THE TUNNEL BUS IN HONG KONG: AN ANALYSIS OF USER PREFERENCES FOR A PUBLIC TRANSPORTATION SYSTEM

by

TIN-MING KO

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Tin-ming KO

School of Community and Regional
Planning
The Faculty of Graduate Studies
The University of British Columbia

ABSTRACT

The importance of consumer preference in transportation as a key to the forecasting of modal choice has received a growing recognition in the last ten years among transportation researchers in North America. Numerous studies of consumer attitudes toward transportation systems have been conducted in order to disclose the motivation underlying transportation consumer behavior.

In Hong Kong the situation is different. In the last decade, several city-wide transportation studies have been conducted, with detailed description of aggregate travel characteristics such as trip purpose, income, and origin-destination. Yet, relatively little is known about consumer values relevant to transportation mode selection decisions. There is a scarcity of information concerning the factors that affect consumer behavior in transport, and the relative importance of these factors. The need for research designed to find information which will help fill this void of information is substantial.

The objective of this thesis is to analyze, by means of an interview survey, the travelling behavior of the Tunnel-Bus passengers, and thereby to establish the relative importance of the different factors which lead to their mode selection decision.

Two pieces of analysis have been undertaken. First, an analysis of the personal, socio-economic and trip characteristics of the passengers is performed. Secondly, an analysis of the passengers' mode-choice decision is made. The passengers' mode-choice decision is related to their personal, socio-economic and trip characteristics. In the light of the findings of these two steps, an appraisal of the predictions of patronage made by the government before the Tunnel Bus was introduced is undertaken.

It is found that convenience and time-saving are the most important determinants that cause the passengers to use the Tunnel Bus. People are generally willing to pay more for a better, faster, more convenient transport mode for their cross-harbor journeys. Their grounds for choice of mode, however, vary with different groups of personal, socio-economic and trip characteristics such as, personal income, sex, trip purpose, frequency of use and previous transport mode.

The implications of the findings are that more refined estimates of both time and convenience are needed in the transportation analysis in Hong Kong, and that modal split models should be made sensitive to mode convenience, users' age and work characteristics as well as time and cost.

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CHAPTER I

INTRODUCTION

1.1 The Study of Consumer Preference in Transportation

The need for the study of consumer preference for public transportation systems has received substantial recognition in the last ten years among transportation researchers in North America. This recognition stems in part from a trend in mode choice analysis that adopts the abstract mode concept. Based on a thesis that it is the intrinsic properties of a good which gives satisfaction, not the good per se, the abstract mode concept defines a transport mode by its performance attributes and the relative utility of these attributes for the individual trip-maker. The choice of mode is considered a function of these performance attributes of a transportation system (Brown,1972:25-26). A second factor of importance is the perception of public transportation systems as existing within a competitive consumer-oriented market (Golob,et.al., 1972:81). This perception points out that if a public transportation system is to be successful, it must be designed to provide service which is attractive and competitive within a growing and changing consumer market. Both factors have

encouraged the use of better and more detailed information about public transportation users, their needs and preferences. One way to achieve an improvement in data selection is to evaluate the performance attributes of existing systems from the user's point of view (Golob, et.al., 1971:81). These needs and preferences, once determined, can then be used to improve modal split models.

A number of studies of consumer attitudes toward public transportation systems have been conducted in North America. The studies have concentrated on particular metropolitan areas, and specific transportation system concepts (Navin & Gustafson, 1973:1). Some of the studies focused on conventional bus service[1], others on demand responsive transits, such as dial-a-bus, and demand jitney[2]. The studies examined consumers' preferences for modes on the basis of their cost, speed, convenience and safety characteristics. It was found that there was a consistent preference ordering for transit attributes for most segments of the American population. Some of the characteristics, other than cost and time, found to be important in the mode-choice decision of the trip-maker were dependability, convenience, comfort and flexibility.

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[1]For example, McMillan and Assal (1968) and (1969); Paine, et.al. (1967); and Purdue University (1971).

[2]For example, Golob, et.al. (1971); and Gustafson, et.al. (1971).

In the case of Hong Kong, no similar studies have been documented to date. In the last decade, several city-wide transportation studies have been conducted which incorporated detailed descriptions of aggregate travel behavior. Yet, relatively little is known about consumer values relevant to transportation mode selection decisions. There is a scarcity of information concerning the factors that affect consumer behavior in transport, and the relative importance of these factors. Research designed to find information which will help fill this void is in order.

The Tunnel Bus service in Hong Kong provides a laboratory for an experimental analysis of the mode-choice behavior of the travelling public, for the Tunnel Bus is a new and so far very successful public transport mode in Hong Kong. The objective of this thesis is to analyze, by means of an interview survey, the travel behavior of the Tunnel-Bus users; and thereby to establish the factors or performance attributes perceived by the users to be important in determining their travel behavior.

This study differs from the attitudinal studies of transportation consumers in North America in an important way: The context in North American studies is one of competition between public and private transportation, whereas in Hong Kong such a context is not maintained. The reason is that, unlike the situation in North America where people depend heavily on automobile transportation, only a small minority of the people in Hong Kong possesses a car for daily use. Most people

are dependent on public transportation. Hence, this study deals with competition between two public transportation services and these are the Tunnel Bus and the ferry.

1.2 Background

General Situation

Hong Kong is a small "city-state" (England, 1976:1) presently ruled by a British colonial government[3]. In the course of history, Hong Kong has evolved as one of the most important metropolitan cities in East Asia, mainly as a result of the growth of trade and, more recently, of industry.

Before 1949 economic activities in Hong Kong were predominantly those of an entrepot. But the influx of refugees from China after 1946 has changed the situation. Among the refugees were many manufacturers from Shanghai and other

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[3]Hong Kong is situated on the southeast coast of China. Its total land area is 398.5 sq.miles, comprising three geographic-political divisions: (Map 1) (1) Hong Kong Island and a number of immediately adjacent islands covering 29.2 sq.miles; (2) Kowloon and Stonecutters Island covering 37.5 sq.miles; and (3) New Kowloon and the New Territories covering 365.6 sq.miles. The first two of these divisions were ceded to the British government after the infamous Opium Wars in 1842 and 1860 respectively and the third division was leased to the same government in 1898 for a period of ninety-nine years. In this thesis, however, these divisions are rearranged to be: (1) Hong Kong Island; (2) Kowloon, including Kowloon and New Kowloon; and (3) the New Territories. Hong Kong Island is separated from the last two by the Victoria Harbor.

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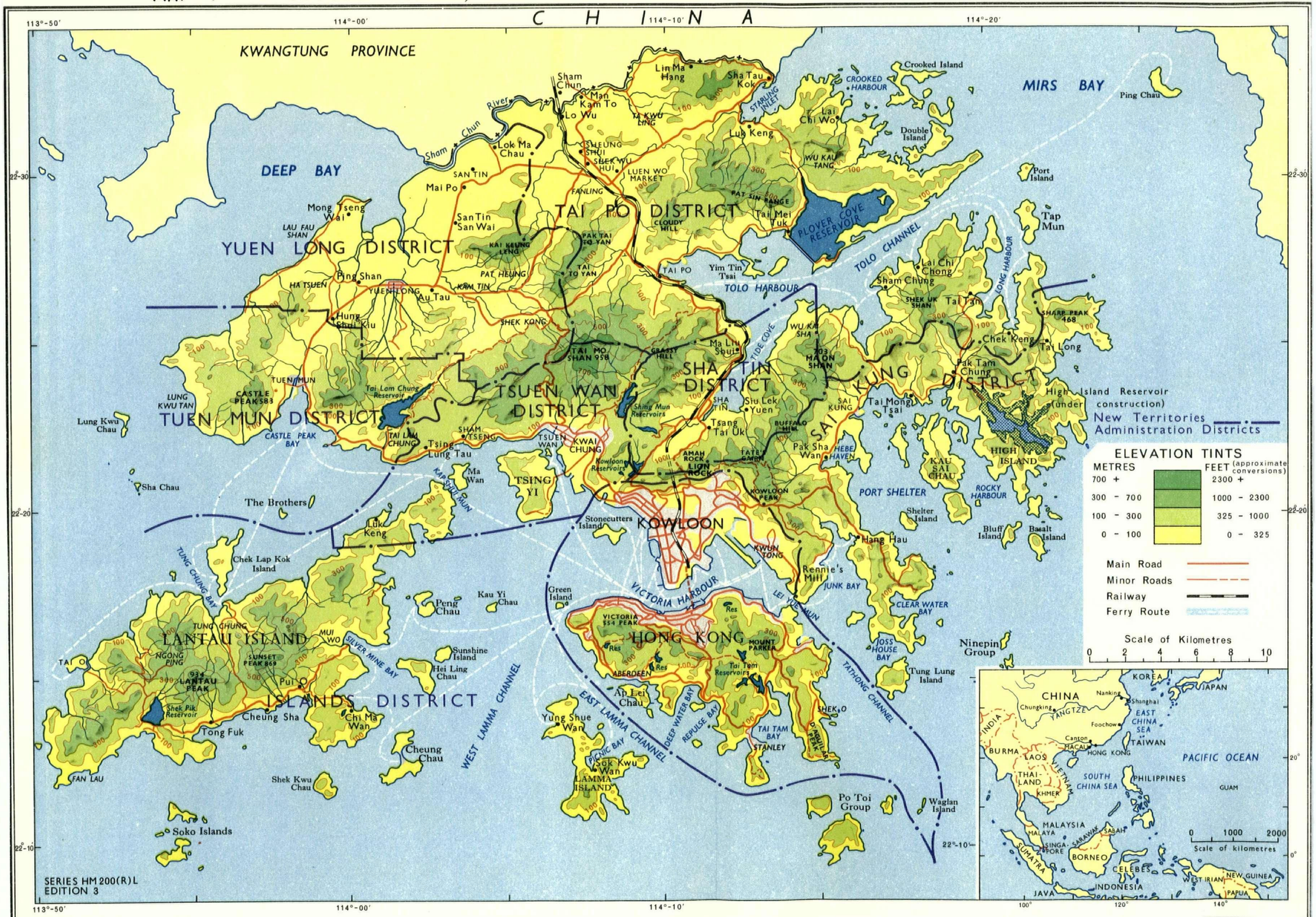
MAP 1

HONG KONG, KOWLOON AND THE NEW TERRITORIES



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cities. Their skill and capital have stimulated the development of an industrial economy. The export of manufactured goods increased from 10% of the total export value (including re-export) in 1947 to 75% in 1961, and since then it has never dropped below this percentage. The number of persons employed in manufacturing industry rose from 512,000 or 43.0% of the city's working population in 1961 to 756,000 or 47.7% in 1971, representing a percentage growth in absolute numbers of 47.4 over the decade (Census and Statistics Department, 1972:86).

Population growth of Hong Kong has been prodigious. In 1945 the population was just over 0.6 millions, but, by the time of the first post-war census in 1961, it had risen to 3.13 millions. Since then the population has increased at an annual rate of 2.5% in the inter-censal period to 1971 and in that year was 3.94 millions (Census and Statistics Department, 1972:21).

Urban growth of Hong Kong has taken place on both sides of the Victoria Harbor. After the War, urban development has been faster on the Kowloon side because of the availability of a greater area of flat land. Of the 3.94 millions population in 1971, 1.0 millions resided in Hong Kong Island, 2.2 millions in Kowloon and 0.67 million in the New Territories.

Internal Transportation

With the growth in population and the rapid expansion of industry, the amount of passenger and goods movement in Hong

Kong has gone up by leaps and bounds.

Public transport is the dominant means of personal travel, because less than 6.7% of its domestic households own a private car for daily use, according to the 1971 census (Census and Statistics Department, 1972:208). Subsequent surveys showed that public transport accounted for 87% of total passenger trips as estimated for 1974 (Smith and Associates, 1976:13).

Total public transport passenger travel has increased steadily over the years, but it seems that this trend is now levelling. The reason for this levelling could be that the existing public transport system has reached a saturation point. New mass transport facilities are needed to cater for future demands for public transport[4]. As a matter of fact, construction of a city-wide mass rapid transit system was started in 1975.

The number of private vehicles has also experienced a very rapid increase in recent years. Private cars increased from 56.9 thousands in 1966 to 119.3 thousands in 1974, representing a growth of 109.6% between these years. The government, however, is clearly in favor of public transport. Its actions in increasing registration and parking fees were able to bring the number of private cars down a bit to 114.4 thousands in 1975.

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[4]The demand for public transport is often described as a "7 days a week, 17 hours a day" demand.

Cross-Harbor Movement

The Victoria Harbor has made a significant contribution to the development of Hong Kong both as an entrepot and later as an important commercial and manufacturing center. But internally, the harbor creates a break in the "urban continuum" (Lo, 1971:40) and is a barrier to movement. In fact the distribution of population and employment on both sides of the harbor creates a massive demand for travel across it.

The number of cross-harbor journeys has grown since 1961[5] (Table 1.1). Although ostensibly cross-harbor passenger journeys constitute only around 20-26% of total public transport passenger journeys, many of them are multi-modal trips requiring the usage of one or two other public transport modes on one or both sides of the harbor to complete the journeys (Pang, 1972:4). Hence, a good portion of passenger journeys by public transport counted as trips in Kowloon and Hong Kong Island may actually be part of the cross-harbor journeys.

Formerly travel across the harbor was carried by ferries run by two companies, the Star Ferry and the Hong Kong and Yau Ma Ti Ferry, and on comparatively rare occassions by boats not belonging to these companies.

With the increasing sophistication of the economy and a

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[5] The drop in 1967 was due to a political and social riot initiated by the left-wing residents in Hong Kong.

Table 1.1

Cross-Harbor Passenger Journeys 1961-1976

Year	Number of Journeys('000)	% of Total Passenger Journeys	Index Number
1961	144,861	16.2	69
1966	210,239	16.9	100
1967	200,219	18.9	95
1968	210,588	17.6	100
1969	222,704	18.1	106
1970	230,725	19.8	110
1971	239,894	21.0	114
1972	240,285	22.5	114
1973	242,990	23.9	116
1974	257,236	23.1	122
1975	267,592	22.2	127
1976	283,357	22.2	135

Index number base: 1966=100

Source: Computed from: Transport Department, (1977).

continuous growth in population, the demand for a more efficient cross-harbor link between the two sides has become very pressing. To meet this demand, the long-planned Cross-harbor Tunnel was built. Construction started in 1969 and the Tunnel was officialy opened to the public on 2 August 1972[6]. This ended the monopoly of cross-harbor movement by ferry.

Tunnel Bus Traffic

Service by Tunnel Bus was started on 5 August 1972, jointly by the Kowloon Motor Bus Company and the China Motor Bus Company[7]. The popularity of the Tunnel Bus grew very rapidly. By 1976, the Tunnel Bus has expanded from three routes to nine routes, serving almost all major parts of the urban area[8] (Map 2).

Passenger volume on the Tunnel Bus rose constantly from an annual total of 46,641,000 in 1973 to 127,790,000 in 1977, representing an increase of 174%. On the other hand, the ferry experienced a steady fall. By 1976, the ferry annual pass-

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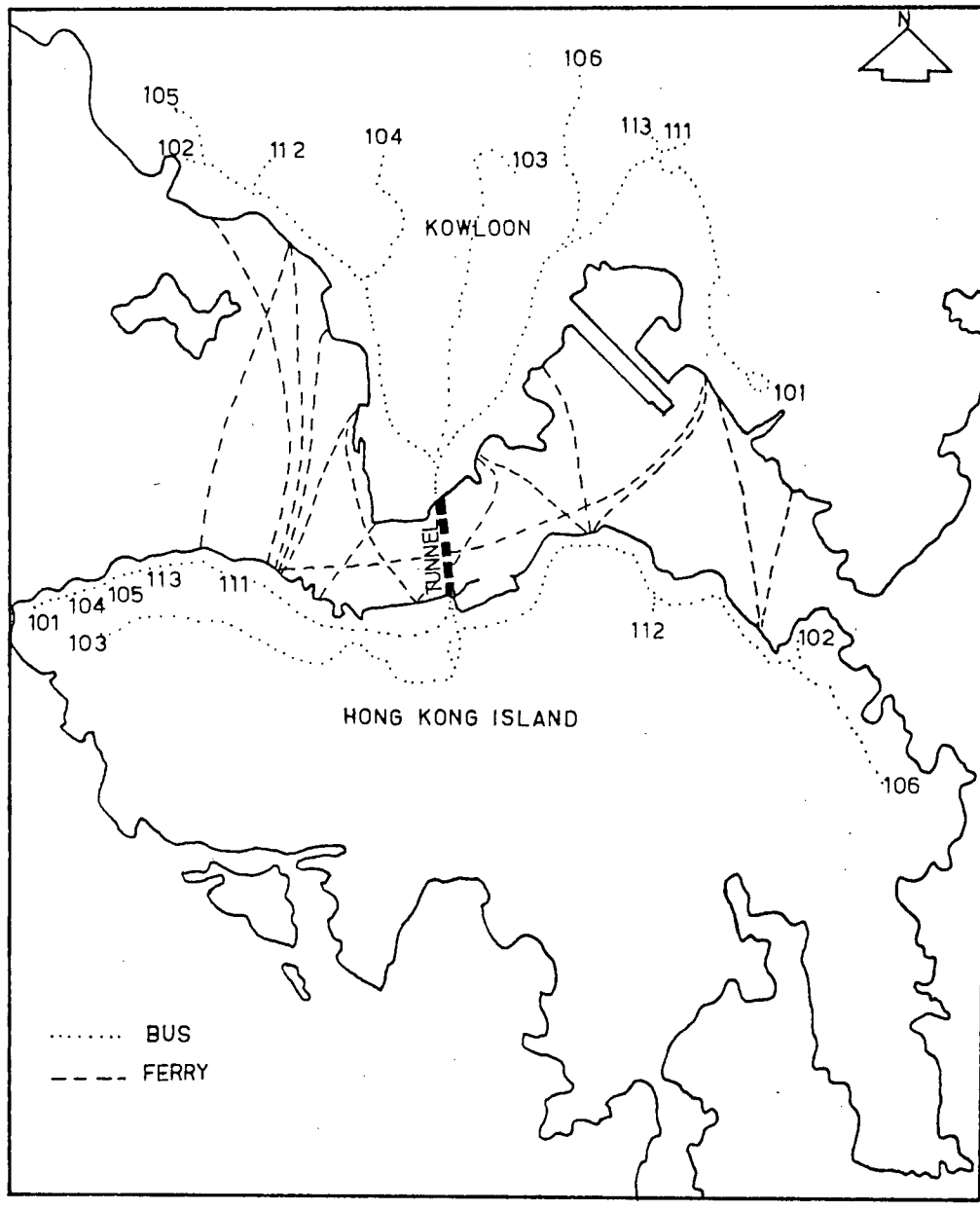
[6] See Appendix A for a discussion of the major events of the planning and implementation of the Cross-Harbor Tunnel.

[7] These bus companies have had the monopoly of motor bus operation in Hong Kong since 1933. The Kowloon Motor Bus Company operates in Kowloon, New Kowloon and the New Territories, the China Motor Bus Company on Hong Kong Island.

[8] Route numbers: 101,102,103,104,105,106,111,112,113. In addition to these, there is also a cross-harbor airport coach line and a route number 170 running only on Sundays and public holidays.

MAP 2 TUNNEL BUS AND FERRY ROUTES (1976)



enger volume had dropped to 169,496,000 from its 1971 figure (that is, before the Tunnel Bus was put into operation) of 239,894,000, representing a loss of 70,398,000, or 29.3% (Fig.1.1)[9].

The relative importance of the Tunnel Bus in cross-harbor movement has grown rapidly. In 1973, Tunnel-Bus journeys constituted only 19.2% of all cross-harbor movement, whereas in 1977, the figure rose up to 43.4% (Fig.1.2).

Thus the Tunnel Bus has continued to tap more and more of the ferry passenger traffic as well as generating more trips. It has thereby brought about a drastic change in the pattern of cross-harbor transportation and in the cross-harbor travelling behavior of many of the people in Hong Kong.

1.3 Organization of Subsequent Chapters

Chapter II of this thesis explains the research design and methodology adopted. Chapter III presents the characteristics of the Tunnel-Bus users, Chapter IV analyses the mode-choice determinants of these users and Chapter V presents the implications of the findings of this research.

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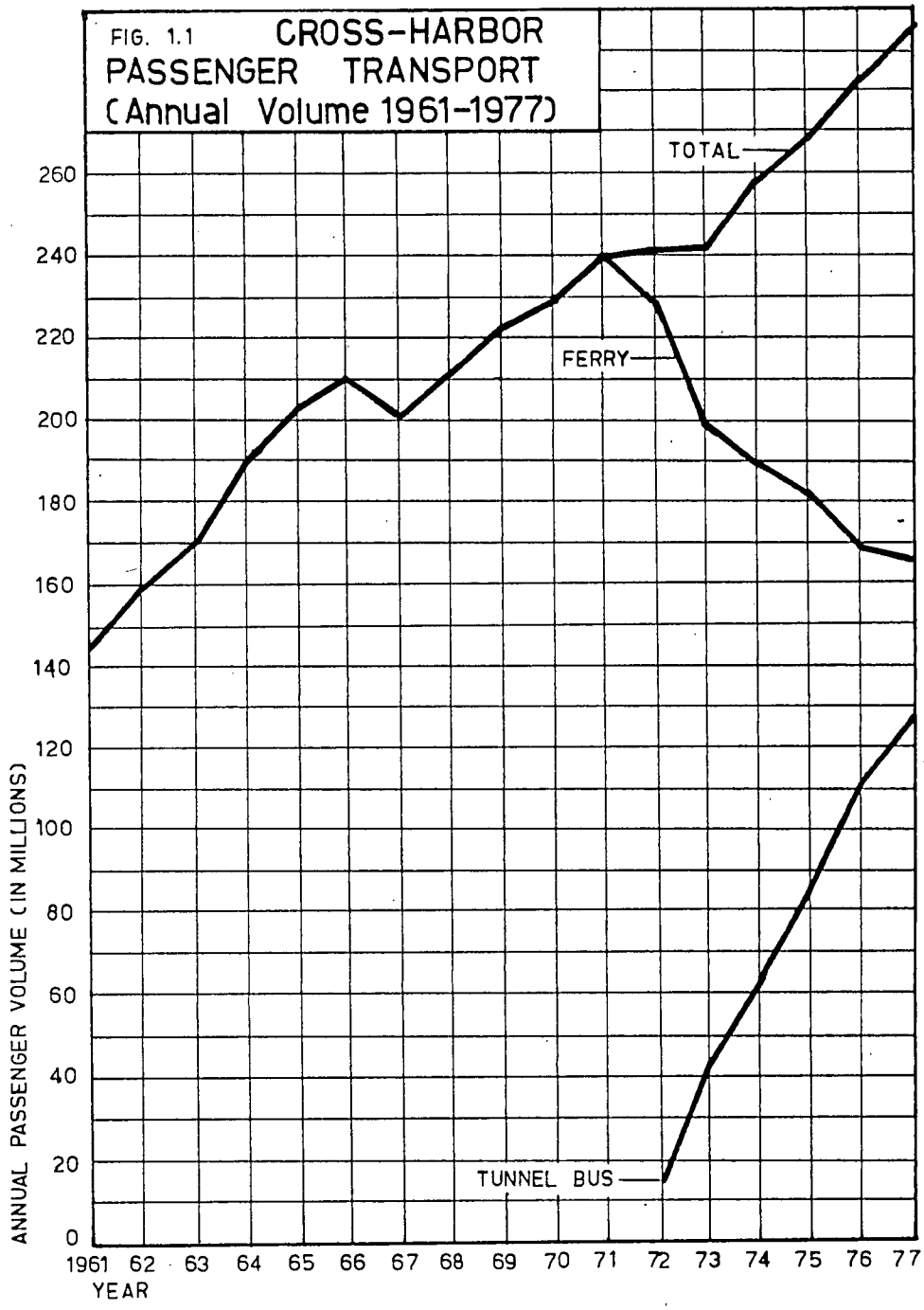
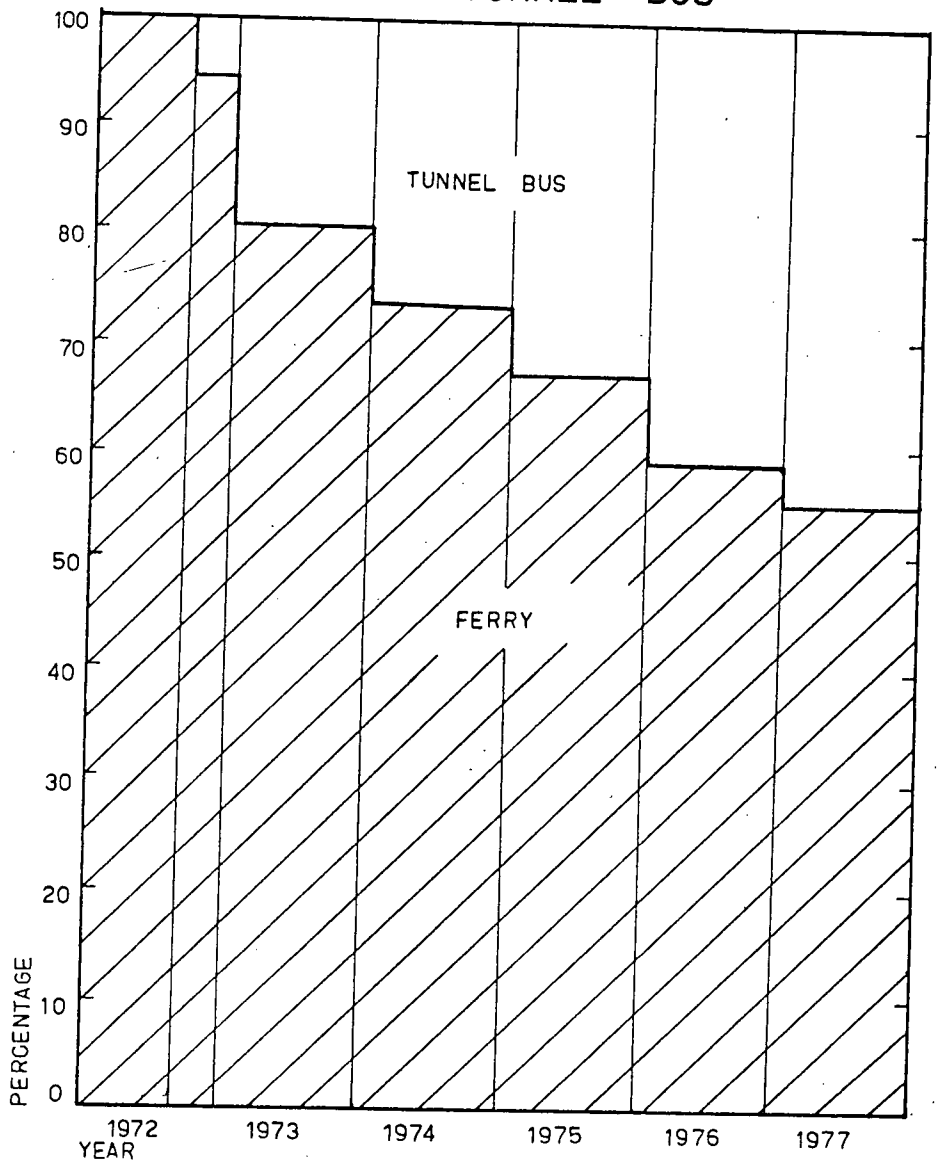
[9]Figures in this section are computed from Census and Statistics Department, (1973-1978).



Source: Census and Statistics Department (1973-78).

FIG.1.2 RELATIVE IMPORTANCE OF FERRY AND TUNNEL BUS



Source: Census and Statistics Department (1973-78)

CHAPTER II

METHODOLOGY

2.1 The Research Design

The thesis is designed to answer the following three questions:

(1) What attributes of the Tunnel Bus do the users regard as most valuable?

(2) What is the perceived relative importance of these attributes?

(3) How are personal, socio-economic and trip characteristics of the users related to the perceived importance of these attributes?

In order to answer these questions, two pieces of analysis have been undertaken. They are:

(1) An analysis of the personal and socio-economic as well as the trip characteristics of the Tunnel-Bus users. This forms a background to the next step.

(2) An attempt to decipher the factors that make the Tunnel Bus so popular, or in other words, to study why people use the Tunnel Bus in preference to the ferry system. The analysis of the mode-choice determinants assumes rational behavior on the part

of the Tunnel-Bus users and emphasizes the relative importance of the determinants, the nature of each of them, and their relationship to users' characteristics.

In the light of the findings of these two steps, an appraisal of the predictions of patronage made before the Tunnel Bus was put into service is carried out. An attempt is also made to discern the possible sources of errors in the prediction procedures and assumptions used.

The information needed was collected primarily from an interview survey of the Tunnel Bus patrons and secondarily from statistical publications of the government.

2.2 Organization and Method of the Survey

Problem at the Outset

In designing and conducting the survey of the Tunnel Bus users, the major problem encountered was a shortage of manpower. Although the survey were graciously assisted by some thirty students of the Department of Geography, Hong Kong Baptist College; each of the students, however, could contribute only a very limited amount of time to interviewing the Tunnel-Bus users. As a result the survey had to be structured and conducted so as to take account of the manpower constraint while maintaining an acceptable standard of statistical accuracy.

Pilot Survey

In order to ensure efficient use of manpower and the best possible collection of relevant information a pilot survey was conducted in the first week of August, 1976. 300 Tunnel-Bus users were interviewed at major bus stops selected randomly in both Kowloon and Hong Kong Island. As a result of the pilot survey, the format of the questionnaire was completely changed; the number of questions was reduced; the interviewing method was revised; and a new sampling procedure was established. On-bus interviewing was also attempted but was found impractical because most of the time the Tunnel Buses were over-loaded. Generally speaking, the Tunnel-Bus users were reasonably cooperative. They were, however, rather imprecise and hesitant toward questions that required answers in quantitative terms, such as travel time and costs.

Sampling Methods

In designing the sample size, the mean of the average daily traffic (ADT) for August 1975 (234,355 trips) and the annual average daily traffic (AADT) for 1975 (235,910 trips), were used as frames of reference. Thus, it was decided that population the survey was dealing with, that is, the number of cross-harbor person trips by Tunnel Bus, numbered about 240,000. In view of the time and manpower constraints, it was decided to draw a 1% sample. In a city-wide public transport study conducted by Wilbur Smith and Associates in

1964-65, a 1.5% sample was used for the bus survey and was found to be adequate (Dalby, 1965:14). Since the present study is focused on a more specific type of bus service, it was concluded that a 1% sample would be reasonable. Hence, the sample size of the interview survey was predetermined as 2,400 persons.

The sample was stratified by traffic district. The following steps were taken:

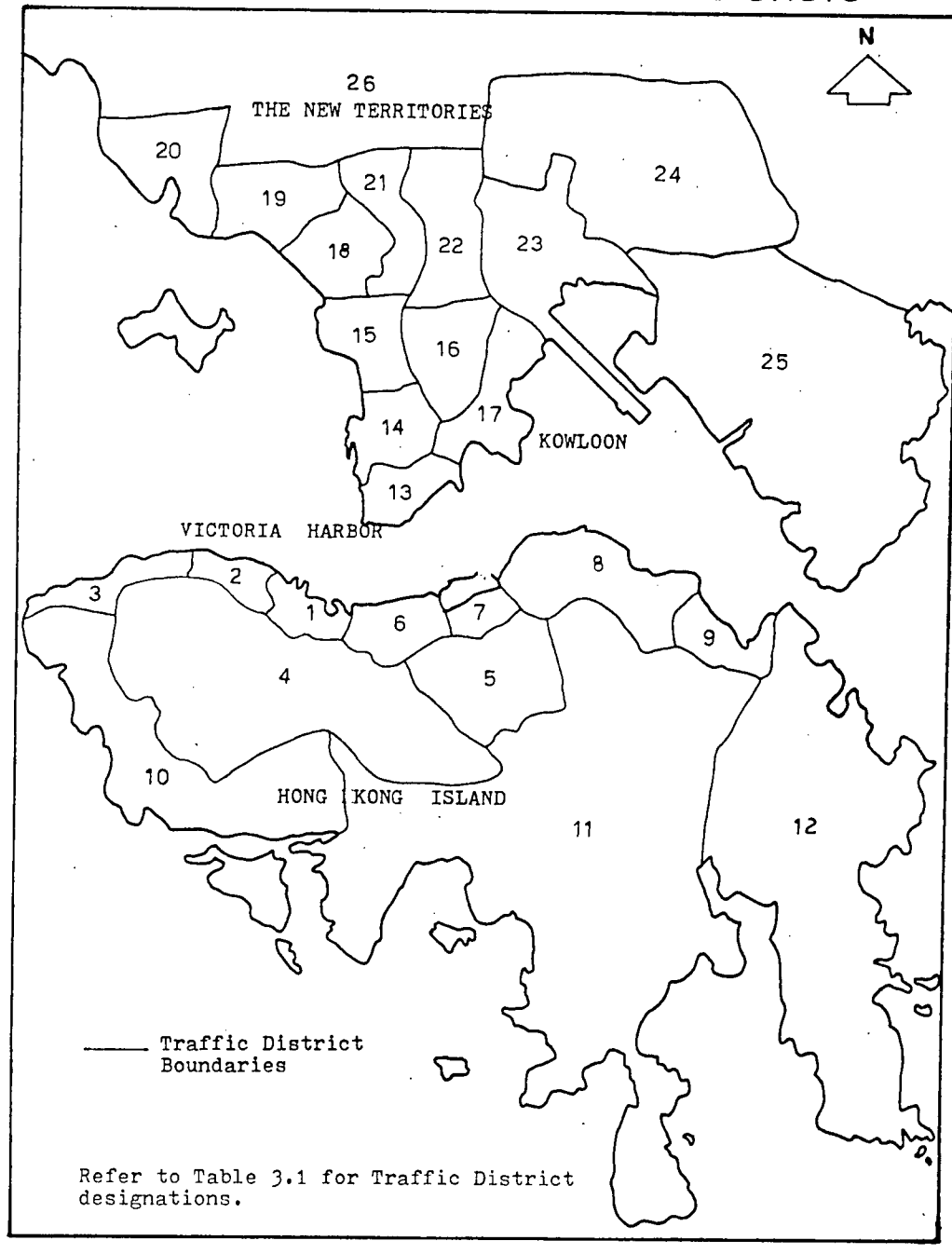
(1) Hong Kong was divided into traffic districts, basically following the scheme laid down by the Transport Department (Map2).

(2) The number of cross-harbor trip ends produced in each of these traffic districts was found from a government study of cross-harbor person trips by T.C. Hung (1970). This served as a criterion to distribute the predetermined sample size to these traffic districts.

(3) Traffic districts which are not served by the Tunnel Bus were not covered, but people from these districts who travelled across the harbor were included in the traffic districts nearest to them, which were served by the Tunnel Bus.

(4) Hence, the following formula was used to determine the sample sizes for each traffic district:

MAP 3 THE STUDY AREA AND TRAFFIC DISTISTS



Refer to Table 3.1 for Traffic District designations.

$$ASS_i = \frac{TE_i}{\sum_{i=1}^{n} TE_i} \times TSS$$

Where,

ASS_i = Sample size for traffic district i;

TE_i = Trip ends produced in traffic district i;

$\sum_{i=1}^{n} TE_i$ = Total cross-harbor trip ends produced in all traffic districts;

TSS = Total sample size, that is, 2,400 persons;

i = Traffic district number;

n = Total number of traffic districts.

Date and Duration of Survey

The interview survey was carried out on weekdays from 21 August to 26 August 1976 (that is Monday through Friday). According to the 1975 data, the average daily traffic of Tunnel Bus passenger traffic for August, 234,355 trips, was closest to the average of the monthly average daily traffic for that year, 235,985 trips. The difference was only 0.7%. Hence it was conluded that a survey conducted in August would be satisfactory.

Each of the survey days was divided into three time periods to represent the morning 'work-trip period'[1], the

[1] In Hong Kong, the morning and afternoon peak periods are not as distinct as they are in most North American cities. They are, however, also dominated by work-trips.

base-day period, and the afternoon 'work-trip period'. They were 7:00-9:30 a.m., 10:30 a.m.-3:00 p.m., and 4:00-6:00 p.m. time periods, respectively. The higher volume of 'work-trip periods' was offset by the longer duration of base-day period to give a roughly constant sampling proportion.

Interview Method and Venue

Personal interviewing was adopted. Tunnel-Bus passengers were interviewed at the origin-ends of their trips. To ensure that ample time for the interview was allowed interviewing began with the last person of a queue at the Tunnel Bus stops in each of the traffic districts after the departure of a Tunnel Bus. Caution was made to see that passengers waiting for different Tunnel routes were more or less proportionately included. However, since volume data by route were not available to us, no precise calculation was made to stratify the sample by route.

The Questionnaire

The questionnaire was designed to find two major types of data which relate to the objectives of this research. The first type of data covered patronage characteristics, including personal, socio-economic and trip data. The second type of data concerned the patrons' reasons for using the Tunnel Bus. The first two reasons given were recorded in order of priority.

The answers to the questions in the questionnaire were pre-coded based on the findings of the pilot survey. A copy of the questionnaire and the questions asked are included in Appendix B.

2.3 Data Analysis

The successfully completed questionnaires were edited, classified, coded and card-punched for computer analysis. Cross-tabulations of the information scanned were performed on an IBM 1130 computer at the Computing Center, Hong Kong Baptist College. Subsequent analyses were done on an IBM 370 computer at the Computer Center, the University of British Columbia, as well as on a table calculator.

Three statistical tests were used to test working hypotheses arising throughout the analysis. They are, the 'z' test, the analysis of variance and the Chi-square test[2].

In all the statistical tests, a significance level of 0.05 was adopted.

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[2] See Appendix C for a brief description of the basic mechanics of each of these tests. For more detailed and analytic explanation, see Yeomans (1968).

CHAPTER III

PATRONAGE CHARACTERISTICS

3.1 General Remarks on the Survey Results

The weather was fine throughout the survey days and no unusual traffic conditions in the city were observed. Thus the results of the survey can be considered undistorted by unusual conditions.

A higher number of successful interviews than expected was achieved in most of the traffic districts, thus securing the degree of accuracy anticipated in choosing the sample size (Table 3.1). An interview was considered usable if the reason(s) of the user interviewed for using the Tunnel Bus could be determined even when other characteristics of the user were missing or unclear. The final size of the sample was 2,466 persons.

The sample collected also gives a fairly good representation for all the Tunnel Bus routes, despite the fact that no stratification by route was made (Table 3.2). However, a 1% sample of average daily trips was not achieved. The reason for this was that the average daily traffic for August 1976 turned out to be 315,129 trips and the annual average daily traffic for 1976, 311,087 trips, representing a consid-

Table 3.1

Traffic Districts and Areal-Stratified Sample Sizes

Traffic District Number	Name	Cross-harbor trip-ends produced ('000) (1970)	Areal-Stratified sample sizes Designed	Achieved
(Hong Kong Island)				
1	Central	62,197	271	283
2	Sheung Wan	42,168	184	192
3	West	26,622	116	121
4	Mid-Levels	14,639	64	67
5	Tai Hang	10,279	45	47
6	Wan Chai	39,365	171	179
7	Causeway Bay	17,152	75	78
8	North Point	40,831	178	186
9	Shau Kei Wan	9,220	40	42
10	Pokfulam	8,430	45	38
11	South	1,940		
12	Chai Wan	4,715	21	21
(Kowloon)				
13	Tsim Sha Tsui	32,563	142	148
14	Yau Ma Tei	35,414	154	151
15	Monkok	45,207	197	206
16	Homantin	6,702	29	30
17	Hung Hom	31,954	139	145
18	Sham Shui Po	30,754	134	130
19	Sheung Sha Wan	9,419	41	43
20	Lai Chi Kok	6,403	28	20
21	Tai Hang Tung	3,231	14	15
22	Kowloon Tong	6,184	27	28
23	Kowloon City	26,084	117	119
24	North Kowloon Bay	7,898	34	36
25	East Kowloon Bay	31,087	135	141
		551,005	2,401	2,466

Table 3.2

Distribution of Patrons Interviewed by Route Number

Tunnel Bus Route Number	Patrons Interviewed Number	% of Total
101	404	16.4
102	395	16.0
103	170	6.9
104	343	13.9
105	313	12.7
106	171	6.9
111	184	7.5
112	286	11.6
113	196	7.9
Route number missing	5	0.2
Total	2,466	100.0

erable increase of 34.5% and 31.9% over the equivalent figures for 1975. The sample therefore is approximately 0.8% of the average daily traffic of the Tunnel Bus. The difference between the planned and achieved sample sizes is however not big. Moreover, a comparison of the origin-destination table of a more extensive survey of cross-harbor person trips conducted by the Traffic and Transport Survey Division, in 1970[1], reveals that they were similar in terms of principal directions of movement. This suggests that the sample collected is adequate and reasonable.

3.2 Personal and Socio-Economic Characteristics

The personal and socio-economic characteristics of the patronage are tabulated in Table 3.3 A and B.

For sex composition, male patrons make up 62.2% of the total and female patrons represent 37.7%. The ratio between male and female patrons is therefore 1.65 to 1.0.

For age distribution, the 21-50 age group accounts for 79.4% of the patronage. The 21-30 age group represents 51.7% and old people above 50 years of age constitute only 4.6%.

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[1]The survey was requested by the Commissioner for Transport in November, 1969, in order to establish the pattern of cross-harbor person movements and provide the information necessary for the design of bus routes that might use the cross-harbor tunnel. During the survey, 56,559 ferry passengers were interviewed. See Hung (1970).

Table 3.3 A

Personal Characteristics of the Patronage

Categories	Number of Patrons	% of Total
I. SEX		
Male	1,535	62.2
Female	931	37.8
Total	2,466	100.0
II.AGE		
(Years)		
11-20	348	16.0
21-30	1,122	51.7
31-40	417	19.8
41-50	184	8.5
51-60	77	3.5
61 and over	24	1.1
Total	2,172	100.0
No answers: 294		

Table 3.3B

Socio-Economic Characteristics of the Patronage

Categories	Number of Patrons	% of Total
I. OCCUPATION		
Clerical	568	26.4
Service	307	18.9
Factory	448	20.8
Professional	220	10.2
Managerial	20	0.9
Student	301	14.0
Housewife	139	6.5
Unemployed	47	2.2
Total	2,150	100.0
No answers: 316		
II. INCOME (HK$)		
1 - 500	79	4.3
501 - 1,000	745	40.8
1,001 - 1,500	480	26.3
1,501 - 2,000	151	8.3
2,001 - 2,500	53	2.9
2,501 and more	71	3.9
No Fixed Income	247	13.5
Total	1,826	100.0
No answers: 640		

The frequency distribution of occupation for the Tunnel-Bus patronage is uneven among the categories given. Clerical (26.4%), factory (20.8%), and service (18.9%) workers are the largest groups. This reflects the not uncommon practice of these categories of workers to work across the harbor from their homes and the decentralization housing policy of the government, which generally does not take into consideration the residence-work place relation. Less active groups in the population such as housewives and the unemployed form only a small fraction of Tunnel-Bus users.

Many of the interviewees declined to respond to the question on personal monthly income. From the replies received it can be said that generally the majority of the patronage has a monthly income between HK$500 and HK$1,500[2]; this is in accordance with the findings of the occupation distribution.

Summing up, the survey reveals that the Tunnel patronage is predominantly young and economically active, with an average income around HK$1,000. Male users are more numerous than female users.

3.3 Trip Characteristics

Origin and Destination

Trip ends are found to be concentrated in traffic districts of large employment and commercial concentrations and

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[2]The offical rate for conversion in 1973 was HK$5.085=US$1.00. From 26 November 1974, Hong Kong dollar floated.

high population density. These include the Central, Wan Chai, Causeway Bay, and North Point on the Island and Monkok, Sham Shui Po and East Kowloon Bay Area (comprising of Kung Tong, Choi Hung and San Po Kang) in Kowloon (Table 3.4).

Six principal directions of movement are identified. They are: (Refer to Map 3 for locations of the origin and destination traffic districts).

(1) Central to Monkok

(2) Sheung Wan to East Kowloon Bay Area

(3) East Kowloon Bay Area to Wan Chai

(4) East Kowloon Bay Area to Central

(5) Monkok to Causeway Bay

(6) Central to Monkok

Work trips comprise a lion's share of journeys in these directions.

Trip Purposes

80.1% of the trips are home-based. Work trips form the single largest group (56.9%) [3]. This fact substantiates

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[3]The Comprehensive Transport Study of the city conducted in 1974 revealed that 47.5% of passengers of all public buses travelled for work purposes. Social trips were only 7.5%; recreation trips, 4.7% and education trips, 23.4% (Smith, 1976:63, Table 4.6). Hence, it is obvious that the trip-purpose composition of the Tunnel Bus patronage differs from that of overall bus service in Hong Kong. On the other hand, 57.3% of ferry person trips was shown to be work trips. This supports the finding of this research that daily commuters form the single largest group of cross-harbor traffic.

Table 3.4A

Origin and Destination of Person Trips: Hong Kong Island to Kowloon

Origin Traffic Districts	Destination Traffic Districts														
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total
1	1	8	87	22	51	25	4	29	3	23	38	12	23	3	329
2	1	11	56	23	31	27	2	10	5	13	45	24	65	0	313
3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
4	0	0	0	0	3	1	0	1	0	0	0	0	0	0	5
5	0	2	0	8	4	0	0	0	0	5	12	5	1	0	37
6	0	8	35	1	28	15	7	20	11	1	23	8	22	0	179
7	0	0	1	7	10	3	1	3	0	3	22	6	0	3	69
8	0	10	35	5	31	26	8	23	0	4	7	1	2	4	156
9	0	1	20	0	7	3	1	4	0	0	4	0	0	2	42
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	3	0	9	0	0	0	0	0	6	0	0	0	18
Total	2	41	247	66	174	100	23	90	19	49	157	56	113	12	1149

Table 3.4B

Origin and Destination of Person Trips:

Kowloon to Hong Kong Island

Origin Traffic Districts	Destination Traffic Districts												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
13	6	0	2	3	1	10	7	7	5	1	0	2	44
14	1	3	1	0	0	2	2	4	0	0	0	0	13
15	29	7	3	15	11	49	56	36	18	5	0	4	233
16	18	2	0	0	1	5	5	0	0	1	0	0	32
17	53	18	10	1	4	44	18	14	7	3	2	2	176
18	36	3	6	4	0	24	30	31	17	0	0	1	152
19	18	1	1	0	1	10	6	8	10	0	0	1	56
20	5	0	0	0	2	0	9	6	5	0	0	3	30
21	19	4	5	1	0	9	3	2	1	0	0	0	44
22	13	2	0	2	2	2	2	2	0	1	0	0	26
23	41	5	0	3	3	23	16	10	6	0	3	6	116
24	3	0	0	0	0	6	0	0	1	0	1	0	11
25	59	21	18	3	6	63	18	2	0	2	0	0	192
26	4	1	2	1	0	4	1	1	0	0	0	0	14
Total	305	67	48	33	31	251	173	123	70	13	6	19	1139

Total both directions: 2288

No answers: 178

our earlier observation that the person trips of the Tunnel Bus originate and end predominantly in traffic districts of high employment potentials and residential density. In other words, commuters are the heaviest users of the Tunnel Bus.

The next largest group is social trips (22.1%). Recreation, shopping, education and other-purpose trips play very minor roles. This suggests that the Tunnel Bus is largely used for trip purposes with strict time and place obligations (Table 3.5)

Table 3.5

Trip Purposes of the Patronage

	Home-based		Non-home-based		Total	
Trip Purpose	Number	%	Number	%	Number	%
Work	911 (79.9%)	56.7	229 (20.1%)	57.4	1140 (100.0%)	56.9
Study	133 (71.2%)	8.3	54 (28.8%)	13.5	187 (100%)	9.3
Social	356 (80.4%)	22.2	87 (19.6%)	19.6	443 (100%)	22.1
Shopping	72 (85.8%)	4.5	12 (14.2%)	3.0	84 (100%)	4.2
Recreation	114 (88.4%)	7.1	15 (11.6%)	3.8	129 (100%)	6.4
Others	20 (90.9%)	1.2	2 (9.1%)	0.5	22 (10.0%)	1.1
Total	1606	100.0	399	100.0	2005	100.0

No answers: 461

Frequency Using the Tunnel Bus

Over half (51.9%) of the patronage has a high frequency of travelling on the Tunnel Bus across the harbor. 20.9% of them travel daily and 31.0% on all weekdays (Table 3.6A). Combining the frequency of travelling and trip purposes, we find that the majority of the high-frequency users travel for work purposes (Table 3.6B). No special feature is observed for those patrons of medium frequency, however, for those who travel occasionally, social trips predominated (39.7%).

Table 3.6A

Frequency Using Tunnel Bus

Category	Number of Patrons	% of Total
Everyday	444	20.9
Weekdays only	657	31.0
4-5 days	181	8.5
1-3 days	182	8.6
Occasional	656	31.0
Total	2120	100.0

No answers: 346

Table 3.6B

Frequency Using Tunnel Bus by Trip Purpose

Frequency Using	Trip Purpose: Work Number	Work %	Study Number	Study %	Social Number	Social %	Shopping Number	Shopping %	Recreation Number	Recreation %	Others Number	Others %	Total Number	Total %
Everyday	289	76.9	21	5.5	45	12.0	10	2.7	9	2.4	2	0.5	376	100.0
Weekdays only	486	76.4	83	13.1	40	6.3	9	1.4	18	2.8	0	0.0	636	100.0
4 - 5 days	72	40.4	18	10.1	68	38.2	5	2.8	15	8.4	0	0.0	178	99.9
1 - 3 days	99	56.6	15	8.6	43	24.6	8	4.6	9	5.1	1	0.6	175	100.1
Occasional	172	28.4	46	7.6	246	40.6	53	8.7	71	11.7	18	3.0	606	100.0
Total	1118		183		442		85		122		21		1971	

No answers: 495

Trip Time

The mean trip time of the patronage is 30.8 minutes. The trip-time frequency distribution (Table 3.7 and Fig. 3.1) skews to the left, forming a peak at the 21-30 minute interval and dropping abruptly to the right from the 51-60 minute interval. This indicates that most of the patrons (90.7%) spend less than 50 minutes and half of them (55.2%) spend less than 30 minutes in their cross-harbor journeys by Tunnel Bus.

Table 3.7

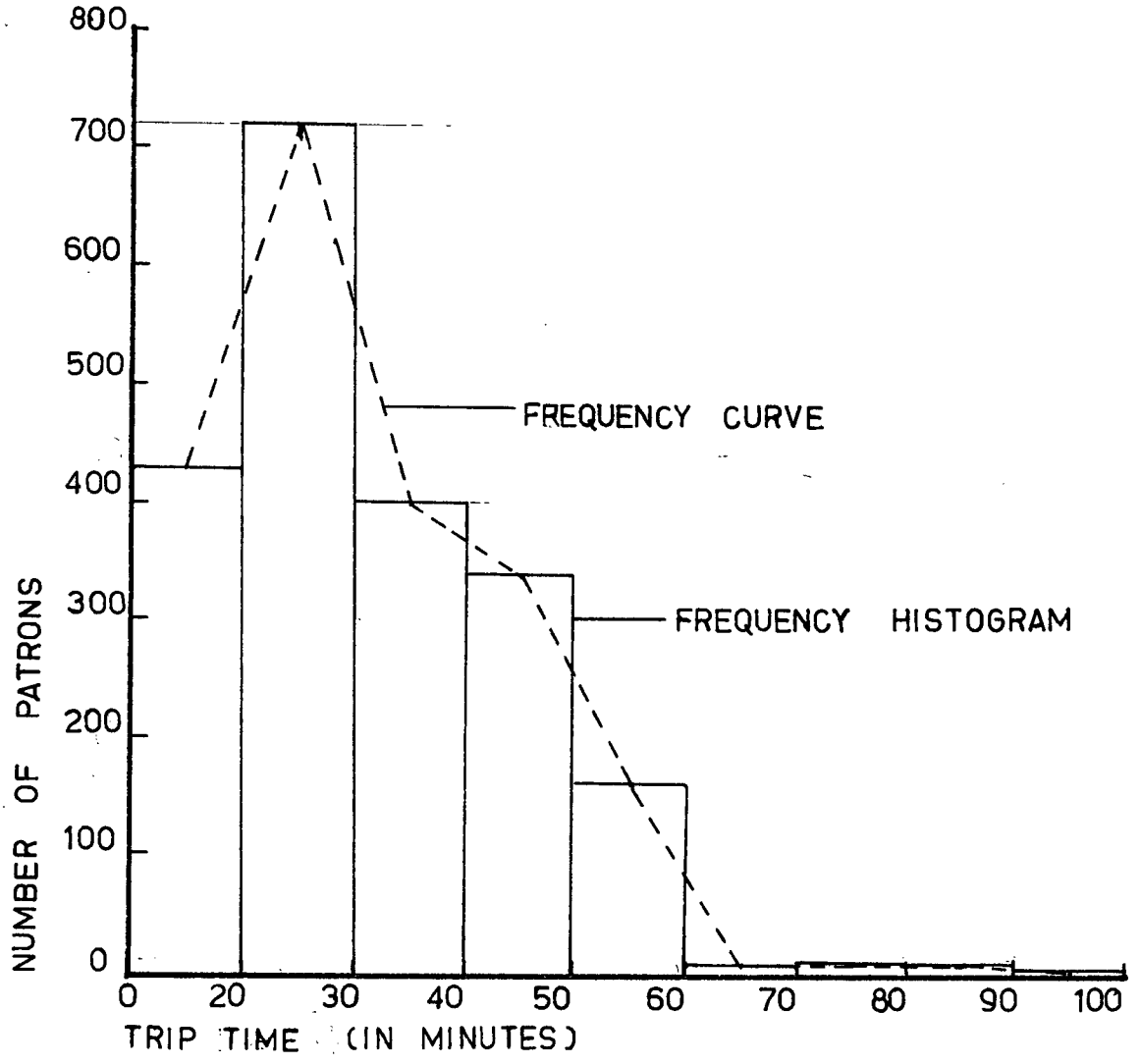
Trip Times

Trip Times (minutes)	Number of Patrons	% of Total
20 and under	429	20.6
21-30	721	34.6
31-40	400	19.2
41-50	341	16.3
51-60	160	7.7
61-70	9	0.4
71-80	11	0.5
81-90	10	0.5
91 and more	5	0.2
Total	2086	100.0

No answers: 380

FIG. 3.1

TRIP-TIME FREQUENCY DISTRIBUTION



Mode Link

The majority of trips require only one mechanical transport mode, that is, the Tunnel Bus, and no transfer to complete. As a matter of fact, the number of patrons decreases with the increase of the number of trip legs per person trip. 25.1% use a mechanical transport mode, either a bus or another type of vehicles, on one side of the harbor, and only 5.3% complete their journeys with transfer to mechanical transport modes on both sides of the harbor (Table 3.8).

Table 3.8

Mode Link of Person Trips

Mode Link	Number of Patrons	% of Total
Walk-Tunnel Bus-Walk	1712	69.4
Walk-Tunnel Bus-Bus	201	8.2
Walk-Tunnel Bus-Others	101	4.1
Bus-Tunnel Bus-Walk	211	8.6
Bus-Tunnel Bus-Bus	61	2.5
Bus-Tunnel Bus-Others	38	1.5
Others-Tunnel Bus-Walk	108	4.4
Others-Tunnel Bus-Bus	20	0.8
Others-Tunnel Bus-Others	14	0.6
Total	2466	100.1

Summing up, the results of the survey show that the Tunnel Bus is used regularly by daily commuters who generally spend around 30 minutes on their journeys. That is to say, daily commuters are the most dependable users of the Tunnel Bus. The Tunnel Bus proves to be most acceptable for cross-harbor journeys with time and place restrictions.

CHAPTER IV

MODE-CHOICE DETERMINANTS

4.1 The Nature of the Mode-Choice Determinants

Relative Importance

The two dominant reasons for using the Tunnel Bus are convenience and time-savings. In other words, convenience and time-savings are the major mode-choice determinants for the Tunnel-Bus users.

Counting only the first reason given by the people interviewed, 51.5% of the users prefer the Tunnel Bus because it is more convenient than the ferry; whereas 43.9% prefer the Tunnel Bus because it is faster than going by ferry. That is to say, the people interviewed place convenience as slightly more important than time reduction in determining their use of the Tunnel Bus (Table 4.1).

There is one caution with respect to these two mode-choice determinants. Since convenience usually includes saving of time resulting from reduction of transferring, it may also be reflected in the reduction of travel time. Double counting may be committed when taking both factors into consideration. But, in this case, only 36.7% of the patronage who claim convenience as the first reason for using the

Table 4.1

Combination of Reasons for Using Tunnel Bus

Given as First Reason	Given as Second Reason					
	Money-Saving	Time-Saving	Convenience	Comfort	Others	Total
Money-Saving						
Number:	(16)	9	7	0	0	32
Row %:	50.0	28.1	21.9	0	0	100.0
% of Total:	0.7	0.4	0.3	0	0	1.3
Time-saving						
Number:	22	(696)	354	10	0	1082
Row %:	2.0	64.3	32.7	1.0	0	100.0
% of Total:	0.9	28.2	14.4	0.4	0	43.9
Convenience						
Number:	39	466	(752)	14	0	1271
Row %	3.1	36.7	59.2	1.1	0	100.0
% of Total:	1.6	18.9	30.5	0.6	0	51.5
Comfort						
Number:	0	3	1	(23)	0	27
Row %:	0	11.1	3.7	85.2	0	100.0
% of Total:	0	0.1	0.04	0.9	0	1.1
Others						
Number:	0	0	0	0	(54)	54
Row %:	0	0	0	0	100.0	100.0
% of Total:	0	0	0	0	2.2	2.2
Total						
Number:	61	478	362	24	(Column): 0	2466 925
Row %:	6.6	51.7	39.1	2.6	0	100.0
% of Column Total:	2.5	19.4	14.7	1.0	0	

*Numbers in ( ) on the main diagonal are the numbers of users who gave one single reason. Thus, these numbers are not added to the respective column totals.

Tunnel Bus also name time-saving as the second reason; likewise, only 32.7% of the patronage whose first reason is time-saving also have a second reason of more convenience. These indicate that the Tunnel-Bus users do see the two factors as two different things.

A very tiny proportion of the patronage travel by Tunnel Bus because it is cheapter or more comfortable. The fact that as little as 1.3% of the patronage name money-saving as the first reason for using the Tunnel Bus suggests that the Tunnel Bus may not be a cheap cross-harbor transport mode and that the patronage are not so cost sensitive as the government predicted (see Chapter V).

The nature of each of the mode-choice determinants is discussed subsequently. Particular references will be given to the two predominant ones, that is, convenience and time-savings.

Convenience

Convenience is the most important mode-choice determinant. It refers, inferring from our analysis, mainly to the avoidance of transfers. This statement is concluded from the following facts:

First, among the patrons interviewed who previously crossed the harbor by ferry, 68.8% complete their journeys by walk-Tunnel Bus-walk link. When they travelled by ferry, only 9.4% of these passengers completed their journeys by walking. This means that 59.4% of the passengers have shifted

from whatever mode links they used previously to walk-Tunnel Bus-walk sequence. They have saved the trouble of transferring by switching to the Tunnel Bus (Table 4.2)

Second, as many as 76.4% of the patronage have had the number of trip-legs reduced: 28.8% by two vehicle trip-legs; 47.6%, one (Table 4.3).

It appears that the patrons who have had the larger number of trip-legs reduced have a slightly bigger tendency to choose more convenience as their reason for using the Tunnel Bus. The significance of this tendency is examined using a chi-square test (Table 4.3).

Third, for that portion of the patronage who did not cross the harbor before the Tunnel Bus was in service, 77.5% require only the Tunnel Bus to complete their cross-harbor journey. 20.8% of them require one more mechanical transport mode than the Tunnel Bus and only 1.7% need two more to complete their journeys (Table 4.2)

Fourth, for the entire patronage, 69.4% are taken solely by the Tunnel Bus from their origins directly to their destinations, 25.3% require another vehicle mode on one side of the harbor, and 5.3% require one on both sides of the harbor to complete the journeys.

Time-Savings

The second most important mode-choice determinant is time-saving. 43.9% of the patronage name time-saving as the first reason for using the Tunnel Bus. Unfortunately, when

Table 4.2

Mode Link of Person Trips Before and After the Tunnel Bus Was Introduced

Before		After W-T-W	W-T-X or X-T-W	X-T-X	Total
A. Those who did cross harbor before:					
W-F-W	N:	166	43	5	214
	R:	77.6	20.1	2.3	100.0
	C:	10.5	7.4	3.8	9.4
	CC:	9.7	6.9	3.8	8.7
W-F-X	N:	749	202	43	994
or	R:	75.4	20.3	4.3	100.0
X-F-W	C:	47.6	34.6	33.1	43.4
	CC:	43.8	32.5	32.3	40.3
X-F-X	N:	659	339	82	1080
	R:	61.0	31.4	7.6	100.0
	C:	41.9	58.0	63.1	47.2
	CC:	38.5	54.6	61.7	43.8
Sub-	N:	1574	584	130	2288
total	R:	68.8	25.5	5.7	100.0
	C:	100.0	100.0	100.0	100.0
	CC:	91.9	94.0	97.7	92.8
B. Those who did not cross harbor before:					
	N:	138	37	3	178
	R:	77.5	20.8	1.7	100.0
	CC:	8.1	6.0	2.3	7.2
Grand-	N:	1712	621	133	2466
total	R:	69.4	25.2	5.4	100.0
	CC:	100.0	100.0	100.0	100.0

*Keys: W = Walk; X = Vehicle modes, including buses, taxi, public light buses and other vehicles; T = Tunnel Bus; F = Ferry. N = Number of users; R = Row %; C = % of column sub-total; CC = % of column grand total

Table 4.3

Number of Trip-Legs Changed by Mode-Choice Determinants

Change in number of trip-legs (separate vehicles)*	Mode-Choice Determinants					
	Money-Saving	Time-Saving	Convenience	Comfort	Others	Total
0	7	210	220	8	5	450
+1	0	38	40	3	5	86
-1	15	487	556	11	19	1088
-2	8	275	346	5	25	659

*Resulted from switching from ferry to Tunnel Bus.

Mean Trip-legs reduced for each person trip = 1.009 leg.

Test of Association:

H_a : Mode-choice determinants are associated with number of trip-legs changed.

H_o : Mode-choice determinants are independent of number of trip-legs changed.

Significance level: 0.05

Degree of freedom : 12

Decision criterion : $\chi^2_{0.05} = 21.026$

Chi-square calculated : $\chi^2_{(cal.)} = 25.839$

Since $\chi^2_{(cal.)} > \chi^2_{0.05}$, H_o is not accepted.

asked about the amount of time saved, many (46.9%) of this portion of the patronage have no idea about it. This may be due to a complex of factors. Many of these patrons just believe that going by the Tunnel Bus is faster than the ferry but have no concrete idea about the difference in real terms. Their image of the Tunnel Bus as a faster mode than the ferry may also be influenced by the decisions of others, such as their friends and relatives or even through the mass media, which consider the Tunnel Bus faster.

Nevertheless, based on the figures given by the other 53.1% of those who use the Tunnel Bus because it is faster than the ferry, the average amount of time saved perceived is 16.5 minutes. Since the average trip time of the patronage (see Chapter III) was calculated as 30.8 minutes, it is therefore inferred that on the average, the patronage have saved about one third of the previous journey time by using the Tunnel Bus.

Incidentially, those who responded to this question fall exclusively into two groups of trip times, namely, the 21-30 minute group and the 31-40 minute group. This makes possible a finer analysis (Table 4.4). 72.0% of the 21-30 minute group and 75.5% of the 31-40 minute group have saved 11-25 minutes. That is to say, for the 21-30 minute group, the majority have saved 20% to 78% of the previous travel time; and for the 31-40 minute group, 26.2% to 59.5%. However, a 'z' test between the statistical means of amount of time saved of these two groups of trip times indicates that they are not significantly

Table 4.4

Time Saved by Trip Times

Time Saved (in minutes)	Trip Times (in minutes) 21-30 Number	%	31-40 Number	%	Total Number	%
1 - 5	40	10.3	16	8.7	56	9.8
6 - 10	41	10.5	15	8.2	56	9.8
11 - 15	93	23.8	47	25.5	140	24.4
16 - 20	93	23.8	48	26.1	141	24.6
21 - 25	95	24.4	44	23.9	139	24.2
26 - 30	16	4.1	10	5.4	26	4.5
31 - 35	10	2.6	3	1.6	13	2.3
36 and more	2	0.5	1	0.5	3	0.5
Total	390	100.0	184	99.9	574	100.1
Mean Time saved:	16.33min.		16.70 min.		16.50 min.	
Standard Deviation:	7.41 min.		7.04 min.			

Test of Difference:

H_a : The means of time saved of the two groups of trip times are not the same.

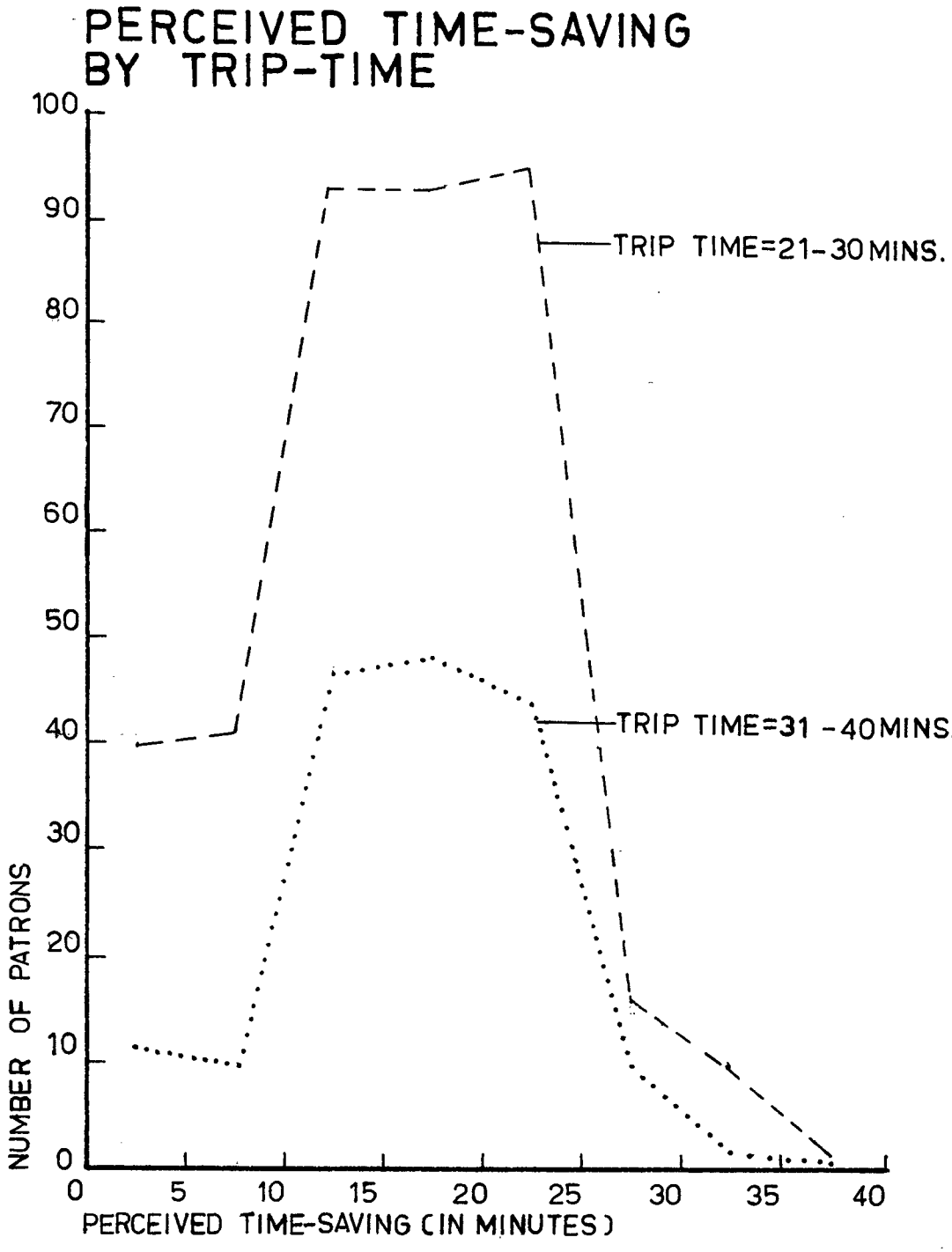
H_o : The means are the same.

Decision criterion = $z_{0.05} = \pm 1.96$

z score calculated = $z_{(cal.)} = -0.578$

Since $z_{(cal.)} > z_{0.05}$, H_a is not accepted. (for a one-tail test)

FIG. 4.2


PERCEIVED TIME-SAVING
BY TRIP-TIME
100
90
80
70
60
50
40
30
20
10
0
NUMBER OF PATRONS
TRIP TIME=21-30 MINS.
TRIP TIME=31 -40 MINS.
0
5
10
15
20
25
30
35
40
PERCEIVED TIME-SAVING (IN MINUTES)

different. In other words, the average time saved (in absolute terms) is not significantly related to trip times (Table 4.4 and Fig 4.1). This suggests very clearly that the source of time-savings is in the cross-harbor leg of the trip.

Cost

Very few people travel by Tunnel Bus because of lower travel costs. As a matter of fact, the Tunnel Bus is not a cheap transport service, compared to the ferry, as well as to other buses. This is illustrated by comparing the travel costs by Tunnel Bus and by ferry on six major directions of travel, that is, major connections of origins and destinations (identified in Chapter III). It is found that in most cases the total costs of the trip by ferry with its necessary mode links is lower than the trip by Tunnel Bus alone. The excess amount of money paid by the Tunnel-Bus users on these direction of travel ranges from HK$0.2 to HK$0.6 per trip.

Comfort

The Tunnel Bus is not comfortable. This is due to poor traffic conditions on the one hand, and highly congested conditions within the bus on the other. The Tunnel Bus has a high daily average occupancy ration of 80% of the maximum capacity at the approaches to the Cross-Harbor Tunnel, and over 100% during peak periods.

Maximum Willingness to Pay Additional Fare

In general, most (61.2%) of the users interviewed are willing to pay more to maintain the Tunnel Bus service (Table 4.5). Also, the greater the reduction in the number of vehicles used for a trip the higher the additional fare that the Tunnel-Bus users are willing to pay.

In order to see whether there is a significant difference in the maximum willingness to pay additional fare among users who use the Tunnel Bus for different reasons, an analysis of variance is performed on the means of maximum additional fare different groups of users are willing to pay. The F score computed suggests that there is no significant difference in this respect (Table 4.6). It may therefore be inferred that users with different mode-choice determinants generally have the same magnitude of maximum willingness to pay additional fare.

The Value of Time and Convenience

Using the amount of time saved, difference in travel costs between the Tunnel Bus and the ferry, maximum additional fare the users are willing to pay and the number of vehicle trip-legs reduced, the values of time and convenience can be estimated.

(1) The Value of Time:

The value of time is estimated based on the following

Table 4.5

Maximum Additional Fare Users Are Willing to Pay by Number of Trip-Legs Changed

Maximum Additional Fare Users Are Willing to Pay (HK$)	Change in Number of Trip-Legs: -2 Number	%	-1 Number	%	0 Number	%	+1 Number	%	Total Number	%
0	228	34.6	411	37.8	199	44.2	49	57.0	887	38.8
0.10 - 0.50	321	48.7	503	46.2	192	42.7	30	34.9	1046	45.8
0.60 - 1.00	79	12.0	122	11.2	44	9.8	5	5.8	250	11.1
1.10 - 1.50	0	0.0	5	0.5	2	0.4	0	0.0	7	0.3
1.60 - 2.00	11	1.7	15	1.4	3	0.7	1	1.2	30	1.3
2.10 - 4.00	20	3.0	32	2.9	10	0.2	1	1.2	63	2.8
Total	659	100.0	1088	100.0	450	100.0	86	100.1	2283	100.1

No answers: 183

Table 4.6

Maximum Additional Fare Users Are Willing to Pay by Mode-Choice Determinants

Maximum Additional Fare Users Are Willing to Pay (HK$)	Mode-choice Determinants* (Number of Users) Money-Saving	Time-Saving	Convenience	Comfort	Total
0	11	364	516	8	899
0.10 -0.50	27	409	610	14	1060
0.60 -1.00	5	90	154	4	253
1.10 -1.50	0	3	4	0	7
1.60 -2.00	1	7	22	0	30
2.10 -4.00	3	24	37	0	64
Total	47	897	1343	26	2313
Mean: (HK$)	0.49	0.317	0.345	0.285	
Standard Deviation (HK$):	0.736	0.533	0.559	0.257	

Test of Difference: (By analysis of variance)

Significance level = 0.05

Decision criterion = $F_{0.05} = 2.60$

H_a ; The means of maximum additional fare users with different mode-choice determinants are willing to pay are not the same.

H_o : The means are the same.

F score calculated = $F_{(cal.)} = 2.523$

Since $F_{(cal.)} < F_{0.05}$ (one-tail) for 3 and ∞ degrees of freedom, H_a is not accepted.

*Since only 5 observations were recorded for other mode-choice determinants, they are not included in this test.

premises:

1. Tunnel Bus fare (P_1) = HK$1.00
2. Ferry fare (P_2) = HK$0.30
3. Fare for connecting mode on one side of the harbor (P_3) = HK$0.40
   (This is the mean of the bus or tram fare, HK$0.30, and the public light bus fare, HK$0.50)
4. Average maximum additional fare users are willing to pay (P_4) = HK$0.32
5. Average amount of time saved (T) = 16.5 minutes

The value of time is:

$$\frac{(P_1 + P_4) - (P_2 + P_3)}{T} \times 60$$

= HK$2.25 per hour per person trip

The value of time per hour per person trip for the Tunnel-Bus users is estimated to be HK$2.25. Since the mean personal income per month for the users was found to be HK$1,000 (Chapter III), the mean wage rate per hour of them is HK$4.81[1]. Hence, the personal value of time calculated

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[1]This is derived by dividing the mean personal monthly income by an average of 26 x 8 working hours per month.

is about 46.7% of the mean horly wage rate[2]. The value of time estimated here is higher than the average value of personal time computed by Freeman, Fox and Associates, that is, HK$1.15, in their study of vehicular tolls for the Cross-Harbor Tunnel (as quoted in Pang, 1970:17), but is closer to the value of time for a hoverferry route[3], that is HK$1.89, computed by a traffic researcher in the Traffic and Transport Survey Division, Public Works Department (Cheung, 1977:4-10). Therefore, the figure derived here is considered reasonable.

(2) The Value of Convenience:

The major problem of quantifying convenience is the lack of a parameter to measure its magnitude. We suggest that the number of vehicle trip-legs per person trip may be used for this purpose. The value of convenience is estimated based on premises for the estimation of the value of time plus:

6. Average number of vehicle trip-legs reduced (L) = 1 (see Table 4.3)
7. Average maximum additional fare users whose mode-choice determinant is convenience are willing to pay (P_5) = HK$0.35

---

[2]The Comprehensive Transport Study (Smith and Associates, 1976: 65) found that for the city at large, the time value as percentage of mean hourly wage rate for work trip-workers was 37%, and 27% for non-work trip-makers, in 1974.

[3]This is a deluxe ferry route between Kwun Tong in Kowloon and Central on Hong Kong Island. Its fare is HK$1.00 per trip.

Hence, the value of convenience:

$$\frac{(P_1 + P_5) - (P_2 + P_3)}{L}$$

= HK$0.65 per trip-leg per person trip.

The value of convenience for the Tunnel-Bus users is estimated to be HK$0.65 per vehicle trip-leg per person trip. In other words, the users are willing to pay HK$0.65 to reduce one vehicle trip-leg perperson trip. Since this is a new attempt of estimating the value of convenience, no comparison can be made with other estimates.

4.2 Relationship between Mode-Choice Determinants and Patronage

In order to see if patrons with different characteristics have different mode-choice determinants, the chi-square test is applied to test the general hypothesis that:

> Patrons' mode-choice determinant is associated with a certain personal, socio-economic, or trip characteristics.

As convenience and time-saving are found to be the predominant mode-choice determinants, only these two determinants are taken into account in the tests.

The patrons' selection of mode-choice determinants is found to be associated with three personal and socio-economic

characteristics of the patrons and with three of their trip characteristics. These are:

(1) Personal and socio-economic characteristics: sex, occupation and income.

(2) Trip characteristics: present frequency using the Tunnel Bus, cross-harbor transport mode before the Tunnel Bus was introduced, and trip purpose.

Based on the findings of the tests and the percent distribution of patrons between the two major mode-choice determinants as tabulated in Table 4.7 A-F, the following points can be made with respect to the relationship tested:

(1) Female patrons rate higher on the factor of convenience.

(2) Likewise, housewives are very sensitive to convenience.

(3) The high income group is relatively more convenience conscious.

(4) Two extreme groups of patrons, those who use the Tunnel Bus everyday and those who use it only occasionally, are particularly concerned with the factor of convenience, in comparison to other groups.

(5) Patrons diverted from ferry rate higher on convenience; but those who drove across the harbor via vehicular ferry are extremely sensitive to time-saving. This is probably due to the long waiting time at the vehicular ferry piers.

(6) Those making study trips are most time conscious.

Other trip makers are more fond of convenience.

To conclude, the principal mode-choice determinants, that is, the grounds for using the Tunnel Bus, are convenience and time-saving. The users are willing to pay a higher cost for a mode with higher speed and more convenience. The selection decision of the Tunnel-Bus users is also found to vary with several of their personal, socio-economic and trip characteristics including sex, occupation, income, frequency of use, previous cross-harbor mode and trip purpose. These characteristics should be given particular attention in making predictions for future patronage of public transportation services.

Table 4.7

Patronage Characteristics Significantly Associated with Selection of Mode-Choice Determinants

Test of Association:

Generalized H_a : Selection of mode-choice determinants by the users is associated with their personal, socio-economic, or trip characteristic X.

Generalized H_o : Selection of mode-choice determinants by the users is independent of their personal, socio-economic, or trip characteristic X.

Significance level : 0.05

Table 4.7 (Continued)

A. Characteristic X = Sex

Sex	Mode-choice Determinants: Time Number	%	Convenience Number	%	Total Number	%
Male	698	47.8	760	52.1	1458	100.0
Female	383	42.7	513	57.3	896	100.0

Degree of freedom = 1

Decision criterion = $\chi^2_{0.05} = 3.841$

Chi-square calculated = $\chi^2_{(cal.)} = 5.877$

Since $\chi^2_{(cal.)} > \chi^2_{0.05}$, H_0 is not accepted.

B. Characteristic X = Personal Monthly Income

Monthly Income (HK$)	Mode-choice Determinants: Time Number	%	Convenience Number	%	Total Number	%
500 and under	46	62.2	28	37.8	74	100.0
501 - 1,000	324	46.2	378	53.8	702	100.0
1,001 - 1,500	243	52.7	218	47.3	461	100.0
1,501 - 2,000	76	51.7	71	48.3	147	100.0
2,001 - 2,500	21	40.4	31	59.6	52	100.0
2,501 and more	18	27.3	48	72.6	66	100.0
No fixed income	73	31.6	158	68.4	231	100.0

Degree of Freedom = 6

Decision criterion = $\chi^2_{0.05} = 12.592$

Chi-square calculated = $\chi^2_{(cal.)} = 47.27$

Since $\chi^2_{(cal.)} > \chi^2_{0.05}$, H_0 is not accepted.

Table 4.7 (Continued)

C. Characteristic X = Occupation

Occupation	Mode-choice Determinants: Time Number	%	Convenience Number	%	Total Number	%
Office	274	49.5	279	50.5	553	100.0
Service	189	49.2	195	50.8	384	100.0
Factory	181	43.0	240	57.0	421	100.0
Professional	92	44.4	115	55.6	207	100.0
Managerial	10	50.0	10	50.0	20	100.0
Student	140	47.8	153	52.2	293	100.0
Housewife	45	33.3	90	66.7	135	100.0
Unemployed	17	40.5	25	59.5	42	100.0

Degree of freedom = 7

Decision criterion = $\chi^2_{0.05} = 14.067$

Chi-square calculated = $\chi^2_{(cal.)} = 16.86$

Since $\chi^2_{(cal.)} > \chi^2_{0.05}$, H_o is not accepted.

Table 4.7 (Continued)

D. Characteristic X = Frequency Using Tunnel Bus

Frequency	Mode-choice Determinants: Time Number	%	Convenience Number	%	Total Number	%
Everyday	177	41.6	248	58.4	425	100.0
Weekdays only	323	50.3	319	49.7	642	100.0
4 - 5 days	96	53.6	83	46.4	179	100.0
1 - 3 days	82	48.8	86	51.2	168	100.0
Occasional	243	42.5	329	57.5	572	100.0

Degree of freedom = 5

Decision criterion = $\chi^2_{0.05} = 11.070$

Chi-square calculated = $\chi^2_{(cal.)} = 15.495$

Since $\chi^2_{(cal.)} > \chi^2_{0.05}$, H_o is not accepted.

E. Characteristic X = Previous Cross-harbor Transport Mode

Previous Mode	Mode-choice Determinants: Time Number	%	Convenience Number	%	Total Number	%
Star Ferry	460	46.1	537	53.9	997	100.0
Yau Ma Ti Ferry	581	44.7	718	55.3	1299	100.0
Driving via Vehicular Ferry	24	70.6	10	29.4	34	100.0
Others	20	51.3	19	48.7	39	100.0

Degree of freedom = 3

Decision criterion = $\chi^2_{0.05} = 7.815$

Chi-square calculated = $\chi^2_{(cal.)} = 9.542$

Since $\chi^2_{(cal.)} > \chi^2_{0.05}$, H_o is not accepted.

Table 4.7 (Continued)

F. Characteristic X = Trip Purpose

Trip Purpose	Mode-choice Determinants: Time Number	%	Convenience Number	%	Total Number	%
Work	532	48.8	559	51.2	1091	100.0
Study	105	57.4	78	42.6	183	100.0
Social	179	42.0	247	58.0	426	100.0
Shopping	35	43.8	45	56.2	80	100.0
Recreation	42	35.0	78	65.0	120	100.0
Others	7	33.3	14	66.7	21	100.0

Degree of freedom = 5

Decision criterion = $\chi^2_{0.05} = 11.07$

Chi-square calculated = $\chi^2_{(cal.)} = 22.355$

Since $\chi^2_{(cal.)} > \chi^2_{0.05}$, H_o is not accepted.

CHAPTER V

IMPLICATIONS

5.1 Implication for Former Predictions: An Appraisal of Former Predictions

In July 1972, that is, about a month before the Tunnel Bus was put into service, the Traffic and Transport Survey Division, Public Works Department, made several patronage predictions for the Tunnel Bus service, as it was then conceived. Three methods of assignment were adopted:

(1) Assignment based on travel time alone;

(2) Assignment based on travel time and convenience;

(3) Assignment based travel time and cost.

The estimates produced by the third method of assignment were adopted, without proper explanation. The conclusion was that the Tunnel Bus would attract 22,000 to 25,000 passengers per day (Pang, 1972:30-31).

It is not our aim to attempt a thorough evaluation of the entire estimation methodology, nor is it possible to make a sound quantitative evaluation of the estimates due to several structural changes in the systems concerned since the Tunnel Bus service was implemented. The major unanticipated changes were:

(1) The fare on the Hong Kong and Yau Ma Ti ferry has

gone up twice from HK$0.10 for the second class and HK$0.20 for the first class to a flat rate of HK$0.30 (The second class was abolished). The fare on the Star Ferry has also risen from HK$0.10 for the second class to HK$0.20; and from HK$0.25 for the first class to HK$0.30.

(2) Tunnel Bus routes have expanded from 3 to 9.

(3) Relocation of some Tunnel Bus routes and some ferry piers.

(4) Changes in travel time relations due to increased congestion in road traffic and acquisition of new ferry boats.

Nevertheless, it is possible to identify several sources of error in the estimation assumptions and methodology; and suggest some modifications for improvement, in the light of the findings of this research. These are discussed subsequently.

Sensitivity to Cost

Sensitivity of the passengers to travel cost was overemphasized in the predictions. This is made evident by the fact that the estimate of patronage dropped drastically (over 80%) between the assignment based on journey time only and the assignment based on time and cost (Pang, 1972:27). Also, the predictions suggested that the fare structure of the Tunnel Bus required to attract a level of patronage more or

less equivalent to the present one would not be compatible with the cost of providing the facility that make the service possible. That is, the fare of the Tunnel Bus would have to be much lower than the present flat rate of HK$1.00. This is obviously an over-weighting of the factor of travel cost (Pang, 1972:1-2).

Estimation of Convenience

Convenience is found to be the most important mode-choice determinant in this research. However, although the predictions did recognize that there was a general tendency to avoid change of travel mode wherever possible for most of the ferry passengers, it did not include the factor of convenience in its final estimation.

In an early stage of the predictions, an estimate of the factor of convenience was made by introducing a time penalty in favor of the Tunnel Bus service, so that even if a given travel time was slightly in favor of the ferry, a proportion of the cross-harbor passenger movements would still be attracted to the Tunnel Bus. The assignment formula was a diversion curve which postulated:(Pang, 1972:3-4):

(1) Passengers would not use the Tunnel Bus at all if the journey time by Tunnel Bus was 15 minutes or more greater than that by the fastest alternative ferry route.

(2) All passengers would switch to the Tunnel Bus if the

journey time by Tunnel Bus was faster than that by the fastest alternative ferry route.

(3) A proportion of passengers would switch to the Tunnel Bus if its journey time was less than 15 minutes greater than that by the fastest alternative ferry route. The proportion decreased with the increase of the difference in journey time.

The critical problem with this estimate of convenience is that it does not in actual fact provide a measure of convenience. As a result it is not possible to simulate the value of convenience for different groups of travellers, which, we have found, is very important in predicting travel demands. Based on the attempt made in Chapter IV, we suggest that the magnitude of convenience be measured by the number of vehicle trip-legs per person trip. The bigger the number of trip-legs per person trip, the lower the convenience level. The value of convenience is estimated and expressed as number of dollars per trip-leg per person trip in real term. When used in transport analysis, this value serves as a shadow price of convenience, as there is no market price for it.

Stratification of Travellers

The prediction did not make any provision for stratifying the passengers. The present research has found that the choice of mode of the Tunnel-Bus users varies with different groups of them based on their particular personal, socio-economic and trip characteristics. These characteristics are: sex,

occupation, income, frequency of use, previous cross-harbor mode, and trip purpose. That is to say, the analysis of travel demands should take account of these characteristics of trip-makers. In particular, the majority of passengers fall into the 21-30 age group and are active members of the work force. In future prediction particular attention should be paid to the motives of this stratum in choosing between modes.

5.2 Practical and Research Implications

With the introduction of the Tunnel Bus service, cross-harbor travellers in Hong Kong are faced with a new, faster, more convenient but more expensive service, and hence new supply conditions. This study reveals that a growing number of the travellers have adopted this new mode of cross-harbor transportation, either as passengers diverted from the ferry system, or as new travellers, despite the higher costs of the Tunnel Bus for most of them. The grounds for their choice of mode are primarily convenience and time-saving. This indicates that the demand for cross-harbor transportation is more convenience and time elastic than it is cost elastic, that is, an increase in the level of convenience and/or a reduction in travel times would cause one of the competing modes to lose passengers to the other, even if the reduction is offset by a comparable increase in the fare charged.

This observation has two implications. First, on the practical side, it suggests that any additional Tunnel Bus routes which penetrate into potential demand areas would tend to draw more passengers from the ferry and generate more new passengers. Similarly, a new transport mode, particularly the mass transit system presently under construction, with its high level of convenience and time attributes, would have a powerful impact on the cross-harbor mode use.

Secondly, on the research and planning side, the findings of this research agree with those of the North American studies cited in Chapter I and suggest that transit demand analysis (or modal split models) need to be made more sensitive to variable other than time and cost. Convenience, it has been suggested, is more important than the travel time and cost (cf. Navin and Gustafson, 1973, 1-18). In addition, certain groups of the travelling public have indicated that there are differences in preferences for some performance attributes of the transportation system. This suggest that the modal choice models should also be sensitive to the personal, socio-economic and trip characteristics of the trip-makers. In this study, such characteristics that cause differences in preferences include sex, occupation, income, frequency of use, previous mode, and trip purpose. In other words, if a public transportation system should be perceived as existing within a competitive consumer-oriented market (Chapter I), this study indicates that there are different preferences for public transport service among specific market segments.

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APPENDIX A

PLANNING FOR THE CROSS-HARBOR TUNNEL : MAJOR EVENTS

The first recorded proposal of a cross-harbor road link was made by Commander Murry Ramsey, the Harbor Master, in his 1920 Annual Report. He proposed a bridge from Central on Hong Kong Island to Tsim Sha Tsui in Kowloon. His major concern, however, was not with cross-harbor travel, but rather with the clearance of the harbor for ocean-going ships (Victoria City Development Company, 1961:2).

Since then advocacy of a cross-harbor road link had been heard many times, but no further substantial proposal had been offered until 1948, when the Preliminary Planning Report by Sir Patrick Abercrombie was published. He found that a bridge or a tunnel from the center of Hong Kong Island to Tsim Sha Tsui in Kowloon very important for the development of Hong Kong (Abercombie, 1948:14).

In June 1950, a government committee was appointed to formulate a long-term plan for cross-harbor ferry services. The committee recommended the provision of more passenger and vehicular ferry as well as a further consideration by the government of Abercombie's concept of a cross-harbor road link.

Following this, the government commissioned in 1954 Messrs Mott, Hay and Anderson, consulting engineers of London to report on the possibility of constructing a toll tunnel across the harbor. The consultants came up with the suggestion that a two-lane tunnel could be constructed between the Central District on the island and Hunghom in Kowloon (China Mail, 18 June 1955). This raised the interest of a number of leading people in Hong Kong, including Mr. Lawrence Kadoorie who later became one of the chief advocates of the Cross-Harbor Tunnel (South China Morning Post, 17 September 1955).

In 1956, the government appointed an Inter-Departmental Committee to consider the implications of the tunnel proposal. The findings of this Committee was released in a report (Inter-Departmental Committee, 1956). The Committee did not consider that sufficient cross-harbor traffic would use the proposed tunnel to repay its cost and hence, the Committee did not recommend the government to provide a subsidy for the construction of the proposed tunnel. However, the Committee recommended that the government should permit commercial interests which were prepared to undertake the construction of the proposed tunnel to do so.

In response to this invitation, the Harriman Realty Company began discussion with the government in 1957. Two years later, the Victoria City Development Company was formed to promote an investigation into the provision of a cross-harbor road link (Victoria City Development Company Limited, 1961:3). The

Company appointed Messrs Scott and Wilson, Kirkpatrick and Partners; and Freeman, Fox and Partners as joint engineers to investigate fully the feasibility of a cross-harbor road link (China Mail, 1 September 1959). The findings of the joint engineers were published in a two-volume report in 1961 (Victoria City Development Company Limited, 1961). The report included the presentation of plans for both tunnel and bridge which met all requirements of the Hong Kong Port Committee.

On 9 May 1963, the government agreed to the proposal of a cross-harbor tunnel for Hong Kong instead of a bridge, mainly because of possible hazards of the bridge to aircraft. In March 1964, a joint statement by the government and the Victoria City Development Company Limited said that the Company had made a firm declaration to the government to the effect that it was preparing in principle, to proceed with the construction of the tunnel on the basis already announced by the government (China Mail, 31 March 1964).

After a series of debates on the Tunnel project, the Legislative Council passed a resolution of appointment and a franchise was granted to the Cross Harbor Tunnel Company Limited, newly formed to succed to Victoria City Development Company Limited, on 11 June 1967, to build and operate a four-lane cross-harbor tunnel (South China Morning Post, 24 June 1965).

Construction of the tunnel started on 1 September 1969 and was completed nine weeks ahead of schedule. The Cross-

Harbor Tunnel was offically declared open on 2 August 1969. With much hesitation and ambiquity of the prospect of patronage (Pang, 1972), the Tunnel Bus was put into service three days later (5 August), jointly by the Kowloon Motor Bus and China Motor Bus Companies.

APPENDIX B

The Questionnaire:

Interview Form and Questions

I. INTERVIEW FORM

Hong Kong Tunnel Bus Users Interview Form

Bus Number ☐☐☐

Interviewer_____ Weather_____ Date_____ Period_____

Origin ☐☐	Sex ☐ Age ☐ Employment ☐ Income ☐ Connecting Transport Mode: Before Boarding ☐ After Alighting ☐ Trip Purpose ☐☐ Trip Time ☐☐ Frequency Using ☐ Transport Mode Before ☐
Destination ☐☐	Connecting Transport Mode Before: Origin End ☐ Destination End ☐ Reasons For Using Tunnel Bus ☐☐ Time-Saved ☐☐ Money Saved ☐☐ Maximum Additional Fare Willing to Pay ☐☐

II. QUESTIONS ASKED

Personal and Socio-Economic Characteristics:

1. Would you mind telling me how old you are?
2. What is your occupation?
3. Would you mind telling me your approximate monthly income?

Trip Characteristics:

4. (Origin) Where did you start this trip?
5. Is it your home, school, work place or other?
6. How did you travel on this trip to this bus stop (i.e. from the origin) ?
7. (If the answer to #6 is "by car") What type of vehicle?
8. (Destination) Where is the final destination of your present trip?
9. Is your destination your home, work place, school or other?
10. How will you travel to your destination after alighting Tunnel Bus?
11. (if the answer to #10 is "by car) What type of vehicle?
12. What is the purpose of your trip to this destination?
13. How long will you expect to complete this journey?
14. Before the Tunnel Bus was introduced, did you cross the harbor?

(If the answer to #14 is "yes", ask #15-#19; if it is "no", go to #20)

15. How did you cross the harbor?
16. How did you go to the ferry pier from your origin?
17. (If the answer to #16 is "by car") What type of vehicle?
18. How did you go to your destination after alighting ferry?
19. (If the answer to #18 is "by car") What type of vehicle?
20. What are your reasons for using the Tunnel Bus?
21. (For those who answer "faster" in #20) How much faster?
22. (For those who answer "cheaper" in #20) How much cheaper?
23. How often do you cross the harbor by Tunnel Bus?
24. How much more would you be willing to pay for the Tunnel Bus service?

APPENDIX C

STATISTICAL TESTS USED

Three statistical test were used to test working hypotheses arising throughout the analysis. They were, the 'z' test, the analysis of variance and the Chi-square test.

A. The 'z' Test

The 'z' test is used to decide whether the means of two groups of observations, $\bar{x}_1$ and $\bar{x}_2$, are significantly different or not. The 'z' value is found from:

$$\frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s^2_1}{n_1} + \frac{s^2_2}{n_2}}}$$

Where, $\bar{x}_1$, $\bar{x}_2$ = two means in question;

s_1, s_2 = standard errors of the two groups of observations;

n_1, n_2 = frequencies of the two groups of observations.

If the 'z' value calculated is less than the 'z' value expected (that is, the value given in the normal deviate table), the difference between the means is significant; otherwise, it is not.

B. The Analysis of Variance

The analysis of variance is used to test whether a group of means of several (more than two) groups of observations are significantly different simultaneously. The approach involves comparing (using the F test) two different estimates of the variance of the assumed common normal populations from which the groups of observations have been drawn. The first estimate deals with variability within the groups (also known as mean square within groups). It is found from pooling the group variances:

$$\frac{\sum_{j=1}^{k} \sum_{i=1}^{mj} (x_{.j} - \bar{x}_{.j})^2}{n - k}$$

Where, k = number of groups;

m = number of observations in each group;

x_{ij} = the i^{th} observation in the j^{th} group;

i = 1,2,3,.....m

j = 1,2,3,.....k

$x_{.j}$ = a specific value in the j^{th} group;

$\bar{x}_{.j}$ = the mean value of the observations in the j^{th} group.

The second estimate of the population variance, which is independent of the first, is based upon the variation between the groups (also known as mean square between groups):

$$\frac{\sum_{j=1}^{k} m_j (\bar{x}_{.j} - \bar{x}_{ij})^2}{k - 1}$$

where: notations same as above.

If the null hypothesis that the population means are equal is true (that is, the group means are not significantly different), then the two estimates should differ only within the limits of random sampling. But if the means are significantly different, then the estimate from between-group variation will be increased, even though the estimate from within-group variation will be unaltered. A one-tail F test is used to compare the estimates:

$$F_{(\text{calculated})} = \frac{\text{mean square between groups}}{\text{mean square within groups}}$$

Only if the numerator is actually greater than the denominator, that is when $F_{(\text{calculated})} > 1$, will there be any evidence against the null hypothesis and therefore any need to ascertain the critical value of $F_{(\text{calculated})}$.

C. The Chi-Square Test

The Chi-square test is used to see if there is a significant difference in the frequency with which several categories of observations in two or more samples occur. The sample frequencies are compared with the frequencies which would be expected if the null hypothesis is true. The comparison is achieved by calculating the χ^2 statistic:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

where, O = the observed frequencies;

E = the expected frequencies.