

CHAPTER II

TRAFFIC STUDIES OF THE BANG PA IN-NAKHONSAWAN HIGHWAY

The prime objective of the Bang Pa In-Nakhonsawan Highway is to serve as a direct main route linking Bangkok to the northern part of the country. It will cut down the travel distance with the benefit to the road user through the reduction in travel time and consequently the operating cost of motor vehicles plus comfort, convenience and lessening of travel strains.

Before economic studies can be carried out it is necessary to obtain information about the traffic flows on the road concerned. Present condition would be obtained by direct observations and these, when taken in combination with the knowledge based on previous work can be used in the study.

Traffic Volume

The first step is to measure the existing traffic volume and its composition. Since 1962, traffic volume counts have been taken systematically on the primary and secondary highways in Thailand by the Department of Highways. There are two types of counting stations: control station and coverage station.

At control stations, traffic counts are taken during four periods a year, in January, April, July and October. Each period

Table 2 Details of Traffic Counting Station Along Route Nos. 32,
1, and 309

Route No.	Station	Kilometage	Section Termini	Type
32	1 ⁽¹⁾	55+850	Bang Pa In-Nakornsawan	Coverage
	2 ⁽¹⁾	96+800	Bang Pa In-Nakornsawan	"
1	3	24+684	Bangkok-Don Muang	"
	4 ⁽¹⁾	35+000	Don Muang-Wang Noi	"
	5	67+900	Wang Noi-Saraburi	"
	6	80+000	Wang Noi-Saraburi	"
	7 ⁽¹⁾	102+000	Wang Noi-Saraburi	"
	8	121+000	Saraburi-Lopburi	"
	9 ⁽¹⁾	142+000	Saraburi-Lopburi	"
	10 ⁽¹⁾	178+000	Lopburi-Khoksamrong	"
	11	190+000	Khoksamrong-Takhli	"
	12 ⁽¹⁾	254+800	Khoksamrong-Takhli	"
	13 ⁽¹⁾	268+047	Takhli-Chai Nat	"
	14	289+793	Chai Nat-Nakornsawan	"
	15	307+000	Chai Nat-Nakornsawan	"
	16	331+000	Chai Nat-Nakornsawan	"
309	17 ⁽¹⁾	10+000	Ayuthaya-Wang Noi	"
	18 ⁽¹⁾	36+000	Pa Mok-Ayuthaya	"

(1) Selected stations for showing traffic volume as summarized in Tables 3, 4 and 5.

begins on the first Sunday of the month. For Sunday, Wednesday and Saturday, a 24-hours of traffic is obtained by taking three 8-hour counts at different periods of the day. On the other days of the week, 16-hour counts are made and expanded to 24 hours by using the factors obtained for Wednesday. These counts are classified as: cars, light buses and trucks, heavy buses and trucks and trucks with more than two axles.

At coverage stations, 8-hour counts (from 08.00-16.00 hrs) are taken on the first five weekdays (Monday through Friday) during April and October. Automatic traffic counters are used for 24-hour counts at these stations to provide the necessary expansion factors.

For both types of station, the ADT is obtained by factoring the available traffic data. The results are not considered to be representative of the annual average daily traffic volume ADT because the duration of counts is too short and the effect of minor road traffic is poorly represented. However, those values are generally of sufficient precision to indicate traffic patterns and trends.

Value of ADT and percentage of trucks and buses at some counting stations are shown in Tables 3 through 5 and depicted in Figs. 2 and 3.

The ADT of route No.1, section between Don Muang to Wang Noi and Wang Noi to Saraburi are high because these sections carried the traffic both north and northeast parts of Thailand. The counts

Table 3 Average Daily Traffic (ADT) and Percentage of Buses and Trucks on
Route Nos. 32 and 1

Year	Station 1			Station 2			Station 4			Station 7		
	ADT	Growth rate,%	T/B %	ADT	Growth rate,%	T/B %	ADT	Growth rate,%	T/B %	ADT	Growth rate,%	T/B %
1965	-	-	-	-	-	-	4106	-	62	4789	-	60
1966	-	-	-	-	-	-	6951	69	59	5724	19	57
1967	-	-	-	-	-	-	7342	6	55	6580	15	56
1968	-	-	-	-	-	-	8700	18	59	7340	11	57
1969	-	-	-	-	-	-	10133	16	57	8196	12	57
1970	-	-	-	-	-	-	11912	17	59	8686	6	59
1971	-	-	-	-	-	-	11704	-2	69	8242	-5	67
1972	-	-	-	-	-	-	13299	14	54	10165	23	54
1973	5092	-	29	3768	-	40	18870	42	55	9966	-2	51
1974	5484	8	40	3450	-10	48	18691	-1	59	10484	5	59

Source: Department of Highways

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Table 4 Average Daily Traffic (ADT) and Percentage of Buses and Trucks on Route No. 1

Year	Station 9			Station 10			Station 12			Station 13		
	ADT	Growth rate,%	T/B %	ADT	Growth rate,%	T/B %	ADT	Growth rate,%	T/B %	ADT	Growth rate,%	T/B %
1965	1942	-	67	1366	-	73	1948	-	55	962	-	67
1966	2403	23	67	1426	4	77	2338	20	56	1462	52	67
1967	2771	15	63	1571	10	73	3006	28	58	1398	-4	52
1968	3409	23	60	1715	9	75	2778	-8	74	1580	13	57
1969	3469	2	62	2296	34	73	3290	18	72	1758	11	58
1970	3711	7	64	2754	20	76	3538	8	76	1958	13	58
1971	3774	2	62	2859	4	80	3434	-3	75	2101	7	63
1972	3911	4	65	1884	-34	75	3732	9	77	2458	17	65
1973	4037	3	59	1710	-9	73	3915	5	76	2771	13	64
1974	3726	-8	60	1761	-3	69	3734	-5	74	2543	-8	69

Source: Department of Highways

Table 5 Average Daily Traffic (ADT) and Percentage of Buses and Trucks on Route Nos. 1 and 309

Year	Station 16			Station 17			Station 18		
	ADT	Growth rate,%	T/B %	ADT	Growth rate,%	T/B %	ADT	Growth rate,%	T/B %
1965	822	-	60	1036	-	56	375	-	56
1966	1277	55	69	1668	61	53	686	82	44
1967	1287	1	62	1570	-6	53	812	18	55
1968	1537	19	64	1716	9	47	992	22	77
1969	1808	18	65	2336	36	48	1419	43	52
1970	2131	18	56	2658	14	49	1659	17	53
1971	2436	14	54	3067	15	49	2555	54	50
1972	2915	19	52	2808	-8	57	1802	-30	58
1973	3497	20	60	1385	-51	68	1470	-18	69
1974	3404	-3	60	1110	-20	67	1868	27	69

Source: Department of Highways

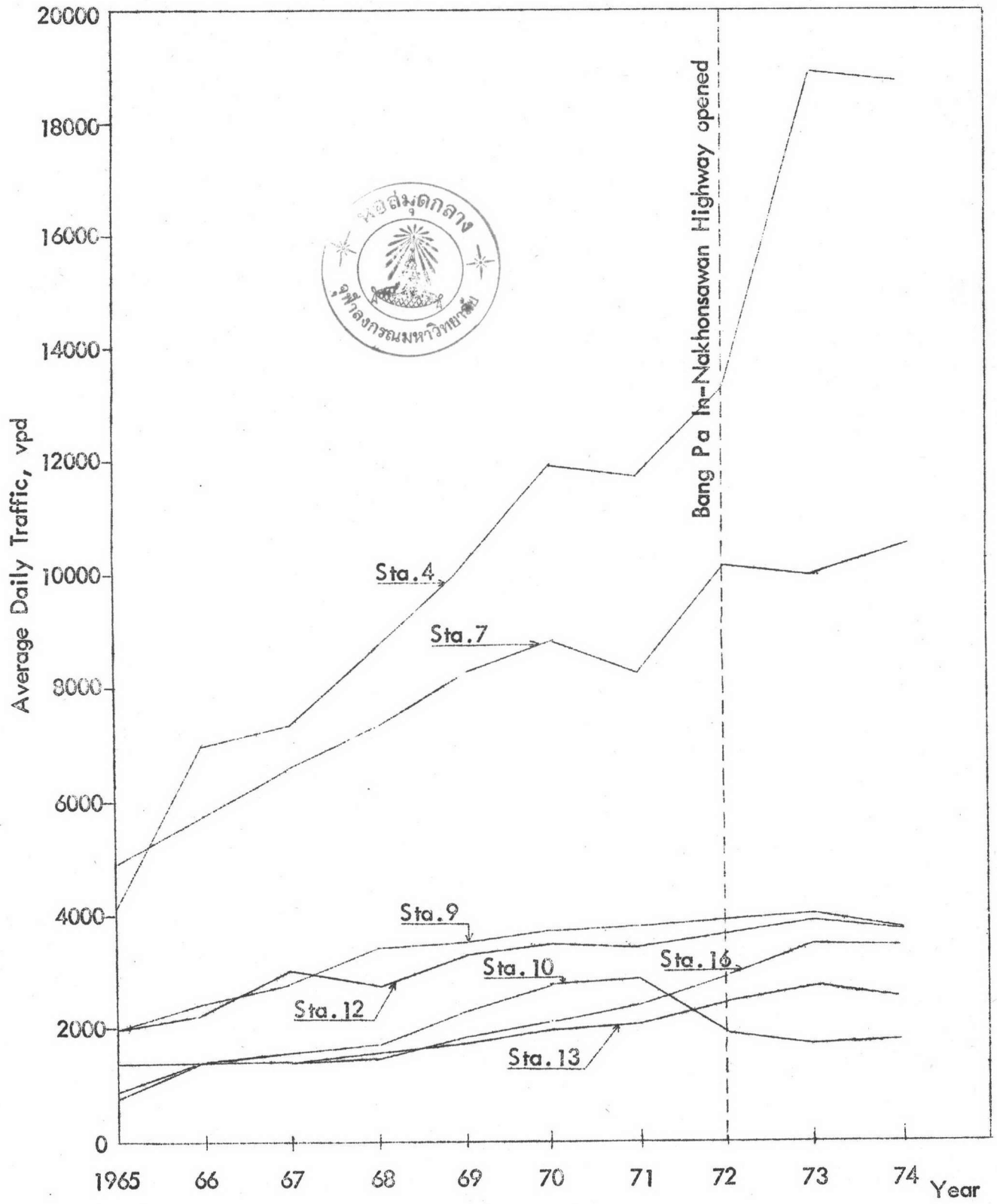


Fig.2 Average Daily Traffic (ADT) on Route No.1

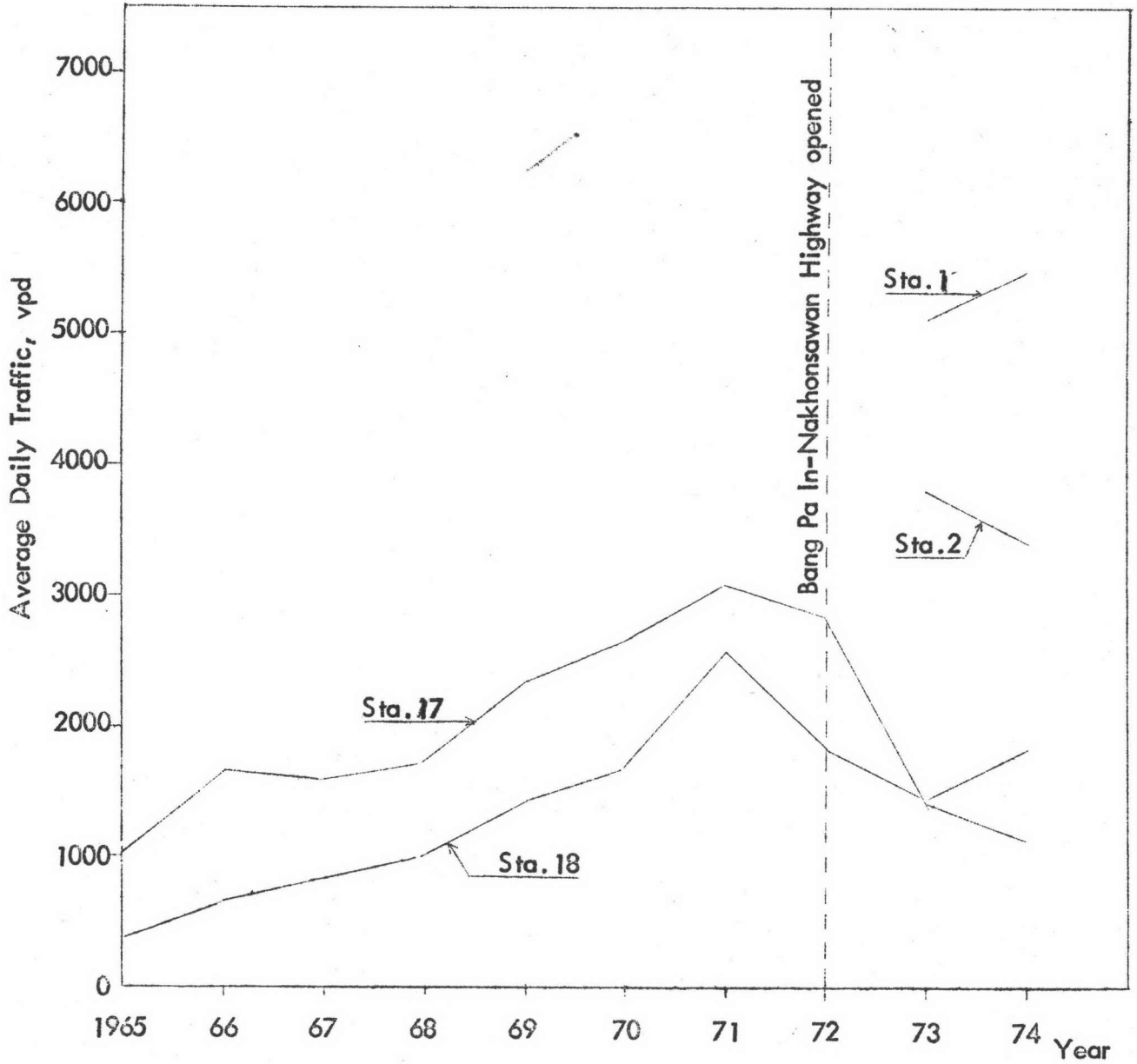


Fig.3 Average Daily Traffic (ADT) on Route Nos. 309 and 32

on other sections of road shown in Fig.2 as stations 9,10,12,13 and 16 were not high since these sections served only the traffic to and from the north of the country. The traffic on the stations 4 and 7 increased from the year 1965 to 1971 at the average growth rate of 32 % per annum. When the route No.32 was officially opened in the middle of the year 1972, the traffic on station 4 increased 42 % from the year 1971. On the other hand, the traffic on station 7 between Wang Noi to Saraburi decreased 2 % from the year 1971. The traffic on section between Saraburi to Lopburi increased at a sharp rate in the year 1965-1968 while, that of station 10 connecting Lopburi-Khoksamrong increased at a sharp rate in 1968. This is when the toll road was opened in 1972. The traffic on this section diverted to the new toll road resulting in the decrease of 34 % of the traffic volume in the year 1971. The percentage of trucks and buses in the section between Lopburi to Takhli were about higher than 70 % of the total traffic volume (excluding motorcycle). This is considered to be rather high as compared to the other road sections. It may be due to the military camp at Takhli. The traffic volume on Takhli-Chai Nat-Nakhonsawan sections were also effected by the new toll road.

For the reference route No.309 connecting Ayuthaya-Wang Noi and Ayuthaya-Ang Thong, the traffic counts at stations 17 and 18 showed an increase in traffic volume during the year 1965-1971 and dropped at sharp rate after 1972 when the toll road was opened.

Vehicle Registration

The registration of vehicles in seven changwats ~~traversing~~ Ayuthaya, Ang Thong, Lopburi, Singburi, Chai Nat, Uthai Thani and Nakhonsawan traversed by the routes understudied were used as a part of additional clues to indicate the traffic growth resulting from opening of the Bang Pa In-Nakhonsawan Highway. The number of vehicle registrations in each of seven changwats, the combined seven changwats and the whole Kingdom excluding Bangkok are shown in Tables 6 through 14. Trends of the indices of vehicle registrations are shown in Figs.4 and 5.

It can be said that after 1965 the vehicle registrations ~~increased~~ in all of the seven changwats, especially in 1972 which showed a sharp increase. Further, it was found that the commercial vehicles dominate the vehicles registered in the studied chagwats. It comprises of 65 percent of the total vehicles registered excluding motorcycles.

It is clear to say that the development of the Bang Pa In-Nakhonsawan Highway influenced the vehicle ownerships because of the rapid increasing in vehicle registrations.

Table 6 Vehicle Registration in Changwat Ayuthaya by Year

Year	Cars		Buses		Trucks		Others ¹		Total	Index ²	M/C
	Number	%	Number	%	Number	%	Number	%			
1965	304	43	33	5	267	37	107	15	711	31	392
1966	311	37	78	9	321	58	121	15	831	37	424
1967	270	36	37	5	289	39	152	20	749	33	615
1968	333	31	72	7	463	43	200	19	1,068	47	840
1969	401	27	95	6	795	54	184	13	1,475	65	978
1970	539	28	180	10	1,021	53	177	9	1,917	85	986
1971	556	27	227	11	1,147	55	160	7	2,090	92	1,175
1972 ³	596	26	200	9	1,306	58	166	7	2,268	100	358
1973	1,585	46	198	6	1,466	42	225	6	3,474	153	1,176
1974	1,008	31	257	8	1757	55	183	6	3,205	141	1,740

(1) Others: Trailer, tractor, motor grader, motor crane, etc.

(2) Index 1972=100

(3) Bang Pa In-Nakhonsawan Highway opened

Source: Department of Highways

Table 7 Vehicle Registration in Changwat Ang Thong by Year

Year	Cars		Buses		Trucks		Others ¹		Total	Index ²	M/C
	Number	%	Number	%	Number	%	Number	%			
1965	71	17	79	19	227	54	42	10	419	48	246
1966	97	20	88	18	251	51	48	10	484	55	394
1967	113	20	112	20	273	48	69	12	567	65	703
1968	169	32	107	20	185	35	67	13	528	60	1,071
1969	278	39	105	15	252	35	78	11	713	82	1,545
1970	282	39	95	13	254	36	84	12	715	82	2,430
1971	348	45	101	13	241	31	88	12	778	89	2,381
1972 ³	329	38	114	14	309	36	122	12	874	100	2,676
1973	419	43	125	13	330	34	103	10	977	112	2,822
1974	432	33	128	10	611	47	134	10	1,305	149	4,178

(1) Others: Trailer, tractor, motor grader, motor crane, etc.

(2) Index 1972 = 100

(3) Bang Pa In-Nakhonsawan Highway opened

Source: Department of Highways

Table 8 Vehicle Registration in Changwat Lopburi by Year

Year	Cars		Buses		Trucks		Others ¹		Total	Index ²	M/C
	Number	%	Number	%	Number	%	Number	%			
1965	397	18	513	24	1,051	49	203	9	2,164	46	456
1966	476	19	506	19	1,296	51	271	11	2,549	54	709
1967	688	22	521	16	1,641	52	313	10	3,163	67	1,180
1968	684	22	521	17	1,538	51	313	10	3,056	64	1,206
1969	939	25	575	15	1,841	48	472	12	3,827	81	1,476
1970	947	23	549	14	2,091	52	453	11	4,040	85	1,730
1971	1,212	27	560	12	2,141	49	489	11	4,402	93	1,787
1972 ³	1,409	30	543	11	2,207	47	583	12	4,742	100	1,938
1973	1,665	30	560	11	2,521	46	716	13	5,462	115	2,294
1974	2,006	28	554	8	3,326	47	1,156	17	7,042	148	3,303

(1) Others: Trailer, tractor, motor grader, motor crane, etc.

(2) Index 1972 = 100

(3) Bang Pa In-Nakhonsawan Highway opened

Source: Department of Highways

Table 9 Vehicle Registration in Changwat Singburi by Year

Year	Cars		Buses		Trucks		Others ¹		Total	Index ²	M/C
	Number	%	Number	%	Number	%	Number	%			
1965	91	13	231	32	342	48	52	7	716	55	1,041
1966	91	11	279	33	403	49	60	7	833	64	1,542
1967	95	12	248	31	378	47	84	10	805	61	2,222
1968	122	13	292	31	419	44	113	12	946	72	3,170
1969	164	23	196	27	317	43	49	7	726	55	2,707
1970	220	20	299	27	424	39	158	14	1,101	84	3,348
1971	230	20	346	30	441	38	145	12	1,162	89	3,729
1972 ³	320	24	279	21	544	42	166	13	1,309	100	4,724
1973	361	21	604	36	550	32	191	11	1,706	130	6,399
1974	447	33	338	26	271	20	287	21	1,343	102	7,473

(1) Others: Trailer, tractor, motor grader, motor crane, etc.

(2) Index 1972 = 100

(3) Bang Pa In-Nakhonsawan Highway opened

Source: Department of Highways

Table 10 Vehicle Registration in Changwat Chai Nat by Year

Year	Cars		Buses		Trucks		Others ¹		Total	Index ²	M/C
	Number	%	Number	%	Number	%	Number	%			
1965	145	19	47	6	414	54	159	21	756	58	836
1966	176	20	80	9	463	53	163	18	882	68	1,500
1967	193	19	85	8	569	55	184	18	1,031	79	2,318
1968	243	23	87	8	583	55	152	14	1,065	82	2,992
1969	345	27	116	9	628	50	171	14	1,260	97	3,541
1970	302	23	125	10	711	55	157	12	1,295	99	3,650
1971	322	24	87	7	767	57	165	12	1,341	103	4,579
1972 ³	337	25	99	8	669	52	193	15	1,298	100	4,557
1973	372	26	102	7	731	52	214	15	1,419	109	5,204
1974	367	26	104	7	701	50	245	17	1,417	109	5,981

(1) Others: Trailer, tractor, motor grader, motor crane, etc.

(2) Index 1972 = 100

(3) Bang Pa In-Nakhonsawan Highway opened

Source: Department of Highways

Table 11 Vehicle Registration in Changwat Uthai Thani by Year

Year	Cars		Buses		Trucks		Others ¹		Total	Index ²	M/C
	Number	%	Number	%	Number	%	Number	%			
1965	87	12	39	6	447	61	154	21	727	79	1,145
1966	104	13	50	7	496	63	132	17	782	85	1,683
1967	135	18	59	8	484	63	84	11	762	83	2,805
1968	156	18	79	9	564	65	74	8	873	95	3,405
1969	182	24	83	11	469	62	23	3	757	82	3,329
1970	169	24	97	14	424	61	8	1	698	76	3,657
1971	178	21	120	15	539	63	12	1	849	92	3,780
1972 ³	206	22	127	14	567	62	23	2	923	100	4,134
1973	230	24	75	7	646	66	25	3	976	106	4,371
1974	234	19	135	11	824	67	37	3	1,230	133	5,844

(1) Others: Trailer, tractor, motor grader, motor crane, etc.

(2) Index 1972 = 100

(3) Bang Pa In-Nakhonsawan Highway opened

Source: Department of Highways

Table 12 Vehicle Registration in Changwat Nakhonsawan by Year

Year	Cars		Buses		Trucks		Others ¹		Total	Index ²	M/C
	Number	%	Number	%	Number	%	Number	%			
1965	553	21	356	14	1,503	58	188	7	2,600	52	1,848
1966	730	23	494	15	1,742	53	310	9	3,276	65	3,341
1967	817	22	536	14	1,862	50	515	14	3,730	74	4,918
1968	1,161	24	1,108	23	2,291	46	364	7	4,924	98	6,193
1969	1,049	25	615	24	2,243	50	503	11	4,410	87	6,980
1970	1,308	26	590	12	2,682	52	510	10	5,090	101	7,174
1971	1,572	27	608	11	3,057	52	584	10	5,821	116	8,333
1972 ³	704	14	581	11	2,964	60	778	15	5,027	100	8,398
1973	796	14	680	12	3,409	58	949	16	5,834	116	9,550
1974	899	13	795	12	3,920	58	1,157	17	6,771	135	11,269

(1) Others: Trailer, tractor, motor grader, motor crane, etc.

(2) Index 1972 = 100

(3) Barg Pa In-Nakhonsawan Highway opened

Source: Department of Highways

Table 13 Vehicle Registration Combined the Seven Changwats

Year	Cars		Buses		Trucks		Others ¹		Total	Index ²	M/C
	Number	%	Number	%	Number	%	Number	%			
1965	1,648	20	1,298	16	4,251	53	905	11	8,102	49	5,964
1966	1,985	21	1,575	16	4,972	52	1,105	11	9,637	58	9,593
1967	2,311	21	1,598	15	5,523	51	1,401	13	10,833	66	14,761
1968	2,868	23	2,266	18	6,043	49	1,283	10	12,460	76	18,877
1969	3,358	25	1,785	14	6,545	50	1,480	11	13,168	80	20,556
1970	3,767	25	1,935	13	7,607	52	1,547	10	14,856	90	22,975
1971	4,418	27	2,049	12	8,333	51	1,643	10	16,443	100	25,764
1972 ³	3,901	24	1,943	12	8,566	52	2,031	12	16,441	100	26,785
1973	5,428	27	2,344	12	9,653	49	2,423	12	19,848	121	28,600
1974	5,393	24	2,311	11	11,410	51	3,199	14	22,313	136	39,788

(1) Others: Trailer, tractor, motor grader, motor crane, etc.

(2) Index 1972 = 100

(3) Bang Pa In-Nakhonsawan Highway opened

Source: Department of Highways

Table 14 Vehicle Registration of the Whole Kingdom of Thailand Excluding Bangkok

Year	Cars		Buses		Trucks		Others ¹		Total	Index ²	M/C
	Number	%	Number	%	Number	%	Number	%			
1965	16,327	21	14,518	18	41,753	53	5,907	8	78,505	40	79,426
1966	21,211	22	15,387	17	50,989	53	7,874	8	95,461	46	118,956
1967	27,362	26	14,340	13	56,404	53	8,246	8	106,352	52	166,339
1968	34,556	29	14,076	12	61,648	52	7,711	7	117,991	57	204,269
1969	41,368	29	14,140	10	78,096	55	7,745	6	141,619	69	229,869
1970	48,638	30	13,922	9	92,201	56	7,506	5	162,267	79	268,548
1971	52,138	29	13,366	8	103,543	58	8,054	5	177,106	86	290,042
1972 ³	57,008	28	13,903	7	115,866	56	18,529	9	205,306	100	304,065
1973	65,491	29	15,171	7	135,195	60	9,939	4	225,796	109	335,686
1974	68,631	26	16,338	6	170,622	64	12,066	4	267,657	130	384,932

(1) Others: Trailer, tractor, motor grader, motor crane, etc.

(2) Index 1972 = 100

(3) Bang Pa In-Nakhonsawan Highway opened

Source: Department of Highways

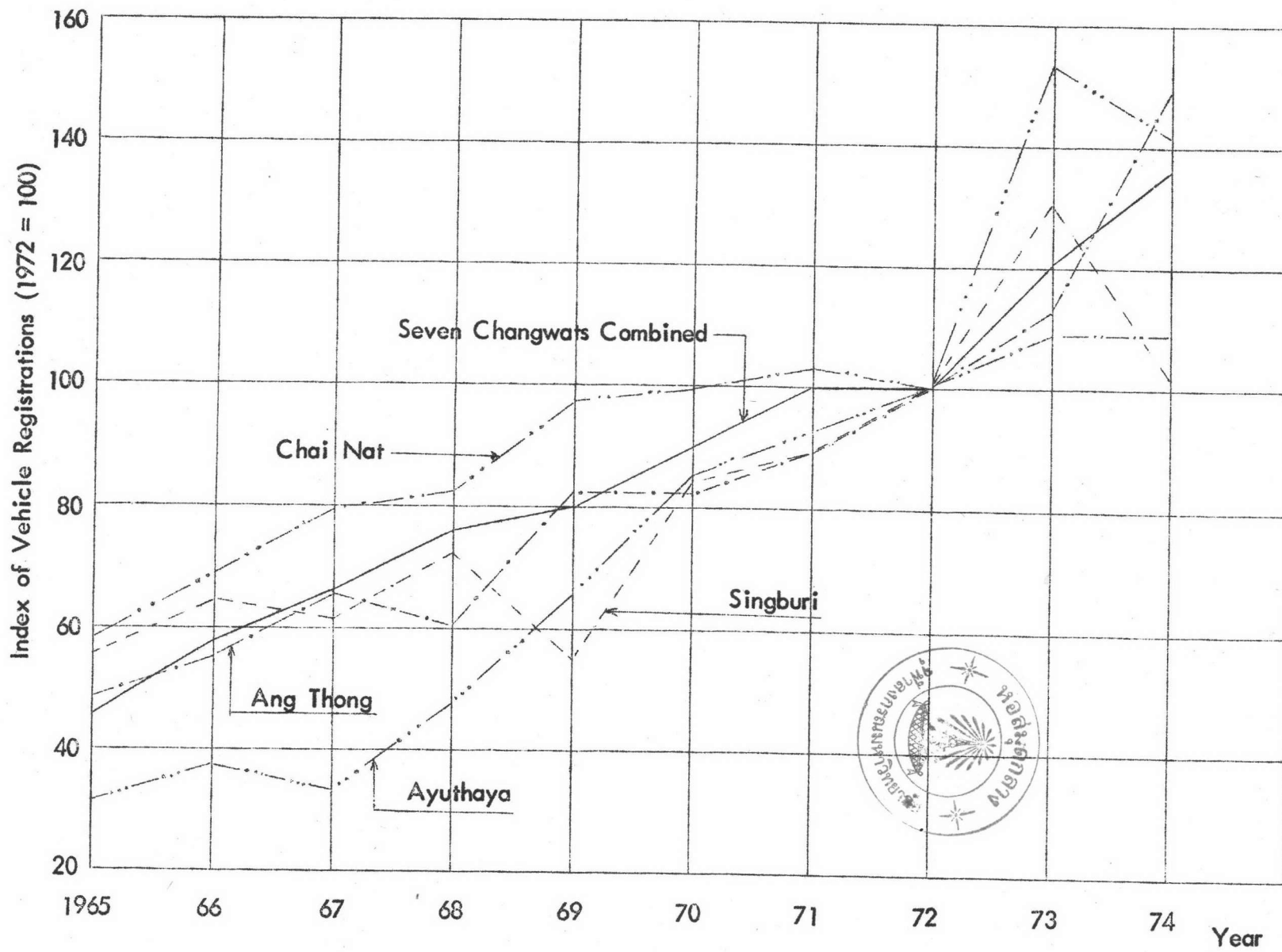


Fig.4 Vehicle Registrations in Changwats Ayuthaya, Ang Thong, Singburi, Chai Nat, and Seven Changwats Combined



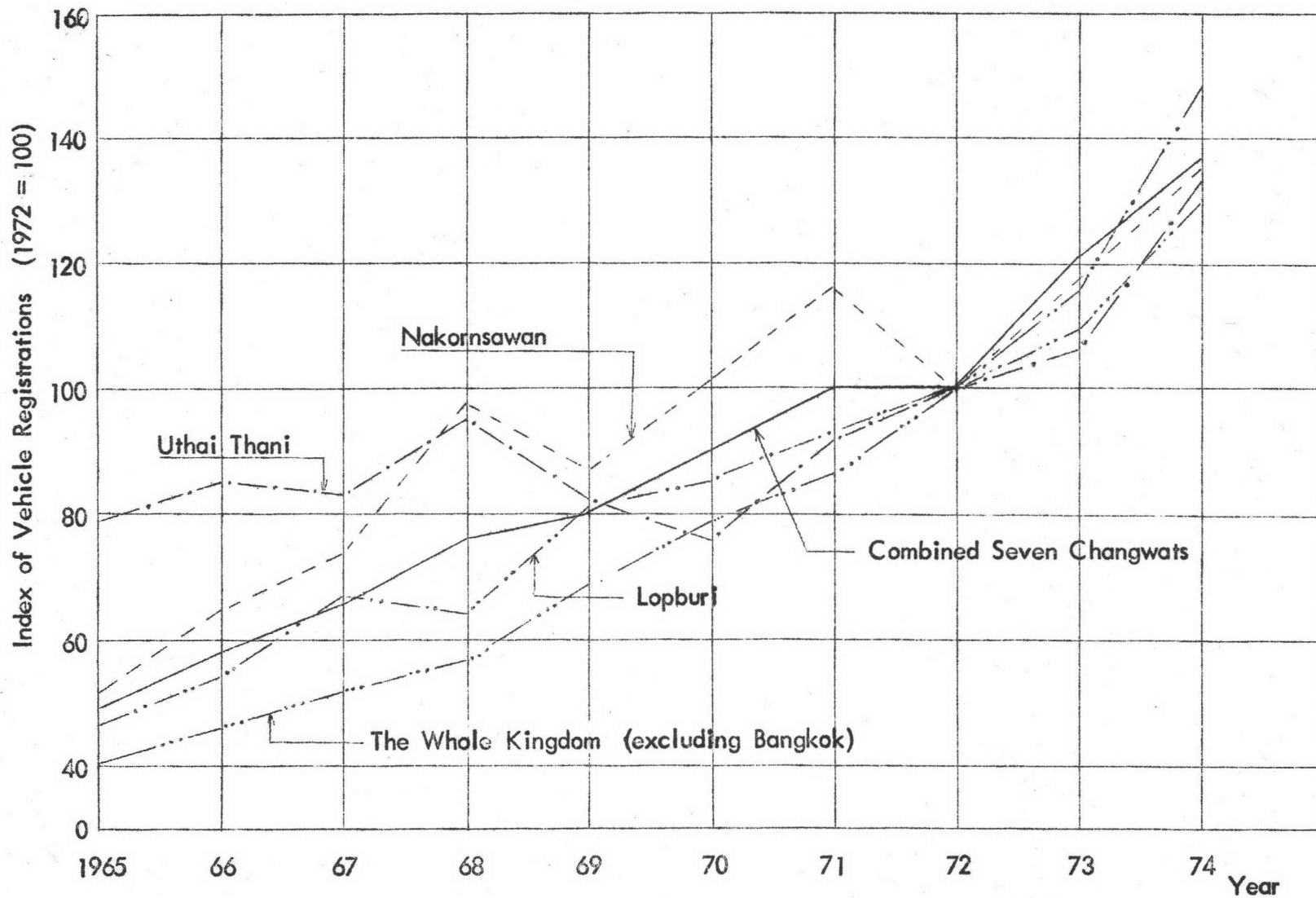


Fig.5 Vehicle Registrations in Changwats Lopburi, Uthai Thani, Nakhonsawan, Seven Changwats Combined and the Whole Kingdom Excluding Bangkok

The Variation of Traffic by Hour

The classified hourly volume counts were carried out to obtain the fluctuation of hourly traffic volume at Bang Pa In toll gate. The survey was conducted on Monday 8th to Sunday 14th, December 1975. The results of hourly volume are shown in Table 15. The daily traffic volume by hour of Wednesday 10th and Saturday 13th, December 1975 were chosen as representative typical weekday and weekend, respectively. On the reviewing of the available data, the chosen two days were justified.

Fig.8 shows the typical weekday hourly volume of 4,908 vpd. The lowest hourly volume occurred during the period of 02.00-03.00hr. and the highest peak hour volume occurred during 10.00-11.00 hr. In case of typical weekend hourly volume, the number of 5,703 vpd were obtained. The peak hour occurred at 16.00-17.00 hr with corresponding hourly volume of 471 vph. The lowest hourly volume was during the period of 02.00-03.00 hr with only 80 vehicles.

However, the fluctuation of hourly volume on the Bang Pa In-Nakhonsawan Highway has the same pattern as the general rural highway in Thailand. Details of volume counts were compiled in Appendix B, Tables B1 through B7

Table 15 Hourly Volume in a Week at Bang Pa In Toll Station
(8th-14th December 1975)

Period	Hourly Volume, vph						
	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.
00.00-01.00	106	109	92	98	111	99	76
01.00-02.00	95	100	86	65	90	82	48
02.00-03.00	113	79	79	78	86	80	40
03.00-04.00	62	60	92	100	128	89	30
04.00-05.00	117	93	106	95	65	101	39
05.00-06.00	114	111	130	96	107	166	34
06.00-07.00	197	166	152	153	116	153	42
07.00-08.00	181	180	198	203	230	205	54
08.00-09.00	258	224	234	273	283	251	344
09.00-10.00	252	263	283	261	285	284	430
10.00-11.00	273	297	351	330	293	366	372
11.00-12.00	283	373	291	275	268	414	276
12.00-13.00	325	316	279	265	306	341	425
13.00-14.00	303	289	312	276	317	372	555
14.00-15.00	290	271	340	290	347	424	439
15.00-16.00	347	333	290	294	357	260	407
16.00-17.00	355	286	303	288	366	471	663
17.00-18.00	253	171	249	263	338	351	467
18.00-19.00	201	188	186	226	299	292	392
19.00-20.00	199	273	156	222	270	251	291
20.00-21.00	149	170	187	210	259	190	234
21.00-22.00	159	179	148	153	256	180	204
22.00-23.00	281	125	202	100	242	204	184
23.00-24.00	157	159	162	114	245	127	121
Total, vpd	5070	4645	4908	4728	5664	5703	6227

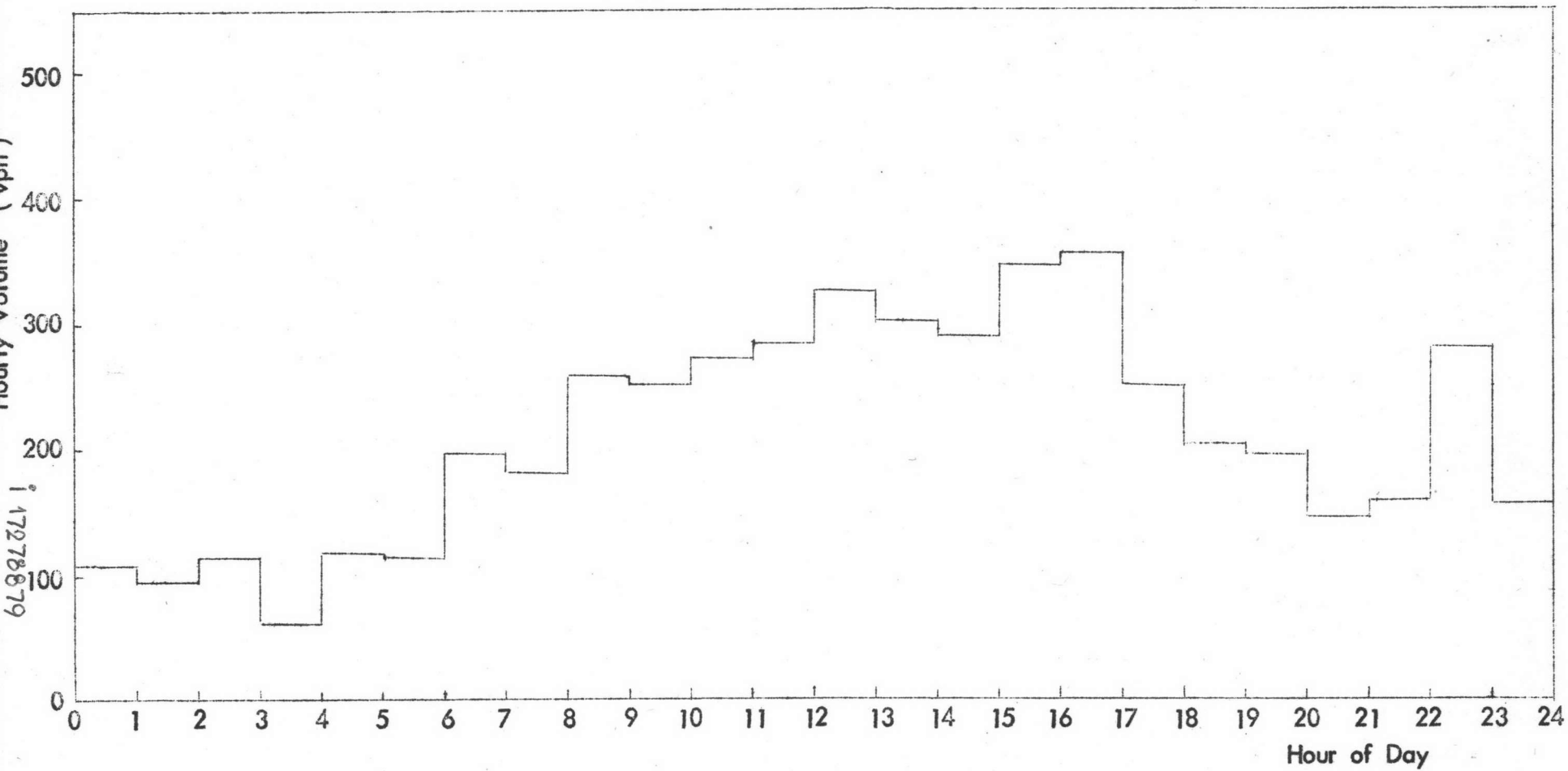


Fig. 6 Hourly Volume at Bang Pa In Toll Gate on Monday 8th December 1975 (both direction)

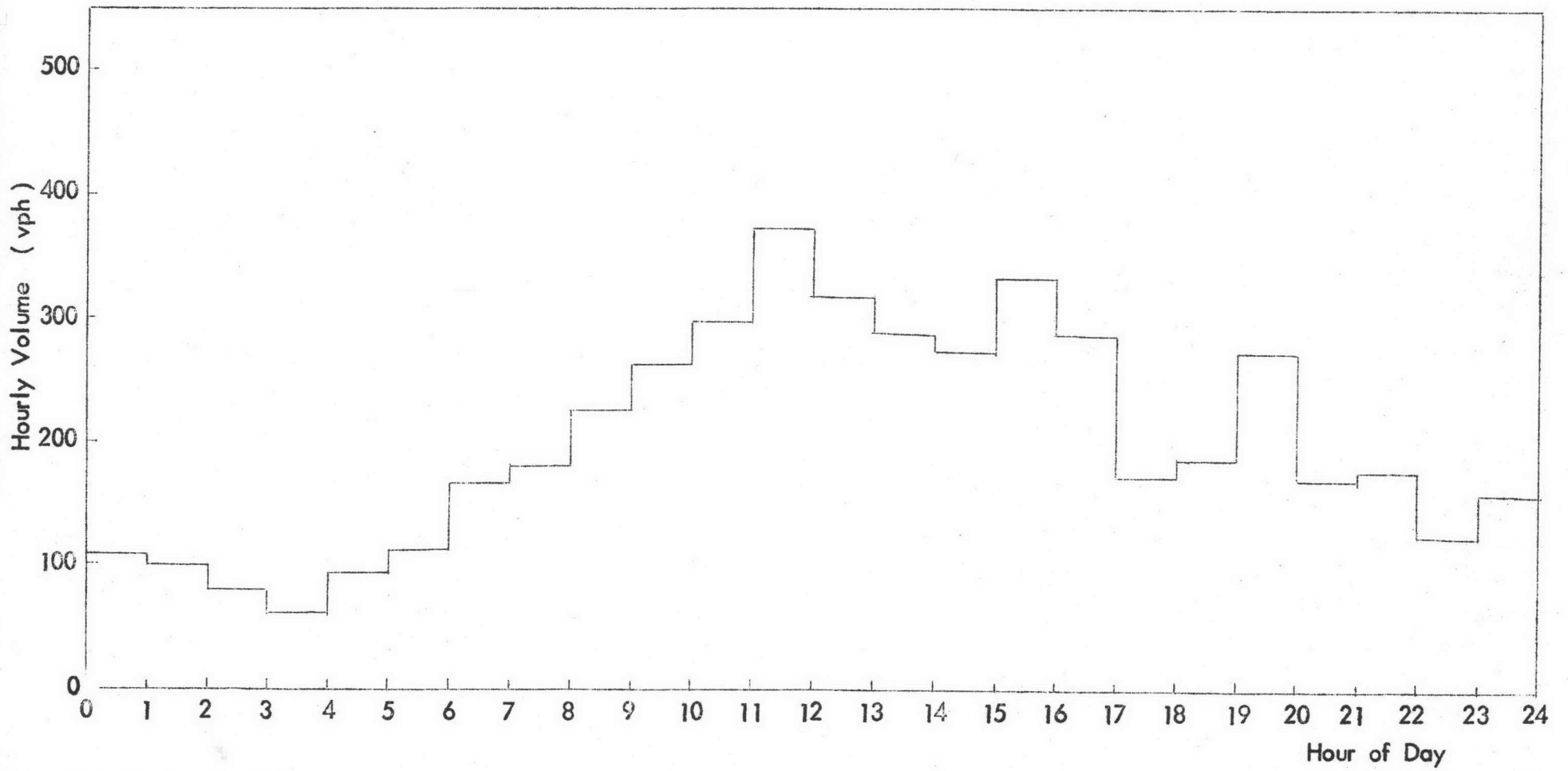


Fig.7 Hourly Volume at Bang Pa In Toll Gate on Tuesday 9th December 1975 (both direction)

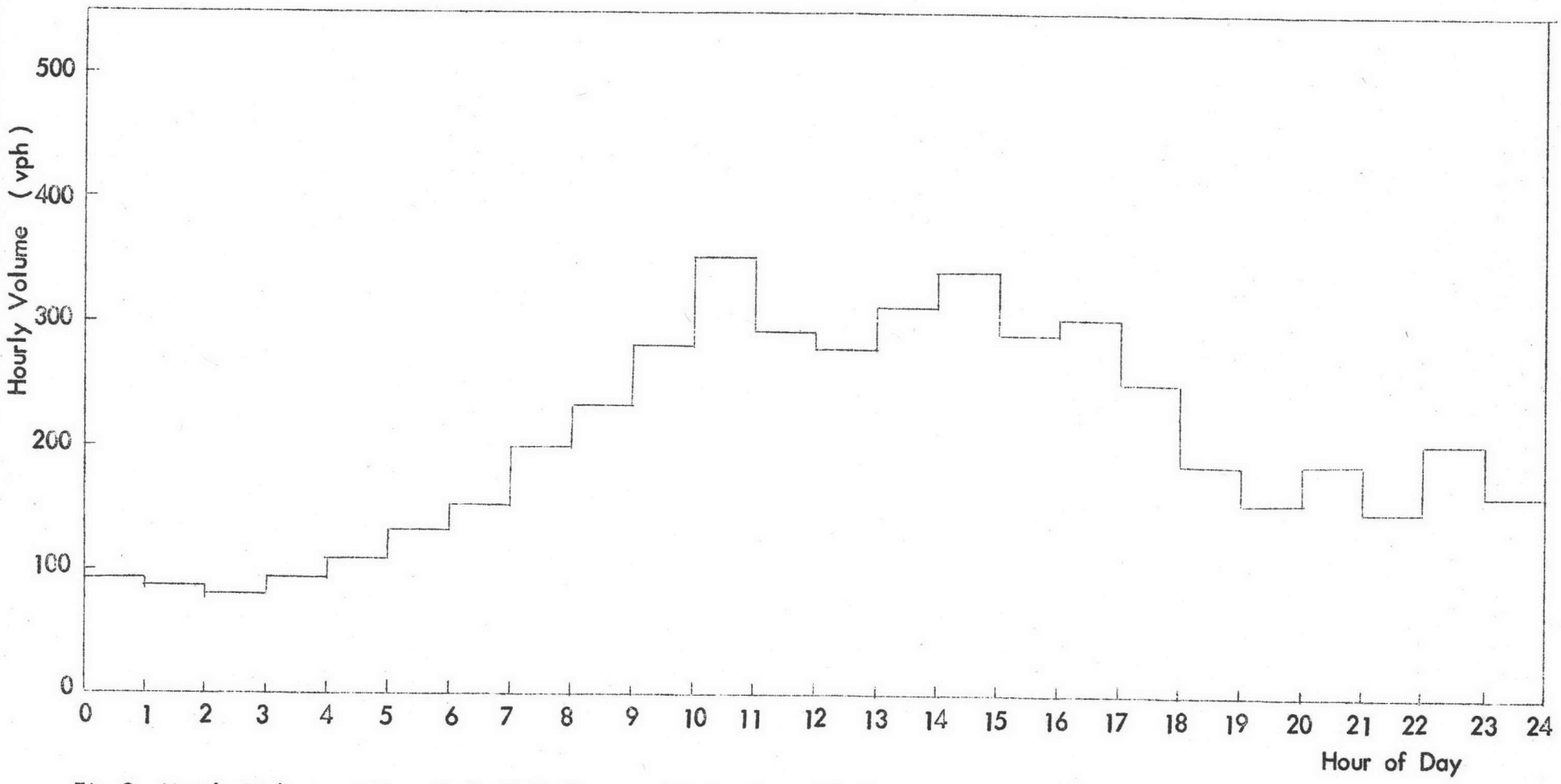


Fig.8 Hourly Volume at Bang Pa In Toll Gate on Wednesday 10th December 1975 (both direction)

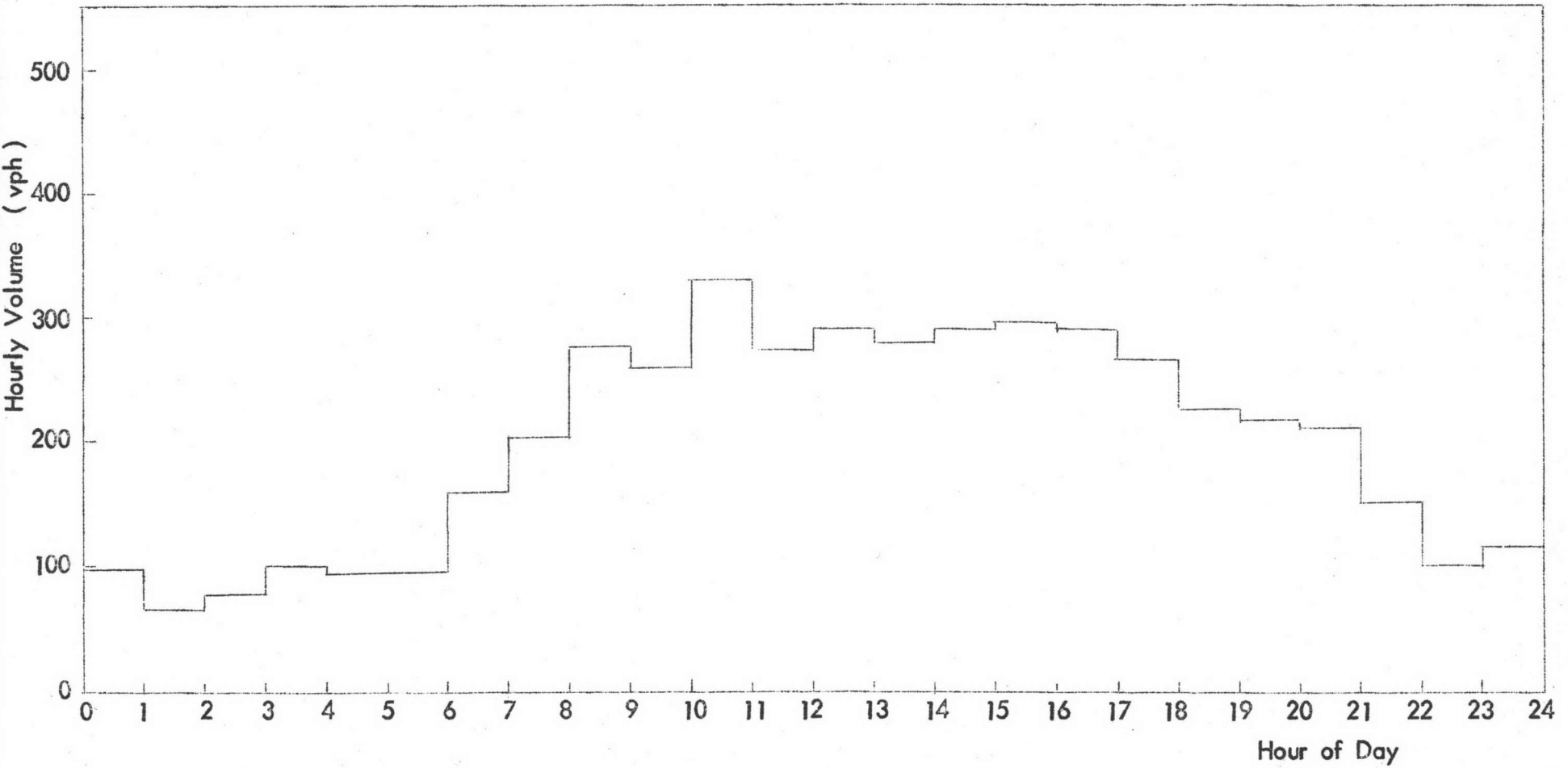


Fig.9 Hourly Volume at Bang Pa In Toll Gate on Thursday 11th December 1975 (both direction)

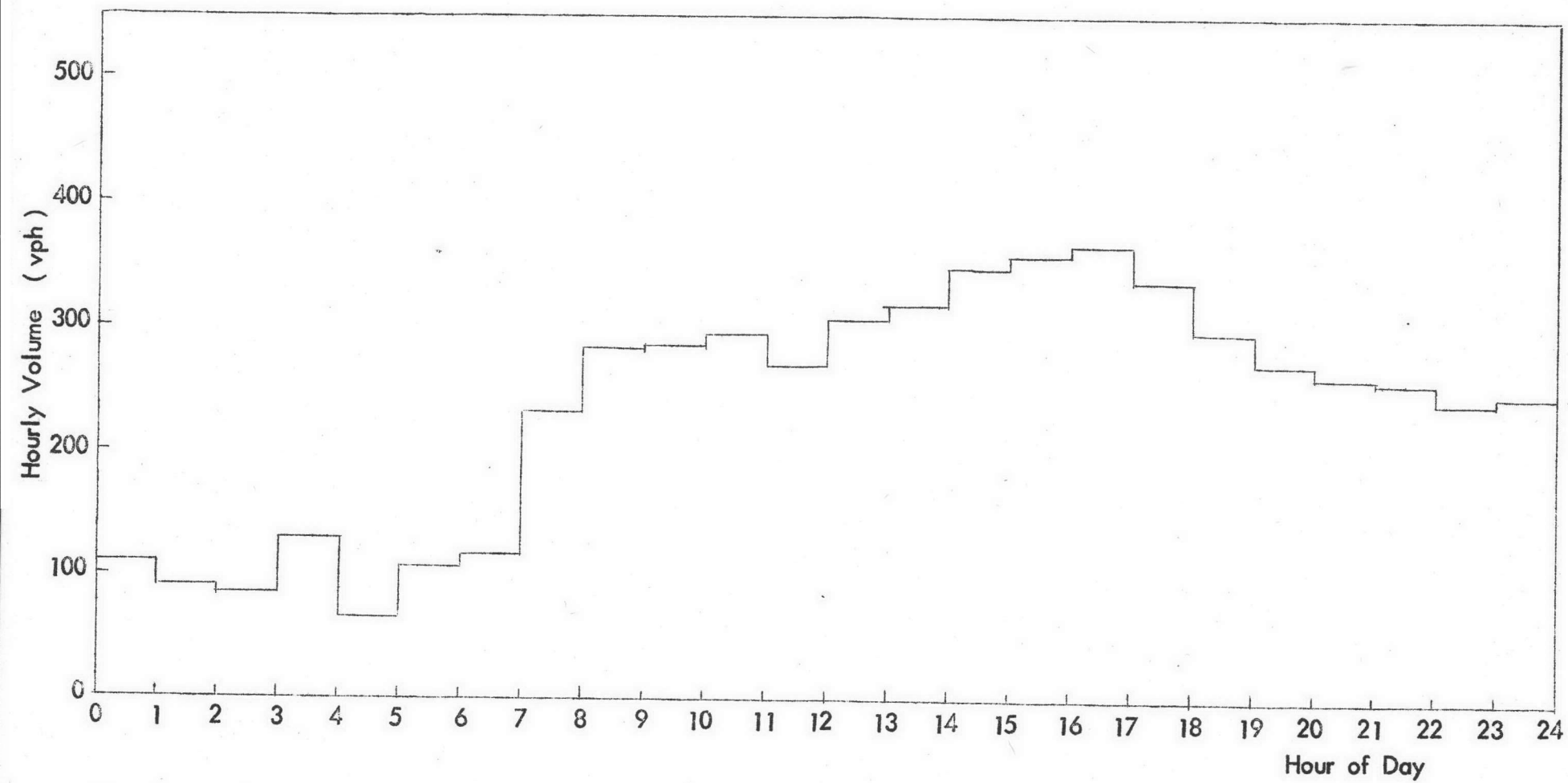


Fig.10 Hourly Volume at Bang Pa In Toll Gate on Friday 12nd December 1975 (both direction)

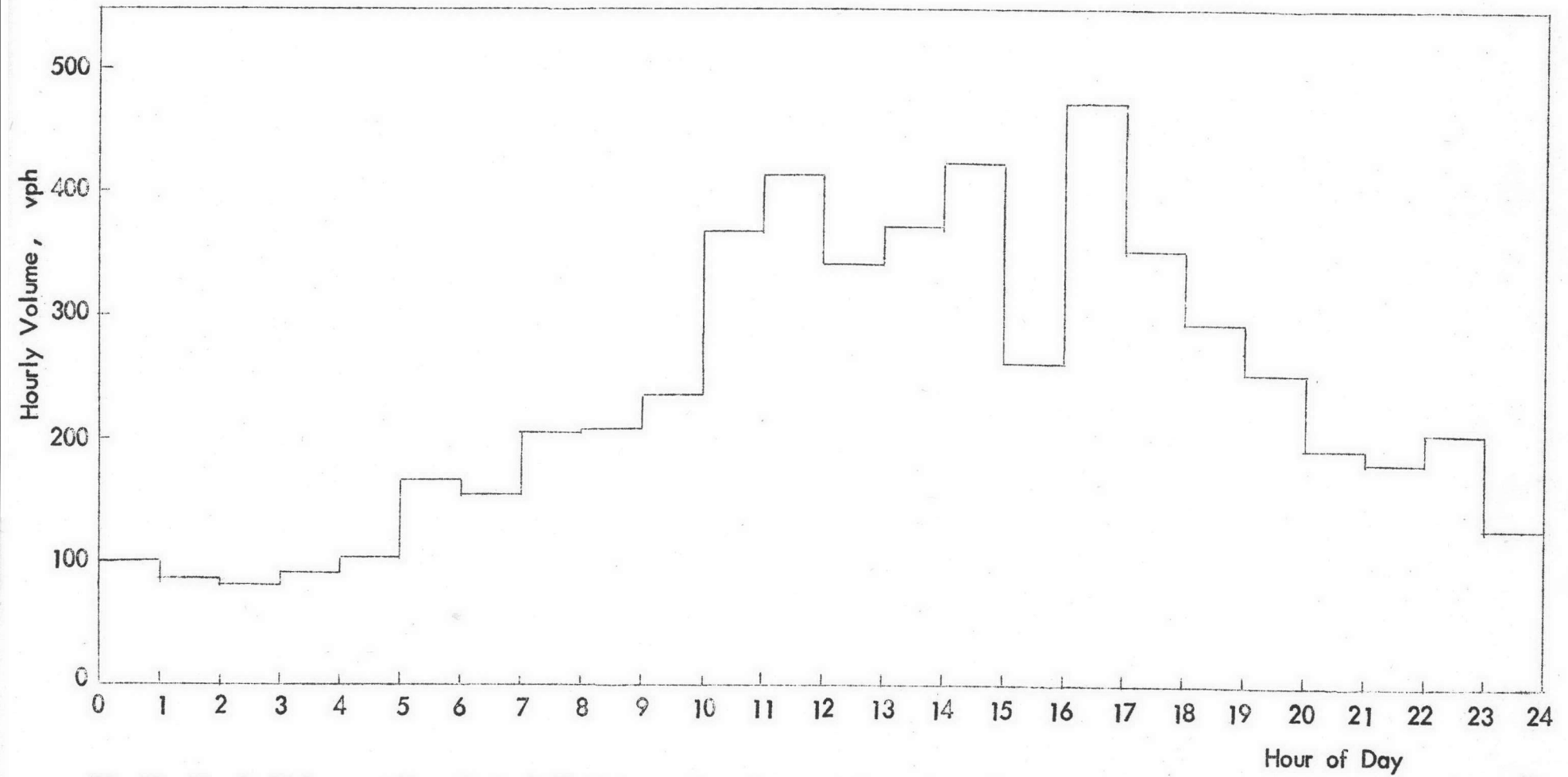


Fig. 11 Hourly Volume at Bang Pa In Toll Gate on Saturday 13th December 1975 (both direction)

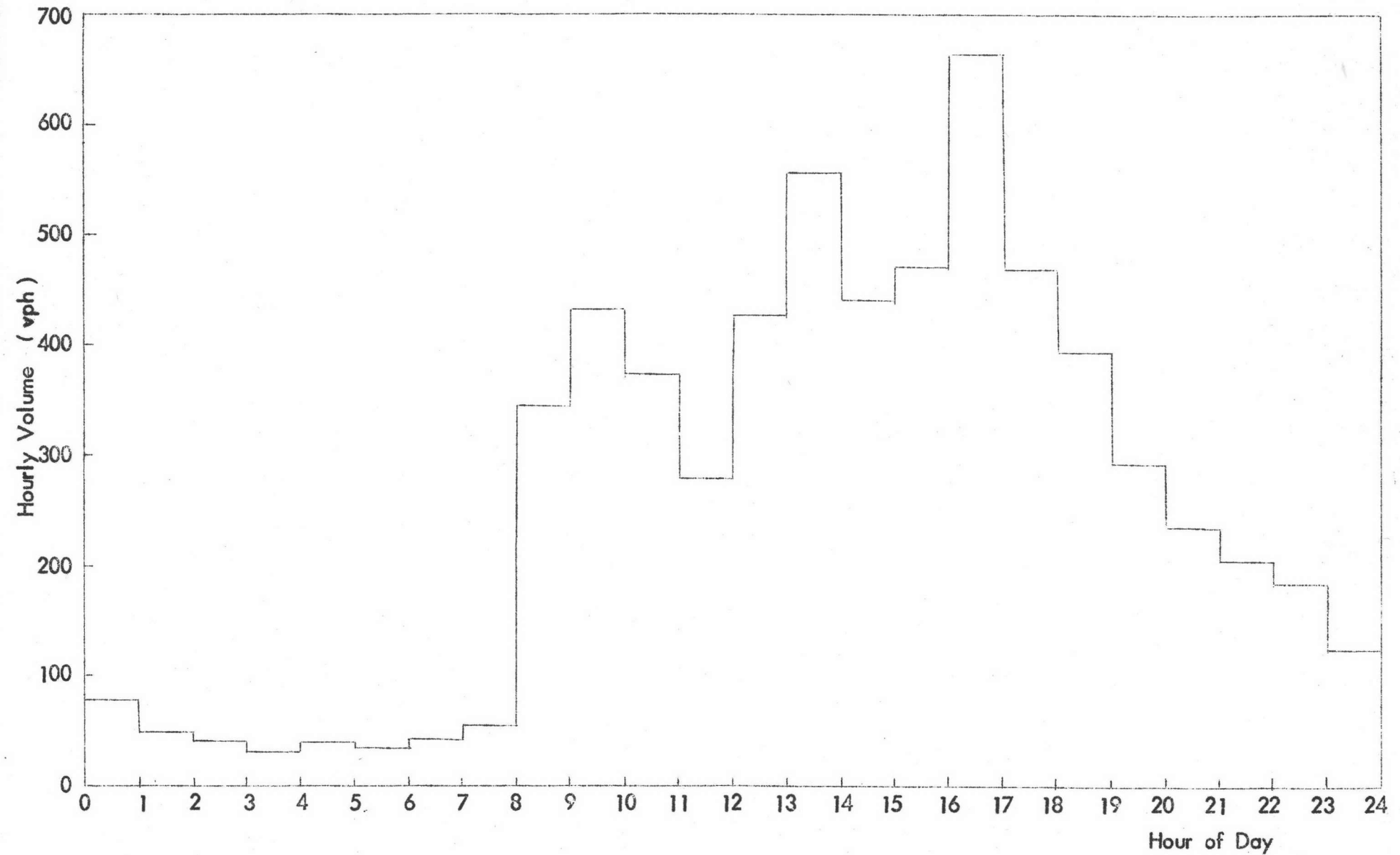


Fig.12 Hourly Volume at Bang Pa In Toll Gate on Sunday 14th December 1975 (both direction)

The Variation of Daily Traffic in a Week

In order to obtain the variation of daily traffic in a week, the classified traffic volume counts on Bang Pa In-Nakhonsawan Highway at Bang Pa In toll gate were conducted on Monday 8th to Sunday 14th December 1975. The results were shown in Table 15 and depicted in Fig.13. It can be said that the average daily traffic on weekends were higher than that of weekdays. The average daily traffic of the week was 5,285 vpd. The highest daily volume occurred on Sunday and it was 18 percent higher than the average daily traffic in the week. The lowest daily traffic occurred on Tuesday. Its volume of 4,645 vpd which was 1,582 vehicles was less than Sunday's volume.

The Variation of Daily Traffic by Month

In order to study the fluctuations of the daily traffic volume by month and season, the average daily traffic by month was obtained from the Statistical Section, Department of Highways. They were obtained from the remaining toll tickets sold. The numbers are shown in Tables 16 and 17 and depicted in Fig.14.

The results show that the average daily traffic by month at Bang Pa In toll gate is higher than that of Ang Thong toll gate; but the average daily commercial vehicle at Bang Pa In ~~was~~ relatively less than at Ang Thong. It was found that during the summer months, especially in April, the total daily traffic volume ~~was~~ the highest

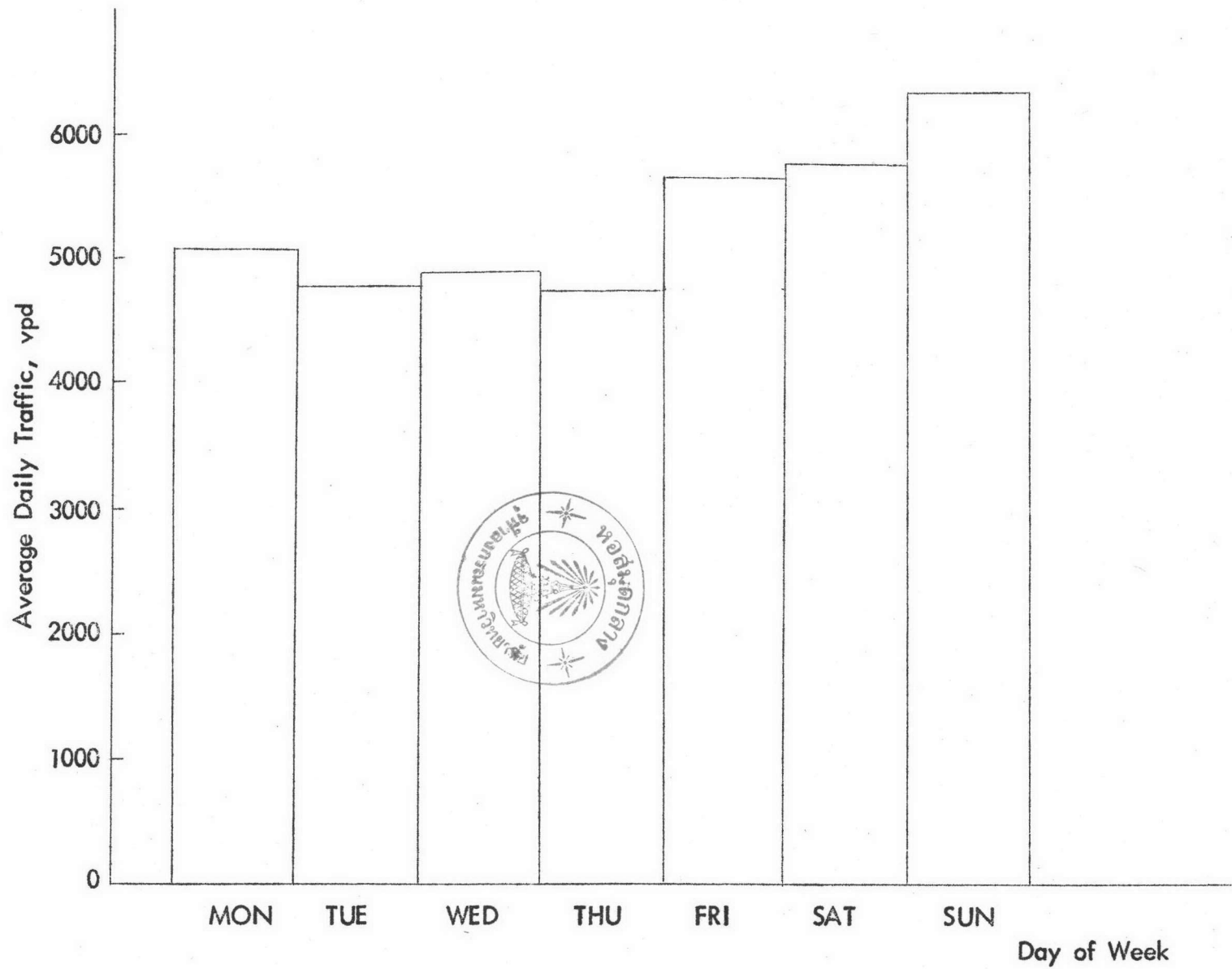


Fig.13 Average Daily Traffic in a Week

Table 16 Average Daily Traffic by Months at Bang Pa In Toll Gate

Month	1972		1973		1974		1975	
	ADT	B&T	ADT	B&T	ADT	B&T	ADT	B&T
JAN	-	-	3,734	862	4,775	1,191	4,592	1,198
FEB	-	-	4,630	1,060	4,933	1,456	5,629	1,275
MAR	-	-	4,611	1,072	5,256	1,416	5,419	1,316
APR	-	-	5,279	1,264	5,711	1,408	5,881	1,333
MAY	-	-	4,478	1,102	5,000	1,280	5,127	1,102
JUN	-	-	4,253	1,064	4,962	1,370	5,167	1,430
JUL	3,422	544	4,463	1,035	5,008	1,504	5,562	1,520
AUG	3,483	662	4,447	1,064	5,309	1,500	5,743	1,623
SEP	3,304	688	4,395	991	4,814	1,349	5,143	1,503
OCT	3,714	804	4,625	1,079	4,864	1,308	5,286	1,592
NOV	3,978	901	4,646	1,135	4,581	1,171	5,110	1,563
DEC	3,894	871	4,648	1,155	5,087	1,268	5,398	1,584

Table 17 Average Daily Traffic by Months at Ang Thong Toll Gate

Month	1972		1973		1974		1975	
	ADT	B&T	ADT	B&T	ADT	B&T	ADT	B&T
JAN	-	-	2,909	1,107	3,297	1,282	3,422	1,353
FEB	-	-	3,329	1,135	3,736	1,499	4,140	1,510
MAR	-	-	3,416	1,144	4,129	1,467	4,167	1,639
APR	-	-	3,855	1,227	3,765	1,486	4,550	1,622
MAY	-	-	3,383	1,186	3,504	1,350	4,013	1,485
JUN	-	-	3,213	1,199	3,602	1,412	3,714	1,438
JUL	2,492	741	3,302	1,167	3,967	1,525	3,791	1,369
AUG	2,463	746	3,289	1,176	3,976	1,715	3,921	1,490
SEP	2,286	731	3,264	1,194	3,472	1,422	3,648	1,457
OCT	2,594	825	3,312	1,254	3,799	1,399	4,032	1,546
NOV	2,772	895	3,342	1,276	3,399	1,326	3,846	1,524
DEC	3,012	1,084	3,349	1,271	3,637	1,372	3,964	1,622

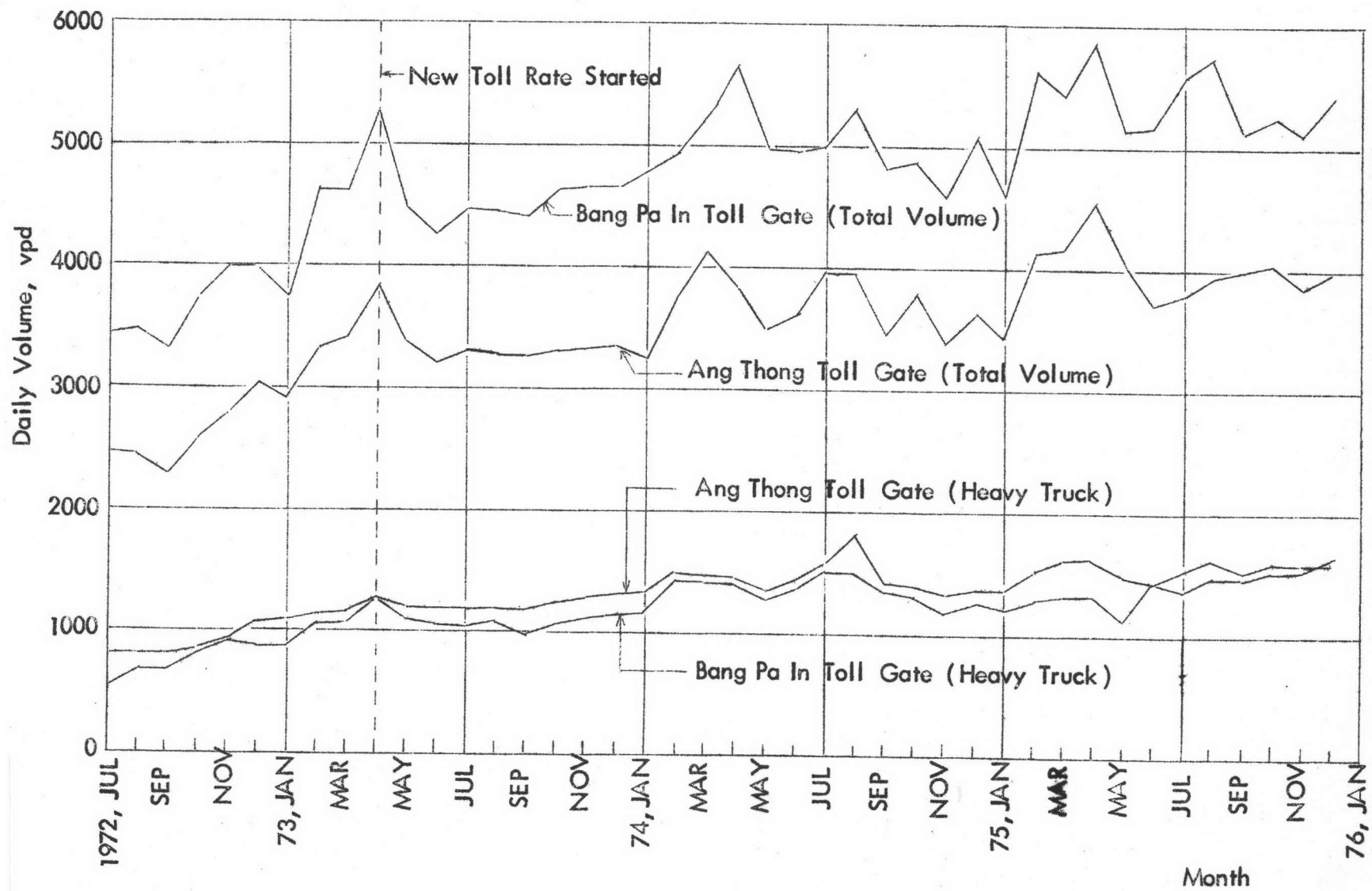


Fig.14 Average Daily Traffic by Month

of the year. The fluctuations of the traffic volume at the two observation stations are somewhat similar in pattern. In case of commercial vehicles, the fluctuation patterns cannot be definitely justified.

It is notable that after the reduction in toll rates for two axles bus and truck together with three axles heavy truck, the average daily traffic by month of the mentioned vehicles increased by 7 percent both at Bang Pa In and Ang Thong toll stations. This indicates the willingness of the vehicle owners to use the toll road if the toll rate is reasonable.

Composition of Traffic Volume

A more detailed definition of volume characteristics requires reporting the composition of traffic stream. For this study the components of traffic stream have been classified according to the usages and characteristics of the vehicles. Hence, the categories of classifications adopted for this analysis are:

- (1) Motorcycles
- (2) Passenger cars
- (3) Light trucks
- (4) Light buses
- (5) Heavy trucks (2-axles)
- (6) Heavy buses
- (7) Heavy trucks (3-axles)

Table 18 Percentage Composition of Traffic Volume

Type of Vehicle	Percent of Total
Motorcycles	4
Passenger cars	51
Light Buses	7
Light Trucks	10
Heavy Buses	7
Heavy Trucks (6-wheel)	9
Heavy Trucks (10-wheel)	12
Total	100

The percentage of vehicle types in the total traffic volume are shown in Table 18. It will be seen that half of the vehicles in the traffic stream are passenger cars. Motorcycles, constituted 4 percent and the commercial vehicle constituted 45 percent.



Origin-Destination Surveys

To determine how the Bang Pa In-Nakhonsawan Highway attracted or relieved and induced traffic as compared to the existing routes, origin-destination surveys were carried out. The surveys would reveal the pattern of movement of persons and goods indicating the level of development of the areas traversed by the highway.

Origin-destination surveys along the study route No.1 and the reference route No.309 were conducted by the crew of 20 persons. The locations of the origin-destination surveys on the study route No.1 was at Bang Pa In toll station and on the reference route No. 309 at 0+500 km from Wang Noi intersection. The roadside interviews were applied for the duration of eight hours from 08.00-16.00 hrs for both directions of traffic flow at both interview stations on 10th Wednesday and 13th Saturday December 1975.

In order to obtain the representative samples, the method of random sample was applied. The vehicles to be interviewed, they consisted of selecting every third or fifth vehicle according to the arrival rate. Subsequently, classified traffic volume counts were made for the whole day on the same dates of the origin-destination surveys in order to provide the expansion factors to obtain the value of daily traffic trips. The traffic volume counts were classified into seven categories of vehicle as mentioned in the traffic composition part. All the types of vehicle were interviewed except

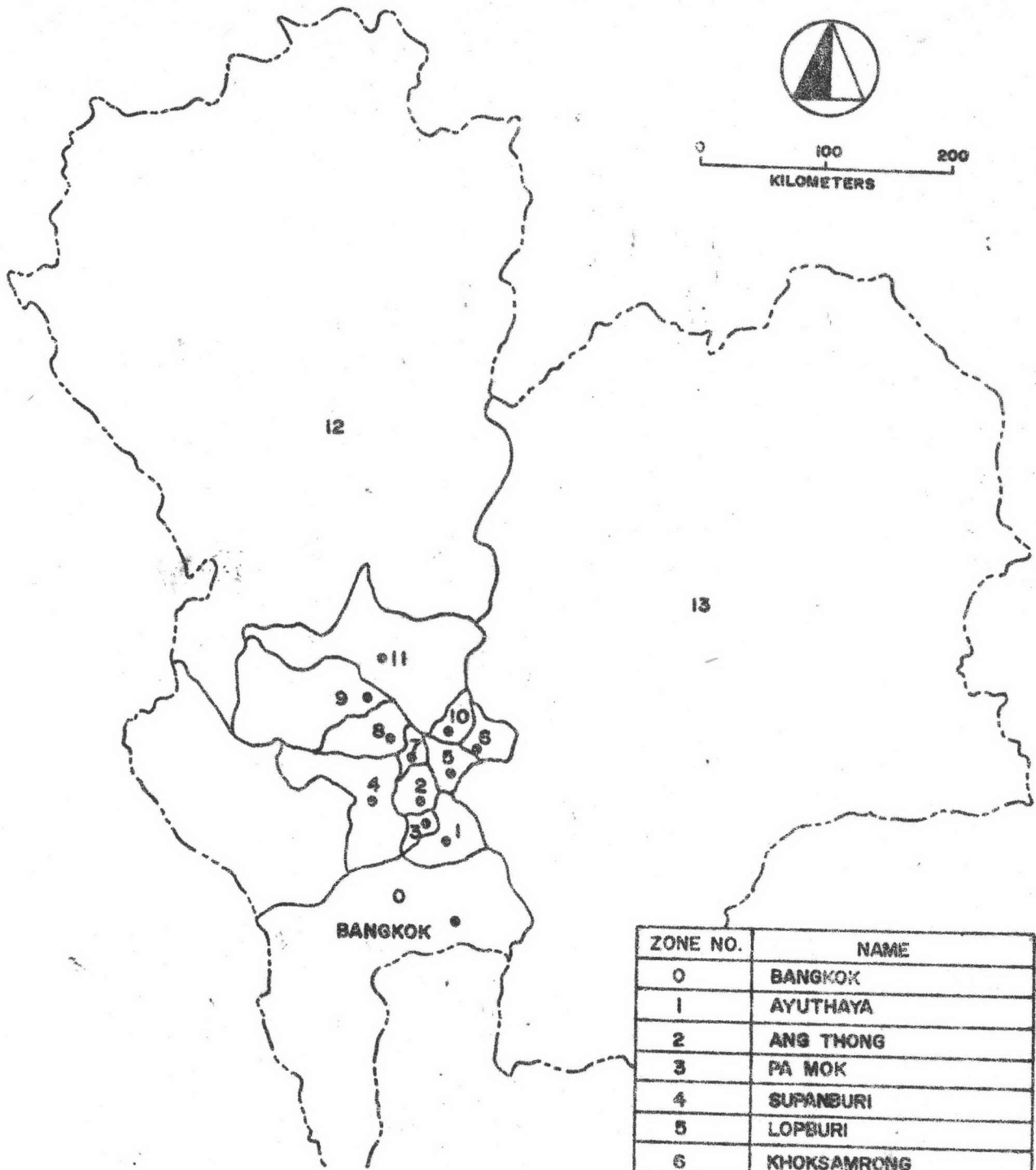
motorcycles, light and heavy buses. The vehicles selected were stopped at the shoulder with traffic controlled by policeman. The interviewers then recorded the vehicle make and model, registration number and the number of occupants. After explaining the objective of this interview, the interviewer then asked the motorist where the journey had started, where it would end, were there any intermediate stops before reaching the interview point and would there be any other stop before reaching the final destination. Motorists were also asked for the chief reason of their choice of route, purpose of trip and their professions. The questionnaire used for this study is shown in Appendix A, Table A1.

In order to analyse the characteristics of the traffic movement from the origin-destination data, the studied and surrounding areas were divided into 13 zones according to changwats and important amphoes as shown in Table 19. The location of zones are shown in Fig.15.

By using the total vehicle volume for each type measured in the day of interviewing (populations) and interviewed sample, sampling factors have been calculated for each direction and class of vehicle, separately. In calculating the sampling factors, it was assumed that the trip patterns of the vehicles in the interviewing period are the same as non-interviewing period. The calculated sampling factors are given in Tables 20 and 21. The sampling factors are the populations divided by the numbers in the sample.

Table 19 Origin and Destination Zones

Zone No.	Name
0	Bangkok
1	Changwat Ayuthaya
2	Changwat Ang Thong
3	Amphoe Pa Mok
4	Changwat Supanburi
5	Changwat Lopburi
6	Amphoe Khoksamrong
7	Changwat Singburi
8	Changwat Chainat
9	Changwat Uthai
10	Amphoe Takhli
11	Changwat Nakhonsawan
12	Beyond Nakhonsawan Region
13	Eastern Region



LEGEND:

COUNTRY BOUNDARY -----

ZONE BOUNDARY _____

ZONE NO.	NAME
0	BANGKOK
1	AYUTHAYA
2	ANG THONG
3	PA MOK
4	SUPANBURI
5	LOPBURI
6	KHOKSAMRONG
7	SINGBURI
8	CHAI NAT
9	UTHAITANI
10	TA KHLI
11	NAKORNSAWAN
12	NORTHERN REGION
13	NORTH-EASTERN REGION

Fig. 15 ORIGIN-DESTINATION ZONES

The data of origin and destination surveys were analysed by manually. The data were compiled in Appendix B, Tables B8-B11. After applying the sampling factors to provide the daily trips for each studied types of vehicle, these daily trips are shown in Tables 22 and 23. Table 24 also shows the summarized total daily trips for the various origin-destination pairs. The percentage distribution of daily weekend and weekday trips for each origin and destination pairs are demonstrated in Fig.16. The daily trips of the four studied types of vehicle between Bangkok Zones and those zones on Bang Pa In-Nakhonsawan Highway were 3,920 vpd on weekday and 4,748 vpd on weekend. There was the highest trip between Bangkok zone and Ayuthaya zone of 21 % of the total trips on weekday and 25 % on weekend.

Table 20 Sampling Factors for Each Type of Vehicle on Wednesday
10th December 1975

Type of Vehicle	North-bound			South-bound		
	Interviewed Samples	Total Veh.	Sampling Factor	Interviewed Samples	Total Veh.	Sampling Factor
Car	243	1,112	4.75	305	1,089	3.57
Light Truck	39	241	6.18	49	264	5.39
Heavy Truck(2 HT)	51	244	4.78	61	284	4.66
Heavy Truck(3 HT)	106	325	3.07	72	357	4.96

Table 21 Sampling Factors for Each Type of Vehicle on Saturday
13th December 1975

Type of Vehicle	North-bound			South-bound		
	Interviewed Samples	Total Veh.	Sampling Factor	Interviewed Samples	Total Veh.	Sampling Factor
Car	287	1,557	5.43	232	1,437	6.19
Light Truck	52	209	4.02	48	280	5.83
Heavy Truck (2HT)	46	217	4.72	44	236	5.36
Heavy Truck (3HT)	120	428	3.57	76	384	5.05

Table 22 Daily Trips by Types of Vehicle Between Zone 0 and Other Zones on Weekday*

O-D Pairs		Cars				Light Trucks				Heavy Trucks (2HT)				Heavy Trucks (3HT)			
Zone No.	Zone No.	NB	SB	Total	%	NB	SB	Total	%	NB	SB	Total	%	NB	SB	Total	%
0	1	238	289	527	24.0	42	91	133	26	34	56	90	17	12	29	41	6
	2	123	150	273	12.4	31	27	58	12	38	37	75	14	18	15	33	5
	3	23	25	48	2.2	-	5	5	1	-	-	-	-	6	5	11	2
	4	96	79	175	8.0	25	11	36	7	14	42	56	11	40	20	60	9
	5	63	70	133	6.0	11	9	20	4	5	10	15	3	6	10	16	2
	6	10	5	15	0.7	8	5	13	3	4	4	8	2	3	5	8	1
	7	91	86	177	8.0	19	32	51	10	24	24	48	9	34	50	84	12
	8	69	71	140	6.3	19	22	41	8	29	9	38	7	15	29	44	6
	9	46	61	107	4.9	12	5	17	3	9	9	18	3	25	20	45	6
	10	46	32	78	3.5	6	11	17	3	19	9	28	5	25	15	40	6
	11	110	107	217	9.8	37	22	59	12	34	37	71	4	61	40	101	15
	12	188	114	302	13.7	31	22	53	11	34	47	81	15	86	119	205	30
	13	9	-	9	0.5	-	-	-	-	-	-	-	-	-	3	-	3
Total		1112	1089	2201	100.0	241	262	503	100	244	284	528	100	334	357	691	100

* On Bang Pa In-Nakhonsawan Highway (Wednesday 10th December 1975)

Table 23 Daily Trips by Types of Vehicle Between Zone 0 and Other Zones on Weekend*

O-D Pairs		Cars				Light Trucks				Heavy Trucks (2HT)				Heavy Trucks (3HT)			
Zone No.	Zone No.	NB	SB	Total	%	NB	SB	Total	%	NB	SB	Total	%	NB	SB	Total	%
0	1	369	526	895	29.9	68	81	149	30.5	33	43	76	16.8	25	25	50	6.2
	2	217	180	397	13.3	37	52	89	18.2	28	16	44	9.7	29	20	49	6.0
	3	38	31	69	2.3	8	6	14	2.9	-	5	5	1.1	-	-	-	-
	4	124	74	198	6.6	12	18	30	6.1	9	11	20	4.4	21	10	31	3.8
	5	72	65	137	4.6	10	6	16	3.3	12	11	23	5.1	20	19	39	4.8
	6	20	16	36	1.2	6	-	6	1.2	2	-	2	0.5	5	6	11	1.4
	7	136	149	285	9.5	8	29	37	7.5	19	21	40	8.8	50	51	101	12.4
	8	103	62	165	5.5	16	17	33	6.7	14	11	25	5.5	18	10	28	3.4
	9	87	62	149	5.0	4	12	16	3.3	14	16	30	6.6	18	5	23	2.8
	10	43	25	68	2.3	4	12	16	3.3	5	11	16	3.5	21	10	31	3.8
	11	174	130	304	10.1	32	35	67	13.7	48	32	80	17.7	103	66	169	20.9
	12	174	99	273	9.1	4	12	16	3.3	33	59	92	20.3	111	152	263	32.4
	13	-	18	18	0.6	-	-	-	-	-	-	-	-	-	7	10	17
Total		1557	1437	2994	100.0	209	280	489	100	217	236	453	100	428	384	812	100

* On Bang Pa In-Nakhonsawan Highway (Wednesday 10th December 1975)

Table 24 Total Daily Trips by Four Types of Vehicle Between Zone 0 and Other Zones*

O-D Pairs		Weekday (10th December 1975)		Weekend (13th December 1975)	
Zone No.	Zone No.	No. of Trips	Percent	No. of Trips	Percent
0	1	791	21.2	1,170	24.6
	2	439	11.2	579	12.2
	3	64	1.6	88	1.9
	4	327	8.3	279	5.8
	5	184	4.6	215	4.5
	6	44	1.1	55	1.2
	7	360	9.2	463	9.8
	8	263	6.7	251	5.3
	9	187	4.8	218	4.6
	10	163	4.2	131	2.8
	11	448	11.4	620	13.1
	12	641	16.4	644	13.5
	13	12	0.3	35	0.7
Total		3,920	100.0	4,748	100.0

* On Bang Pa In-Nakhonsawan Highway

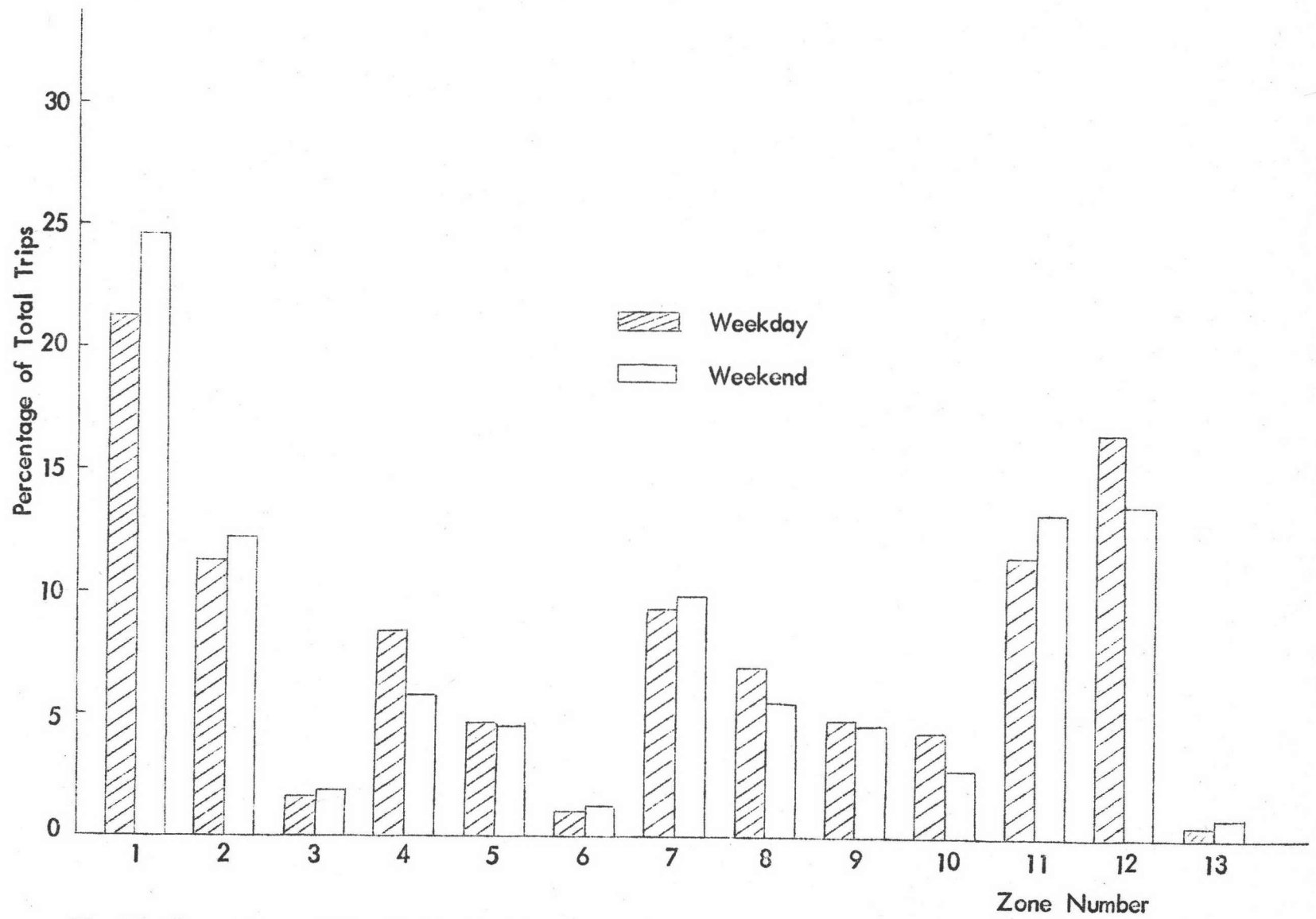


Fig.16 Comparison of Total Trips by Percentage Between Weekday and Weekend

Trip Purpose for Passenger Cars

The trip purpose of passenger cars were classified into three categories as business, leisure and other purposes. The results are shown in Tables 25 and 26 and portrayed in Fig.17.

As it can be expected, the percentage of leisure trips during the weekends were higher than those of the weekdays. Also the north-bound traffic was greater than the southbound. For business trips it was found that it consisted of 78 % of the total trips during the weekdays as compared to 62 % for the weekends.

Table 25 Trip Purposes for Passenger Cars on Typical Weekday by Percentage

Purpose of Trip	North-bound		South-bound	
	No.of Sample	%	No.of Sample	%
Leisure	35	14.4	41	13.4
Business	191	78.6	238	78.0
Other	17	7.0	26	8.6
Total	243	100.0	305	100.0

Table 26 Trip Purposes for Passenger Cars on Typical Weekend by Percentage

Purpose of Trip	North-bound		South-bound	
	No.of Sample	%	No.of Sample	%
Leisure	95	33.1	58	25.0
Business	166	57.8	156	67.2
Other	26	9.1	18	7.8
Total	287	100.0	232	100.0

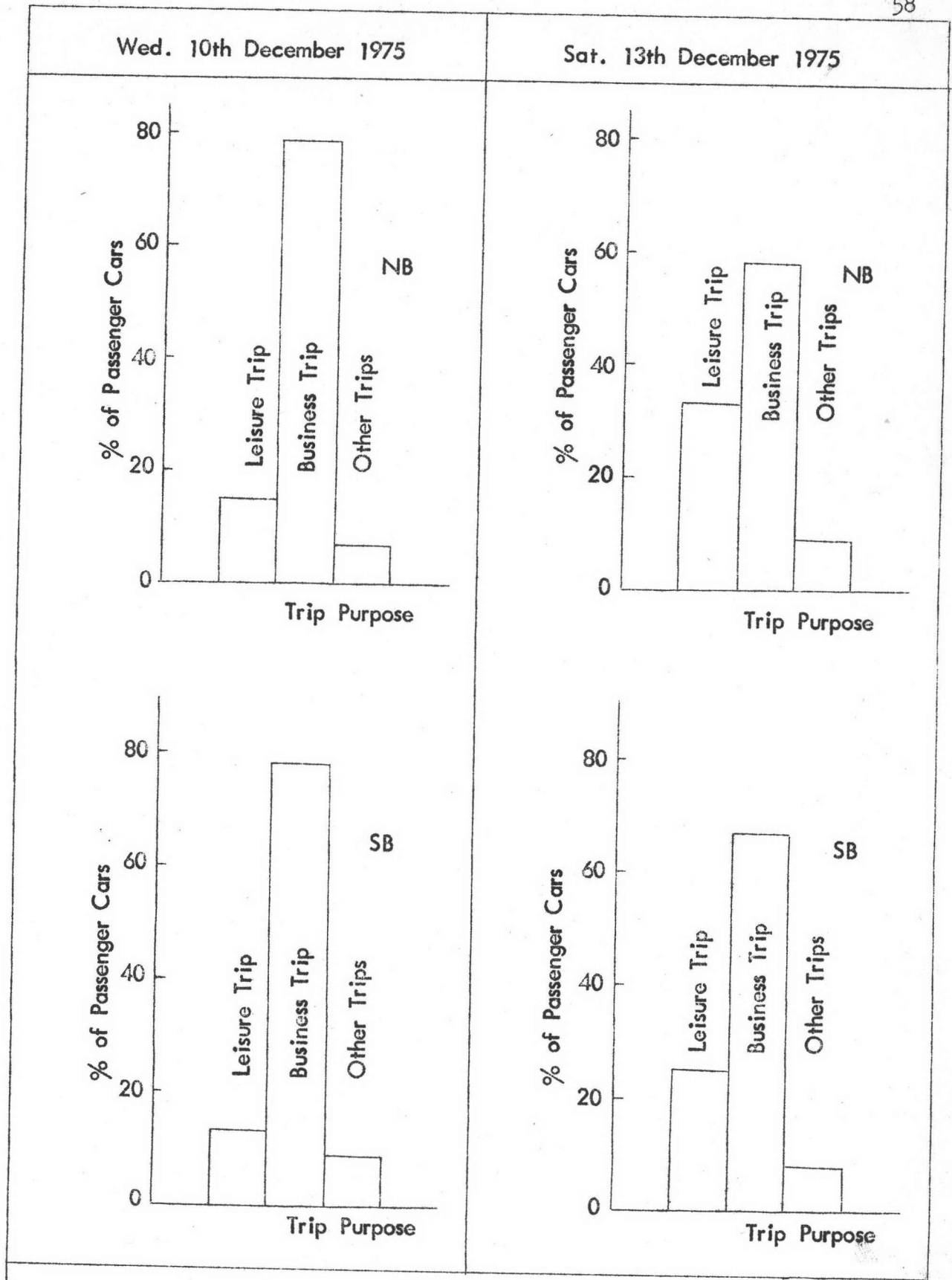


Fig.17 Percentage of Trip Purpose of Passenger Cars on Route No.32

Motorists' Choice of Route

Since the middle of the year 1972, the Bang Pa In-Nakhonsawan Highway was opened to traffic, there have been many traffic volumes diverted from the old existing routes and also an induced traffic. One of the major purposes of an origin-destination study was to obtain informations concerning travel desires of motorists using Bang Pa In-Nakhonsawan toll road compared to its competitive roads. To get such information, the motorists were asked to reply to the question of "Why do you choose the toll road rather than free existing roads?" under the destination heading of 1) quicker, 2) more comfortable to ride, 3) safer, 4) more economic, 5) geography constraint and 6) others.

The results obtained were summarized in Table 27 which included the number of motorists interviewed. Fig.18 illustrates the percentage of motorists' choice of route by studied types of vehicle.

From the results, it can be seen that the chief reason for motorists choosing the toll road was "more comfortable to ride". It comprised about a half of the total number understudied. For the rests, the ranking were as quicker 28 %, safer 15 %, more economic 4 %, geography constraints 2 % and others 3 %.

Table 27 The Number of Sample and Percentage of Total studied Type of Vehicle for Motorists' Choice of Route

Reason	Cars		Light Truck		Heavy Truck (2HT)		Heavy Truck (3HT)		Total Veh.	
	No.of* Sample	%	No.of* Sample	%	No.of* Sample	%	No.of* Sample	%	Total No.* of Sample	%
1. Quicker	268	25	59	31	65	32	109	30	501	28
2. More Comfortable	530	50	96	51	94	47	163	45	883	48
3. Safer	158	14	23	12	30	15	72	20	283	15
4. More Economic	39	4	4	3	7	3	113	4	63	4
5. Geography Constraints	33	3	1	-	-	-	1	-	35	2
6. Other	39	4	5	3	6	3	6	1	56	3
Total	1,067	100	188	100	202	100	364	100	1,821	100

* For both weekday and weekend interviews

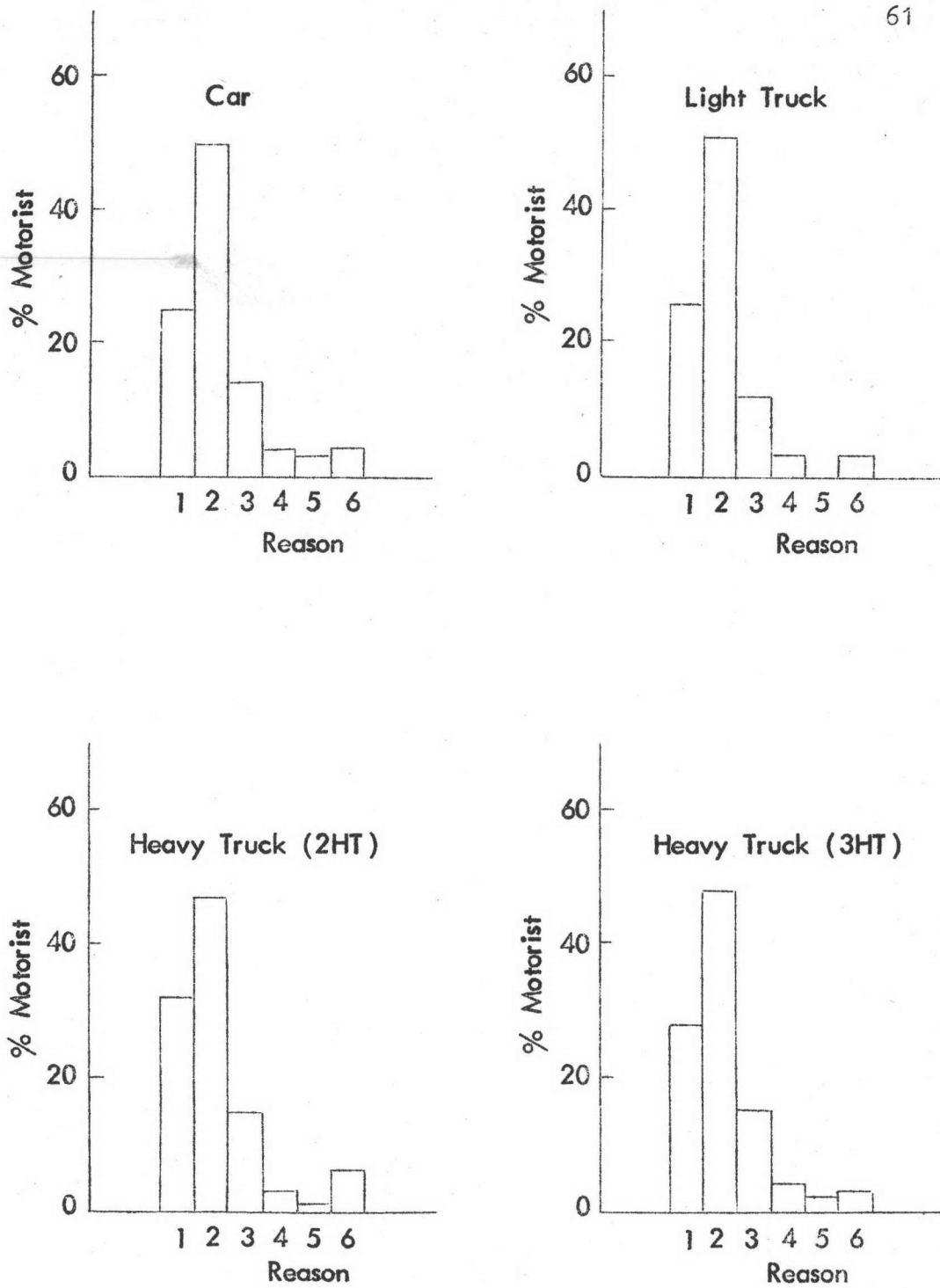


Fig.18 Reason Distribution by Percentage of Motorists' Choice of Route No.32 by Each Type of Vehicle

Average Occupancy Rate

The occupancy rate (including driver) by each type of vehicle was obtained at the same time of origin and destination surveys. The data and analyses are compiled in Appendix B, Tables 12 through 15. For passenger cars, the analysis of average occupancy rate were divided according to trip purposes as business trip and leisure trip. Table 28 shows the result of the average occupancy rates by each type of vehicle using the route. To check the validity of this result, comparisons were made with the Department of Highways' surveys made on the primary routes about 20 km outside Bangkok.

Table 28 Average Occupancy Rate

Type of Vehicle	Average Occupancy Rate	
	Route No. 32	* THD's Survey
Car: Business	3.2	3.4
Leisure	4.0	4.4
Light Buses	-	10.0
Heavy Buses	-	23.0
Light Trucks	3.2	4.0
Heavy Trucks (2HT)	2.5	-
Heavy Trucks(3HT)	3.0	3.0

* THD = Thai Highway Department

Journey Time and Speed Measurements

The running costs of the motor vehicles and the travel time are directly related to the speed of the vehicles. In an analysis for the economy of the highway, it is necessary to obtain the informations about the traffic speed. In this study, two types of measurement were considered.

Toll Road: To obtain the average running speed and travel time by each type of vehicles, the licence plate method was used. The two observers with synchronized watches were stationed at Ang Thong and Bang Pa In toll gate. As each vehicle passed the observers, they would note and record registration numbers and time of passage. Later the registration number and time were matched and the individual vehicle travel time was determined. The study was conducted at the same time when the origin-destination surveys were carried out.

The data and analysis are compiled in Appendix B. Tables B16 through B19. Table 29 gives the results of the average running time and speed between two toll gates which was 40.95 kilometers apart. The average running speed for car was 86 kph, 78 kph for light truck, 67 kph for heavy truck (2HT) and 66 kph for heavy truck (3HT). The average running speeds during the weekday are slightly higher than that during the weekend and also the northbound speed is higher than that of the southbound.

Table 29 Average Travel Time Between Two Toll Gates and Average
Travel Speed by Type of Vehicles

Type of Vehicle	Day	Direction	No. of veh. Interviewed 08.00-16.00	Matched Samples	% Match	Avg Travel Time, min	Avg Travel speed, kph
Car	Weekday ¹	NB	243	125	51	27.3	86.0
		SB	305	134	44	29.1	
	Weekend ²	NB	287	138	48	27.8	
		SB	232	100	43	30.0	
Light Truck	Weekday ¹	NB	39	25	64	30.7	78.0
		SB	49	32	65	31.2	
	Weekend ²	NB	52	28	54	31.8	
		SB	48	28	58	32.4	
Heavy Truck (2HT)	Weekday ¹	NB	51	33	65	34.8	67.2
		SB	61	39	64	36.8	
	Weekend ²	NB	46	33	72	36.4	
		SB	44	43	98	38.4	
Heavy Truck (3HT)	Weekday ¹	NB	106	83	78	37.3	65.8
		SB	72	50	69	38.2	
	Weekend ²	NB	120	96	80	36.0	
		SB	76	73	96	37.8	

(1) Wednesday 10th December 1975

(2) Saturday 13th December 1975

Free Roads: On the routes No.1 and No.309, the travel times were obtained by observers travelling at the average speed of all the vehicle in traffic stream. The reason for not using the licence plate method in this study is because many roads connect with these highways and the nature of traffic being local. These may result the matching numbers to be too low to warrant the significant value. On route No.309 section between Wang Noi to Ang Thong and route No.1 section between Saraburi to Takhli, it was very difficult to drive the test vehicle with the average speed of the traffic since there was little traffic. The driver could only drive at what he felt was a reasonable speed for the road. In those sections the driver tried to balance overtakens and undertakens and thus maintain an average car speed. The data and analysis are shown in Table 30. As for travel speed for section between Bangkok-Saraburi which is two-lane-divided highway, the data obtained from the Highway Department is 85 kph for passenger car, 80 kph for light commercial vehicles and 70 kph for heavy commercial vehicles.

Table 30 Average Travel Time and Speed on Route Nos. 1 and 309
for Cars

Route No.		Direction	Distance (km)	Travel time (min)	Avg. Travel time (min)	Avg. Travel speed (kph)
1	Saraburi-Lopburi	NB	45.0	39	38	71.0
		SB		37		
	Lopburi-Khoksamrong	NB	35.0	31	29.5	71.0
		SB		28		
	Khoksamrong-Takhli	NB	66.0	51	55.0	72.0
		SB		59		
309	Wang Noi-Ayuthaya	NB	25.5	22	23.5	65.0
		SB		25		
	Ayuthaya-Ang Thong	NB	32.0	26	27.0	72.0
		SB		28		