lvea Aem (KD-1)
㉒ Prey Veng-South (NR-1/PV)
㉓ Prey Veng-North (NR-1/PV)
㉔ Svay Rieng (NR-1/SR)
㉕ Takeo (NR-2)
㉘ Kampong Speu (NR-4)
㉚ Kampong Chhnang (NR-5)
㉝ Kampong Cham-West (NR-6/KCM)
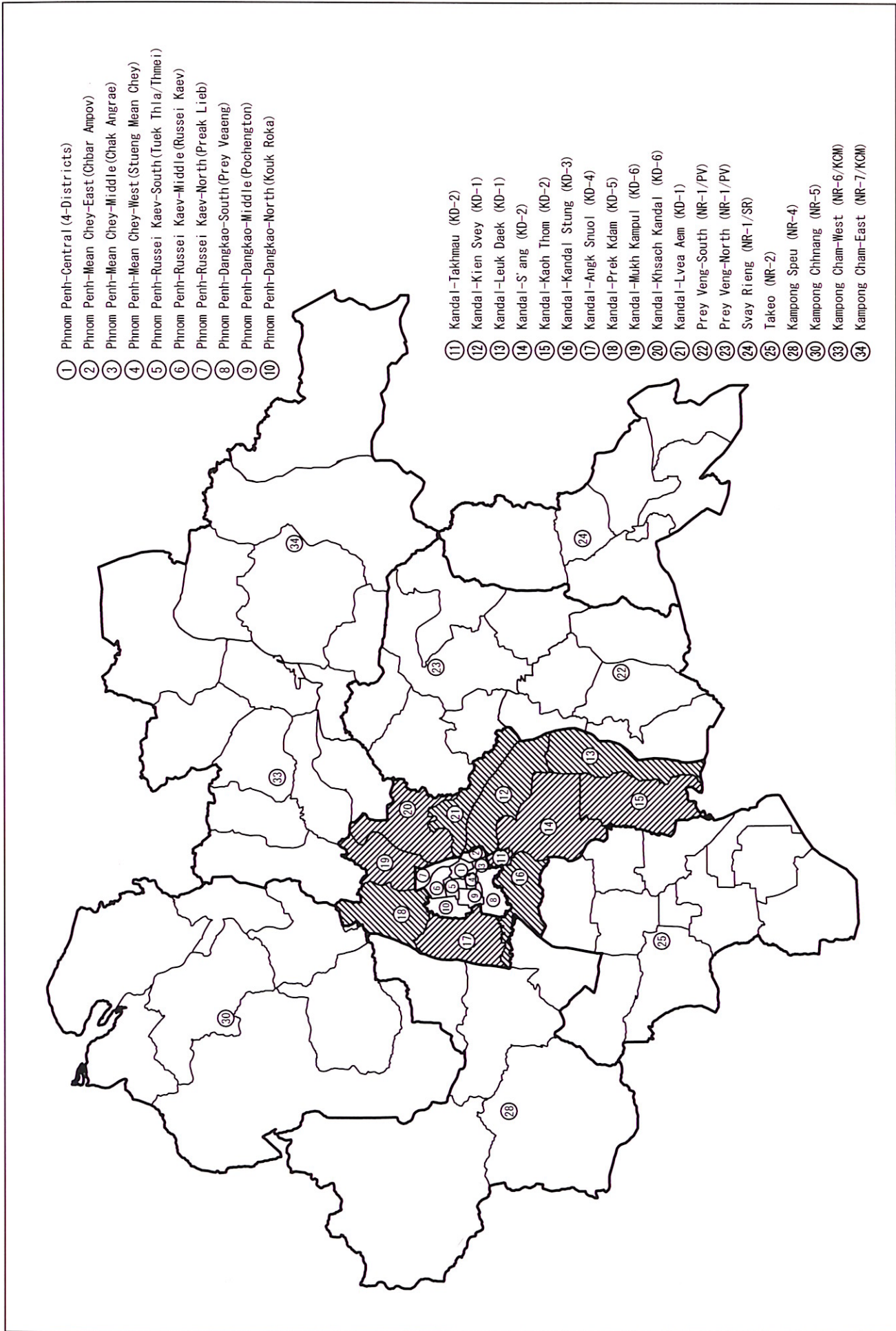㉞ Kampong Cham-East (NR-7/KCM)

Figure 2-2-2   Traffic Zone and Code No. (Southeast Region) (2/2)

2.2.2 Roadside Traffic Volume Counts

The Study team conducted 14-hour continuous traffic volume counts at 15 stations. Data obtained from the survey is summarized as follows.

a. National Road No.1

As shown in Table 2-2-2, the daytime traffic volume varied from 2,300 to 11,200 units (2,000~8,500 PCU) per 12-hours, and peak hour traffic volume also varied from 300 to 1,300 units (240~880 PCU) per hour, by station to station.   14/12-hr ratio and peak hour ratio is assumed to be around 1.07, and 0.13, respectively, at all stations.

Table 2-2-2   Traffic Volumes and Relating Index (NR-1)

Stations	Kilo Post	14-hr Volume	14/12-hr Ratio	12-hr Volume	Peak Hr. Ratio	Peak Hour Volume	Peak Hour
NR-1-1 (RS-1.1)	18	11,910 (8,459)	1.06	11,195 (7,965)	0.12	1,328 (884)	06:00~07:00 (06:15~07:15)
NR-1-2 (RS-1.2)	40	5,922 (3,755)	1.07	5,560 (3,527)	0.13	726 (438)	06:00~07:00 (08:15~09:15)
NR-1-3 (RS-1.3)	60	7,306 (4,171)	1.07	6,842 (3,988)	0.13	861 (595)	08:45~09:45 (08:45~09:45)
NR-1-4 (RS-1.4)	95	2,476 (1,961)	1.07	2,324 (1,820)	0.13	295 (240)	07:15~08:15 (07:15~08:15)

Units: Upper: All Traffic in Vehicle Unit,
Lower: Motorized Vehicle Only in Passenger Car Unit (MC=0.50, LV=1.00, HV=3.00, CY=0.25)

b. National Road No.6, 7, and 11

As shown in Table 2-2-3, the daytime traffic volume varied from 4,900 to 13,300 units (2,700~11,100 PCU) per 12-hours, and peak hour traffic volume also varied from 600 to 1,400 units (360~1,200 PCU) per hour, by station to station.   14/12-hr ratio and peak hour ratio is assumed to be around 1.06~1.10, and 0.11~0.14, respectively, except for the station NR-11-2 with peak-hour ratio of 0.20 for all traffic.

Table 2-2-3   Traffic Volumes and Relating Index (NR-6, NR-7, and NR-11)

Stations	14-hr Volume	14/12-hr Ratio	12-hr Volume	Peak Hr. Ratio	Peak Hour Volume	Peak Hour
NR-6-1 [Preaek Lieb] (RS-6.1)	14,485 (11,945)	1.09	13,311 (10,996)	0.11	1,404 (1,210)	16:30~17:30 (07:45~08:45)
NR-6-2 [Thnol Keng] (RS-6.2)	5,408 (5,473)	1.10	4,926 (4,922)	0.12	570 (610)	08:30~09:30 (08:30~09:30)
NR-7 [Kizuna Br.] (RS-7)	7,375 (4,659)	1.08	6,816 (4,220)	0.14	924 (498)	06:15~07:15 (07:45~08:45)
NR-11-1 [Peam Ro] (RS-11.1)	5,620 (2,906)	1.06	5,322 (2,738)	0.12	653 (387)	06:30~07:30 (07:30~08:30)
NR-11-2 [Ou Reang Ov] (RS-11.2)	7,478 (3,097)	1.07	6,974 (2,908)	0.20 (0.13)	1,375 (364)	06:00~07:00 (06:30~07:30)

Units: Upper: All Traffic in Vehicle Unit,
Lower: Motorized Vehicle Only in Passenger Car Unit (MC=0.50, LV=1.00, HV=3.00, CY=0.25)

c. Arterial and Collector Roads in Phnom Penh

As shown in Table 2-2-4, the data obtained from the survey prove that daytime traffic volume varied from 11,000 to 38,000 units (7,200~20,000 PCU) per 12-hours, and

peak-hour traffic volume also varied from 1,500 to 5,200 units (900~2,600 PCU) per hour, except stations on Tumpun Dike Road (RS-TD) and Monivong Boulevard (RS-MV). 14/12-hr ratio and peak hour ratio is assumed to be around 1.12~1.18, and 0.11~0.17, respectively, except for the station on Phnom Penh Highway with peak-hour ratio of 0.21 for all traffic.

**Table 2-2-4   Traffic Volumes and Relating Index (Phnom Penh Area)**

Stations	14-hr Volume	14/12-hr Ratio	12-hr Volume	Peak Hr. Ratio	Peak Hour Volume	Peak Hour
Inner Ring Road-N (RS-271-1)	37,718 (22,713)	1.13	33,265 (20,027)	0.16 (0.13)	5,175 (2,585)	06:15~07:15
Inner Ring Road-M (RS-271-2)	12,562 (8,086)	1.13 (1.12)	11,137 (7,214)	0.13 (0.12)	1,450 (895)	06:15~07:15 (06:30~07:30)
*Inner Ring Road-S (RS-271-3)	17,507 (8,294)	1.13	15,426 (7,311)	0.14 (0.13)	2,211 (982)	06:00~07:00
Tumpun Dike Rd (RS-TD)	5,620 (2,906)	1.18 (1.14)	5,322 (2,738)	0.17 (0.13)	653 (387)	06:00~07:00
P.P. Highway (RS-BOT)	27,340 (18,224)	1.15 (1.16)	23,698 (15,773)	0.21 (0.16)	4,898 (2,448)	06:00~07:00
NR-5- Ruessei Kaev (RS-RK)	29,832 (19,224)	1.15 (1.14)	25,931 (16,866)	0.13 (0.12)	3,473 (1,990)	06:15~07:15
Monivong Blvd (RS-MV)	87,274 (51,646)	1.13	77,212 (45,755)	0.13 (0.11)	9,723 (5,194)	06:15~07:15 (06:30~07:30)

Units: Upper: All Traffic in Vehicle Unit,
        Lower: Motorized Vehicle Only in Passenger Car Unit (MC=0.50, LV=1.00, HV=3.00, CY=0.25)

d. Modal Share on NR-1

As shown in Fig. 2-2-3, total motorized modal share on NR-1 is as low as 70%, except the section between Chbar Ampov and Kokir market which share is 75%.   The other section on the national road networks shows those shares are around 85-90% on NR-6.
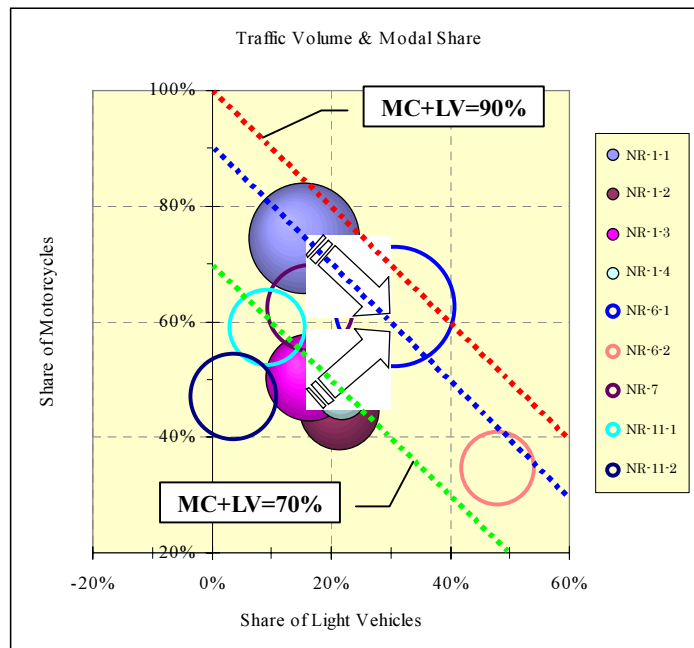
Note: Size of circles corresponds to each station's traffic volume

Fig. 2-2-3   Tendency of Traffic Volumes and Modal Share on the National Road Networks

_____

* This southern section of Inner Ring Road was temporary closed for 4-wheel vehicles due to construction works of pumping station installation during the survey

The stations on NR-11 shows motorized shares are still lower than 70%.   The station on NR-7 shows motorized share is around 80% with 60% for MC and 15% for LV[1]

e. Neak Loueng Ferry

As shown in Fig. 2-2-4, average daily traffic volume which crossing Mekong River by Neak Loueng Ferry seems almost constant since 1993, with average traffic volume of around 1,800 per day except year 1996 and 1999.   Although volume of bicycle has been dropped rapidly, motorized modes, such as motorbike (moto), car, minibus, bus, and trucks, have been increasing gradually.
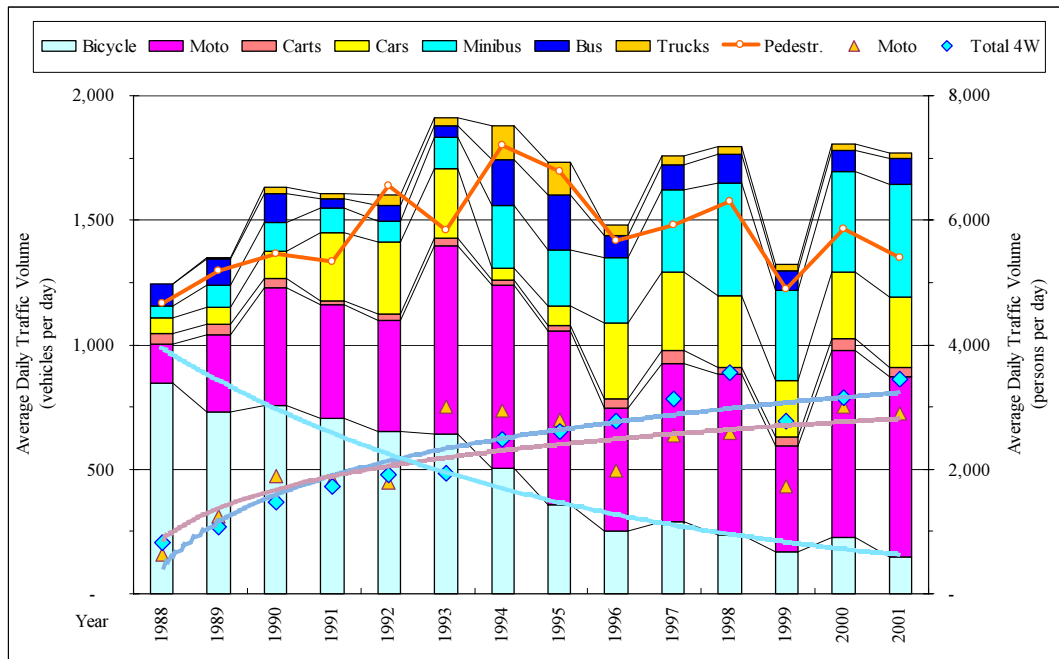
Data Sources: Neak Loueng Ferry, Department of Roads & Infrastructures, MPWT
Note: Vertical Axis / Left: All Vehicles, Right: Pedestrian Only

Fig. 2-2-4   Average Daily Traffic Volume at Neak Loueng Ferry

2.2.3   Cordon Line Survey

The study team conducted 24-hour continuous traffic volume counts at 8 stations on National Road No.1~7.   Data obtained from the survey is summarized hereinafter.

a. Traffic Volume Counts

As shown in Table 2-2-5 and Fig. 2-2-5, the data obtained from the survey prove that daily traffic volume varied from 4,000 units (2,500 pcu) at NR-1-2 to 27,500 units (25,600 pcu) at NR-4 per 24-hours.   Daytime traffic volumes also varied from 3,600 units (2,300 pcu) at NR-1-2 to 22,100 units (20,100 pcu) at NR-4 per 12-hours, and peak hour traffic volume varied from 600 to 3,100 units (270~2,300 pcu) per hour, by station to station. 24/12-hr ratio is assumed to be around 1.18~1.25 for all traffic or 1.20~1.27 for motorized vehicles, except NR1-2 and NR-6.   Peak hour ratio shall be 0.14~0.17 for all traffic or 0.11~0.13 for motorized vehicles at most of stations.

_____

[1] According to this point of view, share of MC and LV on NR-1 may be reaching the condition of present NR-6-1, when road and economic conditions become better than present situations.
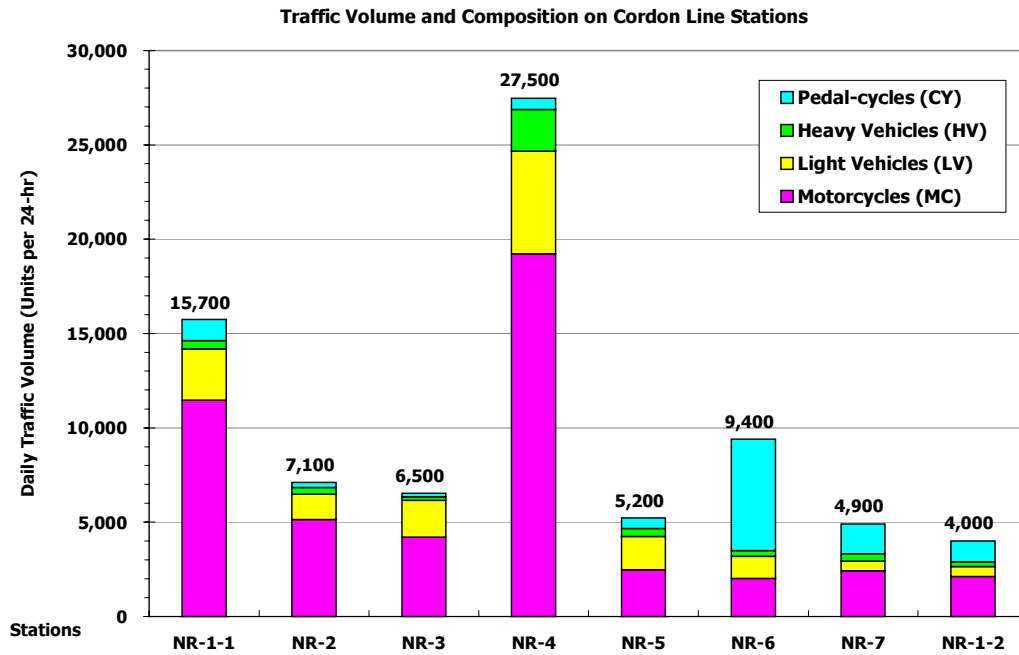
Fig. 2-2-5   Traffic Volume and Composition on Cordon Line Stations

Table 2-2-5   Traffic Volumes and Relating Index (NR-1 to NR-7)

Stations	24-hr Volume	24/12-hr Ratio	12-hr Volume	Peak Hr. Ratio	Peak Hour Volume	Peak Hour
NR-1-1 (CL-1.1)	15,742 (11,619)	1.18 (1.20)	13,304 (9,656)	0.14 (0.13)	1,927 (1,221)	06:15~07:15
NR-1-2 (CL-1.2)	3,993 (2,531)	1.11 (1.12)	3,592 (2,255)	0.17 (0.12)	616 (266)	06:30~07:30 (06:45~07:45)
NR-2 (CL-2)	7,106 (5,738)	1.19 (1.23)	5,975 (4,676)	0.15 (0.12)	877 (569)	06:15~07:15 (06:30~07:30)
NR-3 (CL-3)	6,522 (5,458)	1.25 (1.27)	5,232 (4,282)	0.14 (0.13)	755 (555)	06:00~07:00
NR-4 (CL-4)	27,471 (25,568)	1.25 (1.27)	22,065 (20,130)	0.14 (0.11)	3,064 (2,311)	06:00~07:00
NR-5 (CL-5)	5,233 (5,223)	1.22 (1.25)	4,303 (4,189)	0.11	463 (477)	07:15~08:15 (09:00~10:00)
NR-6 (CL-6)	9,393 (3,632)	1.10 (1.25)	8,510 (2,909)	0.17 (0.11)	1,465 (332)	06:30~07:30 (06:45~07:45)
NR-7 (CL-7)	4,897 (3,101)	1.18 (1.22)	4,139 (2,546)	0.14 (0.12)	592 (300)	06:00~07:00

Units: Upper: All Traffic in Vehicle Unit,
Lower: Motorized Vehicle Only in Passenger Car Unit (MC=0.50, LV=1.00, HV=3.00, CY=0.25)

b.   Modal Share

As shown in Fig. 2-2-6, data obtained from NR-1-1, NR-2, NR-3, NR-4, and NR-5, which are located near urbanized area, indicated total motorized modal shares are as high as 90%.   On the other hand, data obtained from rural stations, such as NR-1-2 and NR-7, indicated motorized modal share are as low as 70%, or NR-6 is showing this around only 30%[2].

_____

[2] We observed a lot of bicycles going to or coming back from the school at station on NR-6
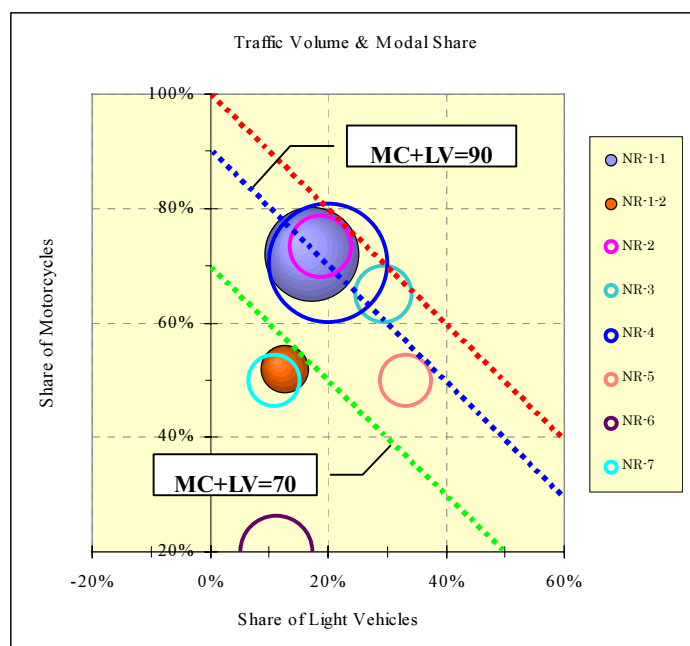
Note: Size of circle corresponds to each station's traffic volume

Fig. 2-2-6   Tendency of Traffic Volumes and Modal Share on Cordon Line Survey Stations

c. OD Interviews and Occupancy Observations

The study team carried out 12-hour continuous OD interviews and occupancy observations[3] at random basis on same day of traffic volume counts.   As shown in Table 2-2-6, total samples reached over 4,600.   Obtained sampling ratio shall be utilized for expanding vehicle OD (origin and destination) data to achieve partially completed vehicle OD matrixes to grasp external trips which crossing those cordon survey lines.

Table 2-2-6   Sampling Number and Ratio of OD Interviews

Stations	Direction	MC	LV	HV	CY	Total
NR-1-1	In	148 (3.4)	147 (13.8)	50 (27.2)	32 (5.8)	377 (6.1)
(CL-1.1)	Out	177 (3.4)	148 (12.1)	63 (42.6)	32 (6.0)	420 (5.9)
NR-2	In	133 (6.2)	89 (14.5)	28 (20.7)	12 (11.8)	262 (8.7)
(CL-2)	Out	166 (7.4)	89 (17.6)	26 (25.2)	14 (10.7)	295 (9.9)
NR-3	In	110 (6.4)	130 (16.7)	44 (77.2)	12 (13.5)	296 (11.2)
(CL-3)	Out	130 (7.7)	99 (13.1)	26 (32.8)	3 (4.4)	258 (10.0)
NR-4	In	287 (3.8)	160 (6.7)	80 (8.4)	15 (5.1)	542 (4.9)
(CL-4)	Out	285 (3.5)	140 (6.9)	39 (5.7)	13 (7.3)	477 (4.4)
NR-5	In	192 (19.5)	135 (18.1)	24 (18.8)	9 (4.9)	360 (17.6)
(CL-5)	Out	184 (15.8)	110 (16.2)	30 (17.0)	13 (5.5)	337 (14.9)
NR-6	In	132 (14.6)	77 (16.2)	28 (20.4)	54 (2.0)	291 (7.0)
(CL-6)	Out	134 (16.8)	77 (15.7)	33 (35.1)	66 (2.2)	310 (7.2)
NR-7	In	96 (9.1)	51 (20.7)	43 (27.9)	3 (0.4)	193 (8.7)
(CL-7)	Out	49 (4.8)	37 (18.5)	18 (12.6)	3 (05)	107 (5.6)
NR-1-2	In	25 (3.3)	74 (32.6)	15 (11.1)	3 (0.7)	117 (7.6)
(CL-1.2)	Out	23 (2.1)	38 (17.0)	19 (17.0)	3 (0.5)	83 (4.0)
Total	In	1,123 (5.8)	863 (13.2)	312 (16.5)	140 (2.8)	2,438 (7.4)
	Out	1,148 (5.4)	738 (12.1)	254 (16.5)	147 (2.8)	2,287 (6.7)

Note: MC: Motorcycles, LV: Light Vehicles, HV: Heavy Vehicles, CY: Pedal-cycles
Figures in the bracket indicate sampling ratio in percentage against the 12-hr traffic volume

---

[3] Note that this survey could not be carried out without assistance from provincial traffic police as well as coordination of provincial department of public works and transport.

As shown in Table 2-2-7, average occupancies by each mode were calculated by observed number of vehicles and passengers. These figures shall be utilized for converting vehicle OD matrixes to passenger OD matrixes.

Table 2-2-7   Observed Occupancy by Mode

Main Categories	Sub Categories	Total No. of Observed Sample	Total No. of Observed Vehicles	Average Occupancy
Motorcycle (MC)	Motorbike	2,055	36,762	1.65
	Motor Tricycle, Motorbike Trailer	216	3,940	11.01
Light Vehicles (LV)	Sedan, Wagon, Pick-up	593	6,960	3.10
	Light Van (Mini Bus)	814	3,263	10.02
	Light Truck	194	2,433	5.13
Heavy Vehicles (HV)	Short & Long Body Bus	52	171	15.85
	Short & Long Body Heavy Truck	455	2,874	2.35
	Semi & Full Trailer Truck	59	380	2.14
Pedal-cycles (CY)	Bicycle	255	8,830	-
	Cyclo, Bicycle Trailer	16	39	-

d. Trip Mode

As shown in Fig. 2-2-7, trip mode except "by Walk" proved that major mode is obviously "Motorbike" which consists of 57.8%, followed by "Private Car (Sedan, Station-Wagon, Pick-up)" with 11.1%, "Bicycle" with 10.1%, and "Motorcycle Trailer (Moto-remork)" with 6.2%. Other light vehicles, such as "Mini Bus (Light Van)" and "Light Truck" are made up of 4.8% and 4.2%, respectively. Heavy vehicles, such as "Bus", "Heavy Truck", and "Trailer Truck", are made up of 0.2%, 4.8%, and 0.9%, respectively.
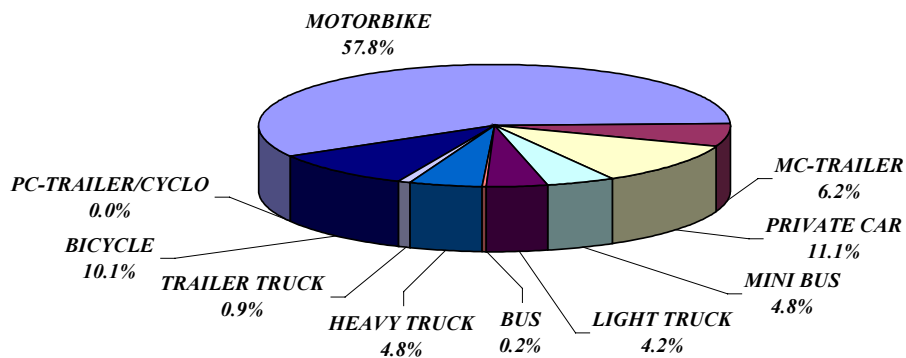
Fig. 2-2-7   Trip Mode of National Road Network Users (except "by Walk")

e. Trip Purpose

As shown in Fig. 2-2-8, composition of trip purpose for national road network users proved that major trip purpose except "Home" trip in NR networks is "Business" which made up of 31.0%, followed by "Work" with 19.3%, "Shop/Market" with 12.6%. Other purposes, such as "School" and "Private (social, recreation, and others)", are 7.7% and 7.9% respectively. On the other hand, "Home" trip is made up of 21.5%, which is second largest as a whole[4].

---

[4] The Study on Transport Master Plan of Phnom Penh Metropolitan Area which carried out by JICA in 2000 proved that trip purpose in urbanized area was consisted from "Work" with 20.3%, "Shop/Market" with 12.9%, "School" with 12.1%, "Business" with 3.3%, "Private with 2.8%, and "Home" with 48.6%.
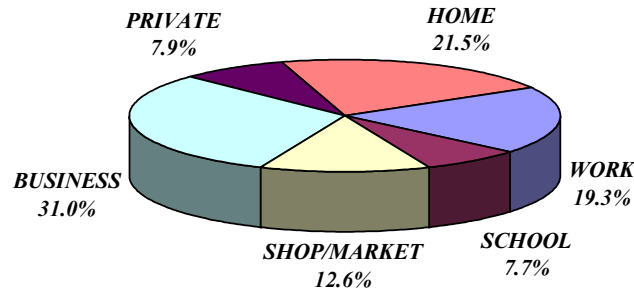
Fig. 2-2-8   Trip Purpose of National Road Network Users

f.   Origin and Destination (OD)

As shown in Fig. 2-2-9, vehicle OD data proved that almost 45% of vehicles crossing cordon lines have its origin or destination in Phnom Penh.   Second biggest origin or destination is Kandal with 31% share, followed by area along NR-4 and Kampong Cham with around 8% and 6% shares, respectively.   Area beyond Mekong River along NR-1 has around 5% shares.
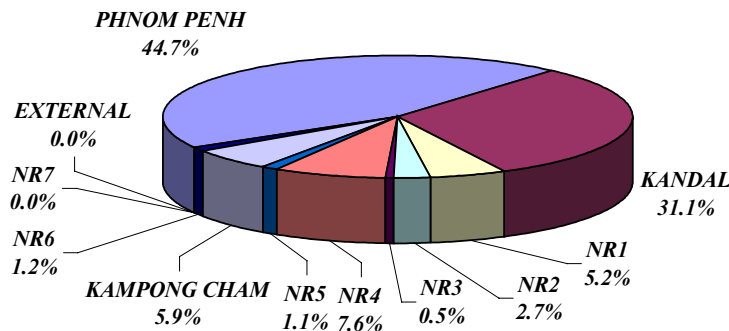
Fig. 2-2-9   Trip Origin and Destination of National Road Network Users (Vehicle OD)

2.2.4   Intersection Traffic Survey

The study team conducted 14-hour continuous intersection traffic movement counts at six stations on National Road No.1, 6, 7 and 11.   Data obtained from the survey is summarized hereinafter and detailed analyses are described in attached Appendix-E.

a.   Monivong

As shown in the Fig 2-2-9 (a), Monivong Roundabout handled approximately 168,000 vehicles in daytime 12-hr (06:00~18:00), and this is equivalent to 64,000 pcu (passenger car unit)[5].   Of which, 145,000 units are motorcycles (MC) and made up of about 87% (57% for pcu), followed by light vehicles with 18,000 units (22,000 pcu), which consists of 11% (34% for pcu) of the total.

_____

[5] PCU equivalents here are as follows; LV=1.25, HV=3.75, MC=0.25, CY=0.10, considering mixture of various size of vehicles within the same categories

Fig. 2-2-10 (a)   12-hr Traffic Volume and Movement at Monivong Roundabout

Total (in Veh.Units)	Out-Bound				Total
	North	East	South	West	
In-Bound North	29	13,371	7,972	9,227	30,599
East	15,369	113	16,810	19,722	52,015
South	11,102	20,090	47	13,983	45,222
West	10,209	18,424	11,177	51	39,861
Total	36,708	51,999	36,007	42,984	167,697

Total (in PCU)	Out-Bound				Total
	North	East	South	West	
In-Bound North	12	4,553	3,267	3,593	11,426
East	5,634	35	6,009	6,855	18,532
South	4,820	6,999	20	5,760	17,599
West	4,619	6,813	5,156	24	16,612
Total	15,086	18,399	14,452	16,232	64,169

b.   Chbar Ampov

As shown in the Fig 2-2-9 (b), Chbar Ampov Intersection handled approximately 128,000 vehicles (44,000 pcu) in daytime 12-hr.   Of which, 112,000 units (28,000 pcu) are MC and made up of about 87% (63% for pcu), followed by LV with 10,000 units (13,000 pcu), which consists of 8% (29% for pcu) of the total.
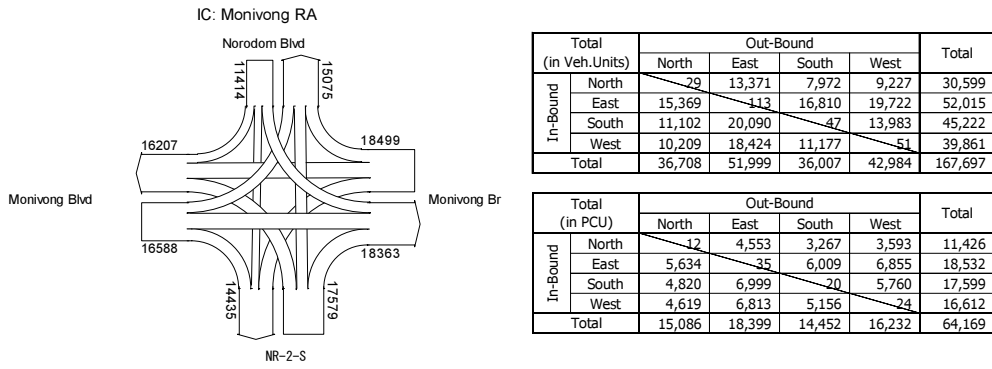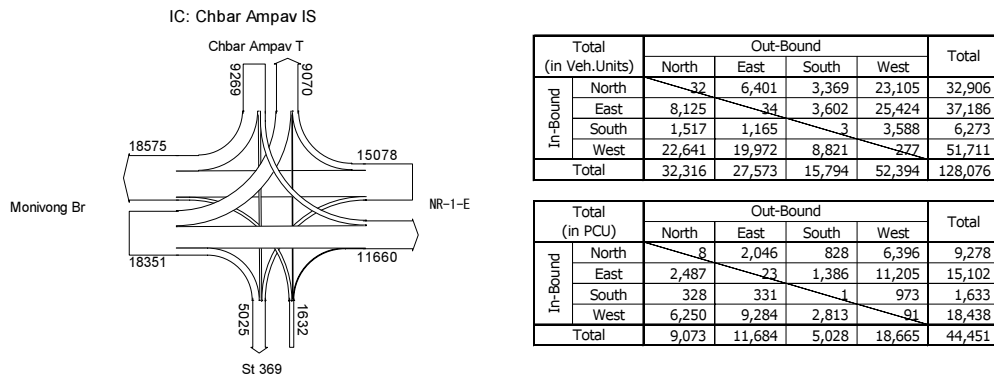

Total (in Veh.Units)	Out-Bound				Total
	North	East	South	West	
In-Bound North	32	6,401	3,369	23,105	32,906
East	8,125	34	3,602	25,424	37,186
South	1,517	1,165	3	3,588	6,273
West	22,641	19,972	8,821	277	51,711
Total	32,316	27,573	15,794	52,394	128,076

Total (in PCU)	Out-Bound				Total
	North	East	South	West	
In-Bound North	8	2,046	828	6,396	9,278
East	2,487	23	1,386	11,205	15,102
South	328	331	1	973	1,633
West	6,250	9,284	2,813	91	18,438
Total	9,073	11,684	5,028	18,665	44,451

Fig. 2-2-10 (b)   12-hr Traffic Volume and Movement at Chbar Ampov Intersection

c.   Tiger Road

As shown in the Fig 2-2-9 (c), Tiger Road Intersection handled 16,500 vehicles (9,000 pcu) in daytime 12-hr.   Of which, 11,500 units (28,000 pcu) are MC and made up of about 70% (32% for pcu), followed by LV with 3,000 units (4,000 pcu), which consists of 19% (44% for pcu) of the total.

Total (in Veh.Units)	Out-Bound				Total
	North	East	South	West	
In-Bound North	0	79	70	544	692
East	232	0	633	6,602	7,467
South	108	490	0	720	1,317
West	505	5,635	885	0	7,025
Total	845	6,203	1,587	7,866	16,500

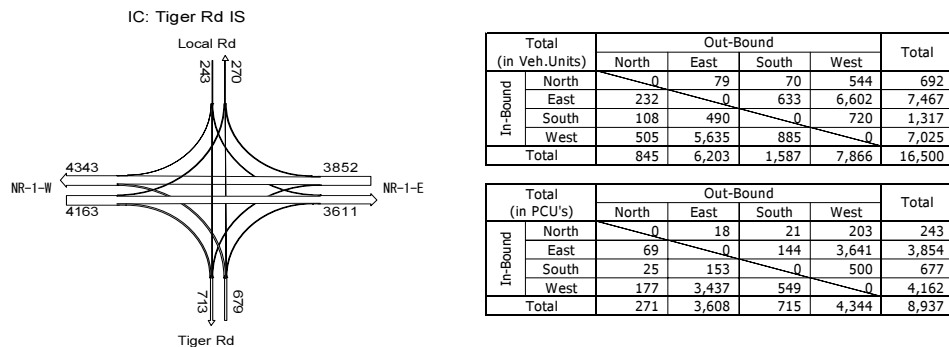| Total (in PCU's)	Out-Bound				Total
	North	East	South	West	
In-Bound North	0	18	21	203	243
East	69	0	144	3,641	3,854
South	25	153	0	500	677
West	177	3,437	549	0	4,162
Total	271	3,608	715	4,344	8,937

Fig. 2-2-10 (c)   12-hr Traffic Volume and Movement at Tiger Road Intersection

d. Neak Loueng East

As shown in the Fig 2-2-9 (d), Neak Loueng East Intersection handled 15,400 vehicles (5,900 pcu) in daytime 12-hr.   Of which, 8,700 units (2,200 pcu) are MC and made up of about 56% (36% for pcu), followed by CY with 4,900 units (500 pcu), which consists of 32% (8% for pcu) of the total.
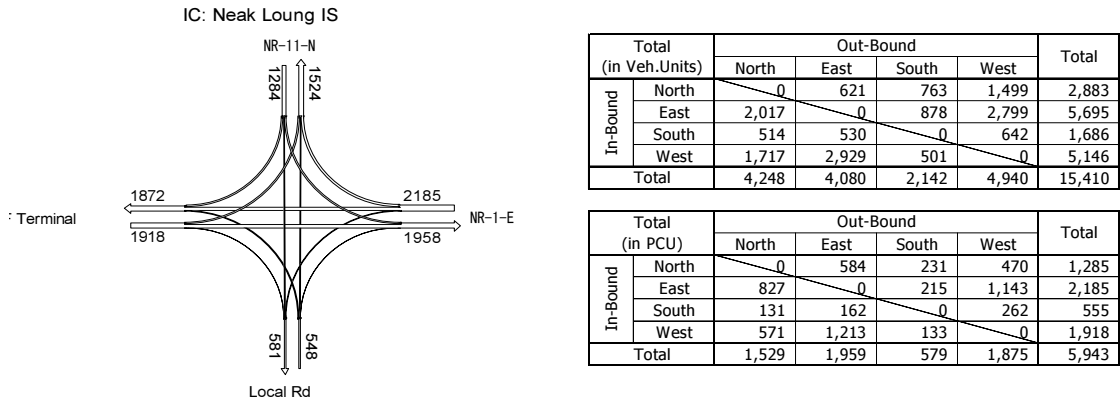
IC: Neak Loung IS

Total (in Veh.Units)		Out-Bound				Total
		North	East	South	West	
In-Bound	North	0	621	763	1,499	2,883
	East	2,017	0	878	2,799	5,695
	South	514	530	0	642	1,686
	West	1,717	2,929	501	0	5,146
	Total	4,248	4,080	2,142	4,940	15,410

Total (in PCU)		Out-Bound				Total
		North	East	South	West	
In-Bound	North	0	584	231	470	1,285
	East	827	0	215	1,143	2,185
	South	131	162	0	262	555
	West	571	1,213	133	0	1,918
	Total	1,529	1,959	579	1,875	5,943

Fig. 2-2-10 (d)   12-hr Traffic Volume and Movement at Neak Loueng East Intersection

e. Skun

As shown in the Fig 2-2-9 (e), Skun roundabout handled 12,700 vehicles (6,700 pcu) in daytime 12-hr.   Of which, 5,800 units (1,500 pcu) are MC and made up of about 46% (22% for pcu), followed by CY with 3,800 units (400 pcu), which consists of 30% (6% for pcu) of the total.
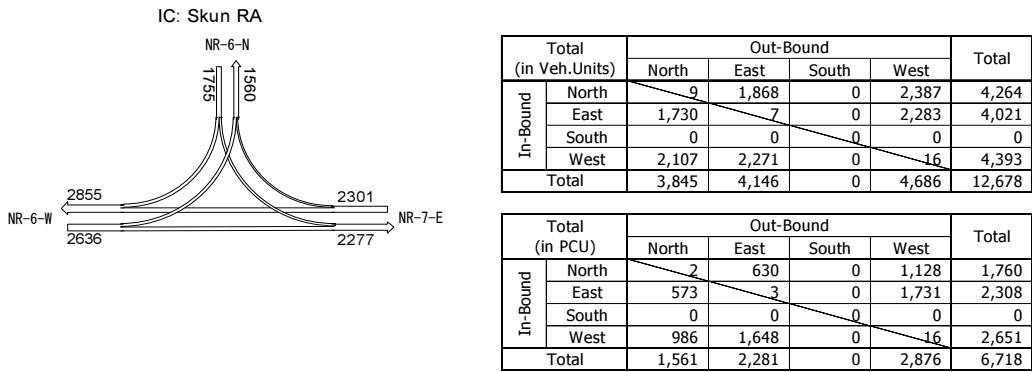
IC: Skun RA

Total (in Veh.Units)		Out-Bound				Total
		North	East	South	West	
In-Bound	North	9	1,868	0	2,387	4,264
	East	1,730	7	0	2,283	4,021
	South	0	0	0	0	0
	West	2,107	2,271	0	16	4,393
	Total	3,845	4,146	0	4,686	12,678

Total (in PCU)		Out-Bound				Total
		North	East	South	West	
In-Bound	North	2	630	0	1,128	1,760
	East	573	3	0	1,731	2,308
	South	0	0	0	0	0
	West	986	1,648	0	16	2,651
	Total	1,561	2,281	0	2,876	6,718

Fig. 2-2-10 (e)   12-hr Traffic Volume and Movement at Skun Roundabout

f. NR-7 with NR-11

As shown in the Fig 2-2-9 (f), Intersection NR-7 with NR-11 handled 7,200 vehicles (4,800 pcu) in daytime 12-hr.   Of which, 3,900 units (1,000 pcu) are MC and made up of about 54% (20% for pcu), followed by CY with 1,600 units (200 pcu), which consists of 22% (3% for pcu) of the total.
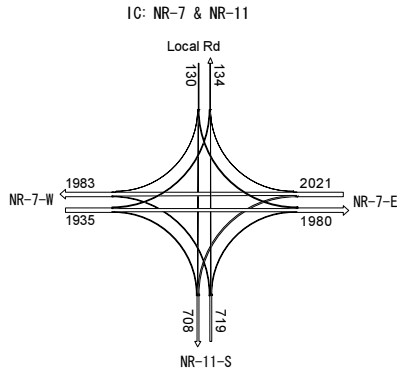
IC: NR-7 & NR-11

Total (in Veh.Units)	Out-Bound				Total
	North	East	South	West	
In-Bound North	0	132	147	279	557
East	196	0	659	1,800	2,656
South	123	840	0	453	1,416
West	225	1,763	573	0	2,561
Total	544	2,735	1,379	2,532	7,189

Total (in PCU)	Out-Bound				Total
	North	East	South	West	
In-Bound North	0	50	25	55	130
East	48	0	326	1,651	2,025
South	41	399	0	277	717
West	48	1,533	356	0	1,937
Total	136	1,982	708	1,983	4,809

Fig. 2-2-10 (f)   12-hr Traffic Volume and Movement at Intersection NR-7 with NR-11

2.2.5   Travel Speed Survey

As shown in the Table 2-2-8 and Fig 2-2-11, the travel speed survey results prove that average speed between Chbar Ampov and Prek Tonloab (West Terminal of Neak Loueng Ferry) is assumed 37.2 km/hr as a whole, and average travel time become 1.48 hr (89 min).   Additional detailed descriptions are attaché in the Appendixes.

Table 2-2-8   Average Travel Speed of National Road No.1 on Section C-1

| Section	Direction	Morning	Daytime	Evening	Average	Description (Distance in km)
North	N-Bound	36.9	36.8	37.7	37.1	Chbar Ampov - Kokir Market
	S-Bound	38.1	37.3	36.0	37.1	(0.0 km - 13.7 km)
Middle	N-Bound	38.7	39.0	39.9	39.2	Kokir Market - Samrong Thom
	S-Bound	40.1	39.0	37.2	38.8	(13.7 km - 34.6 km)
South	N-Bound	33.6	36.0	36.6	35.4	Samrong Thm – Prek Tonloab
	S-Bound	35.6	37.4	34.4	35.8	(34.6 km - 55.0 km)
Whole	N-Bound	36.2	37.3	38.1	37.2	Chbar Ampov – Prek Tonloab
	S-Bound	37.9	38.0	35.8	37.2	(0.0 km - 55.0 km)

Unit; km/hr, Data Source; JICA Study Team
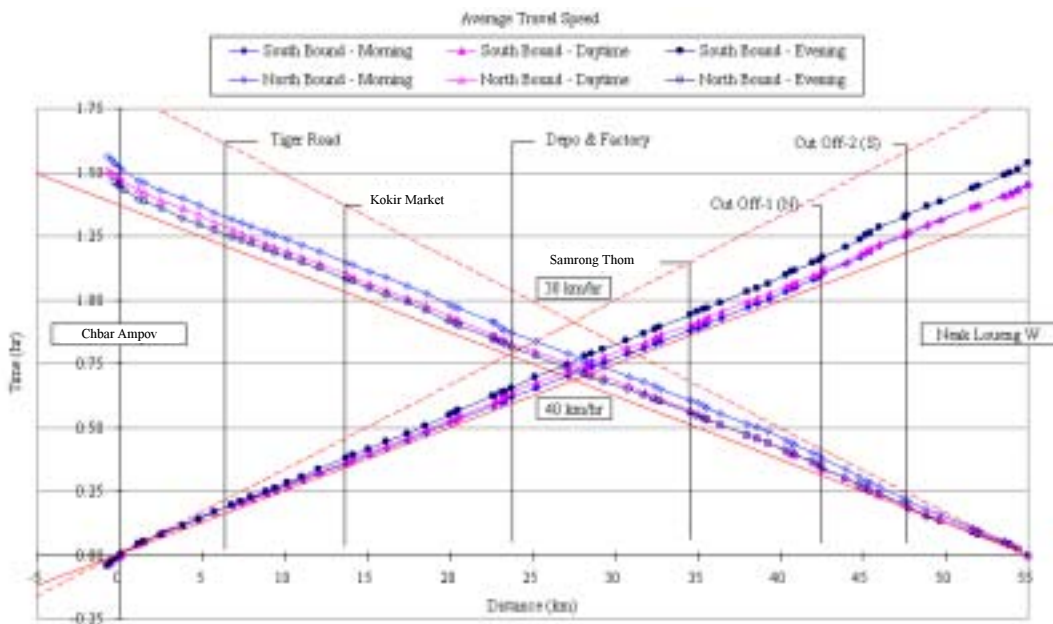
Fig. 2-2-11   Average Travel Speed

2 - 20

2.2.6 Cargo Movement Survey

a. Daily Activities

As shown in the Fig. 2-2-12 and 2-2-13, the cargo movement survey prove that average daily cargo movements based in the study areas are reached approximately 14,200 trips with 119,000 ton per day. Although, weekday average shows about 24-25% higher records with around 17,600 trips or 149,000 ton per day, and weekend average shows about 60-61% lower records with around 5,700 trips and 46,000 ton per day.
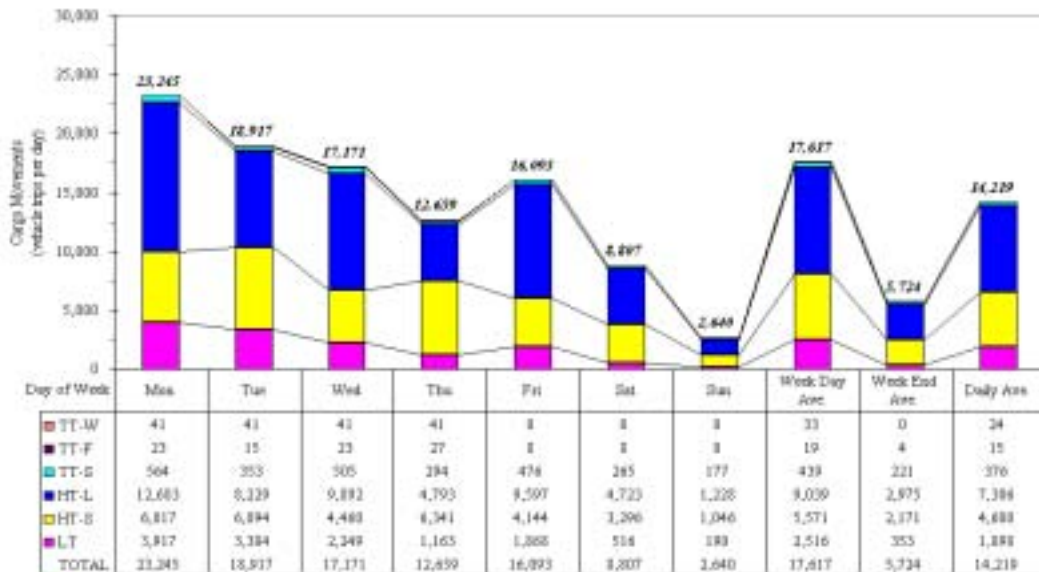

Day of Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Week Day Ave.	Week End Ave.	Daily Ave.
TT-W	41	41	41	41	8	8	8	33	0	24
TT-F	23	15	23	27	8	8	8	19	4	15
TT-S	564	353	505	294	474	285	177	439	221	376
HT-L	12,683	8,229	9,882	4,793	9,597	4,723	1,228	9,039	2,975	7,306
HT-S	6,817	6,894	4,488	6,341	4,144	3,296	1,046	5,571	2,171	4,688
LT	3,917	3,384	2,349	1,165	1,868	516	183	2,516	353	1,898
TOTAL	23,245	18,917	17,171	12,659	16,893	8,807	2,640	17,617	5,734	14,219

Fig. 2-2-12   Daily Cargo Movements by Type of Vehicles

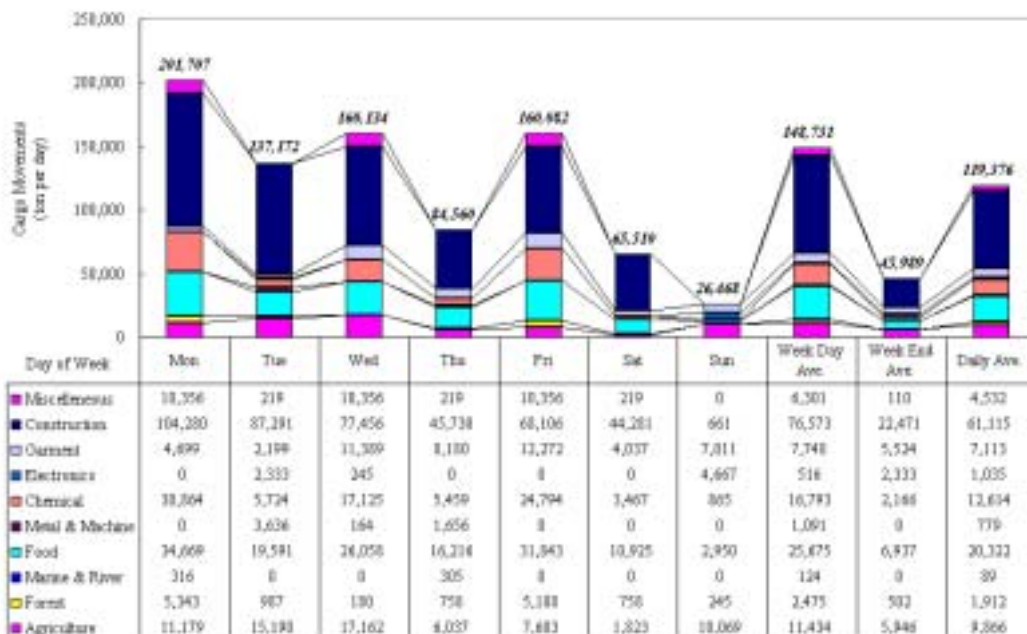| Day of Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Week Day Ave.	Week End Ave.	Daily Ave.
Miscellaneous	18,356	219	18,356	219	18,356	219	0	6,301	110	4,532
Construction	104,280	87,391	77,456	45,738	68,106	44,281	661	76,573	22,471	61,115
Garment	4,899	2,198	11,309	8,180	12,272	4,037	7,811	7,748	5,534	7,113
Electronics	0	2,333	245	0	8	0	4,667	516	2,333	1,035
Chemical	38,864	5,724	17,125	5,459	24,794	3,467	865	16,793	2,166	12,694
Metal & Machine	0	3,636	164	1,656	8	0	0	1,091	0	779
Food	34,069	19,591	26,058	16,214	31,843	10,925	2,950	25,675	6,937	20,322
Marine & River	316	8	8	305	8	0	0	124	0	89
Forest	5,343	987	130	758	5,188	758	245	2,475	502	1,912
Agriculture	11,179	15,188	17,162	4,037	7,683	1,823	18,069	11,434	5,946	9,866

Fig. 2-2-13   Daily Cargo Movements by Cargo Categories (Tonnage Base)

Within the weekday, cargo movements are most active on Monday with around 23,200 trips and 20,200 ton per day, followed by Tuesday with around 18,900 trips and 137,000 ton per day. On the other hand, Thursday's both vehicle and tonnage movements show the lowest in the weekday with around 12,700 trips and 85,000 ton per day. As a result, Monday's data shows 32% or 36% higher, and Thursday's data shows 28% or 43% lower, than weekday average vehicle or tonnage movements.[6]

b. Contents of Cargo Vehicles Classifications

As shown in Fig. 2-2-14, cargo truck movements prove that about half of cargo truck movements are consisted from long-body heavy truck (loading capacity: 8~16-ton), followed by short-body heavy truck (4~8-ton) with 32%. Movements of light truck (4-ton or less) are around 13%, and movements of trailer truck (over 16-ton) are around 3% only in total.
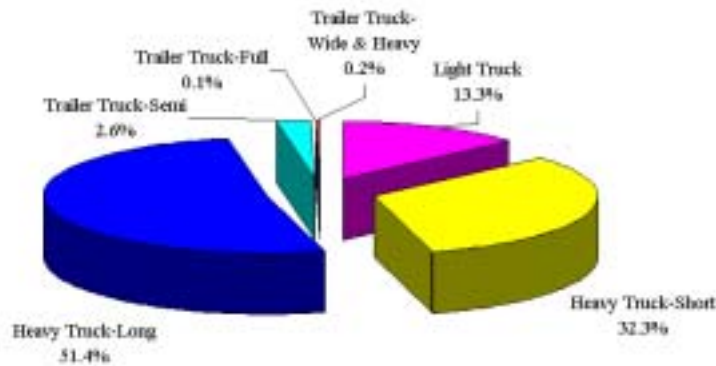

Fig. 2-2-14   Compositions of Cargo Trucks (Vehicle Trip Base)

c. Contents of Cargo Items

As shown in Fig. 2-2-15, about half of cargo item is assumed to be construction material, followed by food products with share of around 17%, chemical products such as petroleum and plastic with around 11% share, then agriculture products with around 8% share, and garment products with around 6% share. These top five categories consist of more than 90% of total cargo movements.
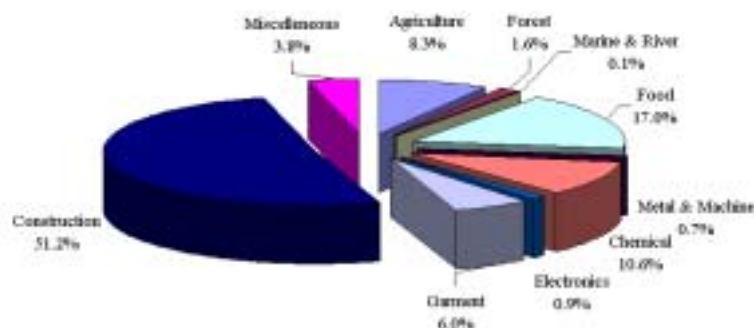

Fig. 2-2-15   Compositions of Cargo Items (Tonnage Base)

---

[6] The data obtained from the traffic counts carried out on Monday or Thursday shall not be utilized during the course of following analysis phase to avoid overestimate or underestimate of cargo vehicle movements, unless adjustment factors which are estimated by at least one-week continuous traffic counts are introduced for offsetting these possibly biased figures in this area.

d. Generation & Attraction

As shown in Fig. 2-2-16, tonnage base cargo OD (Origin & Destination) proves that 56-58% of them are generated from or attracted to Phnom Penh area.   Which is followed by area along National Road No.4 with 27% for generation and 14% for attraction.   Those of which generated from or attracted to the area along National Road No.1 excluding Kandal consist of around 4% or 11% as a total.   And those of which from/to Kandal consists of 1.1% for generation and 5.5% for attraction.   On the other hand, the cargo from/to the area along National Road No.6 and No.7, including Kampong Cham, consists of around 8% for generation and 12% for attraction[7].
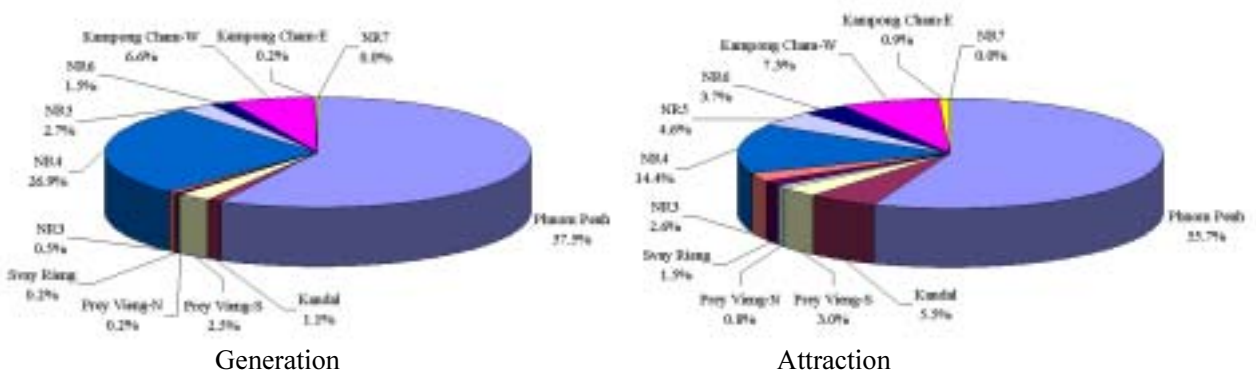

Generation   Attraction

Fig. 2-2-16   Compositions of Cargo Generation & Attraction (Tonnage Base)

e. Loading Weight & Capacity

As shown in Table 2-2-9 and Fig 2-2-17, average gross loading weight is assumed to be 2.81, 9.00, 16.87, and 8.40, against average loading capacity of 2.3, 10.3, 20.1, and 9.5, respectively.   Therefore, average loading weight-capacity (W/C) ratios become 1.23, 0.88, 0.84, and 0.89, correspondingly.

Table 2-2-9   Loading Weight and Capacity of Cargo Vehicles (Interview Base)

Description	Light Truck	Heavy Truck	Trailer Truck	Total/Average
Total No. of Sample	29	138	56	223
Average No. of Weekly Trips	8.6	10.8	10.9	10.5
Average Loading Capacity	2.3	10.3	20.1	9.5
Average Empty Cargo Ratio	0.41	0.43	0.40	0.43
Average Loading Weight (Gross)	2.81	9.00	16.87	8.40
Average Loading W/C Ratio (Gross)	1.23	0.88	0.84	0.89
Average Loading Weight (Net)	4.77	15.91	28.05	14.78
Average Loading W/C Ratio (Net)	2.08	1.55	1.40	1.56

Note: "Net" values are calculated by discarding "Empty" vehicle movements from "Gross" values

Net Figs of each type of cargo vehicles calculated by discarding those empty movements

_____

[7] This result suggests that the area where the road network is improved, such as the area along NR-6 and NR-7, has a potential to generate around two-thirds of attraction volume.   On the other hand, the area where the road network is not improved yet, such as the area along NR-1 and NR-2, has less potential of generation as low as only one-third of attraction volume.   Therefore, the area along NR-1 may have a potential to generate much more cargo movements after improvement projects

prove that they have tendency of "*Overloading*[8]". Net W/C ratios are 2.08 for light truck, 1.55 for heavy truck, 1.40 for trailer truck, and 1.56 as a whole.
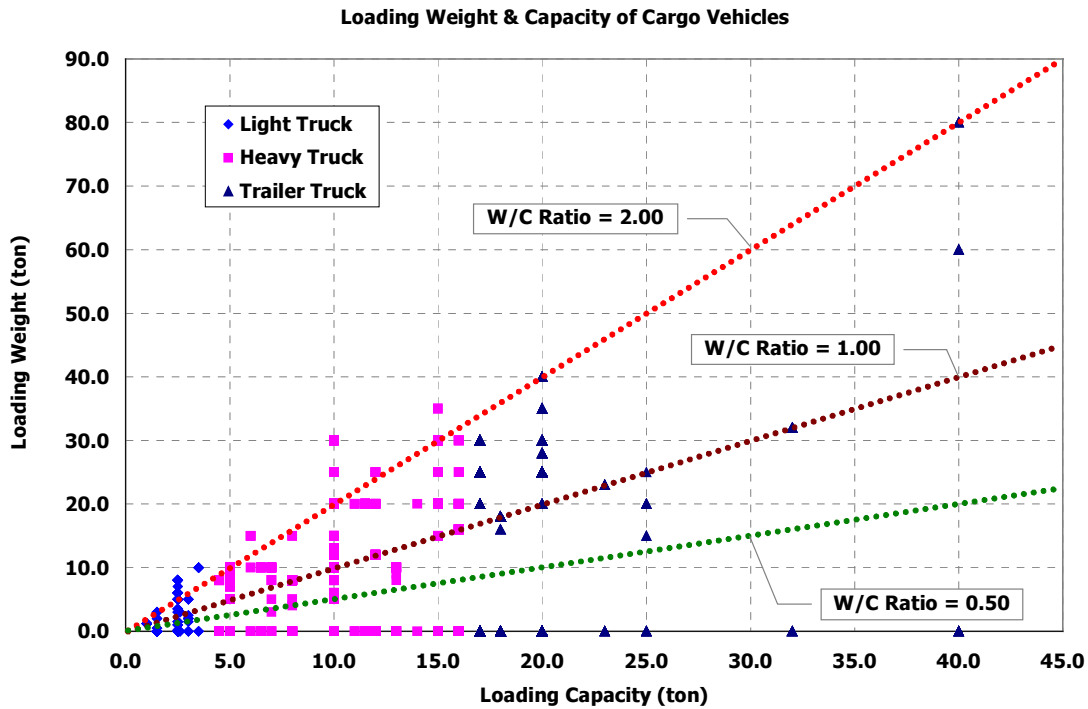

Fig. 2-2-17   Loading Weight and Capacity of Cargo Vehicles (Interview Base)

f. Fuel Consumption

As shown in Table 2-2-10, fuel consumption data prove that average weekly trip hour of cargo vehicles by class become 18.8 hours for light truck, 25.5 hours for heavy truck, 29.8 hours for trailer truck, and 25.6 hours in average.   And also average fuel consumption ratios for each class of cargo vehicles are assumed to be 13.0, 14.3, 24.0, and 17.0 litters per hour, respectively.

Table 2-2-10   Interview Based Fuel Consumption of Cargo Vehicles

Description	Light Truck	Heavy Truck	Trailer Truck	Total/Average
Total No. of Sample	28	108	47	183
Average Weekly Trip Hour (hr/week/veh)	18.8	25.5	29.8	25.6
Average Fuel Consumption Ratio (litter/hr/veh)	13.0	14.3	24.0	17.0
Average Fuel Consumption (litter/week/veh)	245	364	714	436

Note: Category of fuel indicated above is all "Diesel Fuel"

---

[8] Considering negative impact to the pavement by the activities of, especially, those heavy vehicles, MPWT and Ministry of Interior has already launched "Axle Load Inspection Team" to check over-loaded cargo vehicles at several check points along the major national road networks.   This kind of counter-measures against the overloading should be taken a place continuously before and during the course of improvement of national road networks.

2.2.7 Public Transport Survey[9]

a. Number of Operators and Fleets

Public transport survey, which carried out in Phnom Penh, prove that there are three major companies operating long-distance buses along most of national road networks between Phnom Penh and provincial capital cities, or Ho Chi Minh and Bangkok, with total of 77 buses. In addition, six companies are operating inland waterway boats between Phnom Penh and Siem Reap by Tonle Sap, and Kratie by upstream of Mekong, or Chau Doc in Vietnam by downstream of Mekong, with total of 20 boats.

b. Bus

As shown in Table 2-2-11, two companies are operating buses between Phnom Penh (PHN) and Neak Loueng (NLG), Svay Rieng (SVR), or Ho Chi Minh City (HCM) along NR-1. Frequency between PNH and NLG is 12 times everyday from both sides, six each in the morning and afternoon. Number of passenger is around 25-35 for each bus. In addition, another bus between PNH and SVR is operated once a day, with 15 to 40 passengers. Moreover, cross-border bus between PNH and HCM is also operated three times per week, with 15 to 25 passengers for each direction.

Along the other national routes, such as PNH and Takeo (TKV) of NR-2, Sihanoukville (SHV) of NR-4, Oudong (ODG) and Kampong Chhnang (KCH) of NR-5, Siem Reap (SRP) of NR-6, or Kampong Cham (KCM) of NR-7, total of three companies are operating their fleet frequently. Number of passenger varied from 20 to 45 along with the route and frequency of operation or seating capacity of the scheduled buses.

Table 2-2-11   Frequency of Bus Operation to/from Phnom Penh

	O	D	AM	PM	TTL	O	D	AM	PM	TTL	OPRT	CAP	RT	DAY						
1	PNH	HCM	1	0	1						1	45	1		2		4		6	
						HCM	PNH	1	0	1	1	45	1			3		5		7
2	PNH	NLG	6	6	12	NLG	PNH	6	6	12	1	45	1	1	2	3	4	5	6	7
3	PNH	TKV	5	5	10	TKV	PNH	5	5	10	1	45	2	1	2	3	4	5	6	7
4	PNH	SHV	3	2	5	SHV	PNH	2	3	5	1	45	4	1	2	3	4	5	6	7
5	PNH	ODG	6	7	13	ODG	PNH	7	6	13	1	45	5	1	2	3	4	5	6	7
6	PNH	KCH	6	5	11	KCH	PNH	6	5	11	1	45	5	1	2	3	4	5	6	7
7	PNH	KCM	5	3	8	KCM	PNH	4	4	8	1	45	6&7	1	2	3	4	5	6	7
8	PNH	SHV	2	2	4	SHV	PNH	2	2	4	2	50	4	1	2	3	4	5	6	7
9	PNH	HCM	1	0	1	HCM	PNH	1	0	1	3	24	1	1	2	3	4	5	6	7
10	PNH	KPT	1	0	1	KPT	PNH	1	0	1	3	24	3	1	2	3	4	5	6	7
11	PNH	SHV	1	0	1	SHV	PNH	0	1	1	3	24	4	1	2	3	4	5	6	7
12	PNH	BTB	1	0	1	BTB	PNH	1	0	1	3	24	5	1	2	3	4	5	6	7
13	PNH	SRP	1	0	1	SRP	PNH	1	0	1	3	24	6	1	2	3	4	5	6	7
14	SRP	BKK	1	0	1	BKK	SRP	1	0	1	3	24	6	1	2	3	4	5	6	7

Legend:

Origin &	PNH	Phnom Penh	ODG	Odong	Operator:	1	Ho Wah Genting Transport	Day of	1	Monday
Destination:	HCM	Hoh Chi Minh	KCH	Kampong Chhnang	(OPRT)	2	G.S.T. Export Bus	Week:	2	Tuesday
	NLG	Neak Loueng	KCM	Kampong Cham		3	Capitol		3	Wednesday
	TKV	Takev	SRP	Siem Reap					4	Thursday
	SHV	Sihanouk Ville	KPT	Kampot	Route:	1	NR–1	5	NR–5	5	Friday
	BKK	Bangkok	BTB	Battambang	(RT)	2	NR–2	6	NR–6	6	Saturday
TTL:	Total					3	NR–3	7	NR–7	7	Sunday
						4	NR–4			

---

[9] Data showing here are based on operator's timetable as well as results of public transport survey

c. Inland Waterway

As shown in Table 2-2-12, joint operator, consisted of five companies, is operating their fleets between Phnom Penh and Siem Reap along Tonle Sap twice a day, and Kratie via Kampong Cham along Mekong upstream once a day. Total number of passenger varied from 100 to 170 for Tonle Sap, or 75 to 180 for Mekong by day of operation. In addition, the other independent company also operates their boats between Phnom Penh and Siem Reap by Tonle Sap and Chau Doc in Vietnam near the border with Cambodia by Mekong down stream.

Table 2-2-12 Frequency of Inland Waterway Operation to/from Phnom Penh

	O	D	AM	PM	TTL	O	D	AM	PM	TTL	OPRT	CAP	RT	DAY						
1	PNH	SRP	2	0	2	SRP	PNH	2	0	2	1	80	TS	1	2	3	4	5	6	7
2	PNH	KRT	1	0	1	KRT	PNH	1	0	1	1	80	MG	1	2	3	4	5	6	7
3	PNH	CHD	1	0	1	CHD	PNH	1	0	1	2	80	MG	1	2	3	4	5	6	7
4	PNH	SRP	2	0	2	SRP	PNH	1	0	1	2	80	TS	1	2	3	4	5	6	7

Legend:

Origin &	PNH	Phnom Penh		Operator:	1	JV (Rambo, Channa,	Day of	1 Monday
Destination:	SRP	Siam Reap		(OPRT)		Khemera, Royal, Sooly)	Week:	2 Tuesday
	KCM	Kampong Cham			2	Capitol		3 Wednesday
	KRT	Kratie						4 Thursday
	CHD	Chau Doc (Vietnam)		Route:	TS	Tonle Sap		5 Friday
TTL:	Total			(RT)	MG	Mekong		6 Saturday
								7 Sunday

Fig. 2-2-18   Directional Supplied Capacities of Public Transport to/from Phnom Penh

2.2.8 Axle Load Survey

Axle load survey was conducted on 11 June 2002 at Km+13 of NR-1[10] at same location with cordon line survey.

Total 102 vehicles were measured. There was only one portable scale available. Accordingly, weights of left side wheels were measured mainly. The obtained data were used to estimate average Equivalent Single Axle Load (ESAL) of heavy vehicles. Some doubtful data and data of light vehicles were discarded for estimation of ESAL.

_____

[10] Prior to the survey on NR-1, same survey was conducted on NR-5 near Oudong as a practice.

It was also suspected that the measured wheel load was larger than the real load because the measured wheel was pushed up by the truck scale and the load of other wheels may have concentrated on the measured wheel. Therefore, the portable truck scale used in the Survey was compared with the fixed truck scale installed on NR-6 near Thnol Keng. The ratios of the axle loads measured by the portable scale to those measured by the fixed scale varied from 0.925 to 1.258, depending on the type of vehicle single rear axle, tandem axle and double tandem axle). Table below shows the ratio of (axle load by portable scale)/(axle load by fixed scale). The Assuming that the axle load measured by the fixed truck scale is correct, the measured axle loads were corrected by using these ratios.

Table 2-2-13   Ratio of Axle Load by Portable Scale to Axle Load by Fixed Scale

Type of Rear Axle	Single Axle		Tandem Axle		Double Tandem		
Axle	Front	Rear	Front	Rear	Front	Rear 1	Rear 2
Ratio	0.938	1.045	0.968	0.968	1.258	0.984	0.945

The average of ALEF after the corrections described above was 3.84. There was one vehicle with exceptionally heavy weight (total weight was more than 70 ton). When this vehicle is excluded, average ALEF becomes 2.93. Further, when data of five vehicles (6.2 % of the total number of measured vehicles) with ALEF= 13 were excluded; average ALEF was calculated to be 1.89.

Since the Royal Government of Cambodia has started the action to enforce over-loaded trucks, it is expected that the number of over-loaded trucks will decrease in the future. Considering this fact, ESAL = 1.89 is adopted in the pavement design.

Five light trucks were also measured. Using these data, ALEF of light vehicles were estimated to be 0.0036. (See Appendix G-2)

Note: Vertical Axis indicates distribution of ESAL (Left Axis) and Vehicle Weight (Right Axis).
Figures in the Graph indicate corresponding percentages within the sampled vehicles.

Fig. 2-2-19   Distributions of Vehicle Weight and Equivalent Single Axle Load (ESAL)

CHAPTER 3   SOCIO-ECONOMIC FRAMEWORK

CHAPTER 3   SOCIO-ECONOMIC FRAMEWORK

Generally it is known that traffic demand is the derivation demand of an economic activity.   If an economic activity increases, traffic demand will increase, and if an economic activity stagnates, traffic demand will also stagnate.   In order to predict traffic demand, it is therefore necessary to predict the social economic activities.

The purpose of this chapter is to predict the socio-economic activity of both the national and the regional levels as well as traffic zone level.   This chapter consists of analysis of the present socio-economic conditions, reviewing socio-economic development plans and projects, and subsequently the socio-economic indicators being predicted.

3.1   Socio-Economic Studies

3.1.1   Present Socio-Economic Conditions

(1) Gross Domestic Product

1) GDP

Since the Cambodia economy shifted to the market-oriented economy, it has continued its strong recovery although there were some difficulties of 1997 and 1998. It records an annual growth rate of 5.7 % during the periods of 1993 and 2001 as shown in Fig. 3-1-1.

Especially, in the last 3 years the Cambodia economy has achieved high growth rate with 6.9 %.per annum.
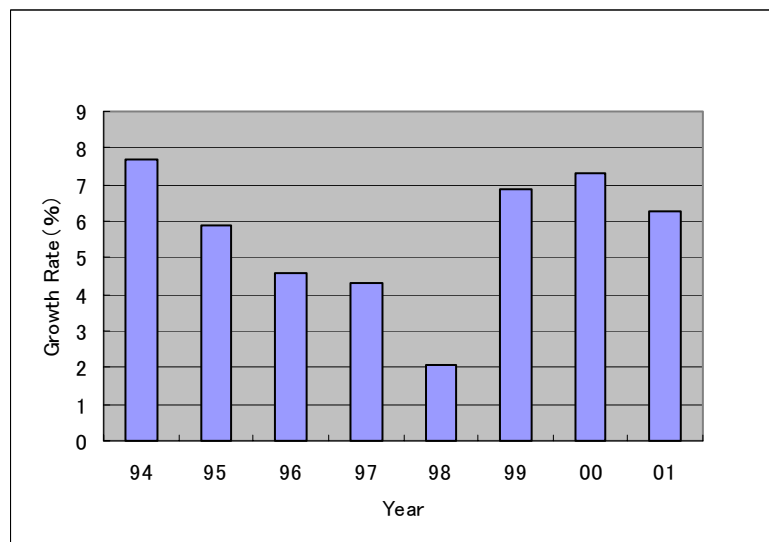
Fig. 3-1-1   Growth Rate of GDP

This is mainly the following reasons:

- Garment manufacturing continues to dominate the improvement economic growth.
- Tourism activity also grew strongly in the recent years.
- Agriculture sector contribute its economic growth steadily.

2) Per Capita GDP

Estimating per capita GDP in 2001 was 1.02 million Riels of current prices, a marginal increase from 2000. In real terms, annual GDP per capita growth has averaged around four percent in three years as shown in Fig.3.1.2. Per capita GDP in terms of US dollars declined in 1997 and 1998 as a consequence of the political instability and economic crisis in the Asian Region. However, since 1999, with improvements in political and regional economic conditions, exchange rate slowed significantly. As a result, per capita GDP in Cambodian Riels has shown modest annual growth of around 3 percent over past 3 years.
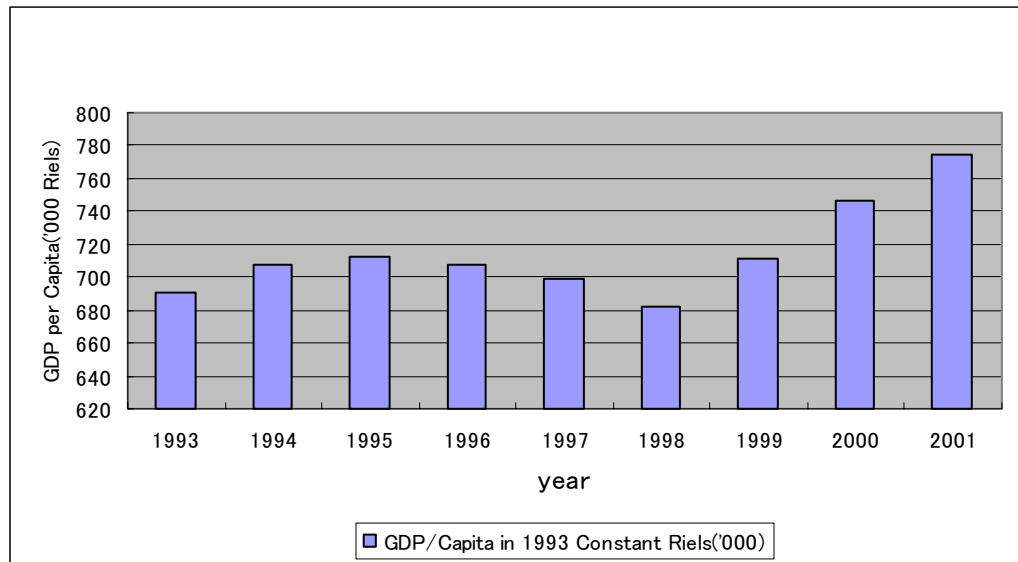
Fig. 3-1-2   GDP/Capita in 1993 Constant Riels('000)

3) GDP by Economic Sector

In current prices, the agriculture sector in 2001 accounts for 37 % of GDP compared with 46 % in 1993. The industrial sector continues to grow, nearly doubling from 12 % in 1993 and 21.9 % in 2001, due to rapid expansion in the textile, wearing apparel and footwear industry and construction activity. Although tourist oriented service sectors grew significantly, the expansion of the industry sector has swamped this, and the service sector contribution to GDP remains at around 35 %. (See Figures 3-1-3 to 3-1-5)

Composition of GDP by Industry in 1993

Tax less
Charge
3%

Tertiary
39%

Primary
46%

Secondary
12%

Fig. 3-1-3   Composition of GDP by Industry in 1993

Composition of GDP by Industry in 2001

Tax less
Charge
6%

Tertiary
35%

Primary
37%

Secondary
22%
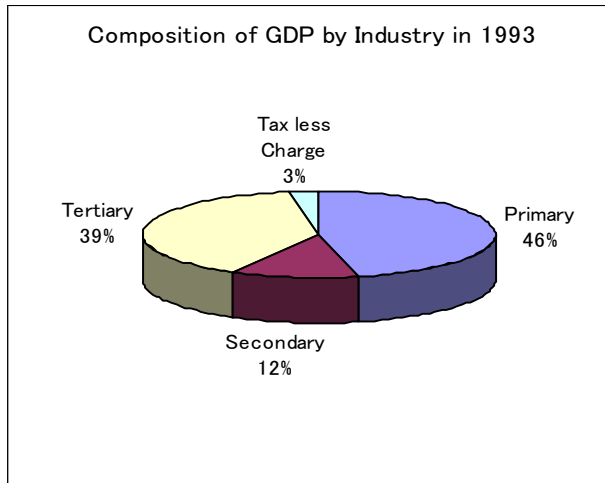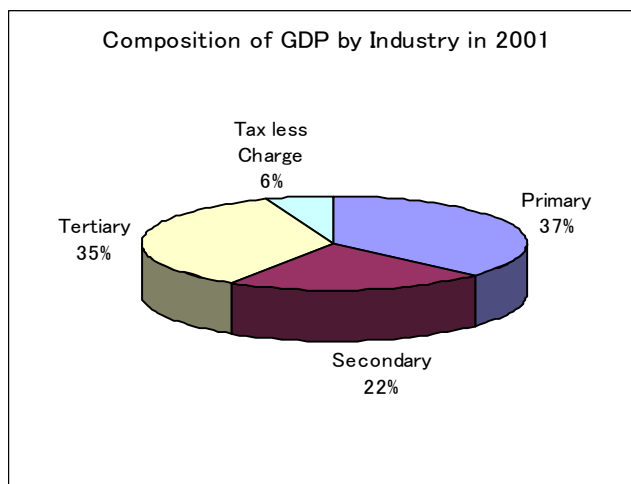
Fig. 3-1-4   Composition of GDP by Industry in 2001

Growth Rate (%)

35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
−5.0

94   95   96   97   98   99   00   01

Year

☐ Primary ■ Secondary ☐ Tertiary
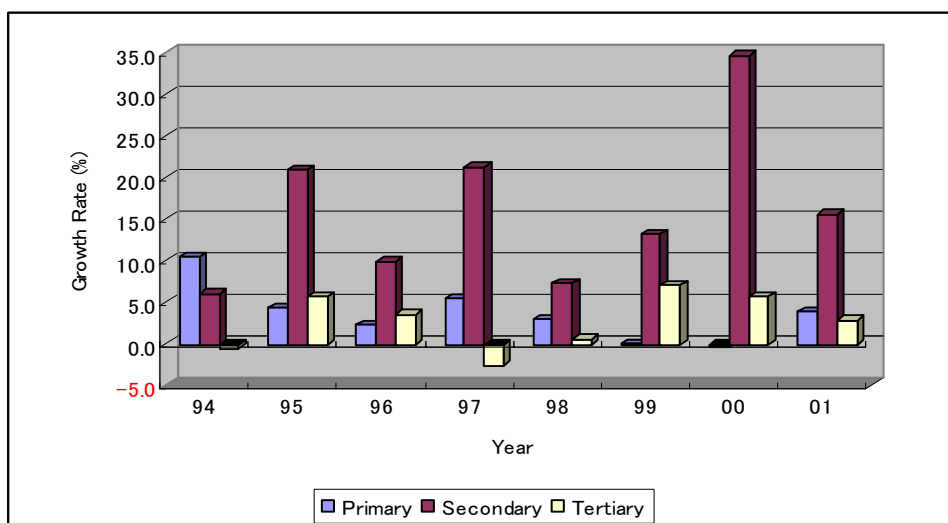
Fig. 3-1-5   Growth Rate of GDP by Industry

(2) Gross Regional Domestic Product (GRDP) by Province

1) Procedure

The GDP was broken down to the city/province using employment productivity by the areas which was obtained from the Socio-Economic Survey 1999 (SES 99). Its procedure is illustrated in Fig. 3-1-6.
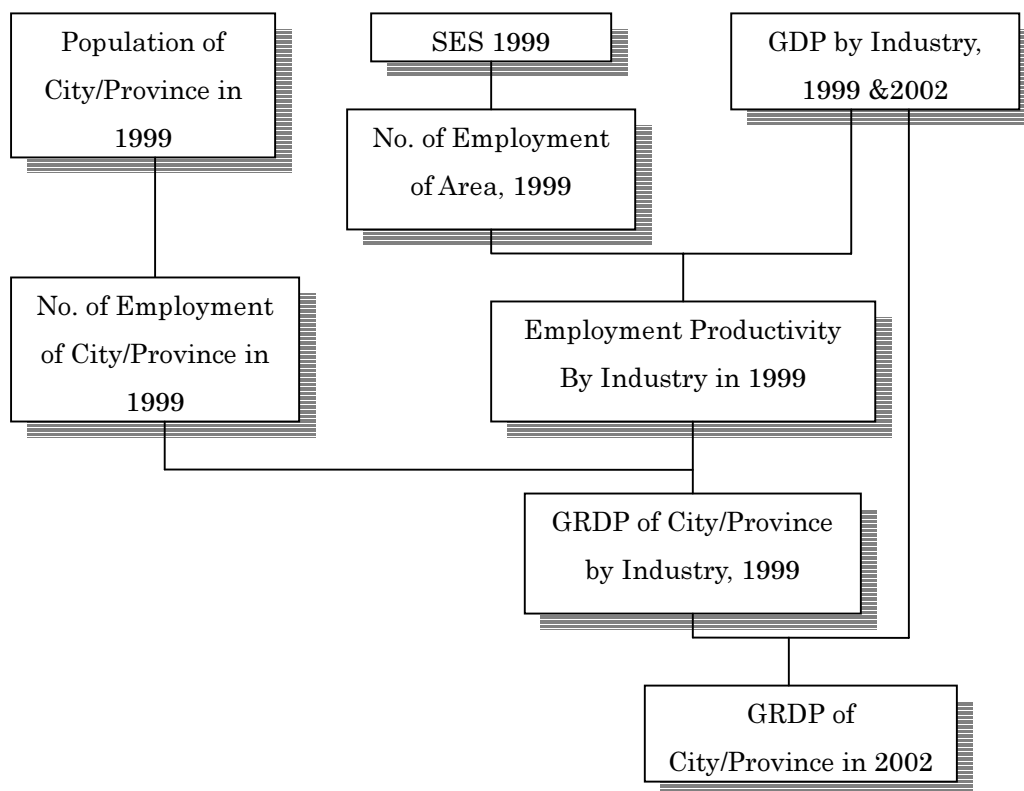
Fig. 3-1-6   Procedure for GRDP Estimation

2) Results of GRDP Estimation

Table 3-1-1 shows the results of the GRDP estimation by districts. About 55 percent of total GDP in 2002 concentrates to the central region, where consists of 6 city/provinces including Phnom Penh.

The GRDP in the direct influence areas of the Project Road accounts for about 4,293 billion Riels with about 40 percent to total GDP of Cambodia.

	Influence Area (A)[1]	Cambodia (B)	A/B (%)
2002 GRDP (Bil. Riels)	4,293.3	10,786	40

---

[1] 1. Influence areas of the Project road are defined as provinces of Phnom Penh, Kandal, Svey Rieng, and Prey Veng

Table 3-1-1   Estimated Gross Regional Domestic Products by Regions, 2002

	GRDP (billion Riels)	Population ('000 pers)	Per capita GRDP	Index
Plains Region	5,784.4	6,802.0	850.4	106
Tonle Sap Region	3,144.9	4,216.0	745.9	93
Coastal Region	797.8	1,005.0	793.9	99
Plateau and Mountain Region	1,026.5	1,410.0	728.0	91
Total	10,786.8	13,433.0	803.0	100

Sources: 1) GRDP is estimated by the Study Team
2) Population is estimated by the NIS

(3) Population in Cambodia

1) Total Population

According to the "General Population Census 1998", Cambodia population has a population of 11.44 million in 1998, comprising of 5.51 million males and 5.93 million females.   Number of household in the country is 2.19 million so that an average household size is 5.2 persons.   The annual growth rate of the population of Cambodia during the period 1981 to1998 is 3.2%.   It was modified and adjusted from population census data in 1998 by undercount population and population at not enumeration villages at displaced camps in Thailand.   The estimated population in Cambodia is 13.099 million in 2001 and 13.43 million in 2002.
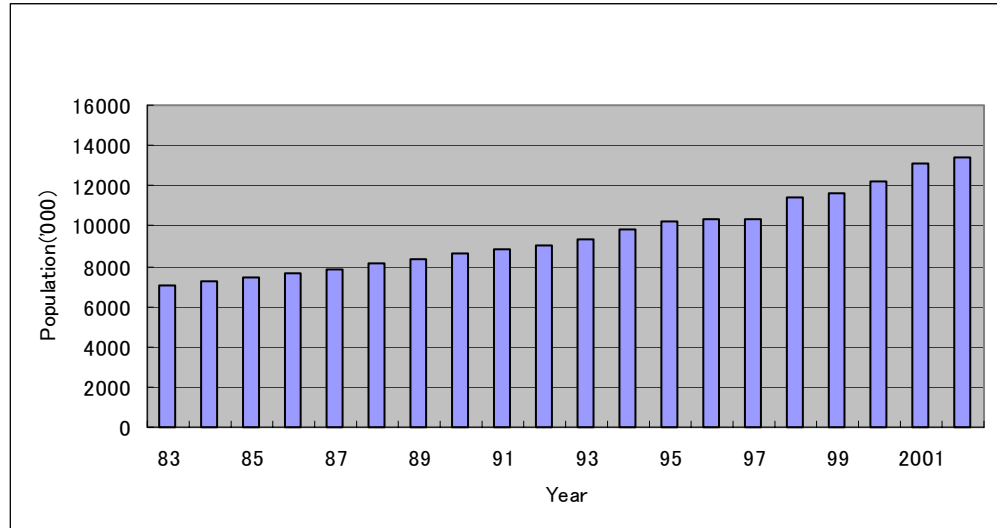
Fig. 3-1-7   Past Trend of Population

2) Urban Population

The present urbanization rate in Cambodia is one of the lowest in Asia at about 16 %.   Concentration in the capital city is high, as Phnom Penh account for 57 % of total urban population in 2001.   Population in Phnom Penh in 2001 is estimated at 1.185 million.

3) Population by Province/City

Table 3-1-2 shows the estimated population by regions in 2002. The population in the direct influence areas of the Project Road accounts for about 4.07 million with 30 percent to total population of Cambodia.

	Influence Area (A)	Cambodia (B)	A/B (%)
2002 Population	4,067,000	13,433,000	30.3

As shown clearly in Appendix Table 3-1-7, its influence area of the Project Road runs along the most densely populated areas, such as Phnom Penh city and Kandal and Prey Veaeng provinces.

Table 3-1-2   Estimated Populations and Population Density by Regions, 2002

	Land Area (km^2)	Population ('000 persons)	Population Density
Plains Region	25,069	6,802	271.3
Tonle Sap Region	67,668	4,216	62.3
Coastal Region	17,237	1,005	58.3
Plateau and Mountain Region	68,061	1,410	20.7
Total	181,035	13,433	74.2

Sources: Analysis of Census Results Report No.6
Population Projections 2002-2021, NIS
Note: Total land areas include 3,000 km^2 of Tonle Sap Lake

(4) Employment

Number of employment in 2002 is estimated on the basis of the CSES 1999 and estimated population by city/province. There are 6.11 million employments in Cambodia, of which 0.47 million in Phnom Penh, 0.64 million in other urban area and five million in rural area. (See Tables 3-1-3 and 3-1-4)

Table 3-1-3   Number of Employment in 2002

	Cambodia	Phnom Penh	Other Urban Area	Rural Area
Population in 2002 ('000)	13,433	1,235	1,454	10,744
10 years and above (%)	70.9	77.2	74.2	69.8
Participation Rate (%)	66.0	50.0	60.7	68.7
Unemployment Rate (%)	0.6	0.5	0.4	0.6
No. of Employment (' 000)	6,247.7	473.9	652.2	5121.6

Source: Report on Cambodia Socio – Economic Survey 1999

Table 3-1-4   Estimated Employment by Industry in 2002   Unit: '000

	Cambodia	Phnom Penh	Other Urban Area	Rural Area
Primary sector	4,737.0	39.3	357.4	4,340.3
Secondary sector	401.7	101.4	60.0	240.3
Tertiary sector	1,109.0	333.2	247.8	528.0
Total	6,247.7	473.9	652.2	5,121.6

Source: Study Team's Estimation

(5) Monthly Household Income

The estimated number of households and the average monthly income received by each area are presented in Table 3-1-5. The household income in Phnom Penh, the other urban area, and the rural area were 1.14 million, 0.52 million and 0.31 million Riels, respectively.

Table 3-1-5   Monthly Wages by Areas in 1999   Unit: Riel

	Cambodia	Phnom Penh	Other Urban Area	Rural Area
Wages	403,334	1,139,553	515,026	314,247
Index	100	282	128	78

Source: Report on Cambodia Socio – Economic Survey 1999

3.1.2   Development Plans in the Study Area

(1) Review of Past Development Plans

With signing of the Paris Peace Accords in 1991, Cambodia restarted to rehabilitate and develop its nation. The National Programme to Rehabilitate and Develop Cambodia (NPRD) as the first comprehensive socio-economic development plan was established and implemented in 1994. After two years of 1996, the First Socio-Economic Development Plan, 1996-2000 (SEDP-1) was formulated in conjunction with this NPRD Plan.

The NPRD Plan emphasized the following development objectives:

- Double the 1994 level of GDP by in real terms, and place heightened emphasis on harnessing Cambodia's agricultural, industrial and tourism potential;
- Extend health, education and social services to the entire population in order to ensure a peaceful way of life and substantial improvement in the standard of living
- Improve rural living standards by promoting rural development as a central feature of the Royal Government's development priorities;
- Ensure that the pattern of development is sustainable socially, politically, fiscally and environmentally; and
- Strengthen domestic self-reliance and thus reduce the current dependence on external financial and technical assistance.

Following the NPRD Plan, in order to achieve the poverty alleviation and human resource development, the development strategy in the SEDP-1 was identified as follows:

- Achievement of poverty alleviation through rural development
- Widening access to social services, especially among women and vulnerable groups.
- Establishment of macro-economic stability and long-term economic management
- Reform of the administrative and judicial institutions.
- Substantial investment in the upgrading and development of physical infrastructure
- The upgrading of human skills
- Development of the production base of the economy
- Generation of employment through labor-intensive manufacturing

Based on the above-mentioned objectives and strategy, the targeted and performed key economic real GDP growth was set up in the Plans as follows:

Table 3-1-6   Target of Key Indicators of Past Development Plans

		1996	1997	1998	1999	2000
Real GDP Growth (%)	Planed[1]	7.5	7.5	7.5	7.5	7.5
	Performed[2]	4.6	4.3	2.1	6.9	7.7
Agriculture (%)	Planed	5.2	5.2	5.2	5.2	5.2
	Performed	2.3	5.5	3.0	0.0	-0.3
Industry (%)	Planed	11.8	9.8	9.8	9.8	9.8
	Performed	9.9	21.3	7.3	13.2	34.6
Services (%)	Planed	8.2	9.0	9.0	9.0	9.0
	Performed	3.6	-2.6	0.7	7.1	5.8

Sources: 1) SEDP-1
            2) National Accounts of Cambodia 1993-2000

Aggregate growth outcomes during the SEDP-1 Period were below the target of 7.5 %. Real GDP increased at an average annual rate of 5.1 % between 1995 and 2000, fluctuating between a high of 7.7 % in 2000 and of 2.1 in 1998. It can be said that overall economic performance was severely affected by the domestic political crisis and regional economic crisis during the period 1997-'98.

(2) Second Five Year Socio-Economic Development Plan

Based on a number of lessons during SEDP – 1 period, the Second Five Socio-Economic Development Plan (SEDP-2) was formulated in 2001. The national development objectives set up in the SEDP-2 are:

-   Economic growth that is broad enough to include sectors where the poor derive a livelihood
-   Social and cultural development
-   Sustainable use of natural resources and sound environmental management

In order to achieve the above-mentioned objectives, the target of the macro-economic indicators set up in the SEDP – 2 are as follows:

Table 3-1-7   Target of Key Indicators of SEDP-2

	2001	2002	2003	2004	2005
Real GDP Growth (%)	6.0	6.0	6.0	6.5	6.5
Per Capita GDP (US $)	275	295	317	341	359
Growth of Agriculture (%)	3.5	3.5	3.5	3.5	3.5
Growth of Industry (%)	7.0	7.0	7.0	7.0	7.0
Growth of Services (%)	8.0	8.0	8.0	8.0	8.0

Source: SEDP-2

3.2 Socio - Economic Framework

3.2.1 Procedure of Setting up a Socio-Economic Framework

This section is to forecast the future socio-economic framework in the study area. The procedure taken in this study is illustrated in Fig. 3-2-1.

In the forecast of the future socio-economic framework, the following presumptions are set up:

- Population projection 2001 – 2021 made by the National Institute of Statistics (NIS) under Ministry of Planning (MOP) is principally employed in this study.
- Macro-economic indicator in the Second Socio - Economic Development Plan is expected to achieve
- However the long term perspective plan (Cambodia Development Plan 2001 - 2020) is still a draft document stage so that it is not employed as presumption of the study.

```
┌──────────────┐ ┌──────────────┐    ┌──────────────┐ ┌──────────┐ ┌──────────────┐
│ Past Trend   │ │ Population   │    │ Past Trend of│ │ SEDP-2   │ │ Long-term    │
│ Of           │ │ Projection   │    │ GDP by       │ └──────────┘ │ Perspective  │
│ Population    │ │ made by NIS  │    │ Industry     │              │ Plan         │
└──────────────┘ └──────────────┘    └──────────────┘              └──────────────┘

┌──────────────────┐              ┌──────────────────┐ ┌──────────────────┐
│ Population        │              │ Estimation of    │ │ Forecast of GDP  │
│ Projection in     │              │ GRDP by          │ │ by Development    │
│ 2005, 2010 and    │              │ Province (1999)  │ │ Scenarios        │
│ 2015             │              └──────────────────┘ └──────────────────┘
└──────────────────┘

┌──────────────────┐
│ Population        │
│ Projection of     │
│ Province, 2005,   │
│ 2010 and 2015     │
└──────────────────┘
                                                    ┌──────────────────┐
                                                    │ Forecasts of     │
                                                    │ GRDP by          │
                                                    │ Development       │
                                                    │ Scenarios In 2015 │
                                                    └──────────────────┘
```
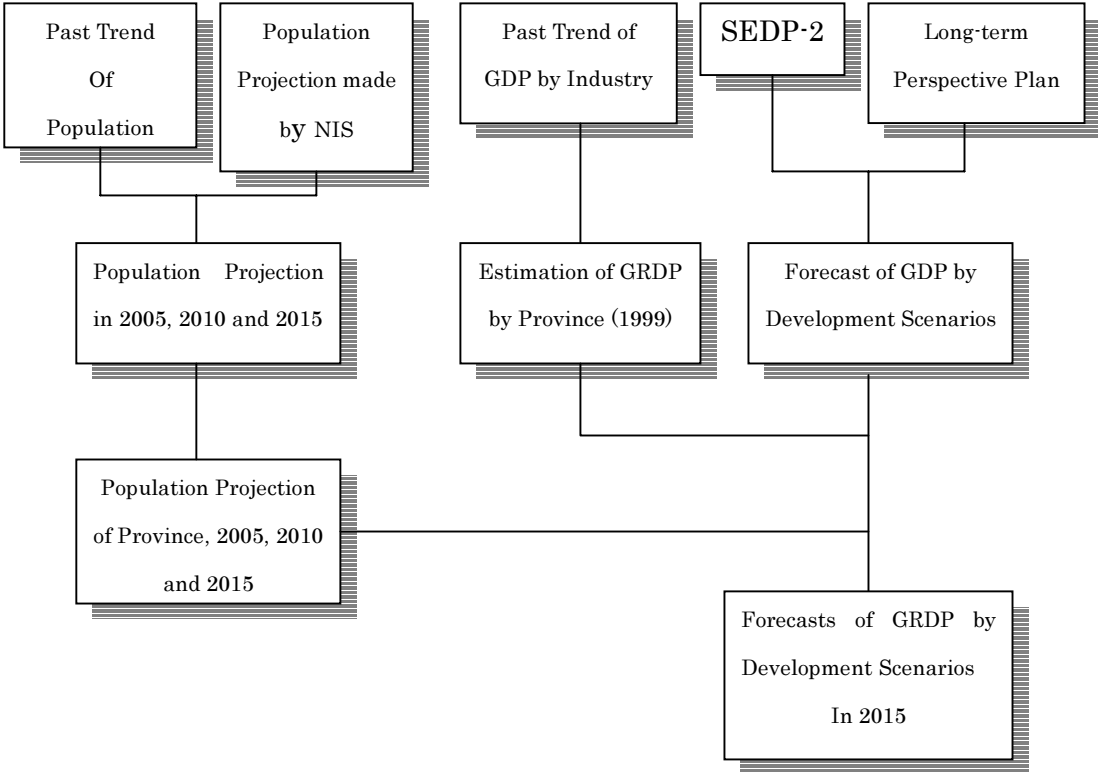
Fig. 3-2-1   General Procedure for Future Socio-Economic Framework

3.2.2 Population Projection

Future population of both national and provincial levels is basically employed after careful examinations of population projections made by NIS.

According to the NIS'S projection, the population is projected using the PEOPLE computer program. The elements used in the model are age structure, fertility rate, mortality rate, migration between city/province. The future population projected is as follows:

Table 3-2-1   Population Projection by Year

Year	Population ('000)	Annual Average Growth Rate (%)
2001	13,099	-
2002	13,433	2.5
2005	14,454	2.5
2010	16,245	2.4
2015	18,091	2.2
2020	19,918	1.9

Source: Population Projections 2001 – 2021, NIS

The population is expected to increase from 13.10 million in 2001 to 18.09 million in 2015 with average annual growth rate of 2.3 %.

3.2.3 GDP Forecast

(1) Input Data and Variables

In Cambodia, statistical data such as population census data, national account data, socio-economic survey data, etc have recently provided. As the national account data 1993-2001 provided by Ministry of Planning (MOP) in 2002 seems to be the most reliable, the GDP forecast in this study is based on this document. The input data for model building is shown in Table 3.2.2.

Table 3-2-2   Socio-Economic Data for Analysis

	GDP in billion Riels				Population ('000)
	Primary	Secondary	Tertiary	Total GDP	
1993	3,035.2	756.4	2,754.0	6,545.5	9,474
1994	3,350.6	802.0	2,894.4	7,047.0	9,954
1995	3,498.1	969.4	2,996.8	7,464.3	10,470
1996	3,578.7	1,065.2	3,163.7	7,807.6	11,034
1997	3,774.1	1,291.7	3,077.5	8,143.3	11,640
1998	3,887.8	1,385.9	3,044.7	8,318.3	12,186
1999	3,888.3	1,569.1	3,431.7	8,889.1	12,503
2000	3,876.1	2,111.6	3,582.0	9,569.7	12,825
2001	4,025.7	2,439.4	3,711.2	10,176.2	13,099

Source: National Account of Cambodia, 1993 – 2001, Bulletin No.6, NIS
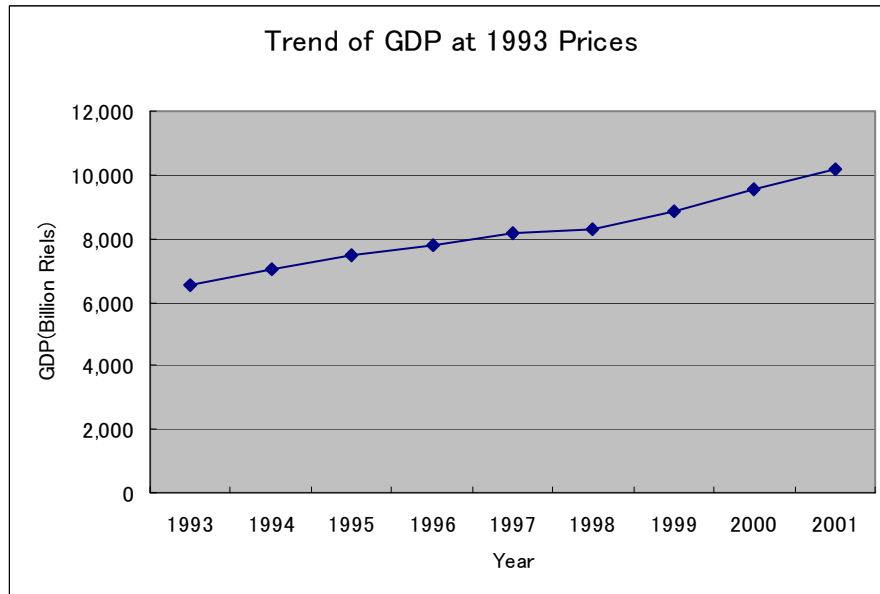
Fig. 3-2-2   Trend of GDP at 1993 Prices

The above figure shows the yearly trend of GDP growth.   From this figure, it can be said that there are two types of GDP trend, one is tendency between 1993 and 1998, the other is between 1998 and 2001.   The GDP growth in the earlier period (1993-1998) is comparatively lower than that in the later period (1998-2001).

(2) GDP Forecasting Model

On the basis of careful examinations for formulation of GDP forecasting models, the models developed in this study is as follows:

$$Y = A e^{BX}$$

Where: Y: GDP in billion Riels
         X: Variable
         A, B   Parameters

Based on the observations mentioned above, two types of the GDP growth model are established in the study:

Data based on period 1993-1998

$$Y = 6353.0 \, e^{0.0488x} \qquad (R^2 = 0.976)$$

Where: Y: GDP in billion Riels
         X: Year

Data based on period 1998 – 2001

$$Y = 7774.0 \, e^{0.0579x} \qquad (R^2 = 0.998)$$

Where: Y: GDP in billion Riels
         X: Year

GDP in Cambodia can be explained as an exponential curve since its regression correlation rate is generally high.

GDP by Industry Model

In order to establish forecasting models for GDP by industry, several mathematical models such as exponential model, linear regression model, quadratic equation model etc. are examined carefully. Among these models, the following models are selected:

Primary $\qquad$ $Y = 3120 \, e^{0.031X}$ $\qquad$ ($R^2 = 0.8769$)
$\qquad$ Where : Y : $\qquad$ GDP of primary industry
$\qquad\qquad$ X : $\qquad$ Year

Secondary $\qquad$ $Y = 23.88 \, X^2 - 35.781 \, X + 799.44$ $\qquad$ (R2 = 0.984)
$\qquad$ Where : Y : $\qquad$ GDP of secondary industry
$\qquad\qquad$ X : $\qquad$ Year

Tertiary $\qquad$ $Y = 2927.8 \, e^{0.0637X}$ $\qquad$ ($R^2 = 0.910$)
$\qquad$ Where : Y : $\qquad$ GDP of primary industry
$\qquad\qquad$ X : $\qquad$ Year

As for the GDP of secondary industry model, the quadratic equation model is selected while the GDP of the other industries model are employed as the exponential model because correlation rates of these models are high and forecasting values using these models are appropriate.

(3) Development Alternatives

Medium Growth Scenario

Based on the historical trend of the GDP growth of Cambodia, the annual economic growth rate is expected to increase from 5 to 7 percent per annum. If the economic activity follows higher growth trend for the period 1998 - 2001, it would be about 7 percent per annum, while if that follows lower growth trend for the period 1993 - 1998, it would be about 5 percent per annum. In combined the both growth rate, the estimated economic growth rate would be about 6 percent. This case is so called as 'Medium Growth Scenario'.

Table 3-2-3 Economic Growth Prospects under Trend based Scenario (Medium Growth)

	1996 – 2000	2001- 2005	2006 - 2010	2011 – 2020	SEDP-2
Real GDP Growth (%)	5.1	6.0	6.0	6.0	6.2
Primary sector (%)	2.0	3.2	3.2	3.2	3.5
Secondary sector (%)	16.8	12.4	10.2	9.6	7.0
Tertiary sector (%)	3.6	8.0	4.8	4.2	8.0

Source: Study Team's Estimation

<u>High Growth Scenario proposed by DCDP</u>

The Government has tentatively formulated the Draft Cambodia Development Plan （DCDP）, 2001 – 2020.   This development plan is based on the following new directions of development;

- Promote national pride and confidence
- Ensure sustainable growth
- Institutional development
- Poverty alleviation
- Human resource development
- Harnessing private sector as the engine of growth

In the DCDP, it has proposed the following economic growth prospects for the period 2001 – 2020 as the macro – economic indicators:

Table 3-2-4   Economic Growth Prospects in the DCDP

	1996 – 2000	2001- 2005	2006-2010	2011 – 2020	SEDP-2
Real GDP Growth (%)	5.1	6.0	8.0	8.0	6.0
Primary sector (%)	2.0	3.2	3.2	3.2	3.5
Secondary sector (%)	16.8	12.4	13.1	11.7	7.0
Tertiary sector (%)	3.6	8.0	7.7	7.3	8.0

Source: Draft Cambodia Development Plan, 2001 – 2020

It can be said that the future GDP growth rate proposed in the DCDP 2001 – 2020 is optimistic estimation judging from the historical trend and future potential.   However, it is assumed that the GDP growth rate proposed in the DCDP is employed as a high growth scenario.

<u>Low Growth Scenario based on Past Trend</u>

The current high growth rate of the GDP of Cambodia is results for too much concentration of investments to the garment and foot wear-manufacturing.   However, it may not be expected to continue such investments to such manufacturing sector for coming decade.   This may become low growth scenario.   This case is so called as 'Low Growth Scenario'.

Table 3-2-5   Economic Growth Prospects in 'Low Growth Scenario'

	1996 – 2000	2001- 2005	2006 - 2010	2011 – 2020	SEDP-2
Real GDP Growth (%)	5.1	6.0	4.0	4.0	6.2
Primary sector (%)	2.0	3.2	3.2	3.2	3.5
Secondary sector (%)	16.8	12.4	5.5	5.4	7.0
Tertiary sector (%)	3.6	8.7	3.5	3.5	8.0

Source: Study Team's estimation

(2) Results of the Forecast and their Analysis

The results of the GDP forecast are shown in Table 3-2-6.   The GDP growth rate of the medium growth scenario from 2002 to 2015 is about 6 % per annum.   As a result, the GDP per capita will increase from 803,000 Riels in 2002 to 1,290 Riels in 2015.

The GDP growth rate of the other scenarios from 2002 to 2015 is forecasted at 7.65 % for high growth scenario and 4.5 % for the low growth scenario.

(3) Selection of the Development Scenarios

Among the proposed development scenarios, the medium growth scenario is selected to use as the future macro-economic framework for future traffic demand forecast.   This is because a probability of this scenario that will occur for the coming decade is the highest among three alternative scenarios judging from past trend of the Cambodian economy. However, the other two scenarios such as high and low growth scenarios will be examined in sensitivity analysis in the economic evaluation.

Table 3-2-6   Results of GDP Forecast by Year

		Population ('000)	GDP (billion Riels)	Growth Rate (%)	GDP per Capita ('000 Riels)	Growth Rate (%)
2000		12,825	9,569.7	7.7	746.2	5.0
2001		13,099	10,176.2	6.3	776.9	4.1
2002(Base Year)		13,433	10,786.8	6.0	803.0	3.4
2003		13,770	11,434.0	6.0	830.4	3.4
2004		14,111	12,177.2	6.5	863.0	3.9
2005		14,454	12,968.7	6.5	897.2	4.0
2010	Medium	16,245	17,355.1	6.0	1,068.3	3.6
	High		19,055.3	8.0	1,173.0	5.5
	Low		15,778.4	4.0	971.3	1.6
2015	Medium	18,091	23,225.0	8.0	1,289.8	3.7
	High		27,998.5	6.0	1,554.9	5.7
	Low		19,196.9	4.0	1,061.1	1.8

Notes: 1) 1993 -2001 Figure: National Account of Cambodia, Bulletin No.6
2) Population in 2005, 2010 and 2015 is Population Projection 2001-2021
3) GDP growth rate between 2002 and 2005 is based on SEDP-2
4) High case of GDP in 2010 and 2015 is based on DCDP
5) Low case of GDP in 2010 and 2015 is forecasted by the Study Team
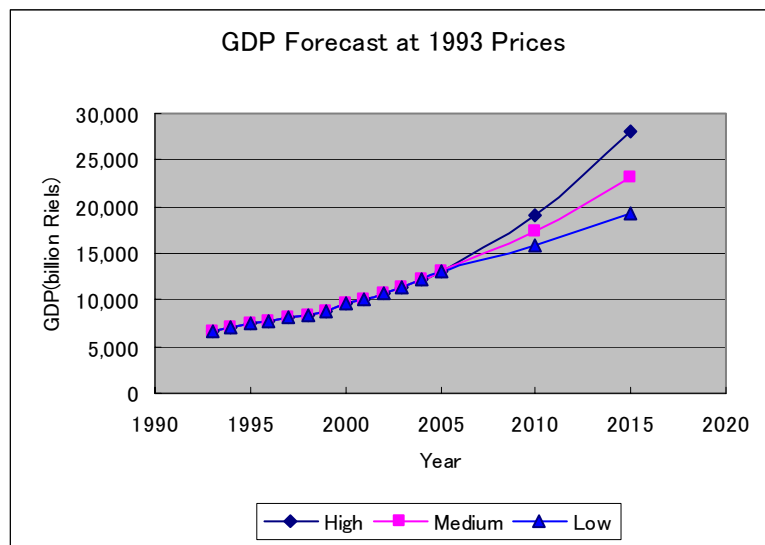

Fig. 3-2-3   GDP Forecast at 1993 Prices

(4) GDP by Industrial Sector

Following the GDP by industry models developed in the previous section, the GDP by industrial sector is estimated and presented in Table 3-2-7.

Table 3-2-7   Result of GDP Forecast by Industry and Year in Medium Growth Scenario

Billion Riels

	Primary		Secondary		Tertiary		Total GDP	
	GDP	Growth Rate (%)	GDP	Growth Rate (%)	GDP	Growth Rate (%)	GDP	Growth Rate (%)
2000	3,876.1	-0.3	2,111.6	34.6	3,582.0	4.4	9,603.9	7.9
2001	4,025.7	3.9	2,439.4	15.5	3,711.2	3.6	10,195.6	6.2
2002(Base Year)	4,152.5	3.2	2,735.7	12.1	3,898.6	5.1	10,786.8	5.8
2003	4,283.3	3.2	3,062.3	11.9	4,088.4	4.9	11,434.0	6.0
2004	4,418.2	3.2	3,458.1	12.9	4,300.9	5.2	12,177.2	6.5
2005	4,557.4	3.2	3,895.6	12.7	4,515.8	5.0	12,968.7	6.5
2010	5,321.8	3.2	6,337.2	10.2	5,696.1	4.8	17,355.1	6.0
2015	6,214.5	3.2	10,009.5	9.6	7,001.0	4.2	23,225.0	6.0

Sources: 1) 1993 -2001 Figure: National Account of Cambodia, Bulletin No.6
        2) GDP in 2010 and 2015 is forecasted by the Study Team

3.2.4   Employment Projection

Number of employment in future is estimated on the basis of population projection, employment productivity (GDP per employment by industry) and labor participation rate.

Table 3-2-8   Number of Employment by Industry in 2015

	Cambodia
Population in 2015	18,091.0
10 years and above (%)	70.5
Participation Rate (%)	66.0
Unemployment Rate (%)	0.6
No. of Employment(' 000)	8,863.4

Source: Study Team's Estimation

In 2015, number of employment in Cambodia is estimated at 8.9 million.

Table 3-2-9 shows GDP productivity per employment.   According to this table, productivity per employment is expected to increase from 1.7 million Riels in 2002 to 2.6 million Riels in 2015 with growth rate of 1.52.

Table 3-2-9   Comparison of Employment in 2002 and 2015

	2002	2015	2015/2002
GDP (Billion Riels)	10,786	23,225	2.15
Employment ('000)	6,247.7	8,863.4	1.42
Productivity ('000 Riels / Employ)	1,726	2,620	1.52

Source: Study Team's Estimation

Number of employment by industrial sector in future is estimated on the basis of employment productivity (GDP per employment by industry) and GDP.   The results show in Table 3-2-10 and Figure 3-2-4.

Table 3-2-10   Number of Employment by Industry in 2015

	Primary Sector	Secondary Sector	Tertiary Sector	Total
GDP (billion Riels)	6,214.5	10,009.5	7,001.0	23,225.0
Productivity ('000 Riels / Employ)	1,043	8,105	4,189	2,620
Employment in 2015	5,957.5	1,235.1	1,670.8	8,863.4

Source: Study Team's Estimation
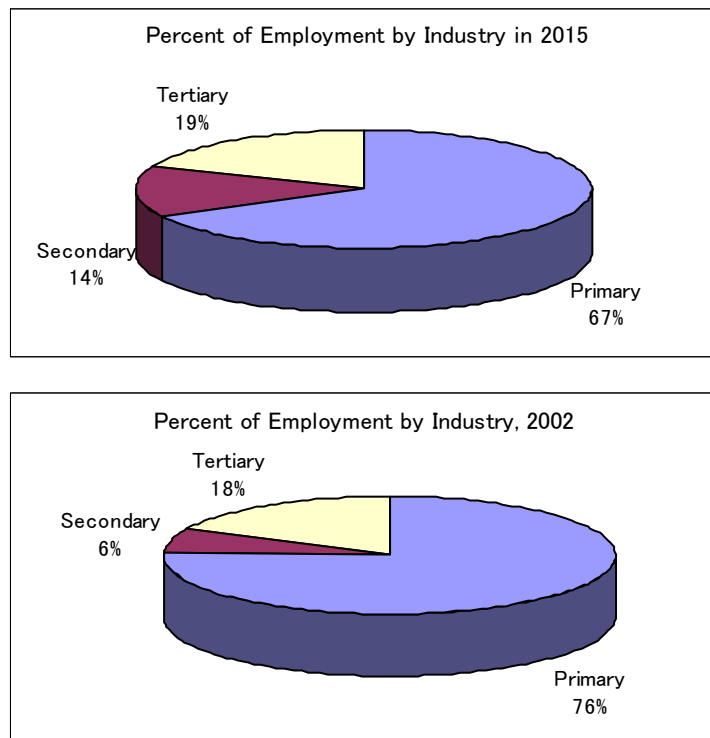
Fig. 3-2-4   Comparison of Percent of Employment by Industry, 2002 and 2015

3.3　Distribution for Traffic Zone

3.3.1　Distribution Process for the Traffic Zone

The future GDP of Cambodia will be distributed for the traffic zones. The distribution procedure is shown in Fig. 3-3-1.
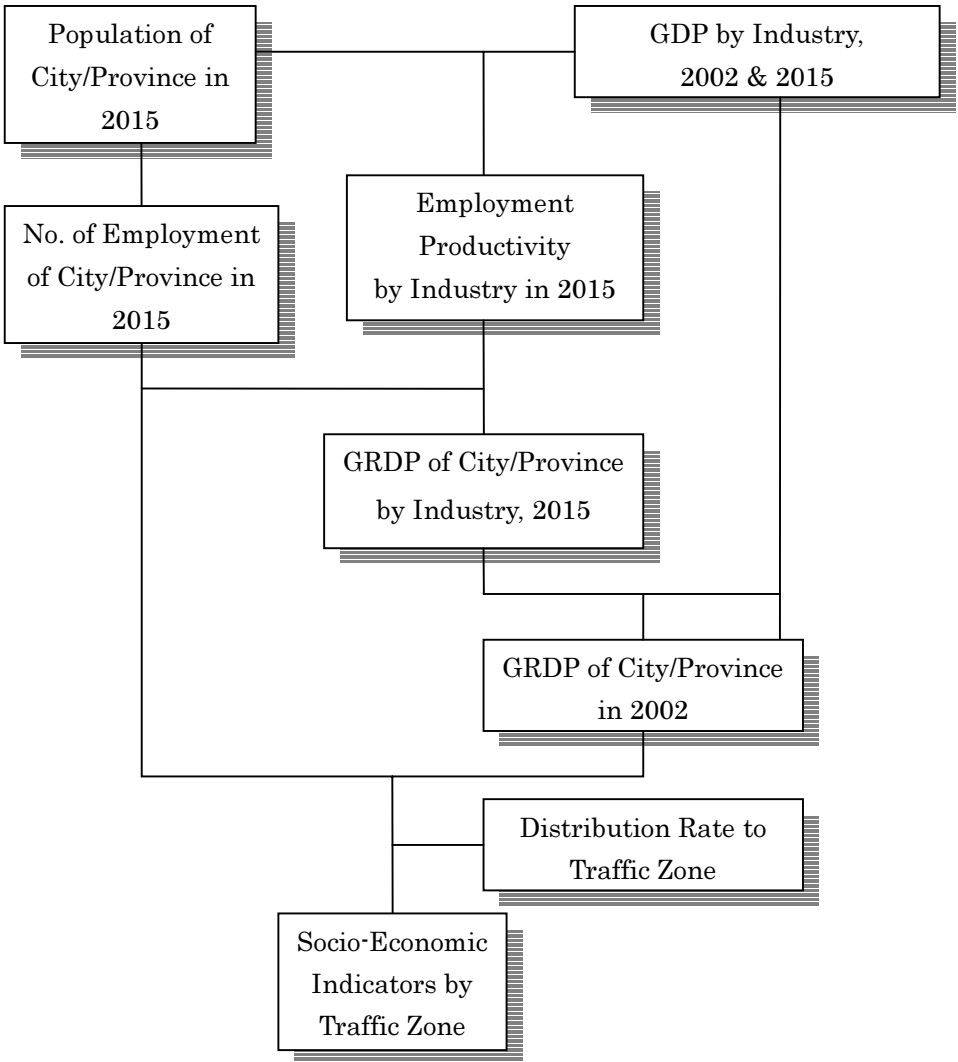

Fig. 3-3-1　Procedure for Distribution to Traffic Zone

3.3.2　Future Socio-Economic Framework by Traffic Zone

(1) Population

Table 3-3-1 shows the projected population by city/province in the years of 2005, 2010 and 2015. According to the projection, population in the influence area of the Project Roads, which consist of four districts, is expected to increase from 4.06 million in 2002 to 4.38 million in 2005, 4.91 million in 2010 and 5.44 million in 2015 with the growth rate of 1.34.

	Influence Area('000)	Cambodia('000)	Percent (%)
2002	4,064	13,433	30.2
2015	5,440	18,091	30.2

Note: Share of the influence area to total Cambodia looks like unchanged between 2002 and 2015. This is because population share of Phnom Penh will increase but share of population of the rural provinces such as Prey Veng and Svay Rieng will decrease.

The population projection at traffic zone level is summarized in Appendix Table 3-3-1.

Table 3-3-1　　Population Projection by Regions and Provinces

' 000 Persons

	2002 (Base Year)	2005	2010	2015
Plains Region	6,802.4	7,272.7	8,088.2	8,887.4
Kampong Cham	1,838.8	1,952.2	2,144.8	2,332.7
Kandal	1,231.1	1,309.6	1,444.4	1,579.5
Phnom Penh	1,235.3	1,385.3	1,658.8	1,931.6
Prey Veng	1,059.9	1,109.9	1,190.8	1,262.8
Svay Rieng	540.9	570.3	619.8	666.6
Takeo	896.4	945.4	1,029.7	1,114.2
Tonle Sap Region	4,216.4	4,549.7	5,143.5	5,781.6
Banteay Meanchey	725.1	794.2	915.8	1,044.4
Battambang	970.6	1,037.5	1,156.1	1,283.0
Kampong Chhnang	489.3	527.5	596.1	669.9
Kampong Thom	658.0	703.3	783.6	868.2
Krong Pailin	30.2	34.9	43.2	52.2
Oddar Meanchey	94.5	104.2	122.3	143.0
Pursat	427.6	459.4	517.2	583.2
Siem Reap	821.1	888.7	1,009.3	1,137.7
Coastal Region	1,004.5	1,098.2	1,260.9	1,432.4
Kampot	599.6	632.8	691.0	750.7
Koh Kong	172.9	201.3	249.6	301.0
Krong Kep	35.6	41.7	51.4	62.4
Krong Preah Sihanouk	196.4	222.4	268.9	318.3
Plateau and Mountain Region	1,410.1	1,532.9	1,752.5	1,990.1
Kampong Speu	699.4	753.2	850.9	957.1
Kratie	311.3	337.1	382.7	429.7
Mondul Kiri	40.4	44.9	53.0	61.9
Preah Vihear	145.7	160.8	187.9	217.9
Rattanak Kiri	115.7	128.2	151.0	176.5
Stung Treng	97.6	108.7	127.0	147.0
Total	13,433.4	14,453.6	16,245.1	18,091.5

Source: Population Projections 2001 – 2021, National Institute of Statistics (NIS), Ministry of Planning

Note:　There are some differences of estimated 2015 population between this Study and the Transport Master Study in Phnom Penh Metropolitan Area completed in 2001[1].　This is because population forecast in this study is based on newly revised population figures by NIS.

_____

[1] The Study on the Transport Master Plan of the Phnom Penh Metropolitan Area in the Kingdom of Cambodia, Final Report, November 2001

(2) Future GRDP

Potential GDP has been estimated at regional and provincial levels as well as traffic zone level with consideration of employment productivity (GDP/employment) and population projection by province. The GDP forecast at regional level in case of medium growth scenarios is summarized in Tables 3-3-2 (1) and (2) and that at provincial level are presented in Tables 3-3-3 (1) and (2). The GDP forecast at traffic zone level is summarized in Appendix Tables 3-3-2.

Table 3-3-2 (1)　　Gross Regional Product in 2015 (Medium Growth Scenario)

	GRDP (billion Riels)	Population (' 000)	Per Capita GRDP (' 000 Riels)	Index
Plains Region	12,802.7	8,887.4	1,440.5	112
Tonle Sap Region	6,463.4	5,781.6	1,157.0	90
Coastal Region	1,740.6	1,432.4	1,215.2	95
Plateau and Mountain Region	2,218.3	1,990.1	1,015.1	79
Total	23,225.0	18,091.5	1,283.8	100

Source:　Study Team's Estimation

Table 3-3-2 (2)　　Gross Regional Product by Industry in 2015 (Medium Growth Scenario)

Unit: Billion Riels

	Primary	Secondary	Tertiary	Total
Plains Region	3,025.0	5,811.8	3,965.9	12,802.7
Tonle Sap Region	2,006.6	2,585.1	1,871.7	6,463.4
Coastal Region	480.2	717.4	543.1	1,740.6
Plateau and Mountain Region	702.6	895.4	620.2	2,218.3
Total	6,214.5	10,009.6	7,000.9	23,225.0

Source:　Study Team's Estimation

Table 3-3-3 (1)   Gross Regional Domestic Product by City/Province, 2015 (Medium Growth Scenario)

Unit: Billion Riels

	GRDP (Bil. Riels)	Population ('000)	Per Capita GRDP ('000 Riels)	Index
Phnom Penh	4,703.4	1,931.6	2,435.0	190
Kandal	2,018.1	1,579.5	1,277.7	100
Kampong Cham	2,421.3	2,332.7	1,038.0	81
Svay Rieng	737.1	666.6	1,105.8	86
Prey Veaeng	1,488.4	1,262.8	1,178.6	92
Takao	1,227.6	1,114.2	1,101.8	86
Kampong Thom	970.1	868.2	1,117.3	87
Siem Reap	1,713.4	1,137.7	1,506.0	117
Banteay Meanchey	1,057.4	1,044.4	1,012.5	79
Battambang	1,461.7	1,283.0	1,139.3	89
Pursat	650.3	583.2	1,115.1	87
Kampong Chhnang	696.7	669.9	1,039.9	81
Krong Preah Sihanouk	573.4	318.3	1,801.3	140
Kampot	836.6	750.7	1,114.4	87
Koh Kong	257.1	301.0	854.1	67
Krong Kep	64.1	62.4	1,027.6	80
Kampong Speu	957.3	957.1	1,000.2	78
Preah Vihear	221.1	217.9	1,014.9	79
Stung Treng	155.4	147.0	1,057.0	82
Rattanak Kiri	174.5	176.5	988.8	77
Mondul Kiri	62.6	61.9	1,011.1	79
Kratie	559.5	429.7	1,302.0	101
Oddar Meanchey	149.4	143.0	1,045.1	81
Krong Pailin	68.5	52.2	1,313.3	102
Total	23,225.0	18,091.5	1,283.8	100

Source: Study Team's Estimation

Table 3-3-3 (2)   Gross Regional Domestic Product by City/Province and Industry, 2015 (Medium Growth Scenario)

Unit: Billion Riels

	Primary	Secondary	Tertiary	Total
Phnom Penh	57.7	2,596.3	2,049.4	4,703.4
Kandal	744.3	796.5	477.3	2,018.1
Kampong Cham	929.0	948.5	543.8	2,421.3
Svay Rieng	275.9	290.1	171.1	737.1
Prey Veaeng	545.7	588.1	354.6	1,488.4
Takao	455.9	483.9	287.8	1,227.6
Kampong Thom	327.5	388.9	253.7	970.1
Siem Reap	439.8	682.9	590.7	1,713.4
Banteay Meanchey	331.8	429.0	296.6	1,057.4
Battambang	455.5	593.6	412.6	1,461.7
Pursat	207.1	263.2	180.0	650.3
Kampong Chhnang	240.5	278.3	177.9	696.7
Krong Preah Sihanouk	85.8	251.4	236.2	573.4
Kampot	304.7	331.0	200.9	836.6
Koh Kong	75.7	105.3	76.1	257.1
Krong Kep	9.6	28.1	26.4	64.1
Kampong Speu	345.3	379.4	232.6	957.3
Preah Vihear	68.5	89.9	62.7	221.1
Stung Treng	41.7	64.5	49.2	155.4
Rattanak Kiri	54.1	70.9	49.5	174.5
Mondul Kiri	18.6	25.6	18.4	62.6
Kratie	150.5	232.0	177.0	559.5
Oddar Meanchey	39.0	62.2	48.2	149.4
Krong Pailin	10.3	30.0	28.2	68.5
Total	6,214.5	10,009.6	7,000.9	23,225.0

Source: Study Team's Estimation

(3) Employment

Potential employment has been estimated at regional and provincial levels and traffic zone level taking into account of GRDP by province, future employment productivity, and population projection. The employment by city/province estimated is summarized in Table 3-3-4 and that by traffic zone level is summarized in Appendix Table 3-3-3.

Table 3-3-4   Number of Projected Employment by City/ Provinces and Industry, 2015

Unit: '000 persons

	Primary	Secondary	Tertiary	Total
Phnom Penh	61.4	346.0	526.3	933.7
Kandal	712.8	95.6	110.3	918.7
Kampong Cham	889.6	113.7	125.7	1,129.0
Svay Rieng	264.2	34.8	39.5	338.5
Prey Veaeng	522.6	70.6	82.0	675.2
Takao	436.6	58.0	66.5	561.1
Kampong Thom	313.6	46.7	58.7	419.0
Siem Reap	421.2	81.9	136.5	639.6
Banteay Meanchey	317.7	51.4	68.5	437.6
Battambang	436.2	71.2	95.4	602.8
Pursat	198.4	31.6	41.6	271.6
Kampong Chhnang	230.3	33.3	41.1	304.7
Krong Preah Sihanouk	82.2	30.1	54.6	166.9
Kampot	291.8	39.7	46.5	378.0
Koh Kong	72.5	12.6	17.6	102.7
Krong Kep	9.2	3.4	6.1	18.7
Kampong Speu	330.7	45.5	53.7	429.9
Preah Vihear	65.6	10.8	14.5	90.9
Stung Treng	40.0	7.8	11.3	59.1
Rattanak Kiri	51.8	8.5	11.4	71.7
Mondul Kiri	17.8	3.1	4.3	25.2
Kratie	144.1	27.8	41.0	212.9
Oddar Meanchey	37.4	7.5	11.1	56.0
Krong Pailin	9.8	3.5	6.6	19.9
Total	5,957.5	1,235.1	1,670.8	8,863.4

Source: Study Team' Estimation

3.4 Socio-Economic Framework in Vietnam

3.4.1 GDP and GRDP in Vietnam

JICA has carried out the Study on the National Transport Development Strategy in the Socialist Republic of Vietnam in 2000 (VITRANSS). In the VITRANSS[1] study, it has forecasted the socio-economic framework of national level and its break down to the regional and provincial levels in 2010 and 2020. As the results of the careful review of the VITRANSS study, it can be judged that the socio-economic framework projection in the VITRANSS study is made as reasonable and comprehensive manner so as to being utilized this framework as the socio-economic framework in Vietnam.

According to the VITRANSS study, the results of GDP forecast are as follows:

Table 3-4-1 GDP Forecast Results of Vietnam

	High Case		Low Case	
	GDP	Growth Rate	GDP	Growth Rate
1998	244,676	100	244,676	100
2002	330,254	135	321,057	131
2005	412,274	168	384,549	157
2010	598,574	245	531,226	217
2015	824,932	337	684,195	280

Source: VITRANSS Study
Note: Unit: VND Billion at 1994 Constant Prices

Potential GDP has been estimated at regional and provincial levels in the same study. The results of the GRDP are shown in Table 3-4-2. The estimated GRDP is utilized to estimate the traffic growth rate in the traffic zones in Vietnam.

Table 3-4-2 GRDP Forecast Results of Vietnam

			1998	2005	2010	2015
1	All country	Low	244,676	384,549	531,225	685,909
		High		412,274	598,574	827,435
2	Red River Delta	Low	42,136	67,661	94,897	122,819
		High		72,710	107,360	149,204
3	Northeast	Low	19,385	29,851	40,634	52,191
		High		31,678	44,989	61,810
4	Northwest	Low	2,987	4,825	6,795	8,716
		High		5,038	7,318	10,020
5	North Central Coast	Low	19,166	29,631	40,449	51,935
		High		31,774	45,593	62,707
6	South Central Coast	Low	17,604	27,045	36,752	47,068
		High		29,145	41,780	57,247
7	Central Highlands	Low	6,386	10,507	14,995	17,951
		High		11,208	16,750	20,938
8	Northeastern South	Low	80,150	126,643	175,588	228,764
		High		135,954	198,296	276,516
9	Northeastern South	Low	56,864	88,386	121,116	154,751
		High		94,766	136,488	186,491

Source: VITRANSS Study
Note: Unit: VND Billion at 1994 Constant Prices

_____

[1] The Study on the National Transport Strategy in the Socialist, Republic of Vietnam (VITRANSS), Final Report, Main Text, July 2000

3.4.2 Population in Vietnam

In the VITRANSS Study, it has forecasted the population of national level and provincial levels in 2010 and 2020. In this study, the future population of Vietnam made in the VITRANSS Study in entirely utilized as the population plan.

According to the VITRANSS Study, the results of population forecast are as follows:

Table 3-4-3   Population Forecast of Vietnam

Region/Year	1999	2000	2005	2010	2015	2020	Growth Rate (% p.a.)	
							1997/2010	2010/2020
Vietnam	76,325	80,498.6	87,297.3	94,548.1	100,332.2	109,521.4	1.73	1.48
Red River Delta	1,480	15,438.8	16,565.7	17,698.9	18,785.7	20,024.1	1.44	1.24
Northeast	10,861	11,612.4	12,608.6	13,615.9	14,629.4	15,613.1	1.76	1.38
Northwest	2,228	2,355.7	2,561.5	2,763.7	2,965.7	3,158.4	1.87	1.34
North Central Coast	10,007	10,694.7	11,507.6	12,294.4	13,056.8	13,740.3	1.45	1.12
South Central Coast	6,526	6,923.4	7,393.0	7,886.5	8,391.9	8,892.6	1.47	1.21
Central Highlands	3,062	2,702.9	3,044.2	3,421.6	3,796.3	4,203.2	2.57	2.08
Northeastern South	12,709	12,837.1	14,121.1	15,810.1	17,251.1	18,970.8	2.05	1.84
Mekong Delta	16,132	17,933.6	19,495.7	21,057.0	22,455.3	24,918.9	1.84	1.70

Source: VITRANSS Study
Note: Unit: 000 persons

3.5   Motorization

(1) Registered Vehicles

As shown in Fig. 3-5-1, total number of registered vehicles had been reached 355 thousand units in 2000. Of which, 271 thousand units (76.3%) was "*motorcycles*", 70 thousand units (19.8%) was "*light vehicles*", and 14 thousands units (3.9%) was "*heavy vehicles*".
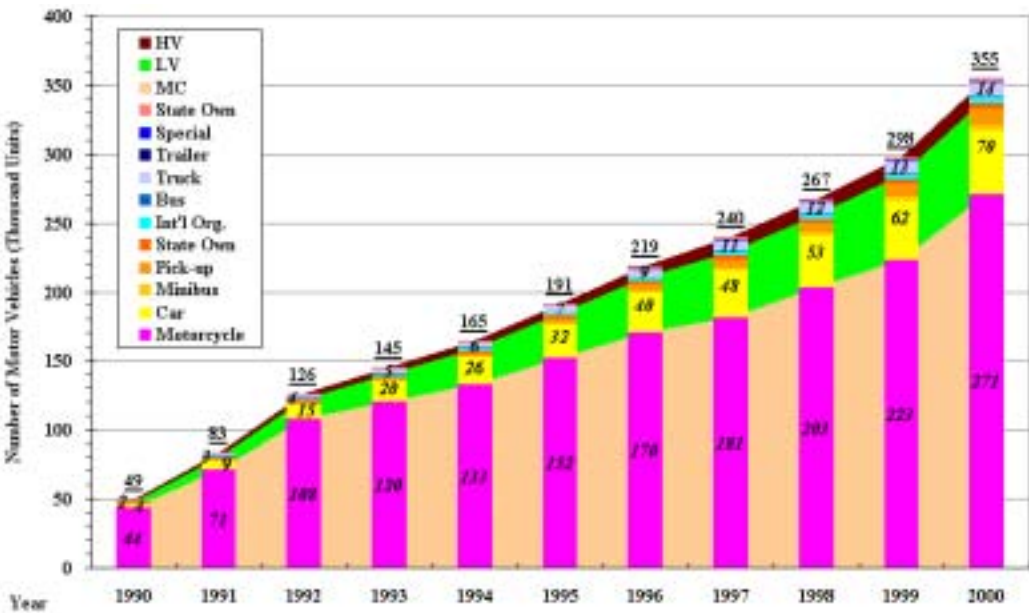

Fig. 3-5-1   Registered Vehicles in Cambodia (1990-2000)

(2) Motorization

As shown in Fig. 3-5-2, motorization in ASEAN countries is assumed to be along the lines of the each country's GDP per Capita.   For example, Philippine and Indonesia have been experienced level of GDP per capita with 1,000 US$ by 1995, and motorization at that time was around 36.7 and 67.8 per 1,000 populations, respectively.   In Thailand, its GDP per capita had been reaching 2,800 US$ in 1995, and motorization was over 200 at that time.   On the other hand, Cambodia's motorization was still 27.6 in 2000, and GDP per capita is still less than 400 US$[2].

After regression analysis by log linear and linear functions, we found following relation between GDP per Capita and motorization in ASEAN countries.   The equations are:

$$Y = a \, Ln \, (X) + b \cdots\cdots\cdots\cdots\cdots\cdots \text{ 3.5-1 (a), or}$$

$$Y = a \, (X) + b \cdots\cdots\cdots\cdots\cdots\cdots \text{ 3.5-1 (b)}$$

Where, X: GDP per Capita (in US$)
         Y: Motorization (vehicles per 1,000 populations)
         Ln: Natural Logarithm
         a, b: Parameters

Country	a	b	R^2
Thailand	341.697	-2,452.592	0.755
Indonesia	30.065	-142.568	0.956
Philippine	26.080	-143.326	0.984
Cambodia (I)	24.847	-119.446	0.942
Cambodia (II)	0.084	-3.356	0.955

(I): Log-Linear, (II): Linear, R^2: Correlation Coefficient
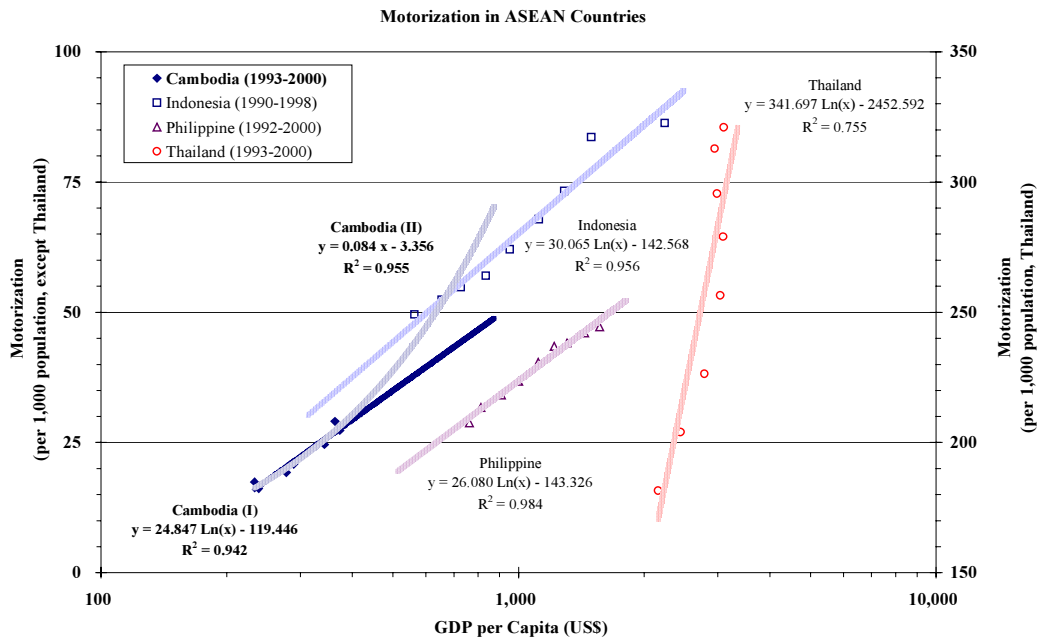

Motorization in ASEAN Countries

Fig. 3-5-2   Motorization in ASEAN Countries vs. GDP per Capita

_____

[2] GDP per Capita indicated in this section are all US$, which converted from local current price with 1993's official exchange rate in the corresponding countries.

According to this analysis, motorization in Cambodia will be reaching 52 ~ 81vehicles per 1,000 populations, when GDP per capita is reaching 1,000 US$ level.

Table 3-5-1   Expected Motorization in Cambodia

Level of GDP per Capita	(US$)	400	500	600	700	800	900	1,000
Motorization (I)	(Per 1,000)	29.43	34.97	39.50	43.33	46.65	49.58	52.19
Motorization (II)	(Per 1,000)	30.24	38.64	47.04	55.44	63.84	72.24	80.64

(I): Log-Linear, (II): Linear

(3) Modal Shift

As shown in Fig. 3-5-3, modal share in Cambodia has been changed gradually in line with its motorization, hence economic growth[3].   Regarding this scenario, we have also determined following log linear functions to explain the relation between motorization and modal shift.   The equation is:

$$Y = a \, Ln \, (X) + b \cdots\cdots\cdots\cdots\cdots\cdots \quad 3.5\text{-}1 \text{ (c)}$$

Where, X: Motorization (vehicles per 1,000 populations)
Y: Modal Share
Ln: Natural Logarithm
a, b: Parameters

Mode	a	b	R^2
Motorcycle	-0.1300	1.1828	0.883
Light Vehicle	0.1130	- 0.1688	0.918
Heavy Truck	0.0166	- 0.0148	0.599
Bus	0.0005	- 0.0008	0.120

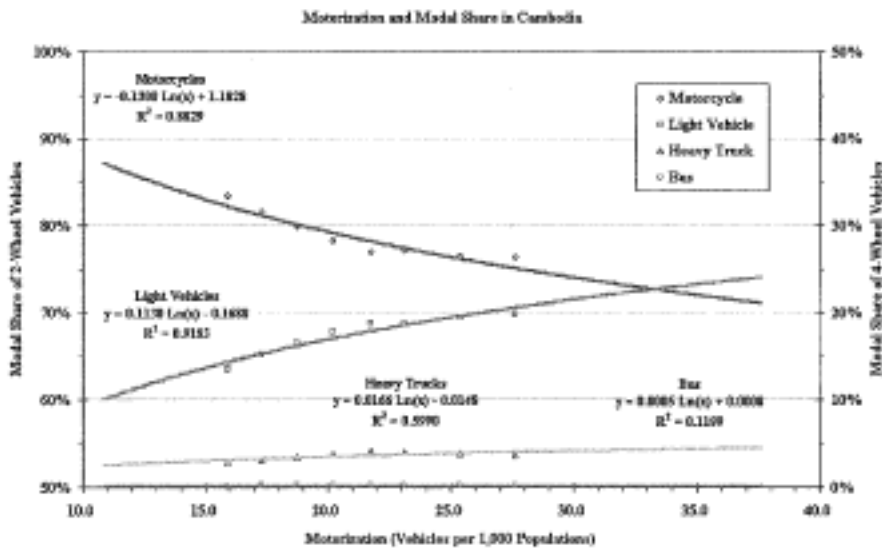R^2: Correlation Coefficient

Fig. 3-5-3   Motorization and Modal Shift

[3] Trend of modal shift itself was seemed to be different before and after 1997. For example, modal shift from motorcycle to light vehicles before 1997 was quicker than that of which after 1997. To avoid overestimate or underestimate, we have judged to utilized the data before and after 1997 altogether

(4) Number of Motorized Vehicles

By using pre-described functions with results of GDP forecast, number of motorized vehicle in Cambodia was estimated for both cases, namely "High Growth" and "Low Growth" by using linear and log-linear functions.

As shown in Table 3-5-2, 3-5-3 and Fig. 3-3-4, number of motorcycles will be reaching more than double for both cases in 2015 against the level of year 2000. Number of light vehicles will be also reaching almost triple or double and half level in 2015, respectively. Therefore, total number of motorized vehicles will be reaching slightly less than double and half level for high growth case, or a little more than double level for low growth case in 2015.

Table 3-5-2   Expected Motorization in Cambodia by Types of Vehicles

Year	2000		2005		2010		2015	
Classification	High	Low	High	Low	High	Low	High	Low
Motorcycle [MC]	269 (1.00)	267 (1.00)	356 (1.32)	340 (1.27)	476 (1.77)	455 (1.70)	636 (2.36)	590 (2.21)
Light Vehicle [LV]	69 (1.00)	69 (1.00)	99 (1.43)	93 (1.36)	142 (2.06)	134 (1.96)	202 (2.91)	184 (2.68)
Heavy Vehicle [HV]	15 (1.00)	14 (1.00)	22 (1.40)	18 (1.25)	29 (1.99)	22 (1.75)	40 (2.70)	27 (1.93)
Total	353 (1.00)	350 (1.00)	476 (1.35)	450 (1.29)	647 (1.83)	579 (1.65)	877 (2.48)	727 (2.29)

Unit: Thousand Vehicles, Figure in the bracket shows growth index vs. year 2000 level

Table 3-5-3   Expected Modal Share in Cambodia

Year	2000		2005		2010		2015	
Classification	High	Low	High	Low	High	Low	High	Low
Motorcycle	76.2	76.4	74.8	75.4	73.5	74.4	72.5	73.7
Light Vehicle	19.6	19.6	20.9	20.6	22.0	22.0	23.0	22.9
Bus	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Heavy Truck	4.0	3.8	4.1	3.7	4.2	3.5	4.3	3.2

Unit: %
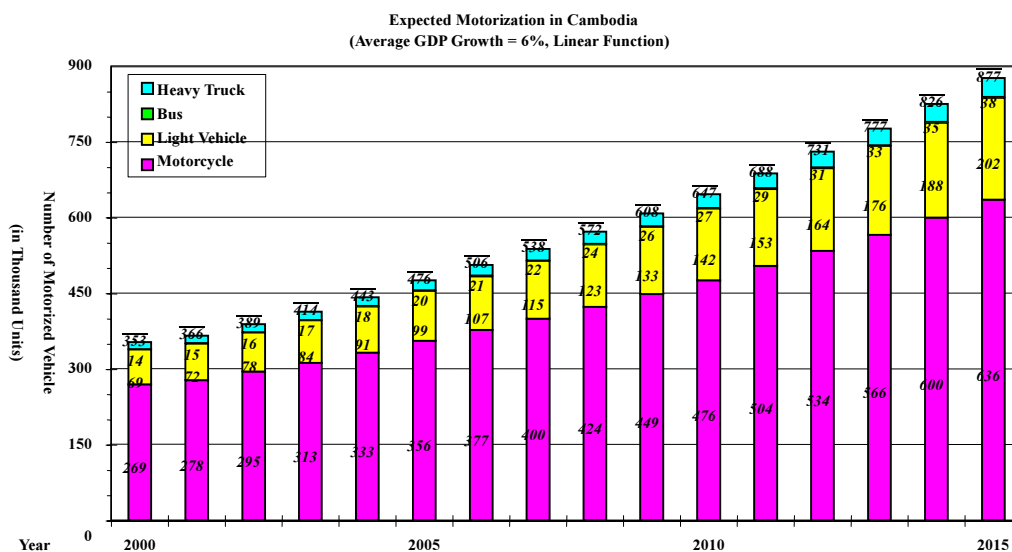
Fig. 3-5-4   Estimated Number of Motorized Vehicles in Cambodia (High Growth) (1/2)

Expected Motorization in Cambodia
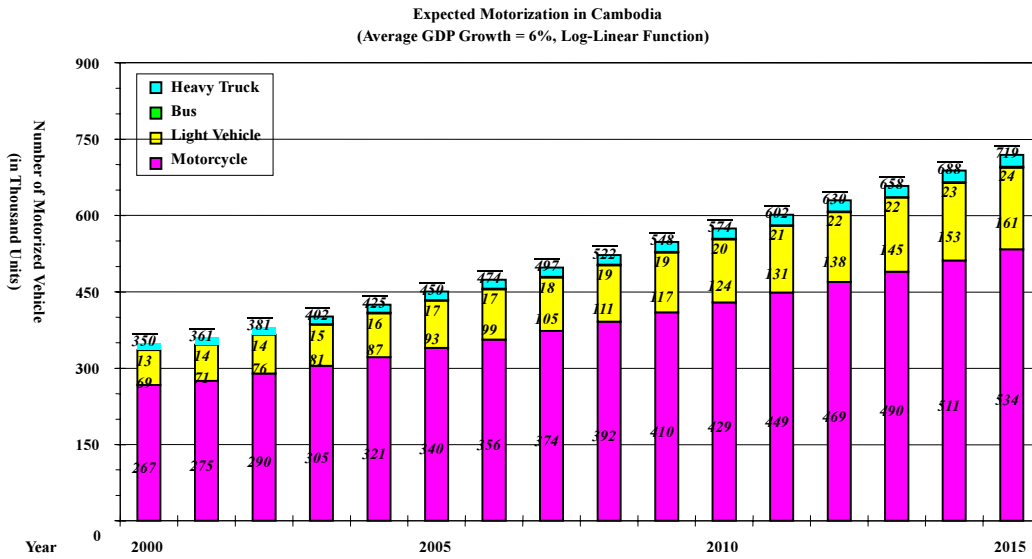**(Average GDP Growth = 6%, Log-Linear Function)**

Fig. 3-5-4   Estimated Number of Motorized Vehicles in Cambodia (Low Growth) (2/2)

(5) Traffic Volume

As shown in Fig. 3-5-5, annual traffic volume[4] closing Mekong River at Neak Loueng Ferry point prove that traffic volume is seemed to be closely relating to the level of motorization.   For example, total volume of motorized vehicles, especially light vehicles, are increasing in line with the level of motorization.   On the other hand, volume of motorcycles is decreasing as reverse way, although this tendency is not clear for heavy vehicles.   In addition, this tendency is also similar to that of modal shift, which is described in previous section.

After rejecting abnormal data, we have found following relations between traffic volume and level of motorization.   The equation is:

$$Y = a \, Ln \, (X) + b \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad 3.3.3\text{-}1 \ (d)$$

Where, X: Motorization (vehicles per 1,000 populations)
　　　　 Y: Traffic Volume (AADT, annual average daily traffic)
　　　　 Ln: Natural Logarithm
　　　　 a, b: Parameters

Mode	a	b	R^2
Motorcycles	- 324.969	1652.100	0.953
Light Vehicles	496.408	- 939.663	0.918
Heavy Vehicles	50.680	- 37.323	0.160
Motorized Vehicles	537.670	-216.187	0.887

R^2: Correlation Coefficient

---

[4] A series of annual traffic volume data for past decade is only obtainable from Neak Loueng Ferry Point in this region, except some data obtained from several trials carried out by MPWT, ADB, and JICA.
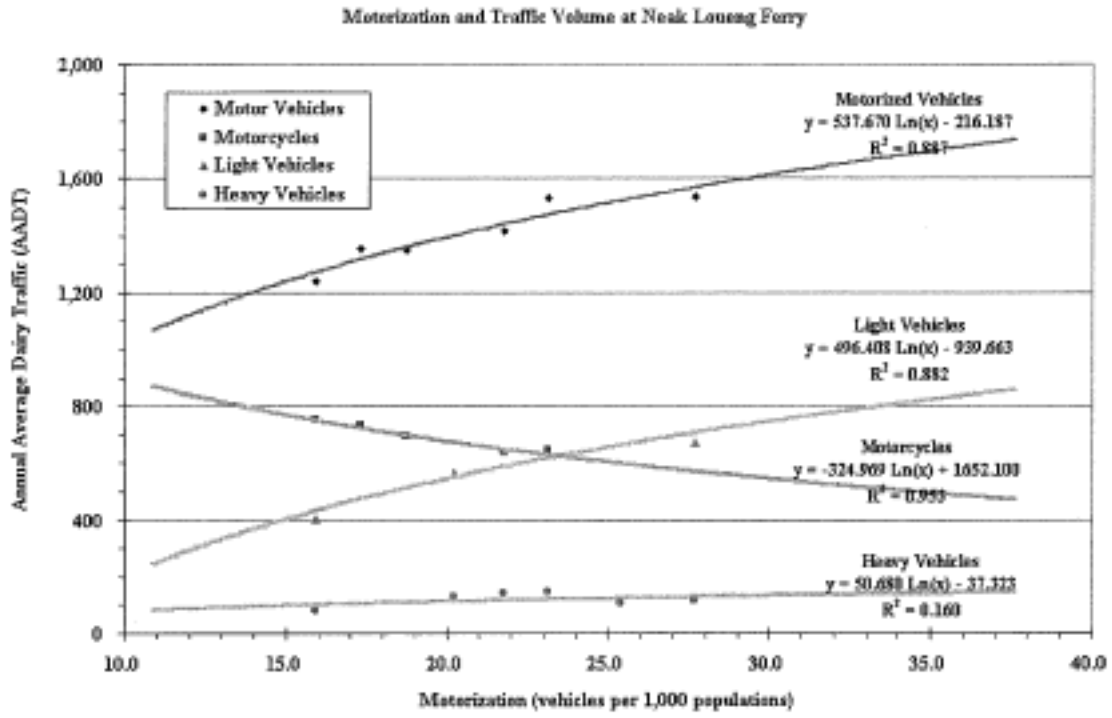
Fig. 3-5-5   Motorization and Traffic Volumes