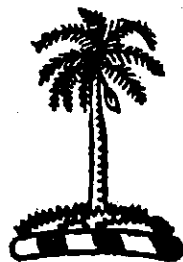


**URBAN TRANSPORT STUDY  
IN  
GREATER METROPOLITAN AREAS  
OF  
GEORGE TOWN, BUTTERWORTH AND BUKIT MERTAJAM  
MALAYSIA**

**THE FERRY STUDY**

**TECHNICAL REPORT - 16**



**FEBRUARY 1980**

**JAPAN INTERNATIONAL  
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THE FERRY STUDY  
( Technical Report - 16 )

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1.

## Introduction

The means of transport by sea is quite important for intra-regional, inter-regional and inter-national traffic, because of the geographical features of Penang State which is separated by the straits into two parts.

Regarding inter-regional and inter-national trade by ship, a detailed description is made in the technical report on 'Port', and so this report concerns the ferry.

The ferry service between Penang Island and Province Wellesley has a history of over 30 years, and is established as the only means of public transport for passengers and vehicles going across the straits.

The significance of the ferry service is easily understood by the fact that there were 56,000 passengers, 12,400 motor-cycles and 10,300 cars that travelled each day from George Town to Butterworth by ferry in 1978.

Although several studies regarding the ferry has been done from various view points up to the present, the ferry will be examined as one of the transport modes from the aspect of comprehensive urban transport study in this report.

Our study approach is as follows:

1. to recognize the present and past role of the ferry
2. to investigate present conditions
3. to survey characteristics of users
4. to forecast its future role, especially after the completion of Penang Bridge, and
5. to suggest a future improvement plan.

The important but difficult point of this study is that the position of the ferry will be changed from an exclusive mode of transport across the straits to a competitive mode of transport among several other transport modes after the bridge is completed.

For instance, it is uncertain whether the ferry service will remain as it is or not. Political factors come into consideration in the judgement of such a situation and this is beyond this report.

Therefore, in our study the two situations - with and without ferry service - will be compared from the viewpoint of traffic demand, and as a result some objective data will be offered in order to make some decision. In addition some suggestions for ferry service in the short-term and long-term can be made after forecasting the traffic demand.



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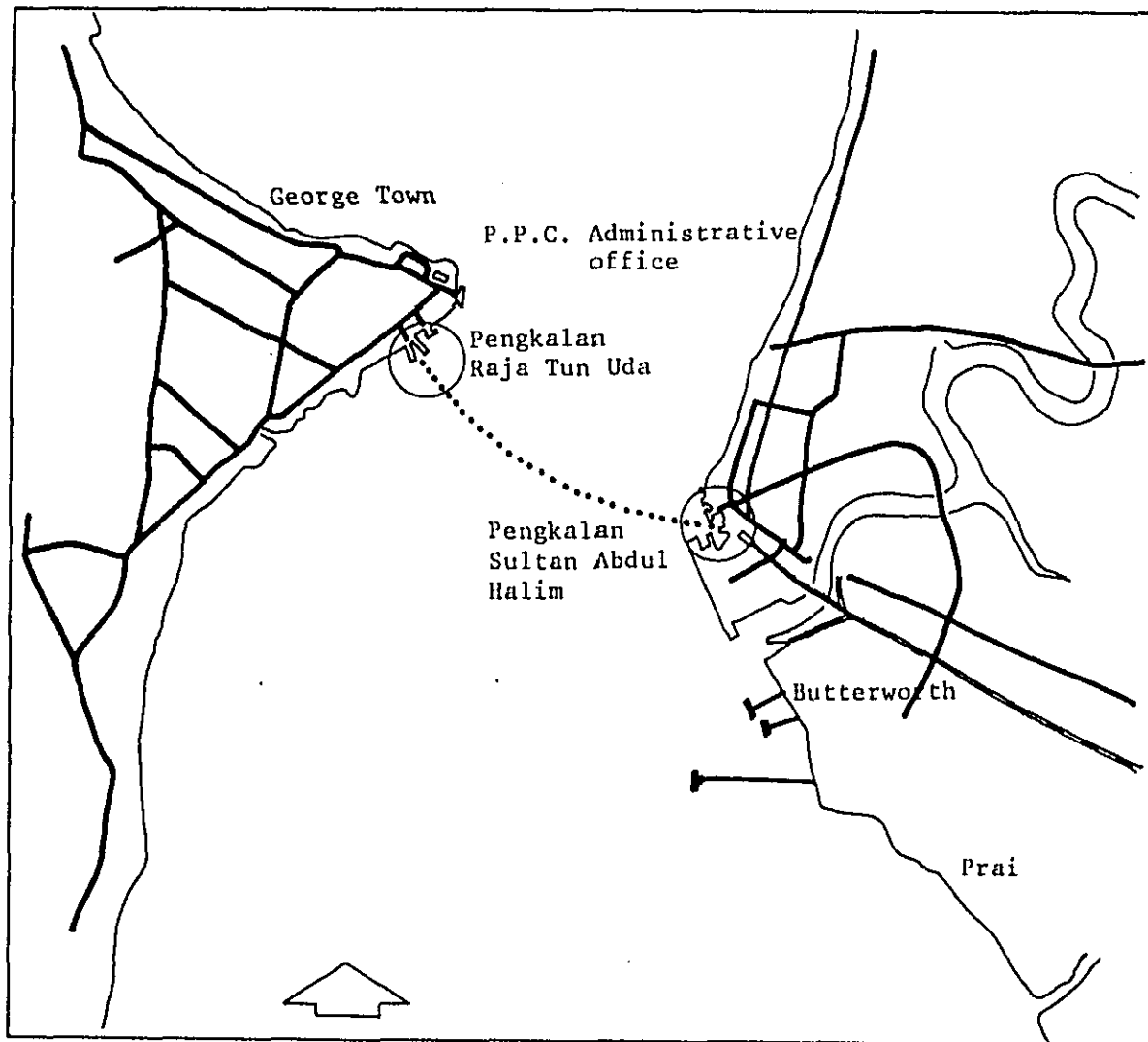
Present Conditions

The ferry service is under the administration of the Penang Port Commission (P.P.C.), which has a supervisory function over the whole Port of Penang.

At first, some general information is given in this chapter in order to evaluate present conditions of the ferry service.

The location of ferry terminals is shown in the figure below.

Fig. 1 Location of Ferry Service



## 2.1 Facilities

The facilities of the ferry consist of two parts; one is land facilities such as office buildings, toll gate, waiting space, piers, docks and so on, the other is sea facilities such as shipping fleets.

### 2.1.1 Terminal Facility

In George Town side, near the end of Gat Leboh Pasar and along Pengkalan Weld, there is the ferry terminal - Pengkalan Raja Tun Uda.

There are 3 berths for ferries, two of them for single-deckers\* which carry both passengers and vehicles, and one for double-deckers\*\* which carry only vehicles.

There are also toll gates and offices where each driver pays a fare according to the type of vehicle he is driving - cars, lorries, motor-cycles or bicycles. On the first floor of the terminal building there are facilities for passengers such as a ticket office and a concourse.

On the other hand, at Butterworth side near the crossing point of Pantai Road and Mitchell road there is another terminal, viz, Pengkalan Sultan Abdul Halim. Here there are three berths and open space for waiting cars. At the Butterworth side the transport terminal function is very important, because it is a terminal for three modes of transport, viz, ferry, railway and road traffic.

Therefore, a multilevel bridge for pedestrians serves to connect the ferry concourse, railway station and bus/taxi terminal. This offers very convenient circumstances for pedestrians who do not have to encounter with vehicles on the same ground level.

\* 'Single-decker' refers to the old type of ferry which has only one deck for vehicles and the other deck for passengers.

\*\* 'Double-decker' refers to the new type of ferry which has both its decks for only cars and lorries.

## 2.1.2

Vessels

Total operating vessels number 11; 8 are old ferries called 'single-deckers' and 3 are new ferries called 'double-deckers'. The features of these vessels are shown in the following table.

Table 1 Vessel Information

Name of Vessel	When Built	Length Overall	Beam Overall	B.H.P.	Speed
<u>Single-Decker</u>					
Pulau Pinang	1956	161'	35'	380 Each	10.85 knots
Pulau Aman	1959	161'	35'	-do-	10.6 "
Pulau Langkawi	1959	161'	35'	-do-	10.40 "
Pulau Pangkor	1959	161'	35'	-do-	10.2 "
Pulau Tioman	1959	161'	35'	-do-	10.91 "
Pulau Lumut	1965	161'	35'	-do-	10.2 "
Pulau Redang	1971	161'	35'	395 Each	10.2 "
Pulau Labuan	1971	161'	35'	390 Each	10.2 "
<u>Double-Decker</u>					
Pulau Undan	1975	171'	39'	550 Each	10.4 "
Pulau Rawa	1975	171'	39'	-do-	10.4 "
Pulau Talang-Talang	1975	171'	39'	-do-	10.4 "

Source: P.P.C.

The oldest one is "Pulau Pinang" which was built in 1956. The new ones are 3 double-deckers, "Pulau Undan", "Pulau Rawa" and "Pulau Talang-Talang" which were built in 1975.

The vessel capacity of a ferry expressed per vehicle type varies depending on the size of vehicle. The size relationship of different vehicle types generally average 5 to 5.5 motor-cycles per automobile and 2 automobiles per large lorry.

If the capacity of the ferries is supposed in terms of vehicle equivalents excluding space available for motor-cycles, the capacity is shown in Column A of Table 2 .

Table 2 Ferry Capacity

Vessel Name	Operational Capacity in Vehicle Equivalents				Maximum Capacity		
	A	B +	C	D	Motor-cycles	Small Lorries*	Large Lorries
Pulau Pinang	26	27.5	26	150		15	5
Pulau Pangkor	30	31.5	32	184		15-25	6
Pulau Labuan	30	31.5	32	184		15-25	6
Pulau Langkawi	30	31.5	32	184		15-25	6
Pulau Lumut	30	31.5	32	184		15-25	6
Pulau Tioman	30	31.5	32	184		15-25	6
Pulau Redang	30	31.5	32	184		15-25	6
Pulau Aman	30	31.5	32	184		15-25	6
Pulau ) Upper Undan ) Deck	34	35.7	34	200		21	--
Lower Deck	36	37.7	36	210		22	9
Pulau ) Upper Talang) Deck	34	35.7	34	200		21	--
Talang) Lower Deck	36	37.7	36	210		22	9
Pulau ) Upper Rawa ) Deck	34	35.7	34	200		21	--
Lower Deck	36	37.7	36	210		22	9

\* Small lorry = 6 tons

+ Includes additional motor-cycle space

If the additional motor-cycle space is included, the capacity is shown in Column B.

If the maximum capacity is calculated in terms of vehicle types, the capacities which the ferry can hold are shown in Columns C, D, E and F.

But, the assignment of vessel capacity on the older ferries is done by observing the motor-cycle and automobile queues. The amount of automobiles to be loaded is selected as shown in Table 3. Once this amount of cars is loaded onto the ferry, the remaining space is filled with motor-cycles as shown in the table.

The loading capacity of the new ferries is normally 32 cars on the upper deck and 16 lorries on the lower deck, with additional vehicles where appropriate. When no lorry queue exists, the lower deck will also be loaded with cars. The number of lorries on the lower deck differs each time depending on the variations in truck size from commercial vans to semi-trailers with capacity exceeding 10 tons.

Table 3 Old Ferry Loading Strategy

Pulau Pinang						
Chain No.	0	1	2	3	4	5
Approximate No. of Automobiles	26	24	20	12	8	6
Motor-cycles		35	55	100	120	130
Other Old Ferries						
Chain No.*	0	1	2	3	4	5
Approximate No. of Automobiles	32	28	24	16	10	6
Motor-cycles	-	25	50	90	130	160

\* Note: 'Chain' refers to the fixed values of P.P.C. by which assignment of vessel capacity is done.

Operation

The ferry serves for 24 hours every day. As the time schedule shown in Table 4, there are very frequent services between 7.00 a.m. to 8.00 p.m. The interval between each ferry is about 5 to 7 minutes during these hours. However, at times there is a change in this schedule depending on the fluctuation in demand. Even at night, there are two services an hour in each direction.

The ferry service is under the administration of the Penang Port Commission (P.P.C.), which had 648 employees in 1978; 74 per cent are operators and crew, 10 per cent are engineers and 17 per cent are clerical and supervisory staff.

There are three working shifts; 6 a.m - 2 p.m, 2 p.m - 10 p.m and 10 p.m - 6 a.m. 9 ferries are provided in the first two shifts and 4 ferries in the third shift. If the demand is high, an additional ferry is kept in service until the queue disappears.

The time taken for ferries to cross the channel is generally 15 minutes to 10 minutes by single-deckers, and 13 or 14 minutes by double-deckers. The time spent at the terminal is 7 minutes on an average. It consists of unloading time, loading time and ramp operation time.

The single-deckers occupy two berths and the double-deckers require the operation of only one berth. This utilization is almost maximum operation, because while three ferries at Penang and Butterworth berth are simultaneously loading or unloading, three other ferries are in transit.

Bunkering of vessel is done once a week for each operating vessel. During normal periods, 6 ferries are fuelled three times in a week and 3 vessels per day. But during slack periods, a vessel is tied up at the terminal two days per week for about four hours for preventive maintenance. During the weekend peak hours 9 vessels operate and during the holiday peaks 10 ferries are brought into service. So, only one older ferry remains out of operation.

Table 4 Time Schedule  
FERRY SERVICE TIMETABLE

PASSENGER FERRY VESSELS (Single-Decker)			(FROM BUTTERWORTH)	
(FROM PENANG)				
0600 hours - 0642 hours	Every 7 minutes & 14 minutes		0600 hours - 0649 hours	
0649 " - 2206 "	Every 7 minutes		0703 " - 2206 "	
2220 " - 2400 "	Every 10 minutes		2220 " - 2400 "	
0015 " - 0100 "	Every 15 minutes		0015 " - 1000 "	
0120 " - 0140 "	Every 20 minutes		0120 " - 0140 "	
0200 " - 0530 "	Every 30 minutes		0200 " - 0530 "	
VEHICULAR FERRY VESSELS (Double Decker)				
0630 hours - 0710 hours	Every 20 minutes		0630 hours - 0710 hours	
0720 " - 2140 "	Every 10 minutes & 20 minutes		0720 " - 2130 "	
2220 "	Last trip		2200 "	

- Note: 1) The ferry time-table is subject to changes depending on traffic condition.  
2) On Saturdays, Sundays and Public Holidays the vehicular ferry service is extended to 1.00 a.m.

This operation in accordance with the time table is carried out under the administration of ferry officers on duty on both sides of the terminal who control the loading volume of motor-cycles and cars according to the length of queues.

Therefore, the number of vehicles on each ferry is different. Even in our field survey, many different loading conditions were observed as shown in the following table.

TABLE 5 SOME SAMPLES OF LOADING CONDITIONS

Single-Decker.

Sample	Motorcars	Lorries	Buses	M/cycle	Passengers	Remarks
A	6	1	-	164	205	max. for Cars
B	35	-	-	-	380	max. for Cars
C	10	-	-	192	434	max. for motorcycle & passenger
D	23	2	-	83	305	
E	13	-	-	47	175	

Double-Decker

Sample	Upper deck		Lower deck			Total			
	Car	Van, pick-up	Car	Lorry	Bus	Car	Lorry	Bus	Total
A	30	-	12	7	2	42	7	2	51
B	30	2	26	3	-	56	5	-	61
C	-	-	15	4	-	15	4	-	19
D	30	-	-	14	1	30	14	1	45
E	33	-	13	10	1	46	10	1	57



## 2.3

### Fare System

The fare for getting across the Channel from Penang to Butterworth is paid only at the Penang side according to type of vehicles and passengers. The trips from Butterworth to Penang is free.

This fare system has been in force since 1st Jan, 1968, for the purpose of the following:

- i) Reduced fares for the majority of ferry users.
- ii) Less delay at Butterworth.
- iii) More convenient to pay once.

The fare for passengers and vehicles are shown in the following table; the fares have just been changed from 1st October, 1979. The table shows the old and the revised fares.

Table 6 Tariffs

	(01.10.1979-) New fare	(-30.09.1979) Old fare	Rate (New/Old)
<b>Passengers</b>			
Children over 5 and under 12 years of age	0.20	0.20	1.00
Adults	0.40	0.35	1.14
Monthly tickets (not valid for travel with bicycles)			
Students (up to 21 years of age)	1.00	1.00	1.00
Adults	6.00	6.00	1.00
Bicycles	0.50	0.50	1.00
Monthly tickets			
Students (up to 21 years of age)	2.00	2.00	1.00
Adults	10.00	10.00	1.00
Motor-Cycles	1.20	1.00	1.20
Tricycles, Trishaws and Hand-Carts	2.50	2.50	1.00
Motor-Cycles with Side Cars	4.00	2.50	1.60
Three-Wheeled Commercial Vehicles up to 1200 c.c.	6.00	-	-
<b>Cars</b>			
1200 c.c. or under	4.00	750 c.c. or under 2.50	(1.60)
1202 c.c. to 1600 c.c.	5.00	751 c.c. to 1600 c.c. 4.00	(1.25)
Over 1600 c.c.	6.00	Over 1600 c.c. 4.90	1.22
<b>Lorries (loaded or empty)</b>			
MPLW		Carrying Capacity	
2 tons and under	8.00	1 ton or under	6.00 1.33
above 2 tons up to 4 tons	12.00	2 tons or under	10.00 0.80
above 4 tons up to 6 tons	16.00	3 " " "	14.00 0.86
above 6 tons up to 8 tons	22.00	4 " " "	18.00 0.89
above 8 tons up to 10 tons	29.00	6 " " "	25.00 0.64
above 10 tons up to 13 tons	36.00	8 " " "	32.00 0.69
above 13 tons up to 16 tons	42.00	10 " " "	36.00 0.81
above 16 tons	48.00	Above 10 tons	40.00 0.90-1.20
Buses and Horse Box Lorries will be charged on their unladen weight according to the above rate.		Extra charge for projection at either end of vehicle per foot or part thereof	.50
<b>Weighing</b>			
Weighing on weighbridge for every ton or part thereof	0.50	0.50	1.00
<b>Goods (not carried on commercial vehicles)</b>			
Loaded baskets - per basket	0.20	Loaded baskets of fish, poultry etc.	
Domestic animals - per animal	0.20	Domestic animals	
Heavy baggage, perambulators, etc. per item	0.20	Heavy baggage, perambulators etc. per Item 0.20 1.00	
Parcels on bicycles etc.			
<b>Special Ferry (from one terminal to another)</b>			
Passenger Ferry - per trip	150.00	SPECIAL LAUNCHES - may be run by arrangement with the Manager. A fee (non re- fundable) of \$50 per trip must be paid when such arrangements are made.	
Double-decker vehicular ferry- per trip	200.00		

2.4

Transport Volume

2.4.1

Annual

The trend of transport volume on ferries has increased during these past twenty years as shown in the following tables and figures.

In particular, there has been a significant increasing trend of motor-cycles and cars during the past ten years; the volume in 1978 was more than three times of that in 1978.

From 1958 to 1978, the average growth rate of cars to each previous year was 9.5% per annum, but recently, in 1968 - 1978, its average is 12.1% per annum. The change in the growth rate appears to have commenced in 1969.

The growth rate of lorries has been increasing from 1958-1978 at 7.0% per annum. However, recently it appears to be increasing at 9.2% per annum.

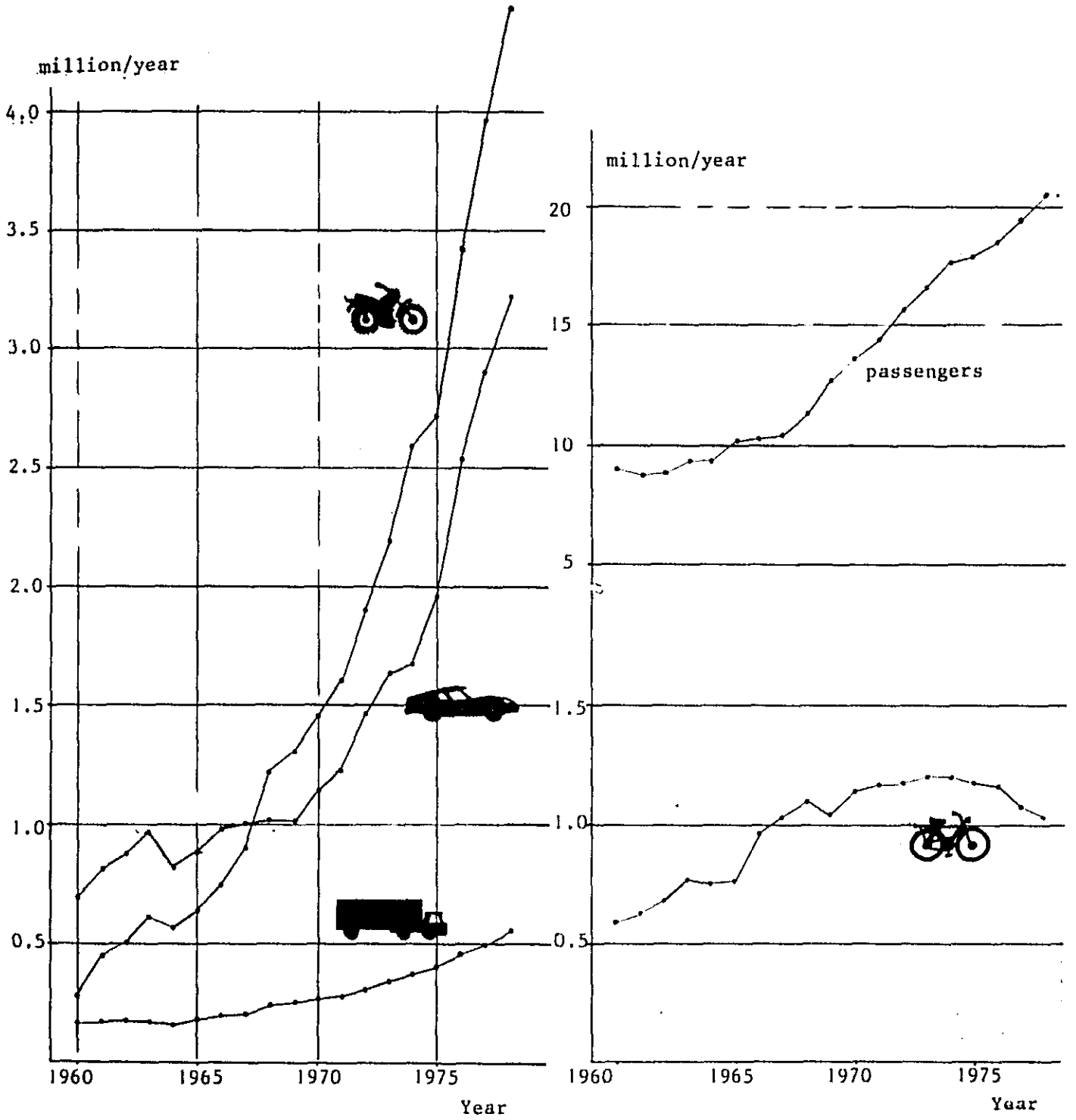
The growth rate of motor-cycles in the long term is 19.0% which is the highest among the 5 modes.

The volume of bicycles has decreased since 1973, and that of the other 4 modes still continue to increase.

Table 7  
Twenty-Year History of Ferry Traffic  
Measured in One Way Trips

	(1000 persons or vehicles)				
	Passengers	Bicycles	Motorcycles	Cars	Trucks
1955	6527.8	507.9	62.3	410.7	146.8
1956	7398.4	597.9	80.6	475.8	154.7
1957	7461.8	622.0	113.4	499.9	153.0
1958	7604.2	643.6	140.8	526.6	147.0
1959	8116.0	594.3	162.0	558.4	150.3
1960	9000.2	596.5	282.2	689.4	154.1
1961	8771.3	626.0	445.6	795.0	168.3
1962	8807.5	691.1	506.1	873.7	172.4
1963	9219.3	759.7	613.7	958.1	174.8
1964	9356.9	753.8	558.8	813.1	165.2
1965	10173.5	760.7	634.4	885.9	179.1
1966	10185.2	931.5	725.2	981.9	189.6
1967	10415.7	1047.8	905.7	997.0	203.0
1968	12622	1108	1228	1024	234
1969	12724	1048	1312	1006	246
1970	13596	1146	1464	1138	260
1971	14288	1156	1596	1236	268
1972	15748	1162	1894	1462	298
1973	16744	1216	2204	1632	342
1974	17954	1208	2596	1678	364
1975	18150	1186	2726	1970	376
1976	18586	1158	3420	2552	442
1977	19644	1084	3858	2900	486
1978	20484	1046	4552	3211	566

Fig. 2 Trend of Transport Volume



2.4.2 Daily

The daily transport volume fluctuates to a great extent especially in the case of passengers. For instance during the Chinese New Year holidays and school holiday, over twice of the average daily volume is recorded in the P.P.C. log book.

Even during normal weeks, the range of fluctuations is relatively wide as shown in the following sample.

Table 8 Daily Transport Volume (Example)

Date	(one direction only)				
	Passenger	Bicycle	Motor-cycle	Car	Truck
05. 03	27,804 (0.99)	1,678 (1.17)	7,224 (1.16)	4,409 (1.00)	943 (1.22)
06	26,125 (0.93)	1,526 (1.06)	6,818 (1.09)	4,006 (0.91)	999 (1.29)
07	25,408 (0.91)	1,482 (1.03)	6,640 (1.06)	4,041 (0.92)	961 (1.24)
08	24,542 (0.87)	1,552 (1.08)	6,633 (1.06)	3,882 (0.88)	939 (1.21)
09	30,022 (1.07)	1,674 (1.17)	6,935 (1.11)	4,887 (1.11)	899 (1.16)
Average in 1978	28,061	1,433	6,236	4,399	776

\* No. in parentheses indicate index number to the average volume.

Table 9 Daily Ferry Traffic Measured in one way trips

(No. of persons or vehicles per day)

YEAR	1 PASSENGERS	2 BICYCLES	3 MOTOR-CYCLES	4 CARS	5 TRUCKS	TOTAL 4 & 5
1968	34581	3036	3364	2806	641	3447
1969	34860	2871	3595	2756	674	3430
1970	37249	3140	4011	3118	712	3830
1971	39145	3167	4373	3386	734	4120
1972	43145	3184	5189	4006	816	4822
1973	45874	3332	6038	4471	937	5408
1974	49189	3310	7112	4597	997	5594
1975	49726	3249	7469	5397	1030	6427
1976	50921	3173	9367	6992	1211	8203
1977	53819	2970	10570	7945	1332	9277
1978	56121	2866	12471	8797	1551	10348

2.4.3 Person Trips

The total number of persons travelling the ferry including vehicle drivers are shown in Table 10.

This has increased constantly in the last ten years, but the growth rate ranges 0.7% to 11.1%. The estimated composition of passengers in the ferry, including passengers with vehicles, indicates that most of the increase in the number of passengers is due to the increase of passengers with vehicles.

Table 10 Person Trips

Year	No. of total person trips	Growth rate to previous year	(per day)	
			Passengers * without vehicle	Ratio to total
1968	44,428	-	29,016	65.3%
1969	44,756	0.7	29,229	65.3%
1970	48,230	7.8	30,929	64.1%
1971	50,705	5.1	32,508	64.1%
1972	56,340	11.1	35,445	62.9%
1973	60,652	7.7	37,173	61.3%
1974	65,205	7.5	40,036	61.4%
1975	66,871	2.6	39,497	59.1%
1976	71,664	7.2	38,068	53.1%
1977	76,636	6.9	39,352	51.3%
1978	81,806	6.7	39,840	48.7%

\* Estimated by the Study Team.

From these tables in sections 2.4.1 and 2.4.2, the number of passengers includes fellow passengers in cars and lorries because of the fare system. The average number of passengers in cars and lorries are 2.17 and 3.43 persons per vehicle from the result of our survey. Therefore, real passengers are less than these figures.

Table 11 No. of Passengers on Vehicles

	(to Butterworth)			
	No. of Pass.	No. of Vehicles	Pass./Vehicles	Fellow pass.
Car + Van + Taxi	9,792	4,515	2.17	1.17
Lorry + Bus	3,620	920	3.93	2.93
Motor-cycles	7,327	6,548	1.12	0.12
Total	20,739	11,983	1.73	0.73

According to the results above, the modal split on ferry can be examined as in the following table.



Table 12 Modal Split on Ferry (1978)

	P.P.C Data	Estimated fellow passengers	(Both ways) Modal Split	
Passengers	56,121	(-16,333)	39,788*	(48.6)
Bicycles	2,866	-	2,866	( 3.5)
Motor-cycle	12,471	1,497	13,968	(17.1)
Cars	8,797	10,292	19,089	(23.3)
Lorries	1,551	4,544	6,095	( 7.5)
<b>Total</b>			<b>81,806</b>	<b>(100)</b>

\* This number indicates only passengers without vehicles.

## 2.5

Revenue and Expenditure

Recent figures on revenue and expenditure after 1970 of the ferry services is shown in the table below. The revenue has constantly increased by 10 to 13% comparing with every other previous year. The increase in revenue has been solely due to the increase in traffic volume handled since there was no tariff increase during this period.

The trend of gross expenditure has been quite irregular; that is, between 1974 and 1975 it increased by 45%, as a result of the expansion of the fleet and increase in staff/operation costs.

Therefore, the net revenue after 1975 was below M\$ 2 million though it had ranged between M\$ 2.7 to 4.3 million up to 1974.

Table 13 Revenue and Expenditure

	(M\$1,000)		
	REVENUE	EXPENDITURE	BALANCE
1970	785	4366	3485
1971	8324	5605	2719
1972	9425	5901	3524
1973	10510	6225	4285
1974	11215	7712	3503
1975	11935	11145	790
1976	14176	13689	487
1977	15974	14762	1212
1978	17628	16210	1418

The revenue in 1978 was M\$ 17,628 million and total expenditure was M\$ 16,210, giving a profit of M\$ 1,418. Now the P.P.C. operates the ferries and gets a constant profit every year.

The composition of revenue by type of vehicles is indicated in Table 14.

Table 14 Revenue by Type of Vehicle

	(M\$1000)					
	Passengers	Bicycles	Motor-cycles	Cars	Lorries and others	Total
1972	2529	252	884	3040	2,720	9,425
1973	2696	260	1032	3388	3,134	10,510
1974	2905	257	1224	3488	3,341	11,215
1975	2943	246	1284	4072	3,390	11,935
1976	3026	238	1617	5224	4,071	14,176
1977	3219	227	1899	5890	4,739	15,974
Annual Growth Rate ('72-'77)	12.8%	-2.1%	16.5%	14.1%	11.7%	11.1%
Composition ('77)	20.2	1.4	11.9	36.8	29.7	100%

The P.P.C. operated 6 ferries before 1972 but in 1972 the number of ferries was increased to 8 vessels. With six ferries in operation, the ferry department comprised a staff of 316. With the introduction of two additional ferries, the staff increased to 399. In 1978 with the addition of a fleet which included 3 double-decker ferries and an additional set of berths, the staff was increased to 648, of which 396 was the floating craft personnel.

Thus the introduction of two ferries required 83 additional personnel. The three double-deckers required 134 floating craft personnel and total number of crew increased from 22 to 32. The new terminal required additional manpower of 115 men. The new ferry crew expanded to include 7 captains, 2 quartermasters, 2 engine drivers, 2 greasers and 7 deckhands. The number of employees in the old ferries remained the same except for the reduction of a quartermaster and two deckhands.

The wages and salaries paid in 1978 for ferry personnel amounted to \$4,158,000, of which about 30% was for overtime.

The clerical staff make up only  $\frac{1}{4}$  of the staff, but 43% of the costs of labour. Comparing with a wage bill in 1970 of 1.195 million, the staff increased 103% and the labour cost increased by 96%. This implies a 7.3% annual increase rate. This means an average of 2.8% per annum, using a cost of living index deflator of 4.5%

The cost of fuel for ferry operations is based on a fuel consumption rate of 18.5 imperial gallons per round trip for the old ferries and 23.4 imperial gallons for the new ferries. This means a fuel consumption of 25 and 36 gallons per operating hour. The current cost of fuel is about \$2.0 million per year.

In 1970, the cost of repairs and maintenance on six ferries amounted to \$734,000 of which material cost accounted \$212,000. With an increase in fleet size by 83% in seven years the cost of repairs and maintenance per ferry increased by 125%. However, almost the entire increase was due to the increase in material cost.

Table 14 Revenue and Expenditure in 1978  
(M\$1000)

Operating Revenue	<u>17,628</u>
Operating Expense	<u>14,597</u>
Operations	10,692
Personnel	4,325
Fuel & Oil	1,967
Maintenance	2,997
Other	1,501
Depreciation	2,834
Interest	1,071
Operating Income	<u>3,031</u>
Tax	<u>1,613</u>
Net Income	<u>1,418</u>
(per cent of Revenue)	(8.04)

### Surveys

The purpose of this survey is to obtain information on passengers and vehicles using the ferry service, and with this information, the nature of trips is determined.

The results from the analysis of the data collected are very useful not only in examining the existing conditions but also in forecasting the demand for ferry after completion of the Penang Bridge in future.

This data can also be used to confirm the traffic volume at the section separated by the channel in the same way as the screen-line survey. Besides this, the results from the interview survey is included as one of the main parts of the whole O-D table showing the total traffic movement in the study area.

#### 3.1 Contents of the Survey

The survey consists mainly of two parts:-

- a) Interviews with passengers and vehicles.
- b) Traffic counting of vehicles and passengers.

Besides this, other surveys as listed below were carried out at the same time.

- c) Departure time of ferry.
- d) Time spent waiting for ferry at Butterworth.
- e) Counting traffic volume of each ferry.

##### 3.1.1 Interviews

Drivers of vehicles and passengers on board the ferry were interviewed.

The supervisor and interviewers chose samples from the passengers and vehicles on the ferry according to the procedure in the survey manual and asked questions from the prepared questionnaire.

###### a) Interview Time

The interview commenced at 7.00 a.m. and ended at 7.00 p.m. on 13th June for the same duration (12 hours) as the cordon survey.

b) Contents

The purpose of the interview on vehicle users is to find out the

- i) Origin of the trip.
- ii) Destination of the trip.
- iii) Purpose of the trip.
- iv) Number of passengers in the vehicle.
- v) Types of commodities carried by the lorries and
- vi) Loading conditions.

The objective of the interview with the passengers is to discover the

- i) Origin of the trip.
- ii) Destination of the trip.
- iii) Purpose of the trip.
- iv) Means of transport before and after boarding the ferry.

A copy of the questionnaire is attached in Technical Report -02; 'A' is the questionnaire for vehicles, and 'B' for passengers.

c) The Procedure

There are eleven ferries and these are classified into two types;

- i) 8 single-deckers - for passengers, motor-vehicles and motor-cycles
- ii) 3 double-deckers - for motor-vehicles.

After one single-decker and one double decker were selected for interviewing, the following number of persons began the survey.

- \* 2 Supervisors
- \* 5 Assistant Supervisors
- \* 5 Clerks
- \* 14 Interviewers and
- \* 6 Policemen.

The desirable sample size for each trip was determined as follows, but this schedule was not accomplished completely as a result of some interviewers having missed a ferry.

TABLE 15 SCHEDULE FOR INTERVIEWER

Type of vehicle/ passengers to be interviewed	Single-deckers		Double-deckers	
	No. of interviewers	(No. of Samples)	No. of interviewers	(No. of Samples)
Passengers	3	(10)	-	
Bicycles	1	( 5)	-	
Motorcycles	2	( 5)	-	
Cars/Taxis	3	( 6)	3	( 7)
Lorries/Buses			2	( 5)
TOTAL	9	(26)	5	(12)

There were 14 interviewers who were divided into 2 groups, group A and B. The interviews were done on both the out-going and in-coming trips of the selected ferries. Group A started at 7.00 a.m. and stopped after completing four trips to and from Butterworth and Penang Island. A ferry journey from Butterworth to Penang Island is considered as one trip and likewise, from Penang Island to Butterworth is another. On completion of four trips by group A, group B took over for the same number of trips. This was repeated up to 7.00 p.m.

## 3.1.2

Traffic Counting

The volume of passengers and vehicles moving into the ferry terminals was counted at both sides. The vehicles counted were cars, buses, taxis, medium lorries, heavy lorries, motorcycles, trishaws and bicycles. The passengers were categorised according to sex.

a) Counting Duration

Traffic counting started at 6.00 a.m. and stopped at 10.00 p.m. (16 hours) on 13th June.

b) The Stations

2 stations were selected for traffic counting (vehicles and passengers)

- i) Pengkalan Raja Tun Uda in George Town.
- ii) Pengkalan Sultan Abdul Halim in Butterworth.

c) The Personnel

The persons involved in performing this task at each terminal were as follows:-

- i ) 2 counters for passengers, (1 for male and 1 for female).
- ii ) 1 counter for motorcycles, bicycles, handcarts and trishaws.
- iii) 1 counter for cars, taxis and vans.
- iv ) 1 counter for medium lorries, heavy lorries, buses and others.

There were many separate gates for different types of vehicles that 5 counters were necessary for complete counting.

3.1.3

Others

a) Departure time of ferry

A specific time-table and a rotation shift chart of ferries is fixed by P.P.C.

According to the time-table, the interval between the departure time of each ferry is approximately 30 minutes from 10 p.m to 6 a.m and 7 minutes in the day time.

In order that the service level of ferries can be estimated the actual interval between departure times has to be examined, so an additional survey was carried out at the same time. One recorder at the top of the wharf noted the time of departure and the name of the ferry. A sample of the survey sheet is attached. in Technical Report -02.

b) Time spent waiting for ferry at Butterworth

At Butterworth side the demand is greatest at peak times from early evening. Long queues are formed, especially during weekends and holidays.

This long waiting time for ferries is one of the factors for a decrease in the quality of their service. This survey was carried out for the purpose of obtaining data regarding time spent waiting.

The personnel involved were:

- \* One Supervisor
- \* Two Assistant Supervisors and
- \* Eight Clerks

The survey card was prepared as shown in Technical Report -02 and the survey was done in two days;

- \* 13th June, Wednesday - 4.00 p.m. to 7.00 p.m.
- \* 6 th July, Friday - 3.00 p.m. to 8.00 p.m.



The survey procedure was as follows:-

Some of the surveyors chose samples from the end of the queue and handed a survey card each to record the time of arrival, while in front of the row, other surveyors recorded the actual time of departure of the ferry when the driver entered the ferry.

The sample size was 5 to 15%. From these results the condition of waiting for ferry is estimated easily.

c) Counting traffic volume by each ferry.

This survey was carried out for two purposes.

- i) to obtain data for the weekend.
- ii) to know the condition of transport of each ferry.

This was done on 6th July, (Friday) in the following manner. 2 Assistant Supervisors and 7 counters were involved at the top of the piers. They counted the number of arrivals and departures of the traffic. The survey sheet used for this survey is different to some extent from the former as shown in Appendix E. The survey began at 6.00 a.m. and ended at 10.00 p.m. as before in order that the two sets of data can be compared.

From the results of our survey at the Butterworth Terminal on 6th July, the maximum and minimum transported volume by ferry is shown in Table 2. During both departure time and arrival times, the volume of motor-cycles and passengers fluctuate with a wider range than that of cars.

The number of cars was counted to be 35 to 32 at departure on single-deckers and 61 & 67 at arrival time on double-deckers. The maximum number of motor-cycles was 192 and 262 in each direction. The maximum number of passengers was 434 and 585.

The minimum volume was only 17 passengers by single-decker and 10 vehicles by double-decker.

3.2 Brief Results

The outline of the results obtained is mentioned here-  
after.

3.2.1 The Interviewed Sample

The sample size for vehicle drivers was 1,200 while that for motor-cycle drivers was 411. The sample ratio to the number counted was 14.2% for vehicles and 3.4% for motor-cycles. A sample of almost 1,000 passengers was collected and the sample ratio was 3.4%.

The sample interviewed is illustrated in the following tables.

TABLE 16 THE SAMPLE INTERVIEWED - 1

DATE: 13TH JUNE 1979

DIRECTION: GEORGE TOWN TO BUTTERWORTH

TIME	Total No. of vehicles counted	Total No. of vehicle drivers interviewed	The Ratio (%)	Total No. of light vehicles counted	Total No. of light vehicle drivers interviewed	The Ratio (%)
-Cars						
-Taxis				-Motor-cycles		
-Vans				-Bicycles		
-Medium lorries				-Trishaws		
-Heavy lorries				-Handcarts		
700- 800	376	33	8.8	1,241	10	0.8
800- 900	380	67	17.6	559	10	1.8
900-1000	444	44	9.9	317	20	6.3
1000-1100	417	76	18.2	358	30	8.4
1100-1200	391	39	10.0	369	17	4.6
1200-1300	281	66	23.5	338	13	3.9
1300-1400	275	50	18.2	340	27	7.9
1400-1500	357	53	14.8	550	10	1.8
1500-1600	378	46	12.2	435	34	7.8
1600-1700	349	68	19.5	350	5	1.4
1700-1800	318	37	11.6	510	19	3.7
1800-1900	218	30	13.8	431	24	5.7
TOTAL	4,184	609	14.09	5,798	218	3.8

TABLE 17. THE SAMPLE INTERVIEWED - 2

DATE: 13TH JUNE 1979

DIRECTION: BUTTERWORTH TO GEORGE TOWN

TIME	Total No. of vehicles counted	Total No. of vehicles drivers interviewed	The Ratio (%)	Total No. of light vehicles counted	Total No. of light vehicles drivers interviewed	The Ratio (%)
	-Cars -Taxis -Vans -Medium lorries -Heavy lorries			-Motor-cycles -Bicycles -Trishaws -Handcarts		
0700-0800	214	23	10.7	592	-	-
0800-0900	225	35	15.5	332	-	-
0900-1000	301	69	22.9	293	20	6.8
1000-1100	284	34	12.0	316	19	6.0
1100-1200	334	69	20.7	244	20	8.2
1200-1300	299	47	15.7	308	19	6.2
1300-1400	380	51	13.4	385	19	4.9
1400-1500	461	52	11.3	399	20	5.0
1500-1600	434	66	15.2	540	24	4.4
1600-1700	493	49	9.0	756	13	1.7
1700-1800	423	56	13.2	1,136	5	0.4
1800-1900	421	40	9.5	876	33	3.8
TOTAL	4,269	591	13.8	6,177	192	3.1

TABLE 18 THE SAMPLE INTERVIEWED - 3

(Passengers)

Time	GEORGE TOWN TO BUTTERWORTH			BUTTERWORTH TO GEORGE TOWN		
	The total counted	The total interviewed	Ratio %	The total counted	The total interviewed	Ratio %
0700 - 0800	2,271	31	1.4	1,467	-	-
0800 - 0900	993	30	3.0	1,082	-	-
0900 - 1000	527	28	5.3	786	30	3.8
1000 - 1100	627	50	8.0	881	35	4.0
1100 - 1200	914	36	3.9	946	59	6.2
1200 - 1300	830	42	5.1	736	35	4.8
1300 - 1400	1,170	49	4.2	971	29	3.0
1400 - 1500	1,159	45	3.9	905	68	7.5
1500 - 1600	1,212	59	4.9	871	30	3.4
1600 - 1700	1,608	50	3.1	1,635	60	3.7
1700 - 1800	1,728	53	3.1	2,053	39	1.9
1800 - 1900	1,270	35	2.8	1,143	55	4.8
<b>TOTAL</b>	<b>14,309</b>	<b>517</b>	<b>3.6</b>	<b>13,476</b>	<b>440</b>	<b>3.3</b>

## 3.2.2

TRAFFIC COUNTINGa) Results of the survey done on 13th June 1979

The number of vehicles and passengers that were counted during the survey was 9,896 vehicles (not including motor-cycles), 14,645 motor-cycles and 33,411 passengers. These passengers do not include passengers in cars. The hourly flow by each vehicle-type is shown in the following tables.

TABLE 19 HOURLY FLOW OF VEHICLES ON FERRY - 1

		<u>FROM GEORGE TOWN</u>										<u>13TH JUNE 1979</u> <u>(Wed.)</u>	
<u>TIME</u> <u>ZONE</u>	<u>TYPE</u>	(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)		(10)
		<u>Cars</u>	<u>Taxis</u>	<u>Van &amp; Pick-Ups</u>	<u>Medium Size Lorries</u>	<u>Lorry With 3 Axles &amp; Trailers</u>	<u>Buses</u>	<u>Sub - Total (1 - 6)</u>	<u>M/Cycles And Scooters</u>	<u>Trishaws</u>	<u>Bicycles</u>	<u>Sub - Total (7 - 9)</u>	<u>Passengers</u>
6 - 7		154	1	6	7	0	1	168	567	0	202	769	1058
7 - 8		329	0	13	23	11	27	376	1009	0	232	1241	2271
8 - 9		313	1	23	37	6	3	380	475	0	84	559	993
9 - 10		338	2	27	61	16	2	444	338	0	79	417	527
10-11		300	3	22	82	10	2	417	312	1	45	358	627
11-12		282	5	23	63	18	2	391	297	1	71	369	914
12-13		208	3	15	45	10	1	281	286	0	52	338	830
13-14		204	2	19	42	8	2	275	254	1	85	340	1170
14-15		251	5	35	47	19	11	357	398	1	152	550	1159
15-16		292	7	23	46	10	1	378	339	0	96	435	1212
16-17		290	1	16	34	8	3	349	268	0	82	350	1608
17-18		267	0	10	31	10	1	318	406	0	104	510	1728
18-19		181	1	7	22	7	2	218	383	0	48	431	1270
19-20		163	0	8	10	5	0	186	179	0	26	205	911
20-21		178	5	10	18	6	4	217	253	0	53	306	668
21-22		106	0	0	7	0	0	113	150	0	22	172	551
<b>TOTAL</b>		<b>3,856</b>	<b>36</b>	<b>257</b>	<b>575</b>	<b>144</b>	<b>61</b>	<b>4,868</b>	<b>5,914</b>	<b>3</b>	<b>1,433</b>	<b>7,350</b>	<b>17,497</b>

TABLE 20 HOURLY FLOW OF VEHICLES ON FERRY - 2

FROM BUTTERWORTH

13TH JUNE 1979  
(Wed.)

TYPE	(1)	(2)	(3)	(4)	(5)	(6)		(7)	(8)	(9)		(10)
TIME ZONE	Cars	Taxis	Vans & Pick-Ups	Medium Size Lorries	Lorries With 3 Axles Trailer	Buses	Sub - Total (1 - 6)	M/Cycle And Scooters	Trishaws	Bicycles	Sub - Total (7 - 9)	Passengers
6 - 7	46	1	1	15	15	0	78	274	0	127	401	914
7 - 8	152	4	10	35	5	0	214	482	0	110	592	1467
8 - 9	164	0	11	41	5	4	225	280	0	52	332	1082
9 - 10	206	3	27	61	4	0	301	226	0	67	293	786
10-11	195	3	22	45	17	2	284	255	1	60	316	881
11-12	234	2	22	68	4	4	334	204	0	44	248	946
12-13	229	4	7	53	6	0	299	244	2	62	308	736
13-14	300	0	18	31	8	3	380	318	1	66	385	971
14-15	365	3	30	48	12	3	461	324	0	75	399	905
15-16	324	4	34	54	13	5	434	408	1	131	540	871
16-17	406	4	38	34	4	7	493	610	1	145	756	1635
17-18	363	12	17	21	6	4	423	951	1	184	1136	2053
18-19	487	2	15	17	0	0	421	715	0	161	876	1143
19-20	343	6	21	11	1	0	382	273	0	52	325	668
20-21	171	1	8	13	2	1	196	197	0	41	238	501
21-22	95	1	7	0	0	0	103	142	0	33	175	303
TOTAL	3,980	50	288	567	102	41	5,028	5,903	7	1,410	7,320	15,914

b) Results of survey done on 6th. July, 1979

In order to obtain data for the peak day of a week, the counting survey was carried out again on 6th. July. The results are mentioned hereafter.

First, the results of 'counting' are shown in the following tables:

TABLE 2) NO. OF VEHICLES ON FERRY - 1  
GEORGE TOWN TO BUTTERWORTH 06.07.79.

TYPE TIME ZONE	NO. OF VEHICLES						M/CYCLES TRISHAWS BICYCLES	TOTAL PASSENGERS
	CAR TAXIS	MEDIUM LORRIES VANS	HEAVY LORRIES	BUSES	SUB-TOTAL			
6 - 7	85	5	7	0	97	380	477	845
7 - 8	281	15	18	5	319	1523	1842	2532
8 - 9	334	32	20	1	387	646	1033	1274
9 -10	281	40	25	-	346	457	803	582
10-11	294	62	30	2	388	339	727	899
11-12	272	71	44	2	389	380	769	1155
12-13	246	43	63	1	353	396	749	1355
13-14	251	50	26	-	327	447	774	1550
14-15	311	36	33	8	388	490	878	1431
15-16	308	29	26	2	365	495	860	1211
16-17	420	45	35	1	501	420	921	2094
17-18	375	47	44	2	468	541	1009	2136
18-19	424	19	18	2	463	548	1011	1507
19-20	415	25	15	5	460	341	801	1353
20-21	264	8	3	4	279	289	568	857
21-22	227	11	8	7	253	353	606	1043
TOTAL	4788	538	415	42	5783	8045	13828	21824

1

TABLE 22' NO. OF VEHICLES ON FERRY - 2  
BUTTERWORTH TO GEORGE TOWN 06.07.79.

TIME ZONE	NO. OF VEHICLES							
	CARS, TAXIS	MEDIUM LORRIES	HEAVY LORRIES VANS	BUSES	SUB-TOTAL	M/CYCLES TRISHAWS, BICYCLES	TOTAL PASSENGERS	
6 - 7	31	12	13	1	57	276	333	1500
7 - 8	138	6	29	10	183	648	831	1461
8 - 9	241	11	33	2	287	487	774	1056
9 -10	297	53	46	5	401	467	868	963
10-11	382	59	23	4	468	425	793	1158
11-12	430	68	23	4	525	438	963	1671
12-13	331	39	30	5	405	449	854	1332
13-14	376	45	26	1	448	387	835	1148
14-15	450	47	41	5	543	485	1028	1136
15-16	352	28	35	1	416	438	854	900
16-17	338	38	30	3	409	778	1187	1657
17-18	405	55	19	2	481	993	1474	2849
18-19	352	26	4	2	384	884	1268	921
19-20	476	20	6	-	502	695	1197	1562
20-21	221	12	5	-	238	364	602	715
21-22	155	11	2	-	168	243	411	482
TOTAL	4975	530	365	45	5915	8457	14372	20511

11,698 vehicles (not including motor-cycles), 16,502 motor-cycles and 42,335 passengers commute between George-Town and Butterworth from 6.00 a.m. to 10.00 p.m. The pattern of hourly flow of traffic is almost the same on week days. There are two peak hours, one at 7 a.m - 8 a.m hours and the other at 5 p.m - 6 p.m.



3.2.3 Actual Frequency of ferry service

The frequency of the ferry service is obtained from the results of the departure-time survey.

TABLE 23 THE FREQUENCY OF FERRY SERVICE (13.06.79)

	<u>No. of Departures from George Town to Butterworth</u>			<u>No. of Departures from Butterworth to George Town</u>		
	Single-Decker	Double-Decker	Total	Single-Decker	Double-Decker	Total
0600 - 0700	6	0	6	6	2	8
0700 - 0800	9	3	12	10	5	15
0800 - 0900	7	5	12	9	4	13
0900 - 1000	11	4	15	10	4	14
1000 - 1100	10	4	13	9	4	13
1100 - 1200	9	4	13	9	4	13
1200 - 1300	8	3	11	8	5	13
1300 - 1400	9	5	14	9	4	13
1400 - 1500	10	4	14	9	5	14
1500 - 1600	10	5	15	11	5	16
1600 - 1700	10	5	15	9	4	13
1700 - 1800	11	4	15	10	5	15
1800 - 1900	7	3	10	10	4	14
1900 - 2000	5	5	10	7	4	11
2000 - 2100	5	2	7	5	6	11
2100 - 2200	6	5	11	7	3	10
<b>Total</b>	<b>133</b>	<b>61</b>	<b>194</b>	<b>137</b>	<b>69</b>	<b>206</b>

\* Not including unloading Trips

There were about 200 trips for each direction during 16 hours and the average frequency was every 5 minutes.

TABLE 24 NO. OF FERRIES

06.07.'79.

	ARRIVAL AT BUTTERWORTH			ARRIVAL AT GEORGE TOWN			BOTH DIRECTIONS		
	SINGLE DECKER	DOUBLE DECKER	TOTAL	SINGLE DECKER	DOUBLE DECKER	TOTAL	SINGLE DECKER	DOUBLE DECKER	TOTAL
0600 - 0700	6	2	8	6	2	8	12	4	16
0700 - 0800	10	4	14	11	4	15	21	8	29
0800 - 0900	10	5	15	9	5	14	19	10	29
0900 - 1000	11	4	15	11	5	16	22	9	31
1000 - 1100	9	5	14	10	4	14	19	9	28
1100 - 1200	11	4	15	11	5	16	22	9	31
1200 - 1300	8	5	13	8	4	12	16	19	25
1300 - 1400	11	4	15	10	4	14	21	8	29
1400 - 1500	9	5	14	11	5	16	20	10	30
1500 - 1600	10	3	13	8	4	12	18	7	25
1600 - 1700	9	5	14	10	4	14	19	9	28
1700 - 1800	9	5	14	10	5	15	19	10	29
1800 - 1900	10	4	14	8	4	12	18	8	26
1900 - 2000	11	5	16	11	5	16	22	10	32
2000 - 2100	6	5	11	6	4	10	12	9	21
2100 - 2200	6	5	11	6	4	10	12	9	21
<b>TOTAL</b>	<b>146</b>	<b>69</b>	<b>215</b>	<b>156</b>	<b>69</b>	<b>215</b>	<b>292</b>	<b>138</b>	<b>430</b>

On Fridays the service is about 10% more frequent than on Wednesdays.

3.2.4 Time spent waiting for ferry

The survey was carried out on two days; on Wednesday and Friday afternoon at the Butterworth terminal on 13th. June and 6th July, 1979.

The results show the sample size according to waiting time (in minutes) at the concourse from the time of arrival at the end of the queue to the time of boarding the ferry.

TABLE 25 TIME SPENT WAITING FOR FERRY - 1  
13/6/79 (Wed.)

Minutes	0-5	6-10	11-15	16-20	21-25	Total
Arrival Time						
0400 - 0500	1	17	1			19
0500 - 0600	5	27	30	15	2	79
0600 - 0700				12	2	14
Total	6 (5.4)	44 (39.2)	31 (27.7)	27 (24.1)	4 (3.6)	112 (100)

( ) No. in parentheses in percentage.

\*\* Sampling ratio for this survey is 5 to 15 per month.

TABLE 26 TIME SPENT WAITING FOR FERRY - 2

06/7/79 (Fri.)

Minutes Arrival Time	Minutes								Total No. of vehicles	Average waiting time (mins.)
	0-4	5-9	10-14	15-19	20-24	25-19	30-34	35-40		
0300 - 0329	1	4							5	6.0
0330 - 0400	1	1	14	16	3	1			36	15.1
0400 - 0429		2	7	4	17	4			34	19.1
0430 - 0500			1	9	18	6	1		35	21.6
0500 - 0529				6	22	7	1		36	22.4
0530 - 0600					19	21	4	1	45	25.6
0600 - 0629				2	11	19	2		34	25.1
0630 - 0700			5	13	10	2	3		33	20.0
0700 - 0729		6	12	8	4				30	13.7
0730 - 0800	2	3							5	5.0
<b>Total</b>	4 (1.4)	16 (5.5)	39 (13.3)	58 (19.8)	104 (35.4)	60 (20.5)	11 (3.8)	1 (0.3)	293 (100)	20.0

\* No. in parentheses is in percentage

\*\* The sampling ratio is 7.0 - 17.0 per cent.

4. ANALYSIS

From the results of our surveys and other data, present characteristics of ferry traffic is analysed from various aspects.

4.1 Examination of Survey Results

Our surveys were carried out on two days only; 13th, June (Wednesday) and 6th, July (Friday). Results from these surveys were examined to compare them with data from the P.P.C.

There are some difference between our data and those from P.P.C. in terms of the method of counting. In the former, the surveyors count directly each subject at the gate by time zone. On the other hand, the P.P.C. records the number of passengers and vehicles from the number of tickets sold every day into their log-books. Therefore, there is a slight difference in the data between the two, as shown below.

Table 27  
Comparison of Data  
13th June

	to Butterworth		to George Town		Both Directions	
	Our Survey	P.P.C. Logbook Ratio*	Our Survey	P.P.C. Logbook Ratio*	Our Survey	P.P.C. Logbook Ratio*
Passengers	17,497	-	15,919	-	33,411	-
Cars	4,149	1,026	4,228	0,992	8,377	1,008
Lorries	780	0,940	710	1,053	1,490	0,991
Motor-cycles	5,914	0,975	5,903	0,943	11,817	0,959
Bicycles	1,438	0,974	1,410	1,099	2,848	1,032
Total**	12,281	0.989	12,251	0,981	24,532	0,985

\* Ratio : Our Survey/P.P.C. Logbook

\*\* Excluding Passengers

In the next table, the ratio of 24 hour's volume to 16 hour's volume is shown by comparing P.P.C.'s 24-hour data to our survey results.

Table 28

The Ratio of 24 hour's Volume to 16 hour's Volume

	(13th, June, '79)		
(to Butterworth)	16 hours	24 hours	Ratio
Passengers	17,497	17,718	1.013
Motorcar	4,149	4,426	1.067
Lorry	780	880	1.128
Motor-cycle	5,914	6,548	1.107
Bicycle	1,438	1,608	1.118
Total	29,778	31,180	1.047
(to George Town)	16 hours	24 hours	Ratio
Passengers	15,914	16,115*	1.013
Motorcar	4,228	4,493	1.063
Lorry	710	841	1.185
Motor-cycle	5,903	6,674	1.131
Bicycle	1,410	1,437	1.019
Total	28,165	29,560	1.050
(Both direction)	16 hours	24 hours	Ratio
Passengers	33,411	33,833	1.013
Motorcar	8,377	8,919	1.065
Lorry	1,490	1,721	1.155
Motor-cycle	11,817	13,222	1.119
Bicycle	2,848	3,045	1.069
Total	57,943	60,740	1.048

The ratio for passengers is very low compared to the other users of the ferry. The reasons could be the lack of supplementary means of transport before and after using the ferry as well as due to less activities in the night. Lorries and motor-cycles show relatively high ratios which are almost the same as that of the day-night ratio of road traffic (1.08 - 1.13).

Since yearly traffic data have been obtained as mentioned in chapter 2, it is possible to compare our survey results with those data.

First, some assumptions must be made in order to estimate yearly volume from the data of our two-days study.

- i) the ratio of weekend to weekday is as follows (from our survey).

	Ratio (weekends/weekdays)
Passengers	1.20
Cars	1.20
Lorries	1.00
Motor-cycles	1.10
Bicycles	1.10

- ii) weekends are Fridays, Saturdays and Sundays; weekdays are Mondays, Tuesdays, Wednesdays and Thursday.

- iii) the Day-Night ratio is almost the same all through the year.

There are 52 weeks in a year and according to the first assumption (i) this means that there are 156 weekends and 209 weekdays. The yearly volume is obtained from the following calculation.

$$\text{Yearly Volume} = \text{one weekday's volume} \times (156 \times \text{weekend ratio} + 209)$$

Particularly in the case of passengers, the data from P.P.C. include the number of fellow passengers of the vehicles; it is necessary to add this figure.



Table 29  
Estimation of Fellow Passengers (Both directions)

	No. of Pass.	No. of Vehicles	Pass/Vehicle	Fellow Pass.
Car (also Van, Taxi)	20,399	9,091	2.24	1.24
Lorry (also Bus, Others)	6,341	1,801	3.52	2.52
Motor-cycle	15,186	13,222	1.15	0.15

Table 30  
Comparison of our Results with P.P.C. Data

	(1) Results of calculation	(2) P.P.C. Data	(1)/(2)
Passenger	13,405	20,125	0.98
Car	3,534	(4,382)	1.10
Lorry	628	(1,583)	1.11
Motor-cycle	5,032	( 755)	1.13
Bicycle	1,159	( 0 )	

From the results above, data is available for the annual average weekday.

#### 4.2 Comparison of the Two Sets of Data

The summary of the comparison of the two sets of data which were obtained on 13th June and on 6th July, is shown in the following table.

Regarding the total volume, the results of the survey on 6th July is 12% to 33% larger than the survey on 13th June except for the case of buses.

Regarding the volume during peak hours, there is more significant difference between these two sets of data.

Table 31  
Comparison of Two Sets of Data

	A 13.06 (Wed.)	B 06.07 (Fri.)	B/A
* 16-hours flow (Both ways)			
Cars	8,467	9,763	1.15
Lorries	1,388	1,848	1.33
Buses	102	87	0.85
Sub-Total	9,957	11,698	1.17
Motor-cycles Bicycles	14,675	16,502	1.12
Total	24,632	28,200	1.14
Passengers	33,411	42,335	1.27
* Peak hour (George Town to Butterworth) 7.00 - 8.00			
Vehicles	1,241	1,842	1.48
Passengers	2,271	2,532	1.11
(Butterworth to George Town) 17.00-18.00			
Vehicles	1,136	1,474	1.30
Passengers	2,053	2,849	1.39

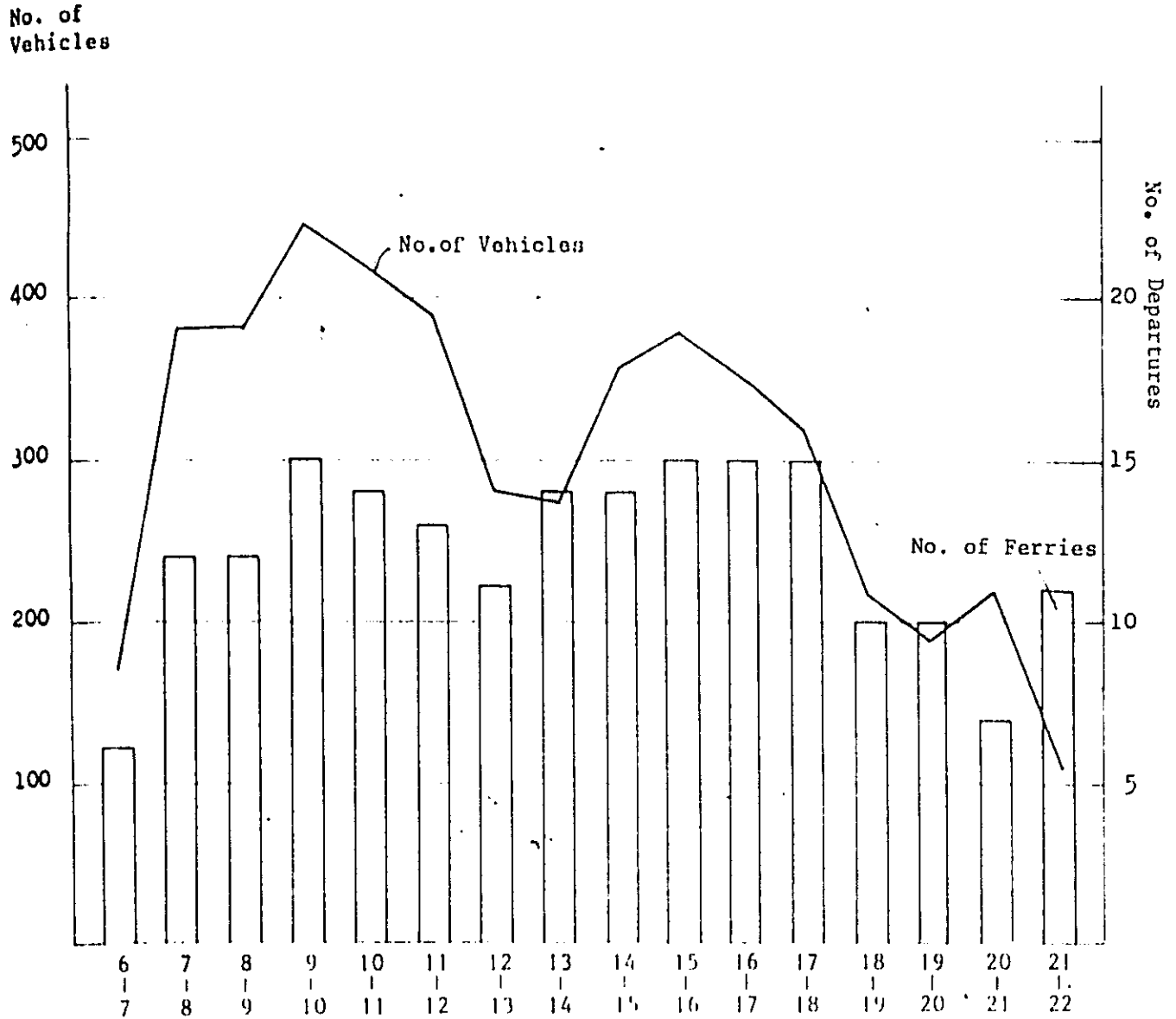
4.2 Hourly Fluctuations

The following figures indicate hourly flow of passengers and vehicles in each direction.

Fig. 3 HOURLY FLOW OF VEHICLES AND FREQUENCY OF FERRIES - 1

From George Town to Butterworth

13th June, 1979.

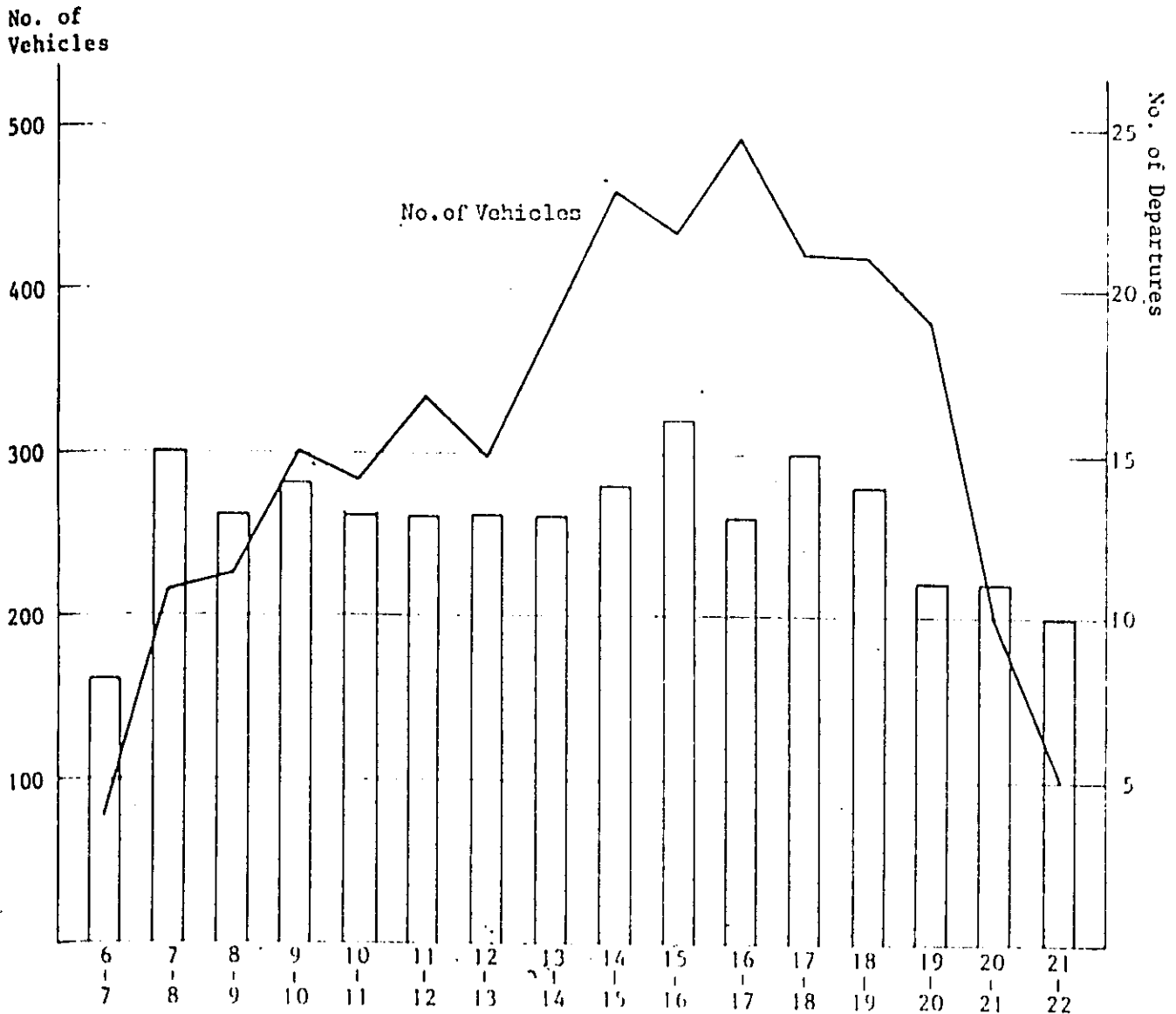


\* excluding motor-cycles and bicycles.

Fig. 4 HOURLY FLOW OF VEHICLES AND FREQUENCY OF FERRIES - 2

From Butterworth to George Town

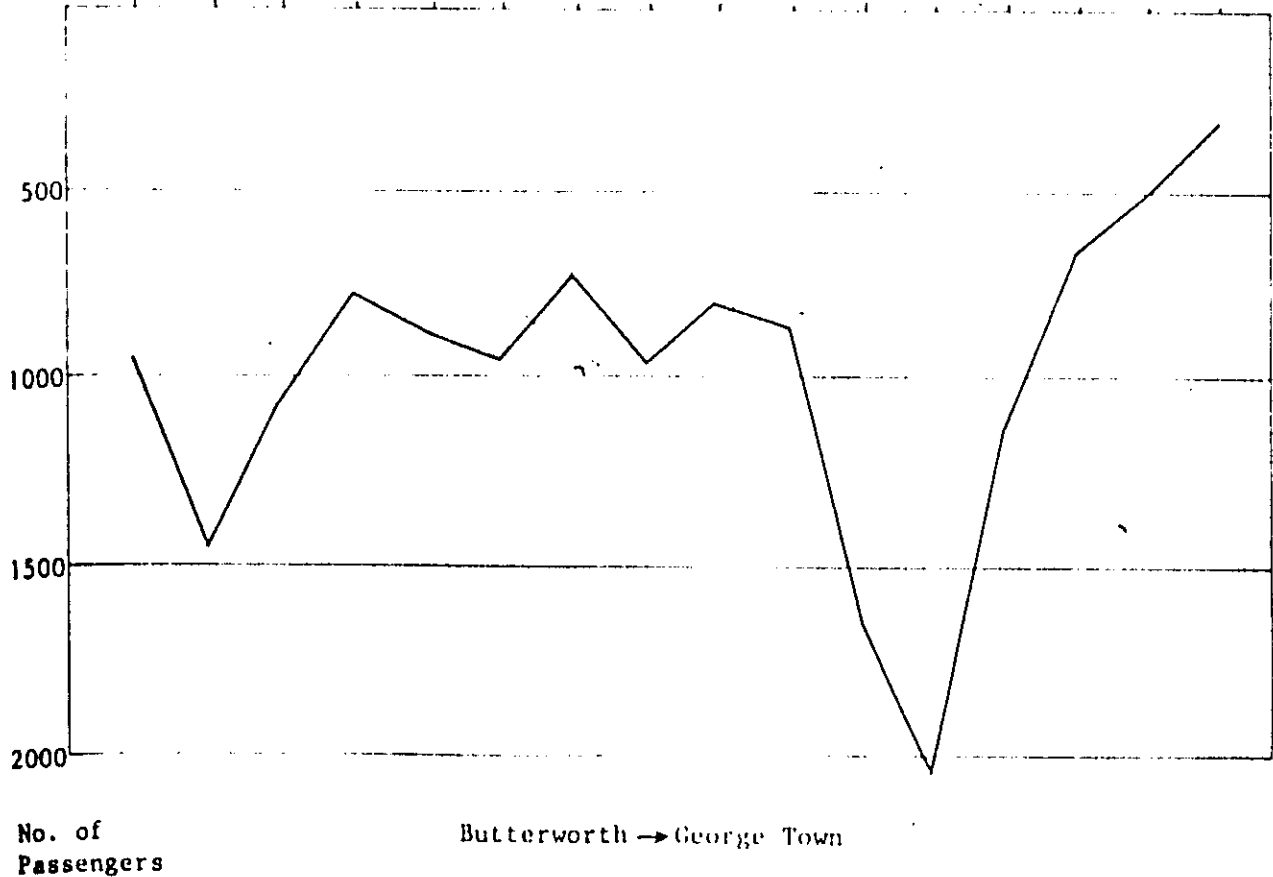
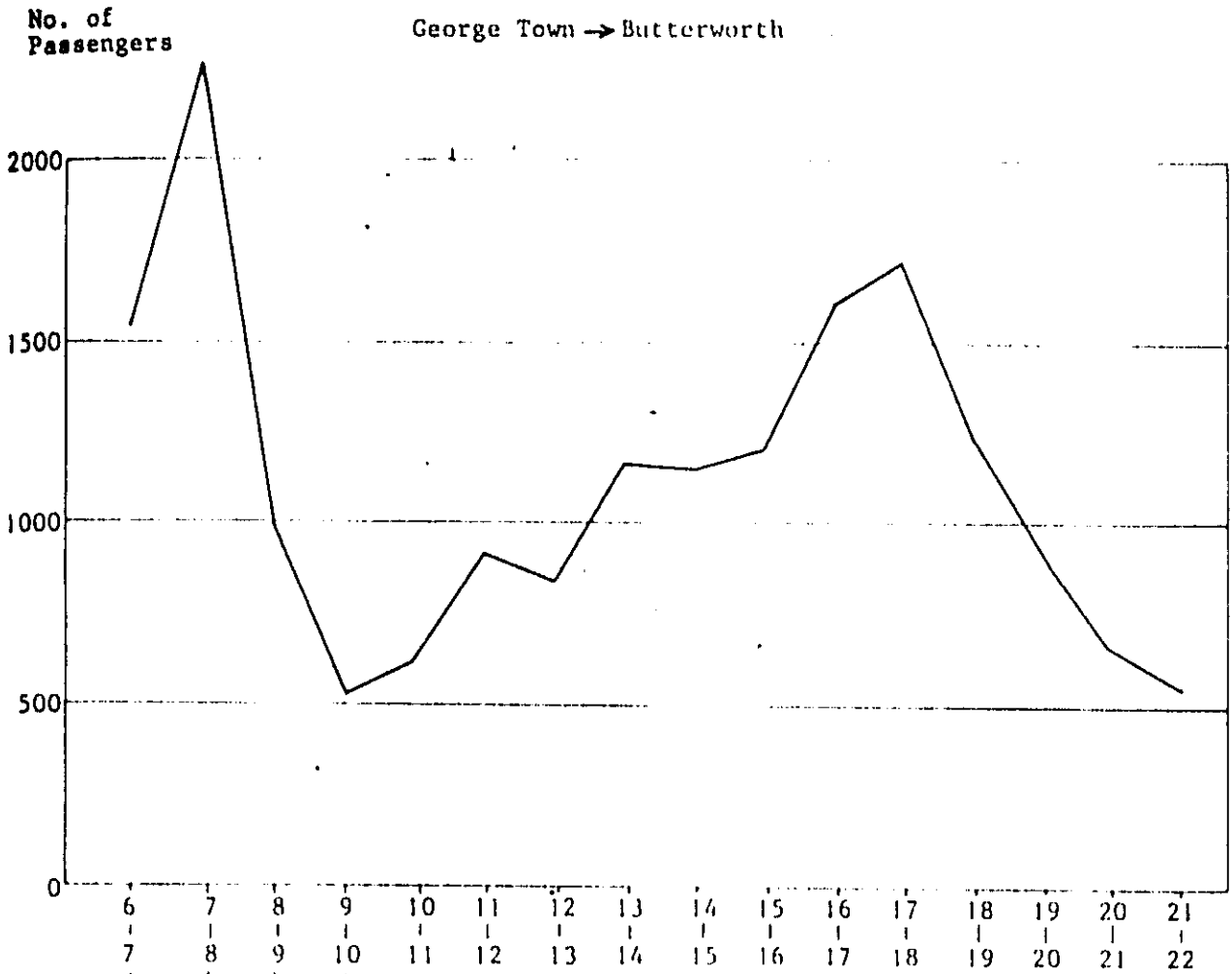
13th June, 1979.



\* excluding motor-cycles and bicycles.

The pattern of hourly flow of vehicles is different for both directions. From George Town to Butterworth, there are two peaks; in the morning and afternoon, but from Butterworth to George Town, there is only one peak which is in the afternoon. This is very significant when comparing with the flow of passengers.

Fig. 5 HOURLY FLOW OF FERRY PASSENGERS



Comparing the hourly flow pattern of cars and lorries, the pattern for motor-cycles and passengers show characteristics which are shown in the figures below.

The hourly flow pattern for passengers and motor-cycles are very similar in that both have morning and evening peaks. On the other hand, the pattern for cars and lorries is different. From these patterns it can be concluded that the trip purpose of most of the motor-cycles and passengers is that of commuting and going home, while that for cars and lorries is that of business engagement.

Comparing the hourly flow pattern of vehicles on the ferry and that of trip generation from the car owner interview survey a significant difference can be seen. In the case of vehicles on the ferry, there are only two peaks and no noon peak. This means that there are few trips with the trip purpose of going home for lunch.

Table 32  
Hourly Vehicle Flow of Ferry  
13.06.79 (Wed)  
(Both directions)

Time Zone	Cars and Lorries	M/cycles and Bicycles	Passengers
6 - 7	246 (2.5)	1,170 (8.0)	2,024 (6.1)
7	590 (6.0)	1,833 (12.5)	3,738 (11.2)
8	605 (6.1)	891 (6.1)	2,075 (6.2)
9	745 (7.5)	710 (4.8)	1,313 (3.4)
10	701 (7.1)	674 (4.6)	1,508 (4.5)
11	725 (7.3)	617 (4.2)	1,860 (5.6)
12	580 (5.9)	646 (4.4)	1,566 (4.7)
13	655 (6.6)	725 (4.9)	2,141 (6.4)
14	818 (8.3)	949 (6.5)	2,064 (6.2)
15	812 (8.2)	9,175 (6.6)	2,083 (6.2)
16	842 (8.5)	1,106 (7.5)	3,243 (9.7)
17	741 (7.5)	1,646 (11.2)	3,781 (11.3)
18	639 (6.5)	1,307 (8.9)	2,413 (7.2)
19	568 (5.7)	530 (3.6)	1,579 (4.7)
20	413 (4.2)	544 (3.7)	1,169 (3.5)
21 - 22	216 (2.2)	347 (2.4)	854 (2.6)
	9,896 (100)	14,670 (100)	33,411 (100)

Table 33  
Hourly Flow of Ferry

06.07.79 (Fri)  
(Both ways)

	Cars and Lorries	M/cycles and Bicycles	Passengers
6 - 7	154 (1.3)	656 (4.0)	2,345 (5.5)
7 - 8	502 (4.3)	2,171 (13.2)	3,993 (9.4)
8 - 9	674 (5.8)	1,133 (6.9)	2,330 (5.5)
9 - 10	747 (6.4)	924 (5.6)	1,545 (3.6)
10 - 11	856 (7.3)	764 (4.6)	2,057 (4.9)
11 - 12	914 (7.8)	818 (5.0)	2,826 (6.7)
12 - 13	758 (6.5)	845 (5.1)	2,687 (6.3)
13 - 14	775 (6.6)	834 (5.1)	2,698 (6.4)
14 - 15	931 (8.0)	975 (5.9)	2,567 (6.1)
15 - 16	781 (6.7)	933 (5.7)	2,111 (5.0)
16 - 17	910 (7.8)	1,198 (7.3)	3,751 (8.9)
17 - 18	949 (8.1)	1,534 (9.3)	4,985 (11.8)
18 - 19	847 (7.2)	1,432 (8.7)	2,428 (5.7)
19 - 20	962 (8.2)	1,036 (6.3)	2,915 (6.9)
20 - 21	517 (4.4)	653 (4.0)	1,572 (3.7)
21 - 22	421 (3.6)	596 (3.6)	1,525 (3.6)
	11,698 (100)	16,502 (100)	42,335 (100)

On Fridays, the volume of cars and lorries is 1.18 times more than on Wednesdays, the volume of motor-cycles and bicycles is 1.12 times more, and the volume for passengers is 1.27 times more.

The hourly fluctuations are almost the same as that for Wednesdays but the ratio after 7.00 p.m. is relatively high for all as shown in the figures.

Fig. 6 Hourly Flow Pattern on the Ferry.

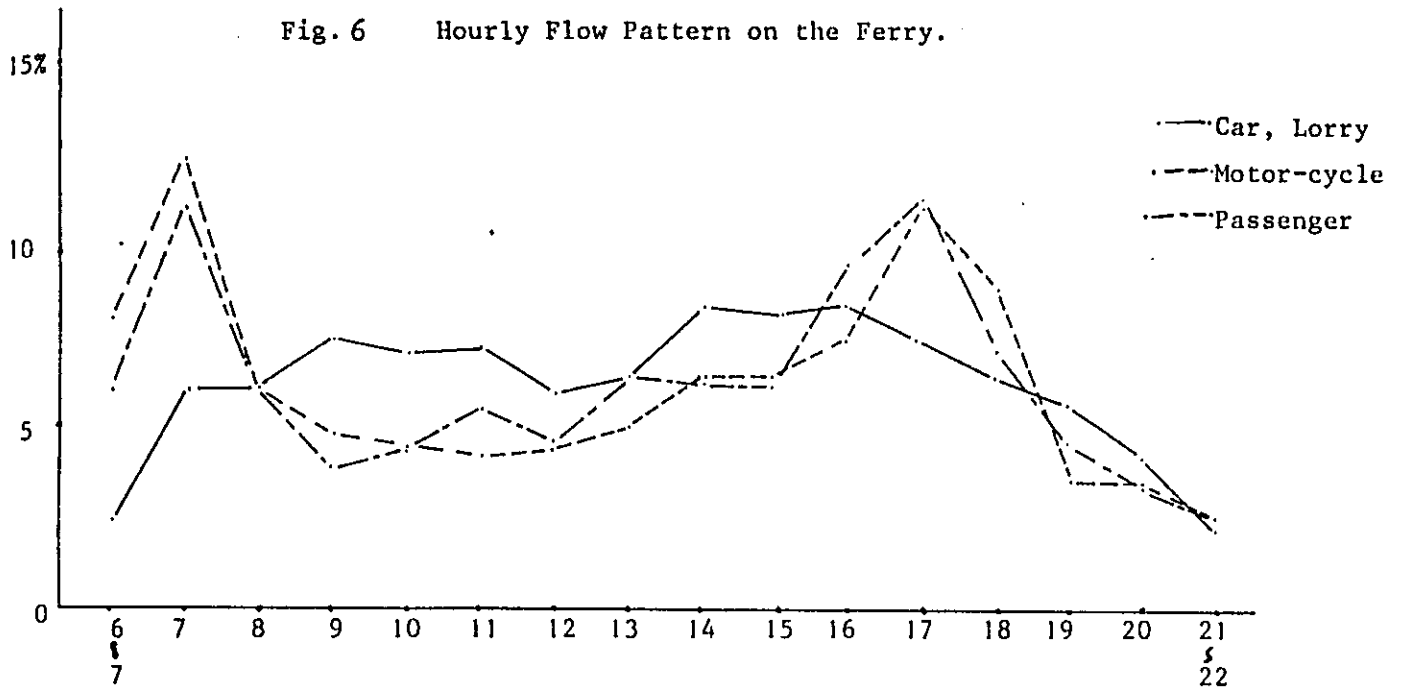


Fig. 7 Comparison between data from the ferry and the owner-interview survey.

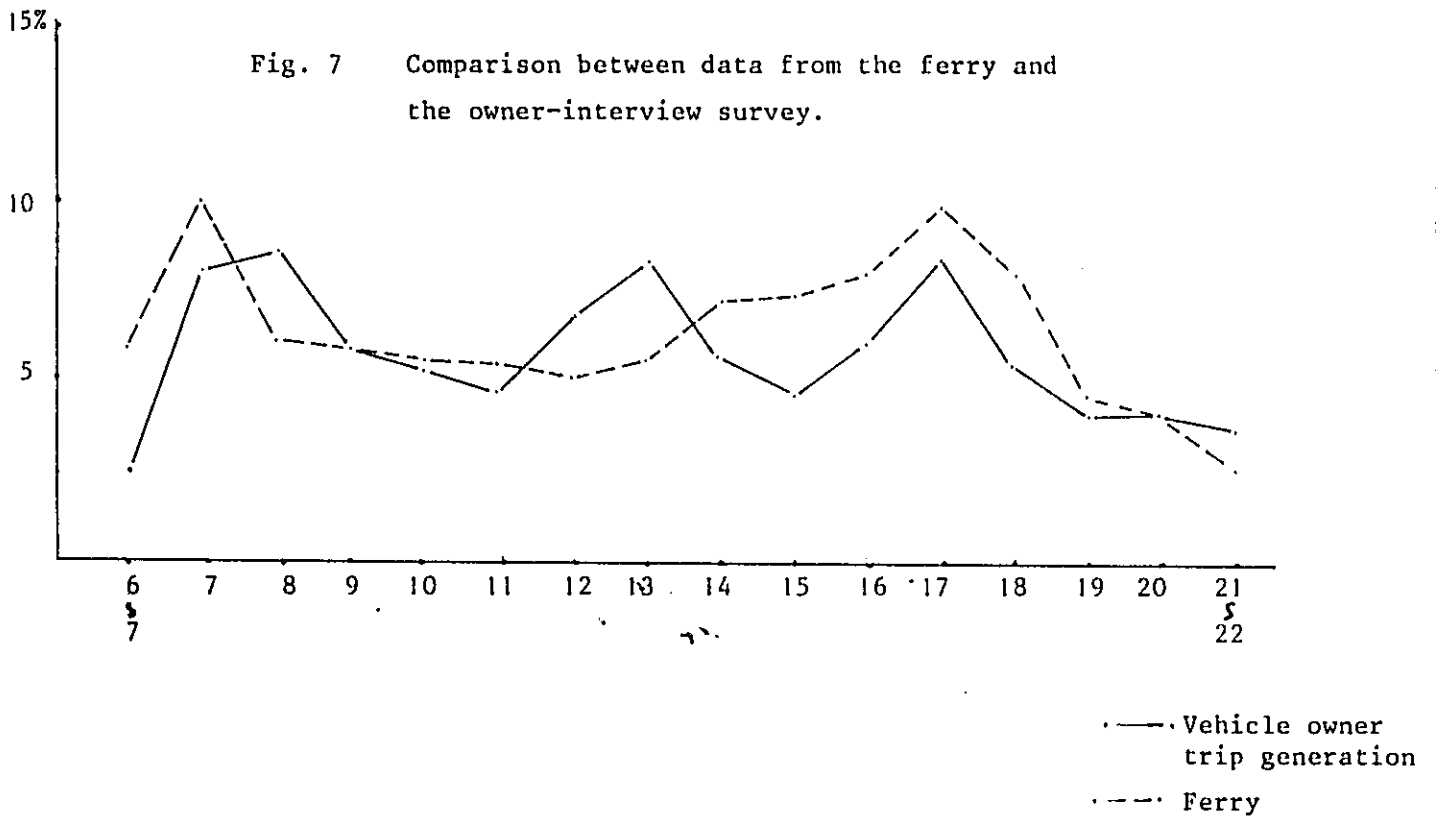
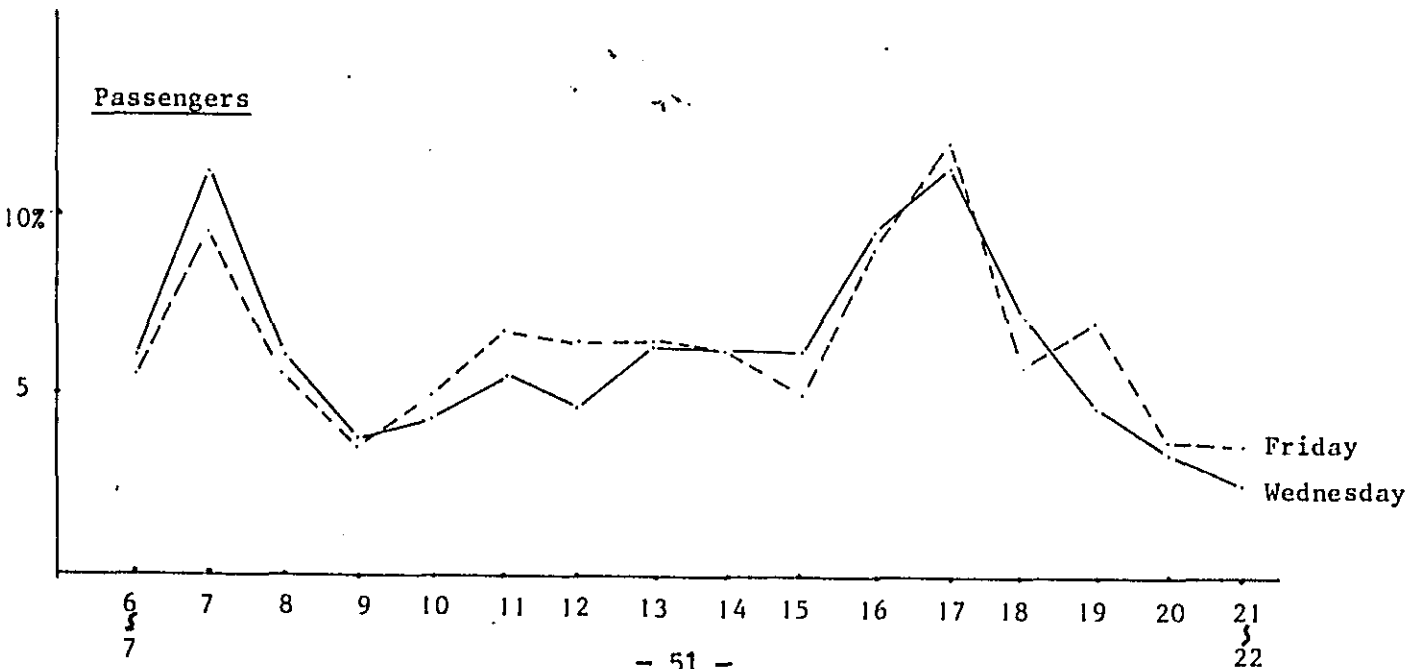
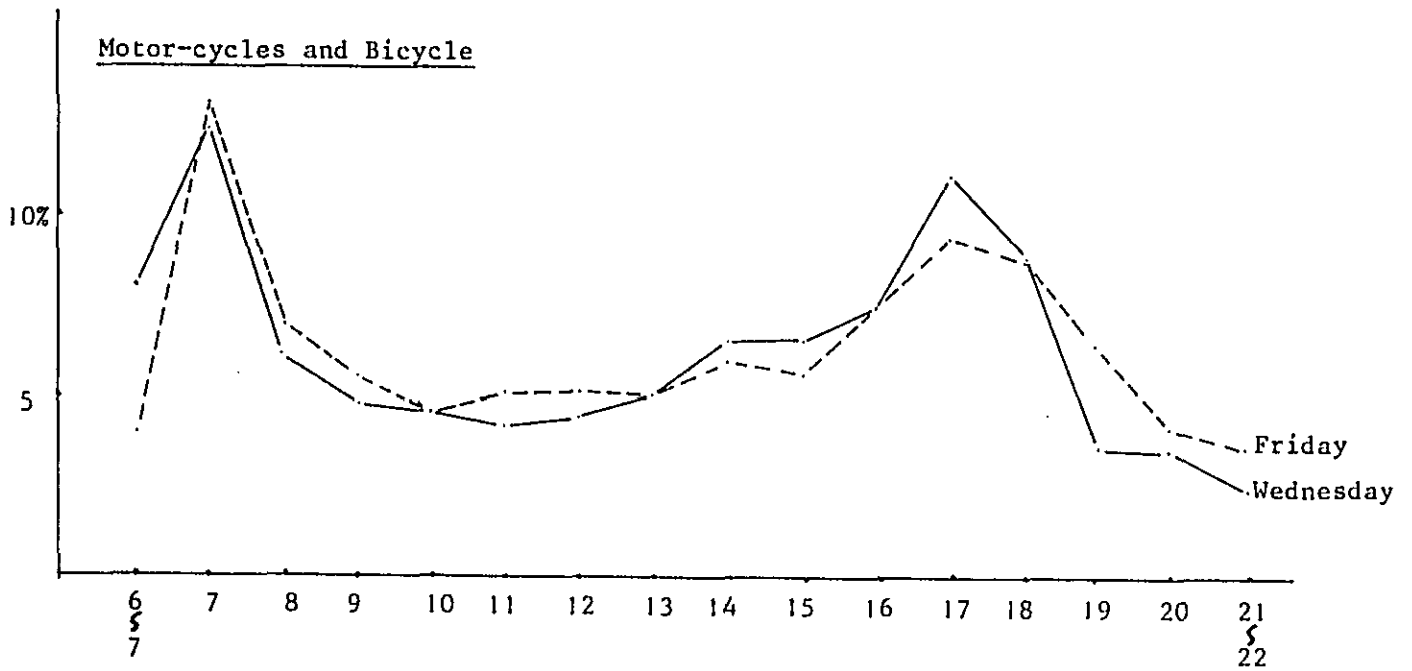
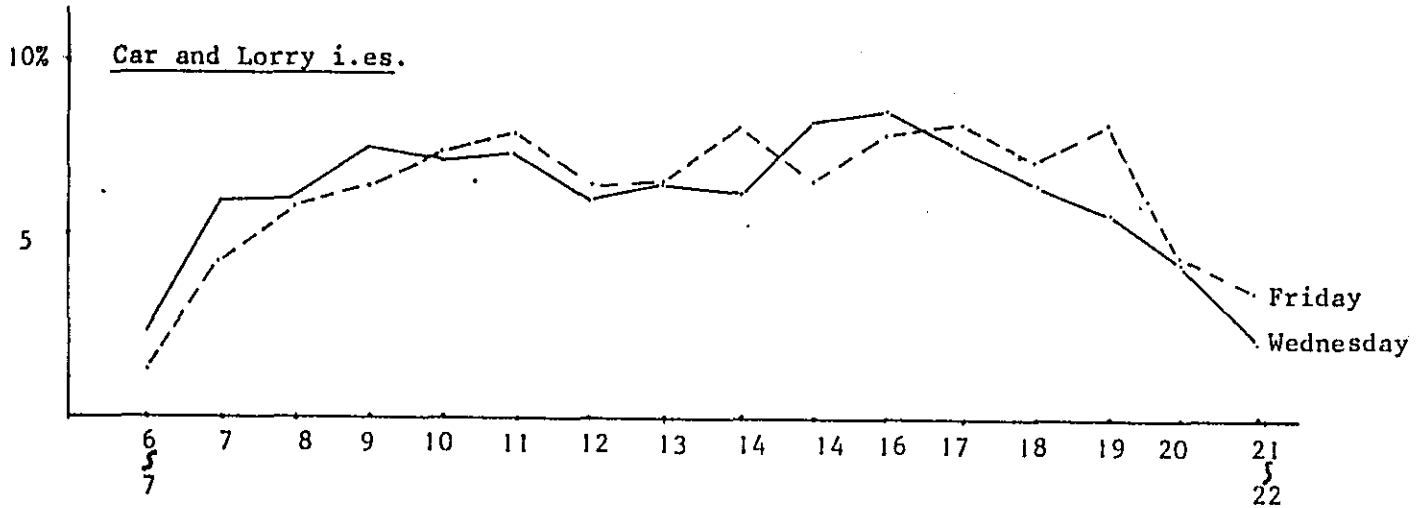




Fig. 8 Comparison of Hourly Flow on Weekday and Weekend.



## 4.4

Loading Conditions

The number of vehicles on the ferry depends on the demand for ferry space at that particular time, but a certain standard is observed for both single deckers and double deckers.

Table 34  
Loading Standard

Single-Decker			
Case	Cars	Motor-cycles	
1	27 - 28	25	(1 chain)
2	24	50 - 60	(2 chains)
3	18	100	(3 chains)
4	10	130 - 140	(4 chains)
5	6	160 - 170	(5 chains)

Double-Decker	
Upper Deck	33 - 34 cars
Lower Deck	14 - 16 lorries

Different loading conditions were observed when counting surveys were carried out and the results are as follows:

Table 35

Samples of Loading Conditions

<u>Single-Decker</u>						
Sample	Cars	Lorries	Buses	M/cycles	Passengers	Remarks
A	6	1	-	164	205	max. for cars.
B	35	-	-	-	380	max. for cars.
C	10	-	-	192	434	max. for motor-cycles & passengers.
D	23	2	-	83	305	
E	13	-	-	47	175	

Double-Decker

Sample	<u>Upper deck</u>			<u>Lower deck</u>			<u>Total</u>			
	Cars	Vans	Pick-ups	Cars	Lorries	Buses	Cars	Lorries	Buses	Total
A	30	-	-	12	7	2	42	7	2	51
B	30	-	2	26	3	-	56	5	-	61
C	-	-	-	15	4	-	15	4	-	19
D	30	-	-	-	14	1	30	14	1	45
E	33	-	-	13	10	1	46	10	1	57

4.5 Characteristics of Trips on Ferry

Various characteristics of trips were obtained from the results of the ferry interview survey carried out on 13th, June, 1979.

A sample of 1,600 vehicle drivers and a sample of 1,000 passengers were enlarged according to each total. First, a summary of the results is mentioned.

4.5.1 Passengers

There were 37,720 passengers of which 18,400 were bound for George Town while 19,320 for Butterworth.

The composition by sex and age group is as follow.

Table 36  
Sex and Age Group Composition

	below 19	20 - 29	30 - 39	40 - 49	above 50	Total
Male	2,620 (6.9)	10,330 (27.4)	5,710 (15.2)	3,890 (10.3)	2,920 (7.8)	25,470 (67.6)
Female	2,630 (7.0)	7,280 (19.3)	1,330 (3.5)	300 (0.8)	890 (1.8)	12,230 (32.4)
Total	5,250 (13.4)	17,610 (46.7)	7,040 (18.7)	4,190 (11.1)	3,610 (9.6)	37,700 (100)

The composition of trip purpose is as follows.

Table 37  
Composition of Trip Purpose

Trip purpose	to George Town		to Butterworth		Total
going to work	2,790	(15)	5,530	(29)	8,320 (22)
business engagement	2,220	(12)	1,270	(7)	3,490 (9)
going home	6,110	(33)	9,790	(50)	15,900 (43)
shopping, social visits, others.	6,790	(37)	2,690	(14)	9,480 (25)
going to school	490	(3)	40	(0)	530 (1)
Total	18,400	(100)	19,320	(100)	37,720 (100)

The trip purpose is dependent upon the direction of the trip taken. In the case of trips to George Town, the trip purpose of shopping, social visits and others make up a greater share while trips to Butterworth have a high proportion of trip purpose of 'going to work' and 'going home'.

The reason why the number of trips with trip purpose of going home is different for both directions is because people have different modes of transport in both direction.

The correlation between the trip purpose and the modes of transport before/after using the ferry is shown in the tables below.

Table 38  
Trip Purpose - Access Mode

Mode of transport.	<u>(Butterworth)</u> <u>before using ferry</u>						Direction		<u>(George Town)</u> <u>after using ferry</u>					
	1	2	3	4	5	Total	1	2	3	4	5	Total		
Foot	270	120	780	350	0	1,520	700	660	230	860	40	2,490		
Bus	1,210	750	3,850	4,130	300	10,240	1,090	700	3,970	4,590	310	10,660		
Trishaw	0	0	40	80	0	120	0	0	80	80	0	160		
Taxi	40	300	270	970	0	1,580	0	40	270	470	0	780		
Car	270	160	700	470	40	1,640	80	40	550	310	0	980		
Bicycle	840	550	120	220	140	1,870	760	550	120	180	140	1,750		
Railway	0	0	40	0	0	40	-	-	-	-	-	-		
Motor-cycle	0	0	0	40	0	40	-	-	-	-	-	-		
n.a.	160	350	310	550	0	1,370	160	230	900	310	0	1,600		
<b>Total</b>	<b>2,790</b>	<b>2,230</b>	<b>6,110</b>	<b>6,810</b>	<b>480</b>	<b>18,420</b>	<b>2,790</b>	<b>2,220</b>	<b>6,120</b>	<b>6,800</b>	<b>490</b>	<b>18,420</b>		

Mode of transport.	<u>after using ferry</u>						Direction		<u>before using ferry</u>					
	1	2	3	4	5	Total	1	2	3	4	5	Total		
Foot	670	80	340	600	0	1,690	400	260	1,570	340	0	2,570		
Bus	2,570	520	6,770	1,790	40	11,690	2,000	300	6,130	1,760	40	10,230		
Trishaw	40	0	80	0	0	120	40	0	260	40	0	340		
Taxi	220	110	560	150	0	1,040	150	80	520	220	0	970		
Car	570	260	600	40	0	1,470	910	340	410	220	0	1,880		
Bicycle	1,190	180	300	0	0	1,670	1,240	140	260	0	0	1,640		
Railway	-	-	-	-	-	-	-	-	-	-	-	-		
Motor-cycle	40	40	300	0	0	380	-	-	-	-	-	-		
n.a.	220	90	860	110	0	1,280	790	160	640	110	0	1,700		
<b>Total</b>	<b>5,520</b>	<b>1,280</b>	<b>9,810</b>	<b>2,690</b>	<b>40</b>	<b>19,340</b>	<b>5,530</b>	<b>1,280</b>	<b>9,790</b>	<b>2,690</b>	<b>40</b>	<b>19,330</b>		

	Cont'd (Butterworth)						(George Town)					
	1	2	3	4	5	Total	1	2	3	4	5	Total
Foot	940	200	1,120	950	0	3,210	1,100	920	1,800	1,200	40	5,060
Bus	3,780	1,270	10,620	5,920	340	21,930	3,090	1,000	10,100	6,350	350	20,890
Trishaw	40	0	120	80	0	240	40	0	340	120	0	500
Taxi	260	410	830	1,120	40	2,620	150	120	790	690	0	1,750
Car	840	420	1,300	510	140	3,110	990	380	960	530	0	2,860
Bicycle	2,030	730	420	220	0	3,540	2,000	690	380	180	140	3,390
Railway	0	0	40	0	0	40	-	-	-	-	-	-
Motor-cycle	40	40	300	40	0	420	-	-	-	-	-	-
n.a.	380	440	1,170	660	0	2,650	950	390	1,540	420	0	3,300
<b>Total</b>	<b>8,310</b>	<b>3,510</b>	<b>15,920</b>	<b>9,500</b>	<b>520</b>	<b>37,760</b>	<b>8,320</b>	<b>3,500</b>	<b>15,910</b>	<b>9,490</b>	<b>530</b>	<b>37,750</b>

Note : 1 - Going to work, 2 - Business engagement, 3 - Going home,  
4 - shopping; social & others, 5 - Going to school.

From these tables it can be seen that bus transport stands in a very significant position as a means of transport to the ferry because in both terminals and for both directions, bus transport makes up more than 50% of the mode of transport used. Next to 'bus' is "on foot", while "oar", "Bicycle" and "Taxi" all occupy the same place after "on foot". "Trishaw" and "Motor-cycle" play only a small role as modes of transport to the ferry.

The findings mentioned above suggest that some terminal facilities in connection with the ferry and other land transport (especially bus) are necessary for the convenience of passengers.

Consequently, an examination of chain trips of ferry passengers by passenger's own transport, shows some distinctive features as indicated below.

Table 39  
Chain Trip Modes

Own transport	before - after	No. of pass.	Percentage
Car	i) Bus - Bus	1,156	13.8
	ii) Car - Car	719	8.6
	iii) Car - Bus	670	8.0
	iv) Foot - Car	485	5.8
	v) Car - Foot	410	4.9
Access trip	Foot	1,939	(18)
	Bus	3,876	(36)
	Trishaw	149	( 1)
	Taxi	708	( 7)
	Car	3,412	(32)
	Motor-cycle	149	( 1)
	n.a.	595	( 5)
		10,828	(100)
Motor-cycle	i) Bus - Bus	1,193	13.9
	ii) Bus - n.a.	632	7.4
	iii) n.a. - Bus	597	6.9
	iv) Foot - Bus	298	3.5
	v) Bicycle - Bicycle	273	3.2
Access trip	Foot	1,342	(12)
	Bus	4,323	(38)
	Taxi	558	( 5)
	Car	224	( 2)
	Bicycle	620	( 5)
	Motor-cycle	75	( 1)
	n.a.	4,305	(38)
		11,446	(100)

(Cont'd)

Own transport	before - after	No. of pass.	Percentage
Others	i) Bus - Bus	1,154	46.6
	ii) Bus - Bicycle	149	6.0
	iii) Bicycle - Bus	122	4.9
	iv) Foot - Foot	112	4.5
	v) Bicycle - Bicycle	111	4.5

Access trips

Foot	336	( 9)
Bus	2,764	(71)
Trishaw	75	( 2)
Taxi	37	( 1)
Car	112	( 3)
Bicycle	530	(14)
n.a.	37	( 1)
	3,891	(100)

Non/N.A.

i) Bus - Bus	12,725	42.1
ii) Bicycle - Bicycle	2,648	8.8
iii) Foot - Bus	1,603	5.3
iv) Bus - Foot	1,266	4.2
v) Car - Bus	894	3.0

Access trips

Foot	4,433	( 9)
Bus	30,892	(65)
Trishaw	484	( 1)
Taxi	2,980	( 6)
Car	2,050	( 4)
Bicycle	5,594	(12)
Railway	37	( 0)
Motor-cycle	187	( 0)
n.a.	782	( 2)
	47,439	(100)



4.5.2 Vehicles

The total number of vehicles for both directions was 24,100 of which 12,100 were bound for George Town while 12,000 were for Butterworth.

The composition by type of vehicles is shown in the table below.

Table 40  
No. of Vehicles by Type

	to George Town	to Butterworth	Total		
Car/Van	4,520	4,430	9,000	(37.3)	(82.7)
Lorry	830	850	1,680	( 7.0)	(15.4)
Bus	50	70	120	( 0.5)	( 1.1)
Taxi	50	40	90	( 0.4)	( 0.8)
Motor-cycle	6,670	6,550	13,220	(54.8)	-
<b>Total</b>	<b>12,120</b>	<b>11,990</b>	<b>24,110</b>	<b>(100)</b>	<b>(100)</b>

This composition is almost the same as that for all vehicles generated and attracted in Penang Island.

The number of vehicles by type of purpose is shown in the following table. In this table, the greater number of trips for "going to work" to Butterworth is remarkable.

Table 41  
Trip Purpose

Purpose	to George Town		to Butterworth		Total	
going to work	2,080	(17.1)	5,050	(42.2)	7,130	(29.6)
business engagement	2,140	(17.6)	2,020	(16.9)	4,160	(17.3)
going home	4,370	(36.0)	3,390	(28.3)	7,760	(32.2)
shopping, social visits, others	3,420	(28.2)	1,510	(12.6)	4,930	(20.4)
going to school	120	( 1.1)	10	( 0 )	130	( 0.5)
<b>Total</b>	<b>12,130</b>	<b>(100)</b>	<b>11,980</b>	<b>(100)</b>	<b>24,110</b>	<b>(100)</b>

As in our interview survey, the number of passengers (including driver) was obtained; the number of vehicles was converted into the number of passengers. The average number of passengers is as follows.

Table 42  
Average Number of Passengers in Vehicles

	to George Town	to Butterworth	Total
Car/Van	2.31	2.16	2.23
Lorry	2.07	2.07	2.07
Bus	30.08	28.05	28.90
Taxi	3.23	3.67	3.41
Motor-cycle	1.18	1.12	1.15
<b>Total</b>	<b>1.78</b>	<b>1.73</b>	<b>1.76</b>

Therefore, the number of persons per vehicle by trip purpose was obtained and modal split of Person Trip by ferry is also clarified.

Table 43  
Relationship of Vehicle Type with Trip Purpose

(to George Town)

	going to work	business engagement	going home	shopping, others	going to school	Total
Car/Van	1,060	1,890	2,910	4,520	60	10,440
Lorry	260	1,140	120	200	0	1,720
Bus	0	0	20	1,430	0	1,450
Taxi	0	150	0	30	0	180
Motor-cycle	1,660	530	3,390	2,200	90	7,870
<b>Total</b>	<b>2,980</b>	<b>3,710</b>	<b>6,440</b>	<b>8,380</b>	<b>150</b>	<b>21,660</b>

(to Butterworth)

	going to work	business engagement	going home	shopping, others	going to school	Total
Car/Van	2,160	2,030	3,180	2,270	10	9,650
Lorry	130	880	640	110	0	1,760
Bus	0	0	680	1,180	0	1,860
Taxi	80	70	0	0	0	150
Motor-cycle	4,020	380	2,020	910	0	7,330
<b>Total</b>	<b>6,390</b>	<b>3,360</b>	<b>6,520</b>	<b>4,470</b>	<b>10</b>	<b>20,750</b>

(cont'd)

(Both directions)

	going to work	business engagement	going home	shopping, others	going to school	Total
Car/Van	3,220	3,920	6,090	6,790	70	20,090
Lorry	390	2,020	760	310	0	3,480
Bus	0	0	700	2,610	0	3,310
Taxi	80	220	0	30	0	330
Motor-cycle	5,680	910	5,410	3,110	90	15,200
<b>Total</b>	<b>9,370</b>	<b>7,070</b>	<b>12,960</b>	<b>12,850</b>	<b>160</b>	<b>42,410</b>

#### 4.5.3 Modal Split

Here an estimation based on the results analysed earlier is tested. A typical pattern of modal split seems to exist along the ferry section.

First, the total number of person trips on the ferry is calculated as follows.

Table 44  
Total Person Trips on Ferry

Trip purpose	to George Town	to Butterworth	Total
going to work	5,770	11,910	17,680
business engagement	5,940	4,640	10,580
going home	12,550	16,330	28,880
shopping, social visits, others.	15,190	7,160	22,350
going to school	630	50	680
<b>Total</b>	<b>40,080</b>	<b>40,090</b>	<b>80,170</b>

About 40,000 people cross the channel everyday of those bound for George Town, 38% of them go there for 'shopping, social visit & others' while 31% are 'going home'. On the other hand, out of those bound for Butterworth, 41% are 'going home' and 30% are 'going to work'.

The Person Trip at George Town and Butterworth by trip purpose and mode of transport are shown in the following tables. In these tables, trips where the mode of transport of which access mode is not clear are not counted.

Table 45

No. of Person Trips by Trip Purpose and Mode -1  
(George Town terminal)

	1	2	3	4	5	Total	
On Foot	1,100	920	1,800	1,200	40	5,060	(6.6)
Bicycle	2,000	690	380	180	140	3,390	(4.4)
Trishaw	40	0	340	120	0	500	(0.6)
Motor- cycle	5,680	910	5,410	3,110	90	15,200	(19.8)
Car	4,210	4,300	7,050	7,320	70	22,950	(29.9)
Lorry	390	2,020	760	310	0	3,480	(4.5)
Bus	3,090	1,000	10,800	8,960	350	24,200	(31.5)
Taxi	230	340	790	720	0	2,080	(2.7)
<b>Total</b>	<b>16,740</b>	<b>10,180</b>	<b>27,330</b>	<b>21,920</b>	<b>690</b>	<b>76,860</b>	<b>(100)</b>

Table 46

No. of Person Trips by Trip Purpose  
and Mode of Transport -2  
(Butterworth terminal)

	1	2	3	4	5	Total	
On Foot	940	200	1,120	950	0	3,210	(4.1)
Bicycle	2,030	730	420	220	0	3,540	(4.6)
Trishaw	40	0	120	80	0	240	(0.3)
Motor- cycle	5,720	950	5,710	3,150	90	15,620	(20.1)
Car	4,060	4,340	7,390	7,300	210	23,200	(29.9)
Lorry	390	2,020	760	310	0	3,480	(4.5)
Bus	3,780	1,270	11,320	8,530	340	25,240	(32.6)
Taxi	340	630	830	1,150	40	2,990	(3.9)
<b>Total</b>	<b>17,300</b>	<b>10,140</b>	<b>27,670</b>	<b>21,690</b>	<b>680</b>	<b>77,520</b>	<b>(100)</b>

The modal split for both George Town and Butterworth is almost the same; the bus service has nearly 30% of the share while car and motor-cycle have about 30% and 20% respectively. Modal split by each trip purpose is shown below.

Table 47  
Composition of Modal Split. (%)

	George Town					Butterworth				
	1	2	3	4	5	1	2	3	4	5
On Foot	6.6	9.0	6.6	5.5	5.8	5.4	2.0	4.0	4.4	0
Bicycle	11.9	6.8	1.4	0.8	20.3	11.7	7.2	2.0	1.0	0
Trishaw	0.2	0	1.2	0.5	0	0.2	0	0.4	0.4	0
Motor-cycle	33.9	8.9	19.8	14.2	13.0	33.1	9.4	20.6	14.5	13.2
Car	25.1	42.2	25.8	33.4	10.1	23.5	42.8	26.7	33.7	30.9
Lorry	2.3	19.8	2.8	1.4	0	2.3	19.9	2.7	1.4	0
Bus	18.5	9.8	39.5	40.9	50.7	21.8	12.5	40.9	39.3	50.0
Taxi	1.4	3.3	2.9	3.3	0	2.0	6.2	3.0	5.3	5.9
Total	100	100	100	100	100	100	100	100	100	100

5.

#### FUTURE ROLE

The ferry service plays a very important role at present, because it is the only means of public transport between George Town and Butterworth.

This situation will continue until the Penang Linkage is constructed. After the completion of the bridge, there will be two ways across the straits and so some changes in the overall traffic volume are expected when the services of both the ferry and the bridge are available without any protective strategies.

As the situation of the ferry service will be affected, our study should be divided into two phases; phase A which is 'before the completion of the bridge' and phase B which is 'after the completion of the bridge'. Besides this, the progress from phase A to phase B should also be considered.

Although the ferry service in the future will surely experience a different situation, there are still some unknown factors such as the toll for the bridge, the actual terms of operation and so forth; thus, it can be said that the future role of the ferry is one of uncertainty. To ascertain this to a certain extent, we will examine future demand in phase A and in phase B separately, and then the progress is considered.

5.1

#### Before Completion of the Bridge (Phase A)

The completion of the Penang bridge is expected to be in late 1984. Prior to this, the ferry service is the only means to and for across the straits. Thus, the role of the ferry will be the same as before.

5.1.1

#### Demand Forecast

The demand for the ferry service depends mainly upon the urban activity potential and partly upon the level of its service.

As the present service level seems almost adequate for satisfying the demand except during peak hours at Butterworth, it will be possible to forecast future demand by means of tracing the present trend.



Some forecasts have already been done by a consultant in April 1978. Here, a summary of the projections is shown.

Table 48  
Forecast of Ferry Traffic Growth  
(Thousands of One Way Trips)

	1977 (actual)	*Upper Bound		Growth rate (%)	*Lower Bound		Growth rate (%)
		1980	1985		1980	1985	
Trucks	486	640	1004	9.5	620	933	8.5
Motorcars	2900	4300	8570	14.0	3910	6450	10.5
Motor-cycles	3858	5870	11800	15.0	5210	8580	10.5
Bicycles	1084	990	850	-3.0	930	720	-5.0
Passengers	19644	23070	30147	5.5	21220	24120	2.6

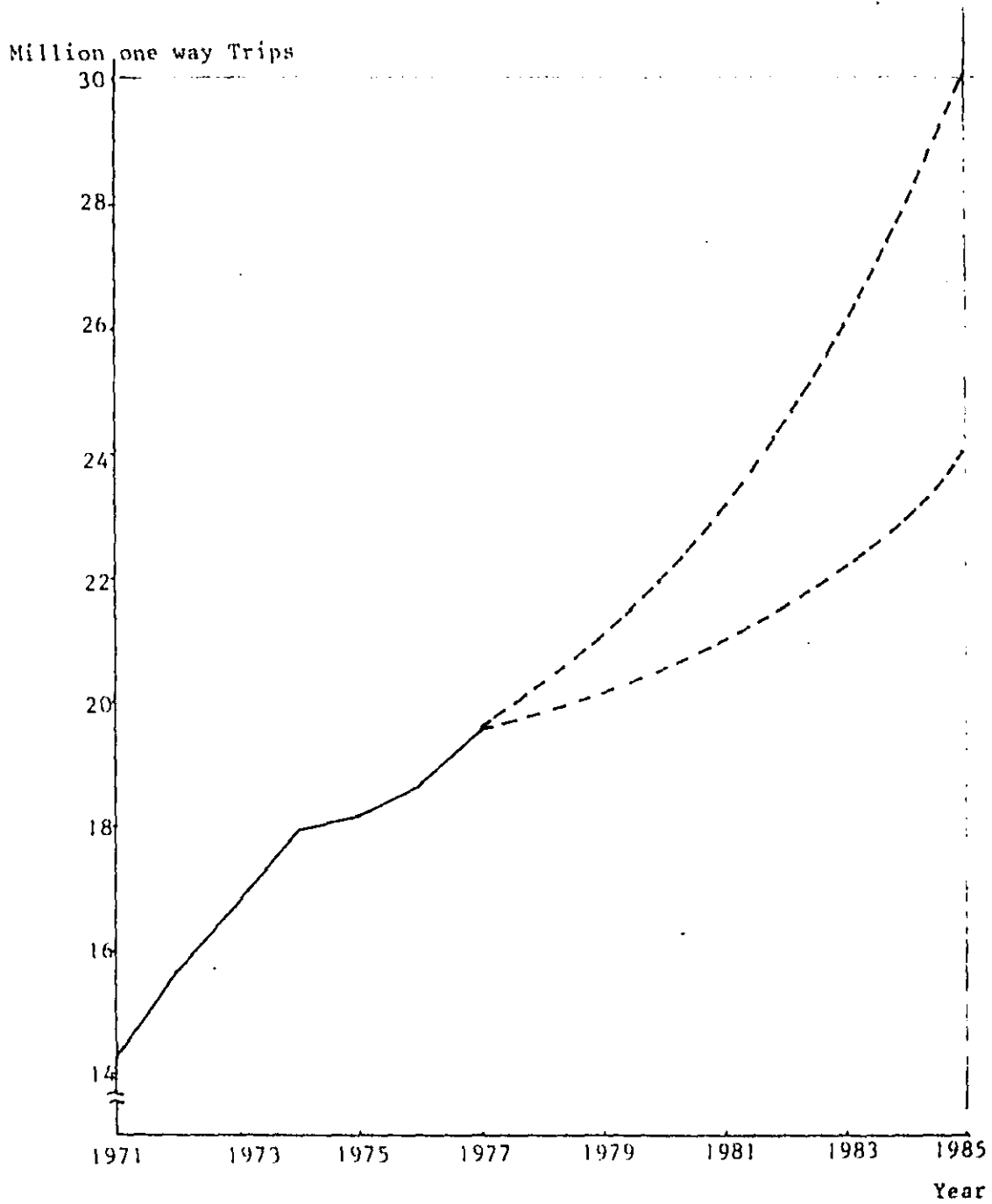
\*Note: 'Upper Bound' as referred in the data source is a 'relatively straightforward extrapolation of the trend over the past 5-10 year. Lower Bound is based on macroeconomic indicators and follows the earlier projections made in connection with the Penang Linkage Study'

Source: "Analysis of the capacity of the Penang Ferry Service", 1978.  
- E.G. Frankel Inc., USA.

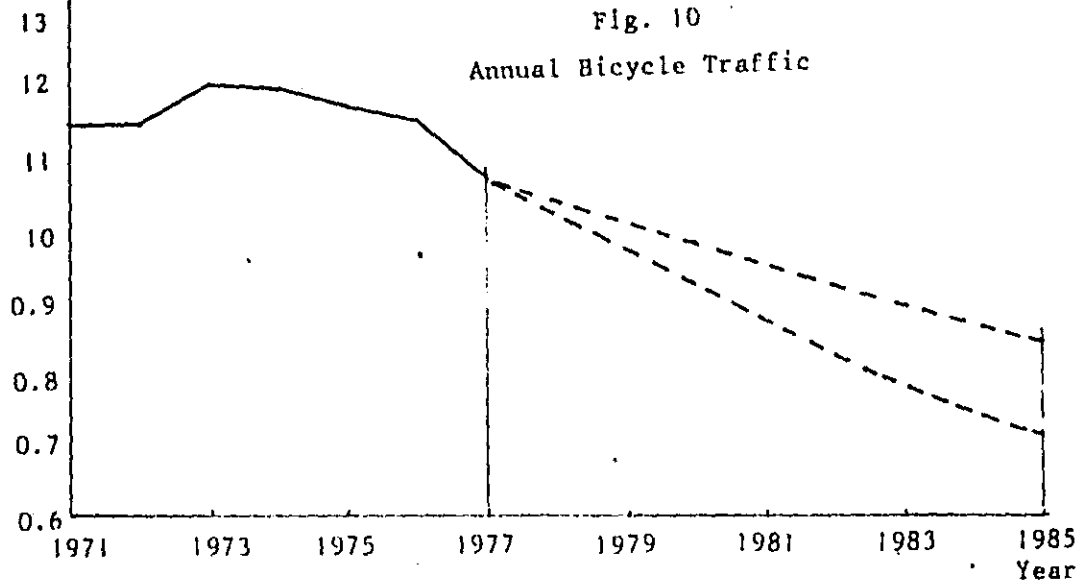
According to these results, all traffic volume excluding bicycles are forecasted to increase by an annual growth rate of 5 to 15% in the upper bound and 3 to 11% in the lower bound.

When these estimates are examined against actual results in 1978, the actual results of motor-cycles, trucks and passengers indicate a greater volume than that estimated in 1978; whereas the volume of cars and bicycles is within the range estimated. Therefore, it will be possible that in future the demand will be beyond the upper bound estimated here in above, even if some the ferry capacity is strengthened according to the increase in demand.

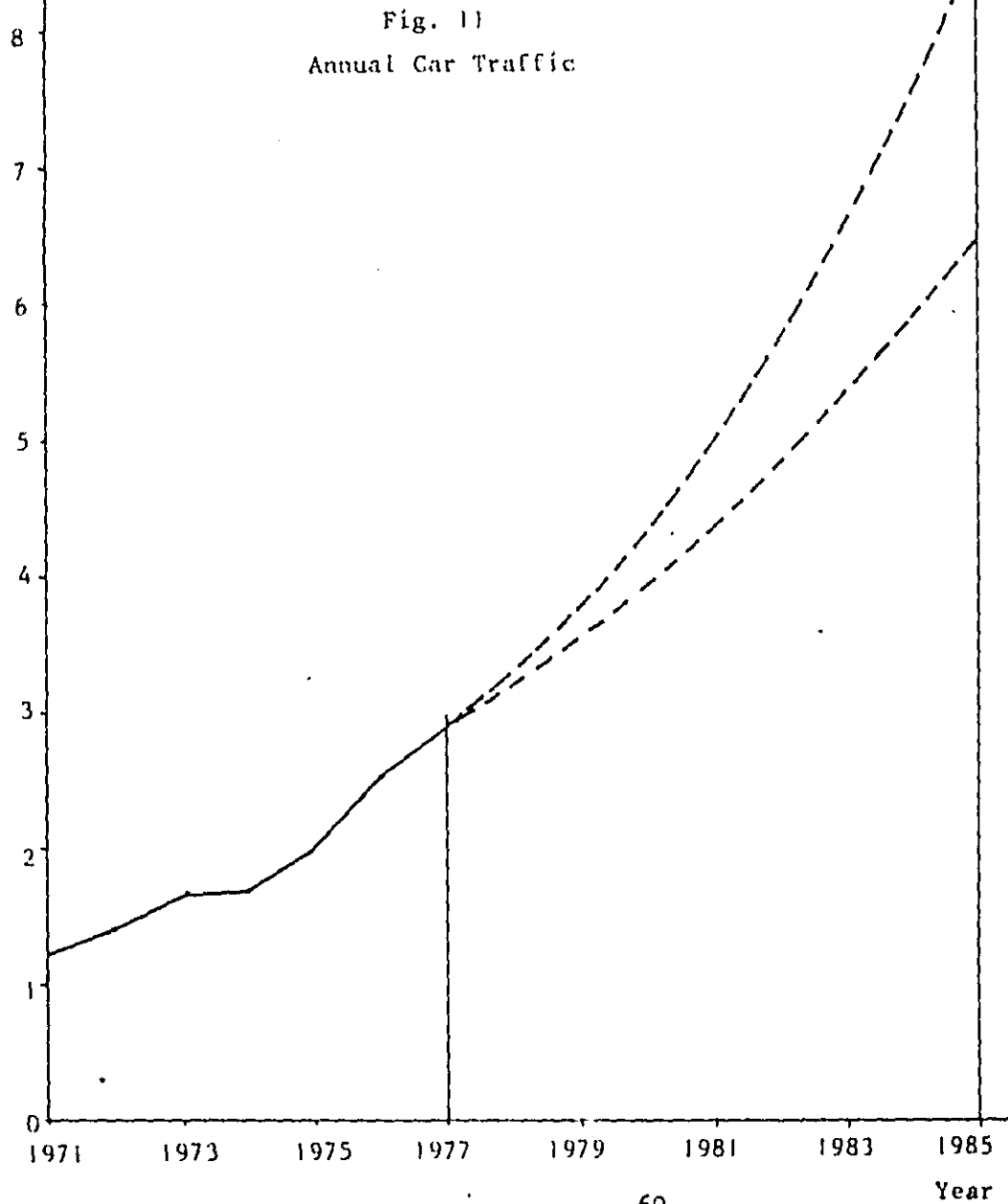
Fig. 9  
Annual Passenger Traffic

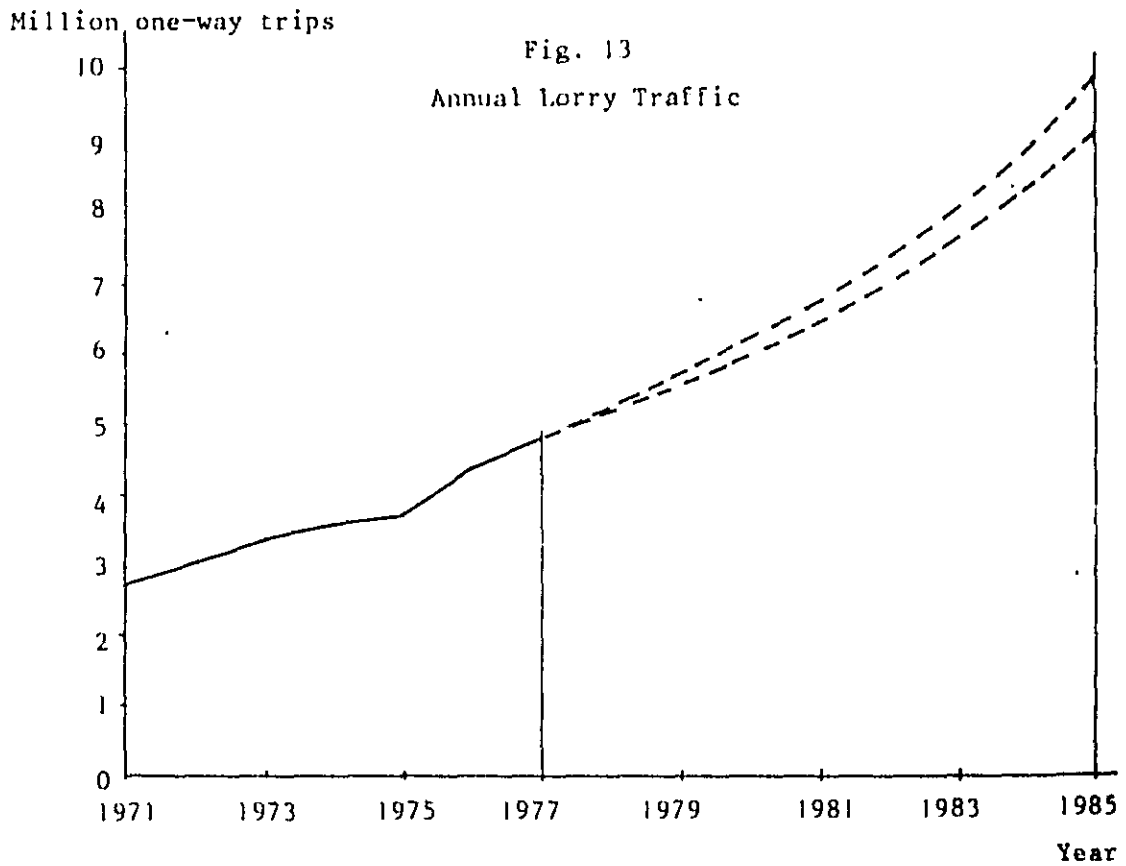
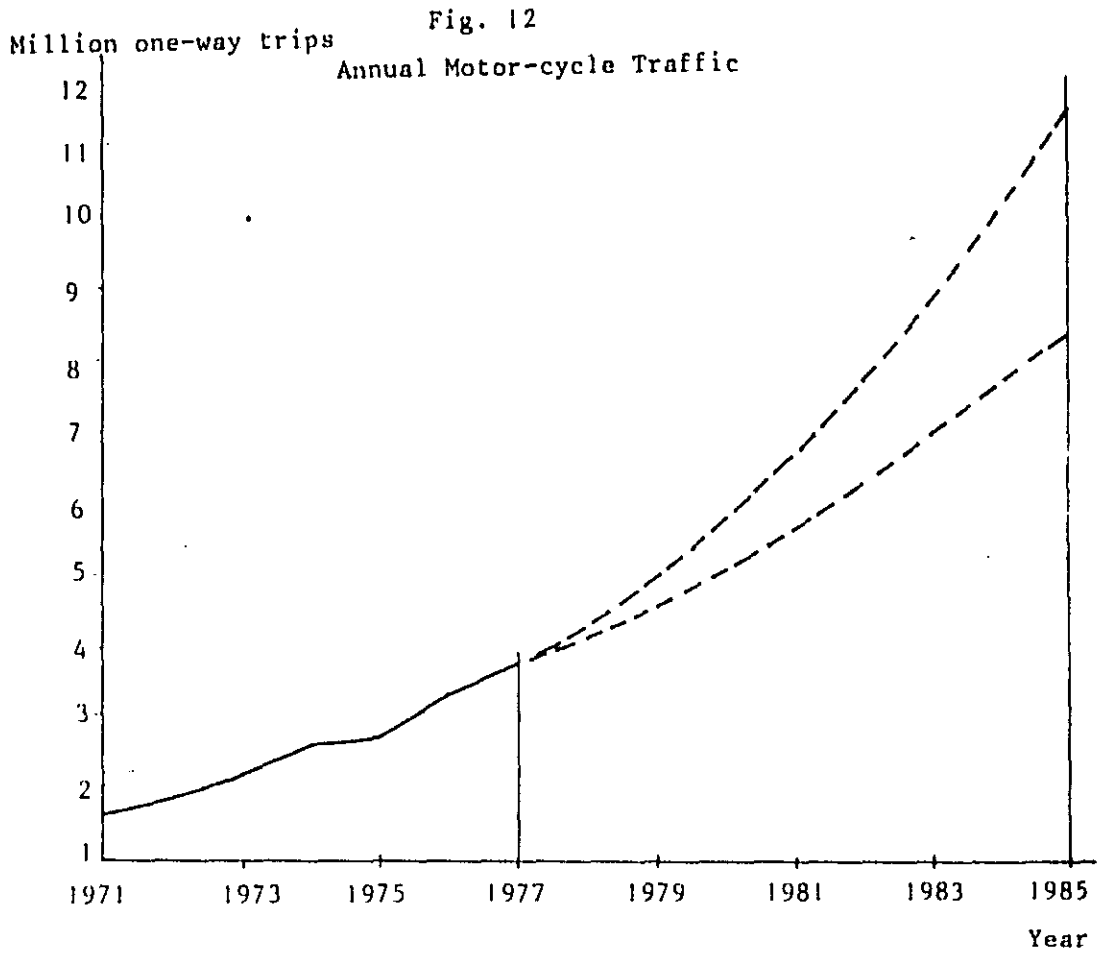


Million one-way trips



Million one-way trips





In addition, the study team forecasted the traffic volume of motor-cycles, cars and trucks on the ferry in 1985 without the Penang Linkage.

The brief results are shown below.

Table 49  
Estimated Ferry Traffic  
(No. of vehicles/day)

	Motor-cycles	Vehicles	(Car , Trucks)
1979	13,000 (100)	10,800 (100)	(9,150 , 1,650)
1985	14,400 (111)	14,600 (135)	(12,170 , 2,430)

These estimates are obtained by the least square method (linear curve) from the results of in 1965 to 1979, and so these are less than those which are forecasted by applying quadric curve.

The traffic volume of the ferry will mainly depend on the ferry capacity provided, and the forecasted results range from 14,600 vehicles to 24,380 vehicles per day. Since the range of the forecasted results is very wide, it's difficult to reach a decision on the most correct forecasted volume. This can be done by comparing the traffic volume before and after the Penang Linkage.

## 5.2 After Completion of the Bridge (Phase B)

### 5.2.1 Demand Forecast

The situation of ferry service will completely change after the completion of the Penang Bridge. The projection of traffic volume until 1985, before the completion of the Penang Linkage, was made in the earlier section and in this section part of the results forecasted for 1985 and 2000 is shown.

In our traffic assignment, we obtained the traffic volume on the Penang Linkage and the ferry as well as on each road section by including these links in the whole network and by using the method in which the bridge toll and ferry fares are converted into the time resistance factor.

The following assumptions are made:

- \* The toll of the bridge is almost the same as that of the ferry.
- \* The time values are 3.7 M\$/hour in 1979, 4.5 in 1985 and 7.3 in 2000 for passenger cars.
- \* Both fares are variable in accordance with the increase of time value.
- \* It takes over 5 minutes depending on the demand at the access of ferry terminal.

As a results, the time resistance is calculated as 4.80 minutes/kilometer for the ferry and 1.40 minutes/kilometer for the bridge in case of passenger cars.

And the results which are estimated based on these assumptions are shown as follows.

Table 50  
Traffic Volume Across the Straits

(per day)

Year	Type of Vehicle	Ferry	Bridge	Total
1979	Motor-cycle	13,000	-	13,000
	Car	9,150	-	9,150
	Truck	1,650	-	1,650
	(P.C.U.)	(19,300)	-	(19,300)
1985	Motor-cycle	6,500	8,200	14,700
	Car	1,400	11,460	12,860
	Truck	280	6,060	6,340
	(P.C.U.)	(5,400) (17.1)	(26,200) (82.9)	(31,600) (100)
2000	Motor-cycle	6,200	9,300	15,800
	Car	10,000	26,180	36,180
	Truck	1,840	14,880	16,720
	(P.C.U.)	(17,700) (23.4)	(58,000) (76.6)	(75,700) (100)

Regarding passengers, the share of fellow passengers in vehicles has increased as shown in section 2. If the ratio of fellow passengers by type of vehicles is constant and the diverted volume to the bridge is small, the following results are estimated.

Table 51  
Passengers Volume on Ferry

	Real passengers	Fellow passengers	Total
1979	39,800	16,300	56,100
1985	43,180*	3,240	46,420
2000	52,940**	17,840	70,780

\* Estimated from the results in 5.1.

\*\* Estimated by annual growth rate 1979 to 1985.

And the volume of bicycles is also estimated from the trend.

Table 52  
Bicycle on Ferry

	1979	1985	2000
No. of Bicycles	2,870	2,150	-

#### 5.2.2

#### Effects of Bridge Tolls

When the traffic volume on the ferry and on the bridge are compared with each other, it is supposed that the time resistance factor influences the share of traffic demand to a large extent.

Four cases of the bridge tolls is presented below in order to measure their effects in 1985.

The assumed factors are as follows.

Table 53  
Fare & Toll Resistance expressed in terms of Time (Min/Km)

	Linkage (10.5 km)		Ferry (3.0 km)
Base Case	1.40	(1.00)	4.80
Case 1	0	(0.00)	4.80
Case 2	2.10	(1.50)	4.80
Case 3	2.80	(1.50)	4.80
Case 4	4.20	(3.00)	4.80

\* Calculated by  $\frac{\text{fare (cent/km)}}{\text{time value (cent/min.)}}$

The following results indicate only vehicle volume in P.C.U.

Table 54  
Comparison of Each case

	Ferry	Linkage	Total
Base Case	2,170 (9.2 (100))	21,320 (90.8 (100))	23,490 (100)
Case 1	910 (3.9 (42))	22,580 (96.1 (106))	23,090 (100)
Case 2	2,570 (10.9 (1.18))	20,920 (89.1 (98))	23,490 (100)
Case 3	3,040 (12.9 (1.40))	20,450 (87.1 (96))	23,490 (100)
Case 4	4,530 (19.3 (209))	18,960 (80.7 (89))	23,490 (100)

Any change in the toll does not influence the traffic volume of the ferry greatly. The reasons seems to be as follows:

1. The total traffic volume across the strait is not so heavy compared with the capacity of access roads to the bridge in 1985.
2. In case of the ferry, the share of fare resistance to the total is smaller than that in case of the Linkage.

Therefore, controlling the toll of the Linkage is not effective as a measure to increase ferry traffic.



APPENDIX A

Cross Harbour Traffic in Hong Kong

(Supplementary Study)

1. Purpose of the study
2. Outline of Hong Kong
3. Transport Network across Victoria Harbour
4. Trend of Cross Harbour Traffic Volume
5. Influence of Cross-harbour Tunnel
6. List of Data Sources

## Supplementary Study in Hong Kong

This study is aimed at obtaining some information on "Cross Harbour Traffic" in Hong Kong which could serve as a comparative study to that in Penang Island. Data and Reports used in Hong Kong are shown in Section 6 of this study.

1

### Purpose of the Study

This study was carried out in order to examine the "Cross Harbour Traffic" before and after completion of the cross harbour tunnel between Kowloon Peninsula and Hong Kong Island in Hong Kong.

Hong Kong is divided into two parts by Victoria harbour; Hong Kong Island and Kowloon Region. Before the cross harbour tunnel was constructed, there was no means of transport between these two parts except for ferry services. Although the cross harbour tunnel was completed in 1972, ferry services still continue both for passengers and for vehicles.

This situation is similar to that of Penang State which is divided into Penang Island and Province Wellesley by the channel.

In Penang a linkage across the channel is now under planning and it will become possible to travel to and fro between the island and the mainland by motor vehicles after completion of the bridge.

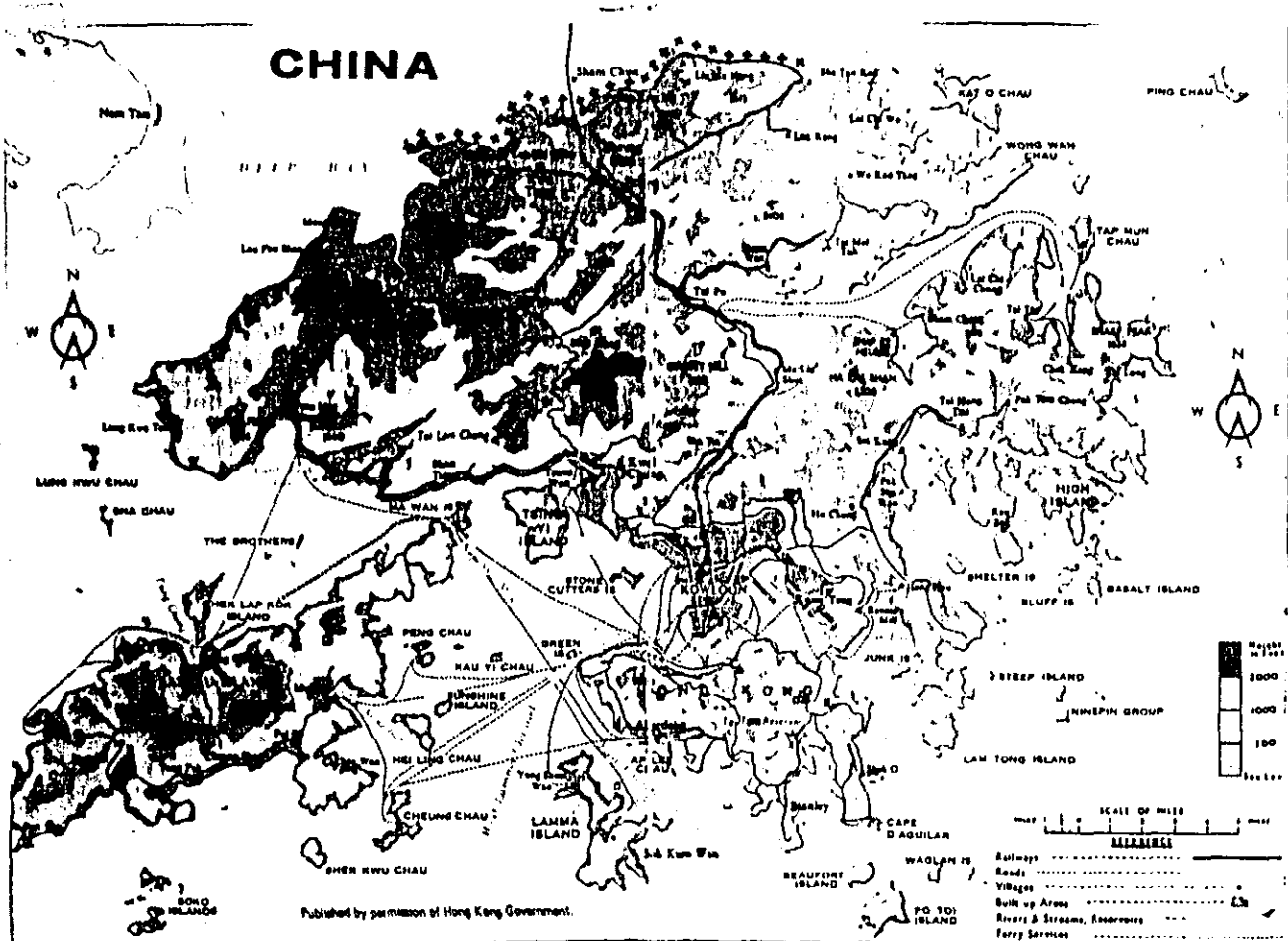
Therefore it would very useful for our study to examine the change in cross harbour traffic before and after the completion of the cross harbour tunnel in Hong Kong.

2

### Outline of Hong Kong

Hong Kong, a British crown colony, consists of three parts; Hong Kong Island, Kowloon Peninsula and New Kowloon. The population is 1,100,000, 900,000 and 2,300,000 respectively. In addition to this, about 65,000 people live afloat on their boats in Colony waters and thus the total population sums up over 4½ million. A map of the whole area is shown in Fig. 1.

Fig. 1



The Central Business District is located on both sides of Kowloon and Hong Kong Island; e.g. Tsim sha tsui, Hung hom and Yau mati in Kowloon, Central district, Wanchai and Causeway Bay in Hong Kong Island. As a result of this location, there is a heavy traffic flow between Kowloon and Hong Kong Island.

This traffic demand has various trip purposes; commuting, going to school, on business, shopping, social intercourse, going home, etc. In Hong Kong, there is limited land area except for New Territories; the area is 85.8 sq. km. (33.5 sq. miles) and the population density is 233 person per hectare.

The traffic demand of such dense urban activities sometimes causes traffic congestion at the central area because of shortage of transport facilities.

In particular between Kowloon and Hong Kong Island there were limited ferry services, which resulted in incredible congestion situations during the office rush hours of 8.30a.m./ 9.30a.m. & 4.30p.m. / 5.30p.m.

The government of Hong Kong has made many attempts to solve these traffic problem since a long time ago; many researches and plans regarding improvement of roads and public transports have been carried out and some effective strategies have been implemented.

The construction of the cross-harbour tunnel is one of these strategies, and seems to be one of the most effective projects. It was completed in October 1972 and it has since become possible to get across the harbour by motor vehicles without the ferry service.

3

### Transport Network across Victoria Harbour

Victoria Harbour separates Hong Kong into Kowloon and Hong Kong Island, and its width is 1.4 Km. at each pier of the Star ferry. (Passenger ferry). Today, there are ferry and tunnel transport services across Victoria harbour.

3 - 1

### Ferry

According to the "Transport Department Fact Sheet" 1979 by the Transport Department, there are many ferry services operated by private companies for the cross harbour and the outlying district traffic. The following table shows routes, fare and daily average amount of traffic by vehicular service and passenger service.

Table 1. Enumeration of Cross Harbour Ferry Service

A. Hong Kong and Yau mati Ferry Company Limited ( HYF ) \*

	Route	Daily Average 1978	Fares
I	Vehicular Ferry	(No. of vehicles)	
1.	Jubilee Street - Jordan Road	5760	\$1 (Motor Cycle) \$3 (P/C) \$6 (Bus) \$6/9/12 (G/Vs.) \$75 (G/V > 11m. long)
2.	North Point - Kowloon City	1796	Same as above
3.	North Point - Kwun Tong	2081	Same as above
II	Passenger Ferry	(No. of pass.)	
1.	Jubilee Street - Jordan Road	61,533	40¢ (children half fare)
2.	Jubilee Street - Kwun Tong	11,305	50¢ - \$2 depending on type of vessels
3.	Jubilee Street - Sham Shui Po	34,111	40¢ (children half fare)
4.	Jubilee Street - Tai Kok Tsui	20,878	40¢ (children half fare)
5.	Jubilee Street - Mei Foo Sun Chuen	9,436	50¢ - \$2 depending on type of vessels
6.	Kwun Tong - North Point	34,161	40¢ (children half fare)
7.	North Point - Hung Hom	24,195	40¢ (children half fare)
8.	North Point - Kowloon City	16,507	40¢ (children half fare)
9.	Sai Wan Ho - Kowloon City (Temporary Licence)	3,749	\$1
10.	Sai Wan Ho - Kwun Tong (licensed under Reg. 10 of Ferries Ordinance for the period of 2.7.73 - 1.7.83)	2,3894	40¢ (children half fare)
11.	Sai Wan Ho - Sam Ka Tsuen (Same as above)	8,907	40¢ (children half fare)
12.	Wan Chai - Hung Hom	10,228	40¢ (children half fare)
13.	Wan Chai - Jordan Road	16,174	40¢ (children half fare)
14.	Wilmer Street - Sham Shui Po	17,237	40¢ (children half fare)

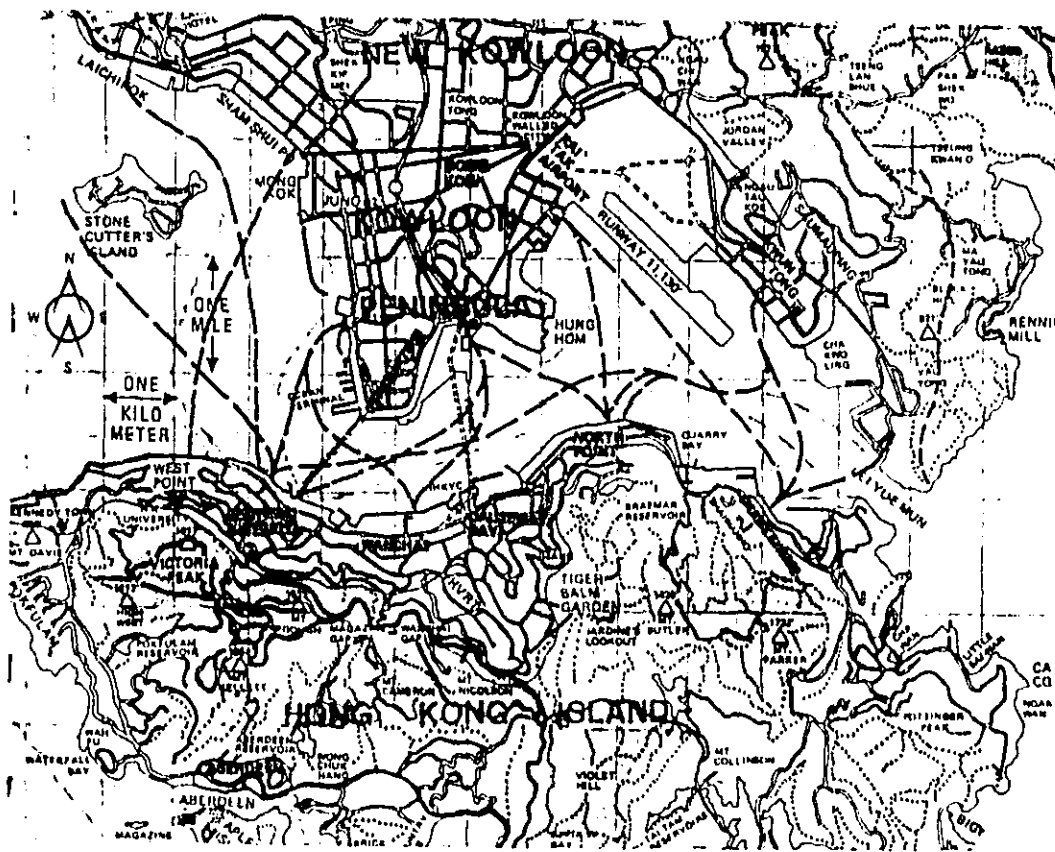
\* In addition to the above mentioned, 1 coastal passenger ferry service, 11 outlying district ferry service and 6 routes of excursion ferry service are in operation.

B. Star Ferry Company Limited (Passengers Only)

Route	Daily Average, 1978 (No. of Passengers)	Fare *
1. Kowloon Point - Edinburgh Place	141,694	1st. Class : 30¢ (Children 20¢) 2nd. Class : 20¢
2. Edinburgh Place - Hung Hom (temporary licence)	6,836	50¢ (flat fare)

\* HK \$ 1 = US \$0.2

Fig. 2 Cross Harbour Ferry Routes



Besides this, "Walla-walla" boats operate for ships anchored in the harbour and provide cross-harbour service at night as well when the ordinary ferry service ceases operation.

## Road Tunnels

The cross-harbour tunnel, a HK\$320 million project was completed in August 1972, and is operated by the Cross Harbour Tunnel Company in which the government has a 25 per cent interest.

The entrance to the tunnel at Hong Kong side is located at the junction of Garden road - Queen's road - Murray road on the eastern part of C.B.D about 3 kms from the center of the Central district.

The other entrance on Kowloon side is situated in Chatham road near the railway terminal.

The length between both toll gates is 3.54 kms (2.2 miles) and the section of immersed tube tunnel is 1.60 kms (5.256 feet) in length.

The cross-harbour tunnel has parallel double tubes for each direction and in each tube there is a 22 ft. Carriageway with two lanes for motor vehicles. This tunnel does not provide any service for pedestrians, cyclists and rickshaws, because it seems that the frequent ferry service provides adequate services for them.

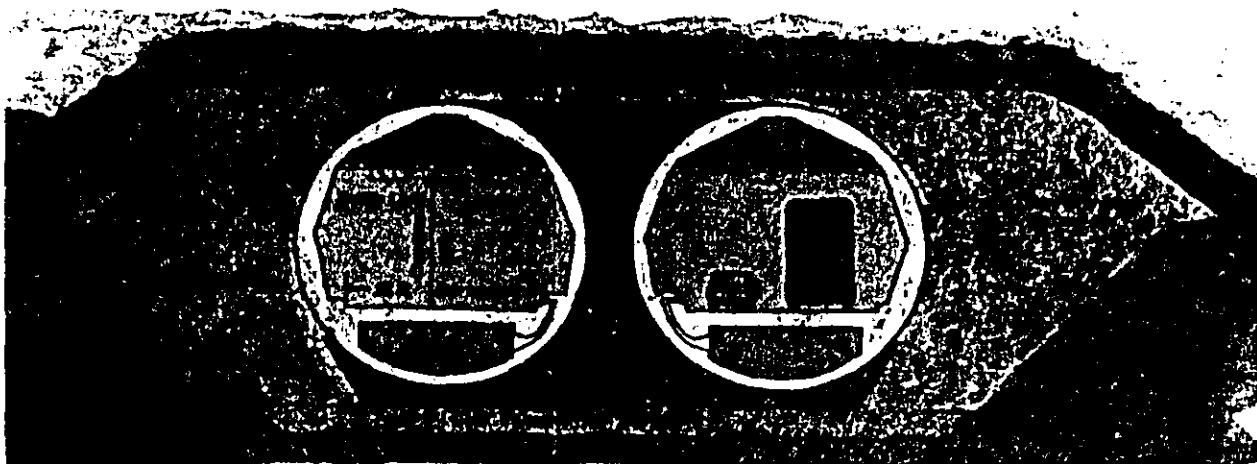
The fare for traffic passing through by type of vehicle is shown in the table below:

Table 2 Tolls

Vehicle Type Class	Single journey toll
0. Private car, Public car, Taxi .....	\$ 5.00
1. Motorcycle over 50cc .....	\$ 2.00
2. Private & Public Light Bus .....	\$ 8.00
Private & Public	
3. - single-decked bus .....	\$10.00
4. - double-decked bus .....	\$15.00
Goods vehicles -	
5. ...not exceeding 40cwt .....	\$10.00
6. over 40cwt.n/ex. 100cwt .....	\$15.00
7. over 100cwt .....	\$20.00
9. each axle, in excess of two .....	\$ 5.00

In the cross-harbour tunnel there is a speed limit, i.e, maximum speed - 40m.p.h. and minimum speed - 10m.p.h. Almost 60,000 vehicles a day use the tunnel of which some 75 per cent are motor cars.

Fig. 3 Tunnel Cross Section



4 Trend of Cross Harbour Traffic Volume

The trend of the number of passengers and vehicles across the harbour are shown as follows:

4 - 1 Passengers

Table 3. Passenger journeys Thousands

	Ferry	Tunnel	Total
1966	210,239	-	210,239
1967	200,219	-	200,219
1968	210,588	-	210,588
1969	222,704	-	222,704
1970	230,725	-	230,725
1971	239,894	-	239,894
1972	227,965	12,320 ( 5.13)	240,285
1973	196,349	46,641 (19.19)	242,990
1974	189,717	67,519 (26.25)	257,236
1975	181,485	86,107 (32.18)	267,592
1976	169,499	113,858 (40.18)	283,357
1977	166,653	127,790 (43.40)	294,443
1978	166,587	139,743 (45.62)	306,330
.....			
1979 Jan.	14,501	13,227 (47.70)	27,728
Feb.	13,334	12,277 (47.94)	25,611
Mar.	14,620	13,214 (47.47)	27,834
Apr.	13,741	12,472 (47.58)	26,213
May	14,532	12,929 (47.10)	27,471

( ) : Share ratio to total



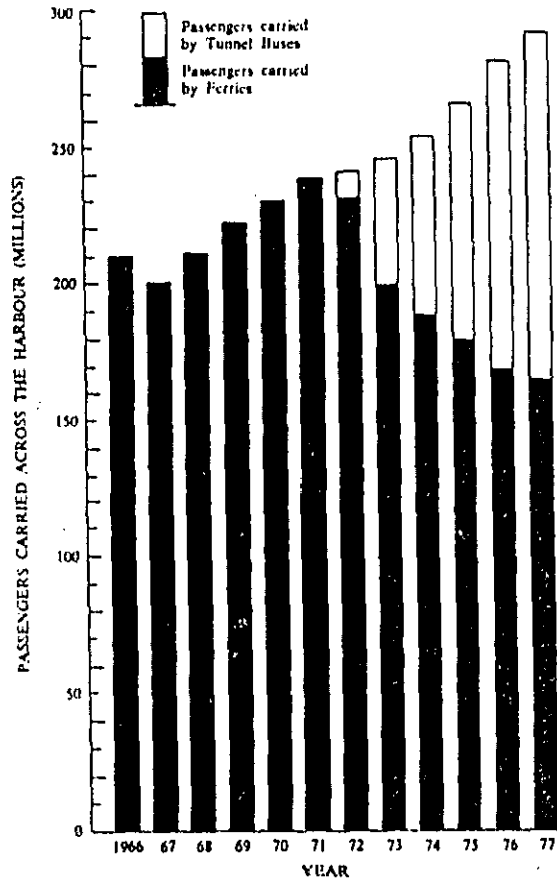
Table 4. Growth indices to previous year - passengers -

	Ferry	Tunnel	Total
1966	*	-	*
1967	0.95	-	0.95
1968	1.05	-	1.05
1969	1.06	-	1.06
1970	1.04	-	1.04
1971	1.04	-	1.04
1972	0.95	-	1.00
1973	0.86	3.79	1.01
1974	0.97	1.45	1.06
1975	0.96	1.28	1.04
1976	0.93	1.32	1.06
1977	0.98	1.12	1.04
1978	1.00	1.09	1.04

There are 200 to 300 million passengers per year - 550 to 840 thousand per day - across the harbour, since 1967 the number has increased to about 4% annual growth rate.

The increasing trend of passengers going by ferry underwent a change after the operation of the tunnel, and its rate of decrease is a few per cent recently.

Fig. 4 ANNUAL VARIATION OF PASSENGERS CARRIED ACROSS THE HARBOUR BY FERRIES AND BY BUSES 1966-1977



In comparison, the typical cross-harbour passenger ferry, Star ferry, shows a moderate variation before and after completion of the tunnel as below:

Table 5. Passenger journeys by Star ferry

	No. of pass. (thousands)	index to previous year
1966	56,332	*
67	48,625	0.86
68	50,986	1.05
69	55,819	1.09
70	56,646	1.01
71	58,216	1.03
72	58,108	1.00
73	52,566	0.90
74	50,465	0.96
75	53,197	1.05
76	50,700	0.95
77	50,961	1.01
78	54,213	1.06

Table 6. Cross Harbour Vehicular Traffic

Year	Types of Vehicles				Total	By Vehicular Ferries (HYF)	By Cross Harbour Tunnel
	Cars	Motor Cycle#	Buses*	Goods Vehicles			
1966	2,650,261	522,909	-	1,150,227	4,323,447	4,323,447	-
67	2,857,130	569,530	-	1,108,978	4,535,638	4,535,638	-
68	3,214,560	546,754	-	1,179,241	4,940,555	4,940,555	-
69	3,572,170	561,419	-	1,376,284	5,509,873	5,509,873	-
70	3,908,897	597,132	-	1,582,598	6,088,627	6,088,627	-
71	4,283,305	780,828	-	1,798,865	6,862,998	6,862,998	-
72	6,584,095	1,381,280	-	2,041,816	10,007,191	6,028,718	3,978,473 (39.8)
73	11,434,213	2,103,461	586,626	2,495,415	16,619,715	4,093,693	12,526,022 (75.4)
74	12,406,465	1,434,257	1,498,893	2,651,712	17,991,327	3,714,881	14,276,446 (79.4)
75	12,792,400	1,263,754	1,822,990	2,920,539	18,799,683	3,501,432	15,298,251 (81.4)
76	14,591,732	1,303,742	2,239,804	3,542,821	21,678,099	3,459,905	18,218,194 (84.0)
77	17,454,884	1,456,010	2,471,546	4,127,842	25,510,282	3,639,951	21,870,331 (85.7)
78	21,905,265	1,556,507	2,693,996	4,667,183	30,822,951	3,517,338	27,305,613 (88.6)

Note: # Including buses until August 1973

\* Buses and light buses

Figures in brackets indicate % of Tunnels share

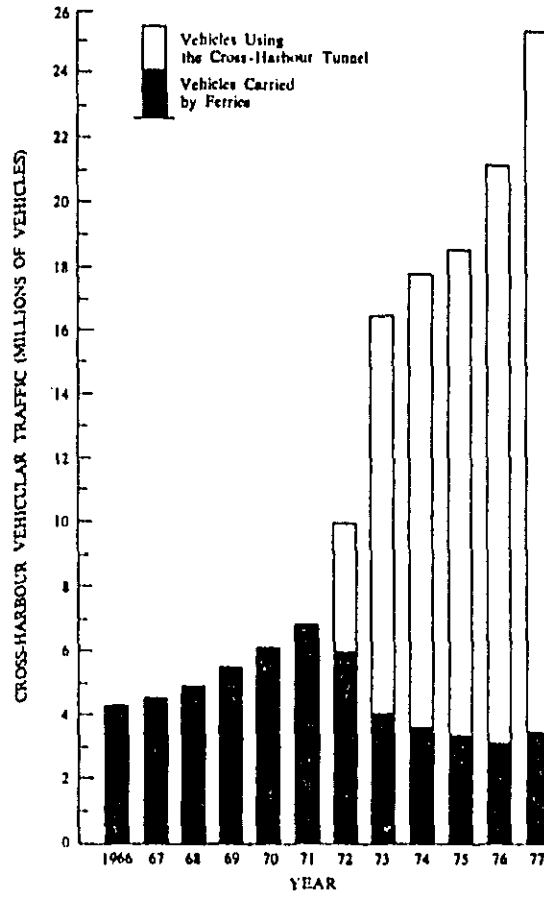
Although the cross harbour vehicular traffic has also increased there are two different trends before and after 1972. The rate of increase before 1972 was at most 13%, while in 1973 it was 66% more than the previous year and has been increasing at a high rate since 1974.

Table 7. Growth indices to previous year - vehicles -

	Ferry	Tunnel	Total
1966	*	-	*
1967	1.05	-	1.05
1968	1.09	-	1.09
69	1.12	-	1.12
70	1.11	-	1.11
71	1.13	-	1.13
72	0.88	-	1.46
73	0.68	3.15	1.66
74	0.91	1.14	1.08
75	0.94	1.07	1.04
76	0.99	1.19	1.15
77	1.05	1.20	1.18
78	0.97	1.25	1.21

After completion of the tunnel the share of traffic has enlarged year by year and in 1978 it reached near 90% of cross harbour traffic, while the traffic by ferry in 1978 became nearly half of the peak volume in 1971.

Fig. 5 ANNUAL VARIATION IN CROSS-HARBOUR VEHICULAR TRAFFIC 1966-1977



Influence of Cross-harbour Tunnel

Since the cross-harbour tunnel went into operation in August 1972, ferry services have been seriously influenced by competitive transport means. The decrease of both passengers and vehicles clearly shows a great damage to the ferry as a means of transport.

For instance, the number of passengers by ferry after 1972 has decreased from 14% to 2% i.e., -32,000,000 to 3,000,000 passengers compared with previous years, up to 1978.

Moreover, there was a more remarkable occurrence regarding vehioular traffic, that is in 1973 the traffic volume by ferry was reduced to 68% of the previous year. And this decreasing trend has continued since 1973 except in 1977.

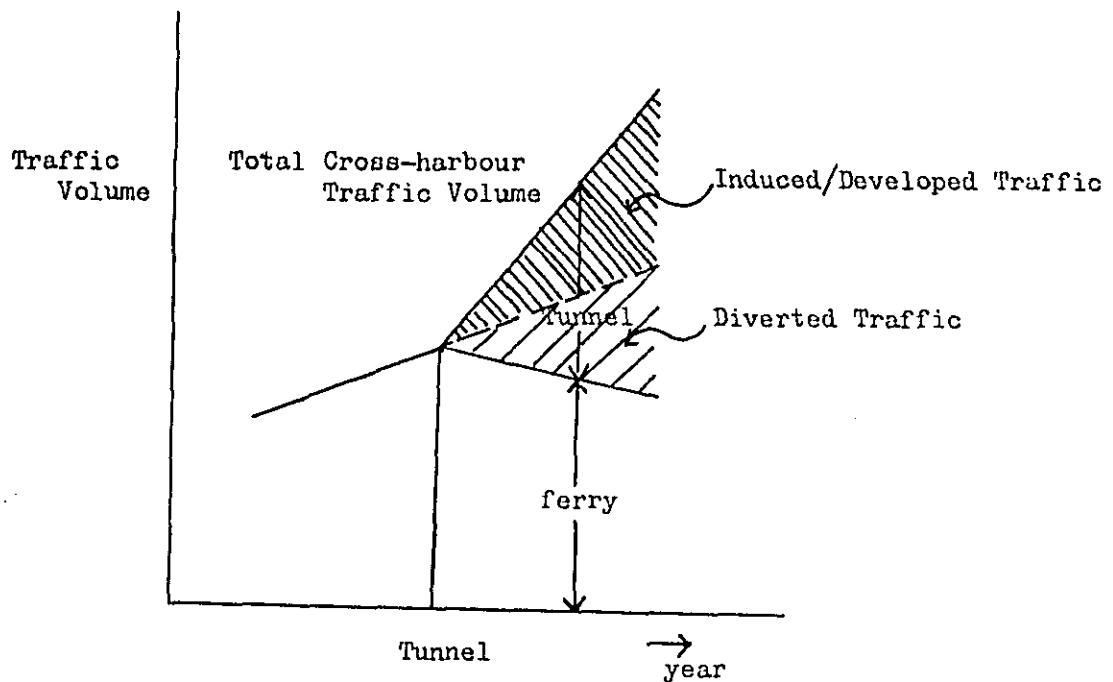
5 - 1

Analysis.

When we trace the trend of total volume across the harbour, the following may be mentioned;

- i) If there was no cross-harbour bridge, the trend of passenger and vehicle traffic by ferry would continue as before or increase the urban activity in accordance with the urban potential.
- ii) In fact, before 1972, both volume of passenger and vehicle traffic by ferry had increased annually. However, there has been a decreasing trend after 1972.
- iii) And so, the gap between actual volume and estimated volume according to paragraph i) may be regarded as the diverted traffic volume from ferry to tunnel.
- iv) Whereas, after the construction of the bridge the traffic volume has increased to a larger extent as compared to the former tendency. This is the reason why the traffic has increased greatly with the cross-harbour tunnel which by itself induced and/or developed it.
- v) Then, the difference between the total volume and the diverted volume of the tunnel is the "induced/developed traffic volume" by the completion of the tunnel.

Fig. 6 Concept of Analysis.



5-2

Results.

According to the analysis procedure mentioned here above, the results are deduced as follows:

i) Passenger.

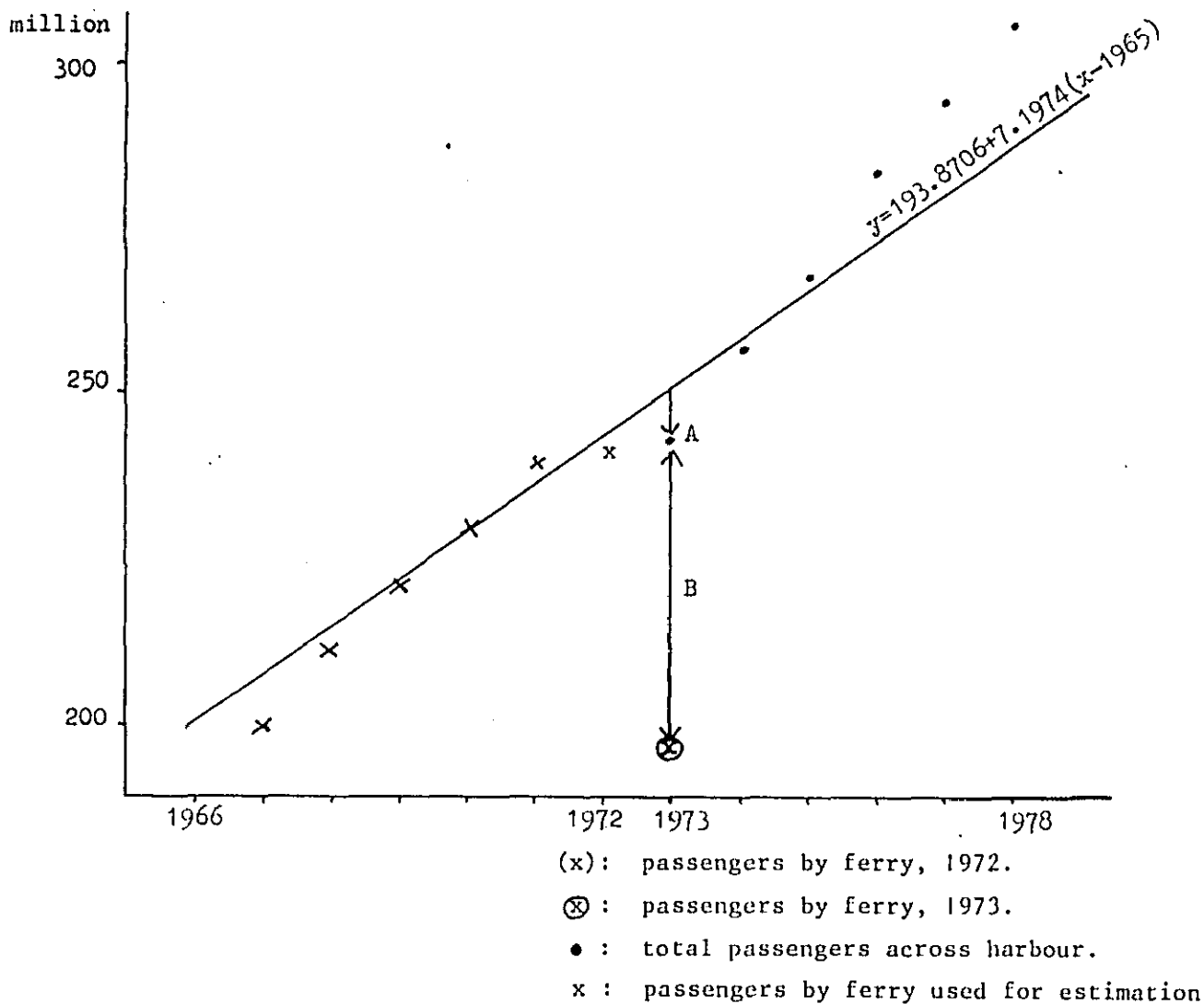
In 1973, the first year when the tunnel was operated for the whole year, there were 242,990 thousand passengers across the harbour, 196,349 thousand by ferry and the rest, 46,641 thousand, by tunnel.

According to the trend of 1966 to 1971 data, the estimated volume in 1973 is 251,450 thousand by the statistical method of least squares.

But the actual volume is only 196,349 thousand by ferry and 46,641 thousand by tunnel. The total volume is 8,460 thousand less than the estimated volume (refer to A in Fig.7. It seem that this reduction is caused by the diversion from ferry passengers to other modes except for tunnel buses. Besides, the actual passenger volume by ferry was 196,349 thousand, and the decreased volume was 55,101 thousand, - estimated volume minus ferry passengers - 21.9 percent of the total.



Fig. 7 Estimation of trend - passengers



This diverted volume is divided into two categories;

- (a) from ferry to tunnel bus, and
- (b) from ferry to other modes of transport.

(a) is 46,641 thousand, and (b) 8,460 thousand. The diverted traffic ratio against the real cross harbour passenger volume is 19.2 percent.

Regarding induced/developed traffic by tunnel, it has begun to appear 3 years after the completion of the bridge, although its volume is small and negligible.

ii) Vehicle

Cross harbour vehicular traffic had continued its normal increase up to 1971 with about 10% annual growth rate, and in 1971 6,863 thousand vehicles, 18,800 vehicles/day moved across the harbour by ferry. In 1973, there were 16,620 thousand vehicles- 4093.7 thousand by ferry (25%) and 12.526 thousand by tunnel (75%) - .

According to the estimation by the former trends, 7681.7 thousand vehicles ought to have been carried on ferry in 1973, if there were no cross-harbour tunnel. And, 3,588 thousand vehicles were diverted from the ferry to the tunnel. This ratio of diverted traffic is 46.7 % against the estimated ferry traffic, and 28.6 % of the tunnel traffic. This is larger than the ratio of passengers'. Besides this a great deal of induced/developed traffic generated from the tunnel, 8,938 thousand vehicles (24.5 thousand per day) and this was over twice the volume by ferry and over three times of diverted traffic volume.

As a matter of fact, the vehicular traffic has been much influenced by the tunnel in its opening year and is still so today. The traffic volume using the tunnel is continuously increasing at the rate of 10 to 25 percent against that of the years after 1973. In 1978 that volume already reached 27,300 thousand, 75,000 vehicles per day, that is over three times that of 1973's.

Fig. 8

Estimation of Trend - Vehicles

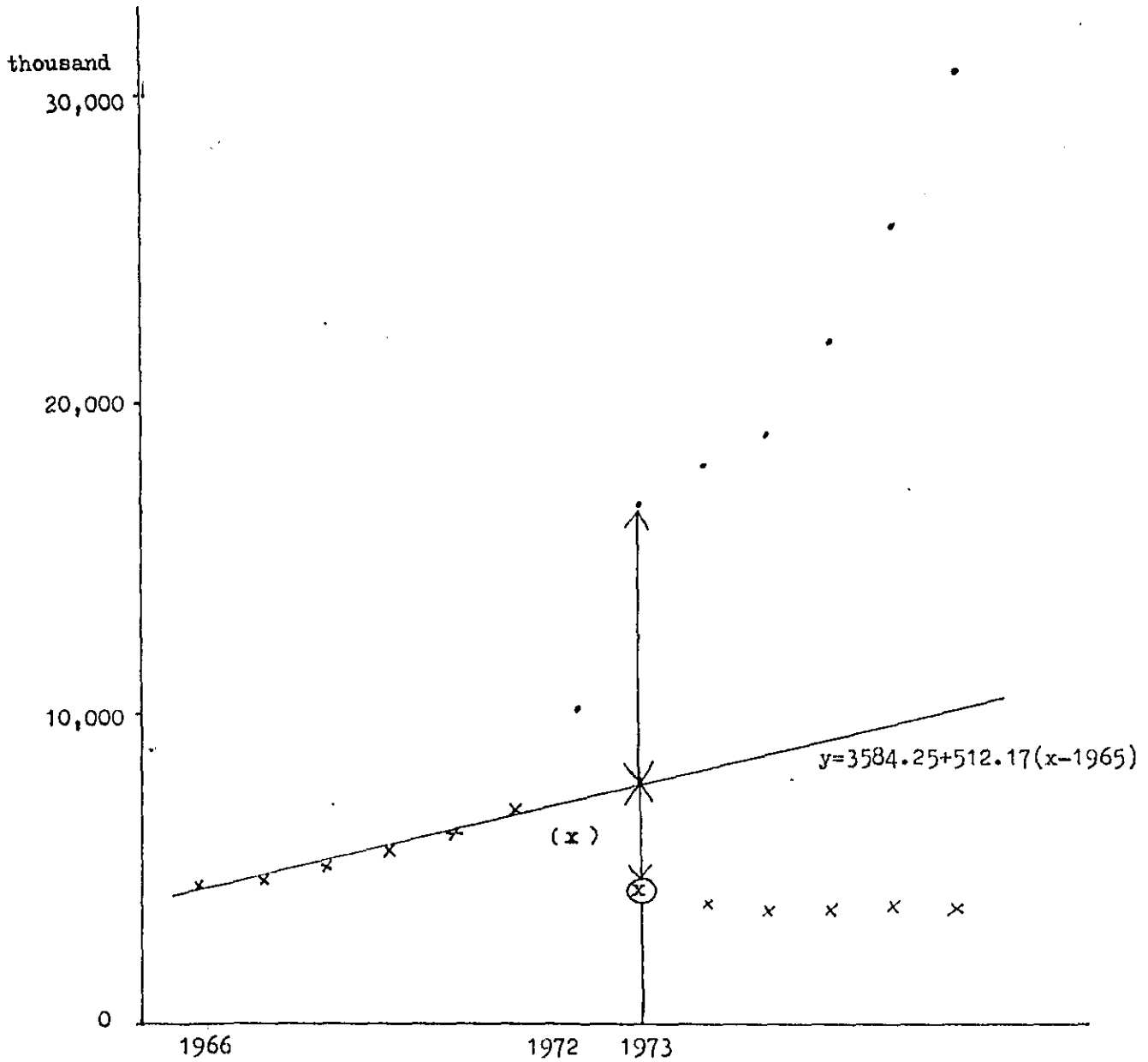


Table 8 Estimated contents of traffic by tunnel.

Year	Total (Thousand)	Diverted Traffic		Induced/Developed Traffic*	
		(Thousand)	(%)	(Thousand)	(%)
1973	12,526	7,682	(61)	4,844	(39)
1974	14,276	8,194	(57)	6,082	(43)
1975	15,298	8,706	(57)	6,592	(43)
1976	18,218	9,218	(51)	9,000	(49)
1977	21,870	9,730	(44)	12,140	(56)
1978	27,306	10,242	(38)	17,064	(62)

\* including diverted traffic from passenger

The above table shows the contents estimated according to the method mentioned in paragraph 5-1, and it indicates a great deal of induced/developed traffic and a rapid growth rate of traffic. The annual growth rates are respectively 16.9 % for total, 5.9 % for diverted traffic and 28.6 % for induced/developed traffic.

This fact evidences that the cross-harbour tunnel had great influences in inducing and developing vehicular traffic.

6.

List of Data Sources.

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2. Hong Kong Tourist Association Official Guide book
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