An evaluation of the factors that determine carrier selection

in

Southern China

By

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A thesis

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DECLARATION

I hereby declare that the thesis entitled "An evaluation of the factors that determine carrier selection in Southern China" is original and has not been submitted for other degrees or the like in this University or any other institution. It does not contain any materials, partly or wholly, published or written previously by others, except those references quoted in the text.

WONG Chi Chung, Peter

ABSTRACT

The selection of freight transport mode in cities like Hong Kong, with little land, is in some respects obvious. The deciding criterion for mode/carrier selection is based on the selection of either the lowest total transport cost or the shortest transit time for the cargo. The peculiar nature of each transport mode, namely; rail, sea, road and air, will definitely earn their own places when shippers need to make a decision on their shipments. The nature of the cargo will also affect the choice of carrier/mode when they are transported in break bulk. Fortunately, the invention of ISO containers in the late 1950s eliminated and overcame the shortfall in some transport modes. With the extensive usage of ISO containers hereafter, shippers can now enjoy a much freer choice of transport mode.

When China started its open-door policy in the late 1970s, many local (Hong Kong) manufacturers relocated their factories to the Pearl River Delta (PRD) due to the low labour and land costs. Delivery of shipments was mainly carried out by Hong Kong freight forwarders as they had been in business with the shippers for decades. Road transport was the only mode choice available at that time due to the inflexibilities in other transport modes such as sea and rail. Progressively, these factories were relocated northwards at a later time due to the gradually increasing labour and land costs. Freight forwarders were then faced with a prolonged delivery time due to the stringent Customs regulations in China as well as a progressive increase in the physical distance between the factory and the loading port in Hong Kong. The continuous developments in adjacent ports in Southern China offered freight forwarders an opportunity to revise the route of consignments so that the lowest cost and shortest transit times were achievable. Nowadays, consignments from the PRD region

can be transported to the loading ports via at least three transport modes, namely, sea (barge), road (truck) and rail.

In addition to physical constraints in the mode/carrier selection, the mode choice in China is further complicated due to the inflexible Customs regulations and government policies on tax rebates.

Considerable research has been done on mode and carrier selection for bulk cargo in Western countries. However there is no explicit study on the mode choice in China. This thesis studies factors that will affect the shippers' mode/carrier choice and ascertains the unique key factors that will affect their mode/carrier choice in the PRD for their overseas consignments. From this study, it was observed that shippers irrespective of the consignment size and cargo value prefer to use a loading port that is reliable and efficienct in operation. This is the first thesis written about carrier mode choice in China applying systematic and rationale methods to express the mode selection criteria in PRD area. The results were achieved by using the pairwise comparison method - Analytical Hierarchy Process (AHP) method so that rigidity of the results is academically accepted. Nevertheless, further study on the mode choice can be carried forward through assessing buying behaviour and the shipper-carrier relationship.

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1.1 Context of Research

1.1.1 The Greater Pearl River Delta

The Greater Pearl River Delta (GPRD) includes the Hong Kong Special Administrative Region (HKSAR), the Macao Special Administrative Region, and the PRD Economic Zone portion of Guangdong Province. The PRD Economic Zone, as specified by Guangdong Province, includes nine municipalities, namely Guangzhou, Shenzhen, Dongguan, Foshan, Jiangmen, Zhongshan, Zhuhai, and the urban areas of Huizhou and Zhaoqing (see Figure 1.1 below).

Figure 1.1 Greater Pearl River Delta
Source: www.mychinadocs.com/images/guangzhou_map.gif

Before China launched the open door policy two decades ago, the PRD in Guangdong Province was largely undeveloped and engaged mainly in agricultural activities. The open

door policy brought significant economic reforms in the late 1970s in the region and has transformed it into one of the fastest growing areas in the world. In the early 1980s, the Special Economic Zones (SEZs) of Shenzhen and Zhuhai were established with the purposes to learn from Hong Kong and Macao due to their close geographic proximity. China would like to use SEZ as the pilot testing ground for further implementation of the open door policy. Obviously, a successful transformation of these two locations from agricultural industries into manufacturing industry became one of the prime duties of the Mayor of the area. These SEZs had special regulations and taxation to attract foreign investments. Hence, many Hong Kong manufacturers moved into the Shenzhen SEZ nearby as well as other parts of the PRD to take advantage of cheaper land, labour and operating costs. Whilst labour intensive activities shifted to the PRD, higher value-added activities, such as management, finance, logistics, design, R&D, quality assurance remained in Hong Kong.

Figure 1.2 Pearl River Delta
Sources: www.pland.gov.hk

1.1.2 The Development of Greater Pearl River Delta

The extensive industrialization in the GPRD created a new wave of transformation of the PRD's economic structure - from one that has been predominantly manufacturing-based to one that is gradually becoming knowledge-based - has taken place. Guangdong Province has been keen in developing its service capabilities and diversifying into higher value-added services. Meanwhile, it has increased the proportion of high-tech and heavy industries such as automobiles, petrochemicals and equipment manufacturing industries, which feature high growth and long production industry value chains. Hence, the PRD is being transformed into a dynamic place with high levels of productivity and considerable technological R&D capabilities. It is the combination of Hong Kong's strengths in financing, management, accounting, legal service, product design, branding, distribution management, marketing and public relations with the PRD's abilities in production and R&D research that has enabled the GPRD to emerge as an economic powerhouse.

	1980	1990	2000	2001	2002	2003
Population (million)	16.27	19.28	23.07	23.37	23.65	23.99
GDP (Billion yuan)	119.2	872.2	7378.6	8363.9	9418.8	11341.1
Primary industry (billion yuan)	30.7	129.4	428.5	445.2	465.0	470.5
Secondary industry (billion yuan)	54.0	404.6	3657.3	4139.0	4688.1	5939.6
Tertiary industry (billion yuan)	34.5	338.2	3292.9	3779.8	4265.6	4930.0
Total amount of exports (US $billion)	6.2	81.4	847.4	908.3	126.1	1450.6
Retail sales of consumer goods (billion yuan)	70.7	445.7	2781.4	3120.1	3481.3	3976.6
Saving deposits by residents (billion yuan)	21.0	552.7	6641.0	7670.6	9240.2	11068.9

Table 1.1: PRD Economic Indicators (at current prices)
Sources: Guangdong Provincial Statistics Bureau and Yearbook 2001,2002,2003 and 2004

Table 1.1 above shows that the GDP of the PRD grew from just below 12 billion yuan (US$1.45 billion) in 1980 to over 1,134 billion yuan (US$ 137 billion) in 2003.

During the period, the average annual growth rate of GDP in the PRD was 21.9%, well above that of Guangdong Province (13.6%) and the country as a whole (9.6%). The per capita GDP of the PRD amounted to 39,782 yuan (US$ 4,806) in 2003, which is 2.3 times that of Guangdong Province and 4.36 times that of the whole country. The PRD is the economic hub of Guangdong province. It accounted for 25% of Guangdong's land area but contributed to 83.2% of the province's GDP in 2003. Moreover, the PRD has increasingly become an attractive consumer marketplace. Over the past two decades, the retail sales of consumer goods in the PRD increased dramatically from 7.07 billion yuan (US$ 0.85 billion) in 1980 to 397.66 billion yuan (US$ 48.04 billion) in 2003.

1.1.3 The role of Hong Kong in PRD

Since the implementation of China's open-door policy, Hong Kong has been the single largest source of Foreign Direct Investment (FDI) into Guangdong, Shanghai, Jiangsu, and Zhejiang. Most of the investments, especially those in the PRD, are in manufacturing. According to official Chinese statistics, during the period 1979-2001, the cumulative FDI from Hong Kong in Guangdong amounted to US$79.0 billion, accounting for 71 percent of total accumulated FDI inflows in Guangdong.

According to official Chinese statistics for 1992 and 2002, FDI from Hong Kong into Guangdong had increased from US$3.1 billion to US$7.1 billion, accounting for 86 percent to 55 percent of FDI inflows in Guangdong in their respective years. But these figures do not take into account Hong Kong's investments in export-processing activities, which should also be added to the FDI figures.

The PRD is the world's fastest-growing export-oriented manufacturing region and Hong Kong has played an essential role in its economic rise. Guangdong's rise has afforded Hong Kong based manufacturers an opportunity to relocate and expand their production activities across the border. As industrialization took off in Guangdong, companies from the rest of

Asia and elsewhere have relocated some production activities to the PRD. In turn, Hong Kong has been transformed into largely a producer services center supporting and driving the manufacturing base in Guangdong.

In 2003, the Federation of Hong Kong Industries carried out a survey about the changing face of Hong Kong manufacturers in PRD for 123,000 Hong Kong registered manufacturing and import-export (HKM&T) companies. The reason for including import-export companies in the survey was because with the relocation of production activities across the border, many manufacturers have become traders in Hong Kong. Moreover, many traders operate export processing activities through subcontracting arrangements in China. Including import-export companies is therefore necessary to obtain a true picture of Hong Kong's manufacturing activities in China. Understanding the closely tied Hong Kong – PRD relationship in the manufacturing sector will help to take a more macro approach when dealing with the mode choice problem.

As the business environment in Guangdong continues to improve and as more highly skilled workers emigrate to Guangdong, there is considerable scope for locating higher value-added activities across the border. Hence, the partnership between Guangdong and Hong Kong has developed over a period of some 20 years.

Transportation services in the PRD region are driven largely by international trade. Given the growing prominence of the PRD as one of the world's leading manufacturing and export bases, the region has become one of the largest markets for sea and air cargo services in the world. Hong Kong has long been the world's busiest container port and airport for international airfreight. Recently, the ports and airports in the PRD, particularly those in Shenzhen and Guangzhou have developed very fast. This provides shippers with additional capacity and additional choice, as well as an impetus for the further development of transportation services in the region.

A distinctive feature of the development of the GPRD is the emergence of a broad range of clusters in various industries such as garments and textiles, footwear, plastic products, electrical goods, electronics, printing, transportation, logistics and financial services.

Many of these clusters can be found in relatively small geographic areas. The industrial cluster has become a major source of the GPRD's competitiveness - enterprises within a cluster can enjoy economies of scale from sharing related production inputs, specialized labour pools, distribution and communication channels, and also networking. Moreover, such clustering can also spur competition, which encourages information, knowledge and technology transfer among related enterprises within the cluster. Such type of knowledge and technology transfer may lead to new industry growth, thereby helping to drive the overall growth of the cluster. The industrial cluster is an integral part of the regional economy.

At present, the overwhelming proportion of manufacturing activities of Hong Kong based companies have been concentrated in PRD, although there is a growing trend of expansion into other location such as Shanghai in China.

The dual role of Hong Kong companies operating in PRD provides the basic theme for this research as they have to look after not only the internal production logistics but also the routing of their consignments to overseas destinations.

1.2 Aims and Objectives

This research project will investigate the critical factors that:

'The selection of transport carriers by shippers in the Shenzhen area of China increasingly depends upon the level of satisfaction of service that is being provided.'

The overall aim of this thesis is to evaluate these factors that determine carrier selection in the Shenzhen area of China.

This aim will be realised through the following objectives:

i. To describe the freight / transport system in the region and to analyse the reasons for its recent development.
ii. To establish the factors that determine the modal choices of shippers for their containerized cargo movements.
iii. From (ii) above, to assess the importance of (customer) service in the choice of carrier.
iv. To produce a taxonomy /hierarchy of the variables in the carrier selection process and to assess their relative importance.
v. To model these variables and to evaluate the use of the model to gain a fuller understanding of transport carrier selection.

Achieving the aims of the research makes three main contributions to enhancing the knowledge of shippers' demand in South China.

First, the general selection criteria of carriers for local and PRD shippers can be defined and identified.

Secondly, the expectation of shippers and the performance of carriers can be quantified and measured through this study. It is expected that the thesis will provide an in-depth understanding into this topic for any interested parties.

Thirdly, some determining factors for the continuous successful development of a multi-modal transport system in Hong Kong as well as the sustainability of Hong Kong's role as the

logistics hub for Southern China will be identified. Parameters will be determined, which give some indications to shippers of when the best conditions will be and the criteria for using third party logistics. The thesis also aims to provide some planning guidelines for companies that are looking for a suitable carrier for their overseas consignments.

1.3 Methodology

Authors such as, Foster and Strasser (1990), Abshire and Premeaux(1991), Ortuzar and Willumsen (1994) and Murphy and Hall (1995), have written about the selection of carrier mode choice in past decades. However, most of them were concentrated on a study of bulk cargo movement mainly influenced by the perception that the correct mode choice will reduce the total transport cost of the consignment. This is peculiar and important in selling the commodity overseas when the production cost for commodity is relatively low, such as for those bulk cargoes. The changes to inventory and procurement managements in past decades have affected the management philosophy of many shippers and buyers; hence the consignment tends to be smaller in size and more sensitive to delivery time. Shippers or buyers would like to see carriers/freight forwarders that can provide the same standard of service when handling their now scaled down consignment. The benefit of chartering a whole ship and enjoying the economies of scale achieved is now retained only by those big shippers and confined to few bulk commodities.

For the rest of shippers and buyers in the trade, it seems that using a container liner service is the obvious choice in deliver their overseas consignments.

Over the past twenty years, there has been an enormous increase in vessel capacity in many liner companies. The average carrying capacity of each linehaul vessel increased from 6,000TEUs (from APL in 1989) to the recent 12,000 TEUs (from Maersk Line in 2006). These additional tonnage supplied into the trade push the overall supply tonnage to a level

that outstrips the actual demand from the trade. Consequently, ocean freight is still charged at the same rate as it was ten years ago while providing much shorter transit time despite the size of consignment. From the shippers' point of view, given everybody enjoys a rather inexpensive and swift delivery in the ocean route, the only competitive advantage that shippers can get hold of falls in the inland section between the factory and loading port. If the shippers can control the inland transport by selecting the right mode of transport then they are in a better competitive position than their rivals.

In this research, the parameters that affect carrier choice as well as mode choice from previous literature were studied and selected to form the main structure of a survey. Several meetings were arranged with local and Shenzhen shippers/freight forwarders associations so that these parameters can be grouped under different categories according to their interpretation from the industry.

The survey was conducted in several stages. In the first stage, questionnaire complied with the parameters selected from journal papers written about mode/carrier choice by shippers/freight forwarders, was sent out to a selected target group and the results were studied. In the second stage, amended questionnaires were sent out again with the help of various associates in industry. Questionnaires were also distributed during a conference meeting, an annual general meeting and over the dinner table of the related associations.

Data collected from the questionnaire were compiled and factor analysis was used to check the validity of the data. Those parameters that are highly correlated were selected, listed and passed to those shippers/freight forwarders who had participated in the first meeting for grouping. A total of seven major factors were consolidated and identified in these meetings and they were further divided under internal and external factor categories.

Subsequently, several meetings were arranged over a time span of nine months; selected shippers/freight forwarders were invited to carry out the pair wise comparison with AHP software – Decision Plus 3.0.

Shippers and freight forwarders were invited to participate based on the peculiar cargo movements in their company. Generally, they are divided into three major groups – weekly cargo volume; cargo value and time sensitivity of the cargo.

1.4 Chapter Outline

This dissertation consists of six chapters. In chapter one, the aims and objectives of this research are explained and the scope of research is defined. An introduction into the general industrial performance of the Pearl River Delta (PRD) region will be included in the second chapter. Within the PRD, the Dongguan, Zhongshan and Shenzhen regions have been selected for investigation, as they will form the sources of input data in this research.

Chapter three is a literature review of previous related publications on mode and carrier selection.

Chapter four is devoted to the research methodology employed and the sampling methods. The intention of this thesis is not to develop a mathematical model; therefore, the research methodology will take the form of a simple mathematical deduction. The methodology used in this research is the Analytic Hierarchy Process (AHP). This is an analytical tool, supported by simple mathematics, which enables researchers to explicitly rank tangible and intangible factors against each other for the purpose of resolving conflicts or setting priorities. The process has been formalized by Saaty (1983) and used in a wide variety of problem areas (e.g sitting landfills, evaluating employee performance, and ranking city liveability). Over the past two decades, Saaty's AHP has been developed to solve decision making problems in various fields by prioritization of alternatives using eigenvectors and manipulations in matrix algebra.

The results from these investigations will be accessed by computer software (CDPlus 30) that specialises in the AHP method. The process involved in organising data collection for this study is also explained fully in this chapter.

In the second half of chapter four explains how shippers and freight forwarders were selected from various industrial sectors that are important in the PRD area. Exporters/shippers with international connections will be given a higher priority on the list. Since the cargo type investigated in this thesis is containers, products and commodities involved will be grouped according to their market value and time sensitiveness on the basis of the information given by the shippers. The mode of transport; types of carriers; distance between the factories and final loading ports will be tabulated for comparison. In the less-than container load (LCL) consignment, shippers will not be too concerned about which mode of transport will be used to load their cargoes. Hence, the mode and carrier selection will solely depend on the carrier / freight forwarders who handle the consignments. However, the carrier/mode selection for those shippers who have full-container-load (FCL) consignments may not be the same.

Despite the significant carrier/mode selection differences between LCL and FCL shippers, the stringent Customs regulations practice in China forces the majority of shippers to leave the carrier selection in the expert's hands when dealing with choice. This is one of the peculiar factors that hinder a smooth logistics flow of cargoes within China. The modes of carrier chosen by these shippers/freight forwarders will be examined for their performance and efficiencies together with the requirements, if any, imposed on the consignments in question. Data will be collected on what will be inputted into the model for verification of their preferred modes of transport for international freight movements. The modes chosen for the shipment will only be studied on the distance between factory/depot to the loading ports (Hong Kong, Yantian and Shekou) within Hong Kong and Shenzhen regions.

Chapter five focus on the process and methods employed in data analysis. The data will provide sufficient scope for analysis and inferences in this yet uncharted area of research. The data that is collected will facilitate the application of various analytical data techniques that will culminate in the identification of different interrelationships between the variables under study. Data collected will also be used make a comparison of loading port selection between Hong Kong and Shenzhen for any possible correlation or significant differences in terms of container movements.

In the final chapter, the results from the survey will be analysed and discussed. The outcomes of the results will form the concluding section of this dissertation, along with an evaluation of the limitation of the research.

1.5 Links between aims and objectives, chapter structure and methodology

Aims and objectives	Chapters where investigated	Methodology used
To describe the freight / transport system in the region and to analyse the reasons for its recent development	Chapter two	Information from government sources
To establish the factors that determines the modal choices of shippers for their containerized cargo movements.	Chapter three	Literature review
To model these variables and to evaluate the use of the model to gain a fuller understanding of transport carrier selection	Chapters three and four	Statistical approach and industrial inputs
To produce a taxonomy /hierarchy of the variables in the carrier selection process and to assess their relative importance	Chapter five	Factor analysis and AHP
To assess the importance of (customer) service in the choice of carrier	Chapter six	Conclusion

Chapter Two – The Pearl River Delta

2.1 Introduction

Starting from the late 1980s, Hong Kong's major industries have undergone a tremendous change with the dispersion of production networks into Mainland China. The manufacturing industries in Hong Kong have gradually shifted northwards to Shenzhen and this has created some logistics flow problems for local shippers. With the manufacturing centres moving further away from the loading/discharging port in Hong Kong and with the changing attitudes to managing their cargo movements in recent years, shippers have been forced to seek the shortest possible route and the lowest freight charges for transporting their cargoes into and out of China. Although the transport infrastructure in China as a whole cannot offer any realistic inland logistics operations, Southern China is well developed and capable of providing a meaningful and efficient cargo delivery network through logistics operations.

The lack of good human resources management in adjacent ports has kept Hong Kong as the prime loading and discharging port for shippers in Hong Kong and Southern China during the 1980s and 1990s. Even when these adjacent ports have furnished their hardware and started catching up in the early 1990s, the stringent Customs regulations imposed on every export and import consignment prolonged the total transit time and incurred additional transport costs. Hong Kong enjoyed this superior competitive edge on both sailing frequency and flexibility in Customs clearance until the late 1990s. Table 2.1 clearly shows that the cargo throughput via. Shenzhen and Guangzhou started catching up with Hong Kong’s volume by the end of 1990s.

Table 2.1 Port throughput ('000 TEUs)			
	HONGKONG	**SHENZHEN**	**GUANGZHOU**
2006	23234	18468	6600
2005	22427	16197	4683
2004	21984	13655	3308
2003	20449	10650	2761
2002	19144	7613	2180
2001	17826	5076	1738
2000	18098	3993	1430
1999	16211	2986	1179
1998	14582	1952	848
1997	14386	1147	687
***Source**: compiled from Port of Hamburg 2007 http://www.hafen-hamburg.de/en/index.php?option=com_content&task=view&id=58&Itemid=91*			

The continuous northward migration of manufacturing centres from Shenzhen, which is nearest to Hong Kong, has progressively moved to Dongguan, which is a few hundred kilometers away from Hong Kong. Shippers that moved to the Dongguan area realised that they are facing problems with increased transport costs and the uncertainty of loading their consignments in China. The PRC Customs clearance regulations required every export shipment together with relevant documents to be delivered to the loading port 24 hours in advance hence prolonging the total transit time from the factory to the loading port.

In response to the ill-managed cargo delivery procedures mainly caused by the strict and inflexible Customs regulations, shippers with large weekly volumes tended to set up their own in-house Customs broker while shippers with small weekly shipments have relied on a Customs broker to provide the service for them. In recent years, the freight forwarder has entered such specialised but ancillary fields to international forwarding such as packing, warehousing and the actual carriage of goods (generally involving road transport to and from Mainland China). Additionally, an increasing number of local freight forwarders' own trailers or containers operate on a similar basis like any shipping liner company. Many local freight

forwarders, especially those who have a business relationship with shippers previously in Hong Kong, provide a one-stop shop service to the shippers hence the function of freight forwarders in such situations will be like a carrier and a Customs broker.

In the past decade, most of the manufacturing sectors have been well established in Southern China, especially the Pearl River Delta (PRD). The passage through Hong Kong incurs additional handling costs and involves a longer transit time. Hence, the selection of an appropriate carrier, or a representative of a carrier, will influence a company's competitive advantage in the marketplace.

On the other hand, many shipping lines would like to see themselves as total logistics service providers and provide a comprehensive door-to-door service to shippers. The term "one-stop shipping" is frequently used to describe their total service capabilities (Lalonde 1991)**.** In addition, the concepts of Just-In-Time (JIT) and Materials Requirements Planning (MRP) as practiced by many shippers, have stretched the capabilities of these logistics service providers to the limit such that many freight forwarders went out of business during the early and mid 1990s.

2.2 Background of The Pearl River Delta

The Pearl River Delta Region (PRD) is a dynamic force representing over 50 million people including Hong Kong and Macau. The combined GDP of the PRD is about the same as Malaysia and larger than the Philippines and Vietnam combined. Their exports exceed the combined exports of Thailand, Indonesia, the Philippines and Vietnam.

The following sections in this chapter will provide an in-depth study of the economic situation in the PRD that will help to explain the rationale for this dissertation. In order to

provide a better macro view of the region, each city in the PRD region is described briefly, followed by a more detailed description of Zhongshan, Dongguan and Shenzhen where the original survey for this research was carried out.

The following paragraphs are based on information freely available from various PRD local Government websites and Statistical Yearbooks (YRD&PRD 2004). The accuracy of data collected within China is hindered by unstable internet connections and infrequent updates of local data on Government websites. On various occasions, data collected does not match with the figures given by other related Government agencies. Hence a direct comparison is difficult to achieve, nevertheless, data collected from these cities falls within the research period from year 2000 to 2006.

2.3 Pearl River Delta

By the end of the twentieth century, China had established itself as one of the world's most important trading nations. The primary engine for this export push was the Pearl River Delta, the area that stretches from Guangzhou to Shenzhen just north of Hong Kong. Despite ports situated around China having invested heavily in their infrastructure, Hong Kong with its good financial and transport infrastructure, remains the most important hub port for re-handling cargoes imported to and exported from China, especially the Southern region. The former Chief Executive, Mr Tung Chee Hwa, at a seminar on 9 January 2003 entitled the "New Era of the Pearl River Delta: Further integration with the World Economy" pointed out that:

> Hong Kong and the PRD have developed a very productive synergy since China's reform and open policies more than two decades ago. The highly successful `front shops, back factories' model of economic co-operation is now classic (typical). …Indeed, Hong Kong has contributed enormously to

the success of the PRD while at the same time accumulated substantial benefits to ourselves. Truly (this is) a win-win situation.

The complementary strengths of Hong Kong and the rest of the PRD have combined to produce phenomenal growth. Hong Kong is the hub for business, logistics, finance and services of the region. What about the PRD? With interlocking clusters of internationally successful industries and services, and the active participation of a continuous stream of upstarts as well as numerous small and medium enterprises, the PRD displays great flexibility in meeting changing market conditions as one of the world's leading power bases in manufacturing. . . . . the delta has been the fastest-growing part of the fastest-growing province in the fastest growing largest economy in the whole world.'

After a quarter of a century of high growth, the PRD is now ready to take on new challenges. The combined GDP of Hong Kong, Macau and the rest of the PRD reached US$260 billion in 2001, placing the region amongst the top 20 economies in the world. The combined GDP of Hong Kong, Macao and the PRD will reach well over US$500 billion in 10 years' time.

The PRD has the highest income per capita on the Mainland, and its population of over 40 million is also becoming an increasingly attractive consumer market, an enormous opportunity for Hong Kong businesses. Also, as the PRD becomes increasingly sophisticated, there is a great need for Hong Kong's professional services, another opportunity for Hong Kong. This opportunity will be enhanced by the CEPA (Closer Economic Partnership Arrangement) which is being negotiated and is expected to be concluded by June this year.

Even with the actual industrial cooperation and development well established two decades ago, the speech provided a long overdue recognition from the Hong Kong Government of the industrial situation in Hong Kong. Furthermore, this speech also unveiled the changes in government’s (PRD region) policies that they will

take a more proactive approach in this connection by launching the CEPA in coming years.

Cities in the PRD

There are eight major cities in the PRD. They are:

1. Shenzhen
2. Huizhou
3. Dongguan
4. Guangzhou
5. Foshan
6. Jiangmen
7. Zhongshan
8. Zhuhai

2.3.1. General Profile of each city

The eight cities encompass a high concentration of factories ranging from traditional industries like textiles, clothing and footwear to more advanced industries like plastic mould injection, electronics, and petrochemicals. These areas are easily accessible to and from Guangzhou and Hong Kong as they are all within two hours of travelling time either by air, rail, ferry or road.

2.3.1.1 Shenzhen

Shenzhen which borders with Hong Kong is one of the five Special Economic Zones (SEZ) established by China in 1979 (the SEZs are: Shenzhen, Zhuhai, Shantou, Xiamen, and the entire Province of Hainan). It is only a half an hour drive from Kowloon, Hong Kong. It is accessible by a major rail link to Guangzhou and the rest of the country and by a superhighway to Guangzhou and Zhuhai. It has a present population of 4 million inhabitants and a total area of 392 sq. km. Shenzhen has experienced tremendous growth in the past two decades and has emerged as the one of the most dynamic regions in the world. The city has three major road (truck) cross border points with Hong Kong, namely, Lok Ma Chau, Sha Tau Kok and Man Kam To.

In the first three quarters of 2006, an average of 40,700 vehicles per day crossed these boundaries. Man Kam To handled about 7 400 vehicles a day, 87% of which were goods vehicles and container trucks and the rest were coaches and private cars. Sha Tau Kok handled about 2 500 vehicles a day, 47% of which were goods vehicles and container trucks and the rest were coaches, private cars and hire cars. Lok Ma Chau's throughput was about 31,100 vehicles a day, 61% of which were goods vehicles and container trucks and the rest were coaches, Lok Ma Chau-Huanggang Cross-boundary Shuttle Buses, private cars and hire cars. The Lok Ma Chau crossing is now operating round-the-clock to serve both goods and passenger vehicles (HKSAR 2006).

Table 2.2 Opening hours for Hong Kong cross-boarder check points

Crossings	**Opening Hours**	
	Goods Vehicles	Passengers
Lok Ma Chau	24 hours	24 hours
Man Kam To	7 am – 10 pm	7 am – 10 pm
Sha Tau Kok	7 am – 8 pm	7 am – 8 pm
Lo Wu	NIL	6:30 am – 12:00 midnight

Source: HKSAR Government Customs and Excise Department 2006
http://www.customs.gov.hk/eng/publications_e.html

2.3.1.2 Dongguan

Dongguan is part of the Pearl River Delta Economic Open Area lying between Guangzhou and Shenzhen. Dongguan is located fifty kilometres south of Guangzhou and ninety kilometres north of Shenzhen. The city is on the main rail link between Guangzhou and Hong Kong. It has a land area of 2,456 sq. km., six times larger than Shenzhen. Table 2.3 shows the Annual Per Captia GDP of Dongguan during the period from 1998-2002. Annual GDP per capita of RMB 20,000 is well above the national average figure.

Table 2.3 Dongguan Annual Per Capita GDP of 1998-2002 (in RMB)

Year	Annual GDP per capita
1998	24.031
1999	27,561
2000	32,477
2001	37,777
2002	43,094

Source: Dongguan Bureau of Foreign Trade & Economic Cooperation website http://www.dgboftec.gov.cn/en/04/index.html

Dongguan has developed into a modern industrial city since the beginning of China's "open door" policy, and has become an important part of the economic circle of Guangdong, Hong Kong and Macao. With an average annual growth rate of 22% in its GDP, Dongguan is one of the areas with the fastest economic development in China, and has been listed in China's top 30 cities in terms of comprehensive economic strength. Over 13,000 "processing, assembling, manufacturing and compensation trade" businesses and foreign invested enterprises have been established. The accumulated foreign invested capital has reached US$ 8 billion. In addition, many world famous international corporations and listed corporations of Hong Kong and Taiwan have invested in Dongguan.

Table 2.4 shows consolidated information on some economic indicators of Dongguan - it reflects the tremendous growth rate in this city. The term “world factory”, a title first given by the Japanese Ministry of International Trade and Industry in a white paper and adopted by other countries time and again, usually referred to Dongguan in the late 90s.

Table 2. 4 Major Economic Indicators of Dongguan in 2002		
Major Economic Indexes		**Growth on a year-on-year basis (%)**
GDP	RMB 67.227 billion	16.12
Gross Output Value of Industry (Current Price)	RMB 157.407 billion	21.8
Import & Export Value	USD 44.247 billion	28.4
Import Value	USD 20.511 billion	25
Export Value	USD 23.736 billion	32.6
Financial Income	RMB 16.788 billion	33.46
Total Investment in Fixed Assets (On Township Level and Higher)	RMB 12.622 billion	65.72
Annual Per Capita Disposable Income of Urban Residents	RMB 17,710	4.56
Total Retail Sales of Consumer Goods	RMB 22.495 billion	14.7
Foreign Exchange Earnings	RMB 14.651 billion	30.11
Power Consumption by Industry	2,070,700 KWH	32.14
Business Volume of Postal and Telecommunications Services	RMB 18.168 billion	48.25
Source: Dongguan Bureau of Foreign Trade & Economic Cooperation website *http://www.dgboftec.gov.cn/en/04/index.html*		

2.3.1.3 Guangzhou

Guangzhou, the provincial capital of Guangdong, is located on the north side of the Pearl River Delta. It is the hub of the province and is accessible by super highways, fast rail links to Shanghai and Beijing and elsewhere, and it has an international airport. It is one of the three major air hubs in China, together with Beijing and Shanghai. The administration is divided into eight districts and four municipalities. Guangzhou has a total land area of 16,000 sq. km., the largest in the province with over 8 million inhabitants.

The municipal government of Guangzhou plans to build the city into a modernized international metropolitan centre. In order to attain this goal, Guangzhou strives to form an open-door setup on a larger scale and at a higher level. The city has completed the building of a world-class port in Nansha. The Guangzhou Government emphasises the development of six major industries. There are the high-tech light industries, communications and transportation, the circulation of commodities, finance and insurance, construction and real estate industry, and the tourist industry. The local government is determined to develop Guangzhou into a regional, international financial center, a commercial center, information center, a tourist center, and a pivot of communications and telecommunication and a modernized international metropolitan centre.

2.3.1.4 Zhongshan

Zhongshan City, is a prefecture-level city with five administrative districts and 24 townships. It is located 86 km south of Guangzhou and 54 km east of Shenzhen. Zhongshan covers 1,688 sq. km. and has a population of over 1.3 million inhabitants .It is accessible by a super

highway connecting Guangzhou, Shenzhen and Zhuhai and has daily ferry services between itself and Hong Kong and Macao.

In this study , four cities within the PRD were selected due to their extensive involvement in the manufacturing industries and they provide a wide spectrum of export variety for this study. The selected cities were Guangzhou, Dongguan, Shenzhen and Zhongshan. Table 2.5 indicates a cross profile of these cities. Guangzhou, Dongguan and Shenzhen have an export percentage of 25.58% of the total export value of China and 23.8% of the total import value of China. Zhongshan is used here just for comparison purposes in the initial stage of this study as the first set of questionnaires were posted to shippers/freight forwarders in this city. The profiles of the following cities are included here in order to provide a broad comparision of their trade.

Table 2.5 Profile of selected PRD cities 2000				
	Guangzhou	Dongguan	Shenzhen	Zhongshan
Area (% of China)	0.08	0.03	0.02	0.02
Population (% of China)	0.77	0.50	0.54	0.18
GDP* (% of China)	2.80	0.60	2.04	0.38
Export Value* (% of China)	4.37	7.13	14.08	1.64
Import Value* (% of China)	4.68	6.35	12.77	1.15
FDI **(% of China)	5.97	3.3	4.55	1.21
Annual Growth 2001				
GDP	+12.7%	+18.0%	+13.2%	+16.1%
Export Value	-1.4%	+10.8%	+8.4%	+18.5%
Import Value	-1.3%	3.9%	+5.9%	+15.7%
FDI	+0.4%	+10.2%	+32.1%	+13.6%
Retail Sales	+11.0%	+15.6%	+13.2%	+12.0%
Fixed Assets Investment	+5.3%	+22.0%	+5.8%	+61.9%
* 2001 whole year				
** from 1979 to 2000 cumulative, utilised FDI				
Source: Hong Kong Trader. Website: http://www.hktrader.net/common/PRD_map.htm				

2.3.1.5 Huizhou

Huizhou faces Daya Bay and is adjacent to Shenzhen and Hong Kong. It is accessible by highway and rail from Shenzhen and Guangzhou. In addition to the city of Huizhou, there is one district and 4 counties with a total land area of 1,130 sq. km. There are over 2.7 million residents. Huizhou has a modern industrial base in electronics, petrochemicals, machinery and textiles. Over 7,800 foreign funded enterprises have been established in Huizhou. Huizhou has six ports but with only one open to international trade while the remainder are for domestic trading.

2.3.1.6 Foshan

Foshan is situated with Guangzhou to the north and Jiangmen to the south. The administration consists of two districts and four cities of county level covering an area of 3,814 sq. km. The population of Foshan is over 3.5 million inhabitants. The local government is trying to promote the city as a place for international business transactions and commodity exchange. It is one of the top ten fastest growing cities in terms of economic growth and social progress. Foshan has a favorable environment for investment with a well-developed infrastructure, ample energy supply and telecommunication systems. The city has five Customs offices, nine container terminals, four passenger ports and an airport (albeit very small).

2.3.1.7 Jiangmen

Jiangmen City is located in the centre, south of the Guangdong Province and west of the PRD. The city has two districts and five county-level cities with a total area of 9,541 sq. km. covering one quarter of the area of the PRD. It has over 3.8 million inhabitants and is the home of many overseas Chinese. Jiangmen is accessible by a super highway from Guangzhou, Zhongshan and Zhuhai. It has the second largest inland river port in Guangdong.

2.3.1.8 Zhuhai

Zhuhai is located in the southern border of Guangdong Province adjacent to Macao. Founded in 1979 as one of the first Special Economic Zones, Zhuhai has become a garden-like city attracting many multinational companies. Zhuhai has a total area of 7,653 sq. km. of which 1,653 sq. km. is land including the islands of which there are 146. There are three

administrative districts with a total of 22 towns. With the intention of turning Zhuhai into a city for tourists, the Zhuhai government built the only Formula-1 racing circuit in China, which hosts car racing festivals annually. Every two years, Zhuhai hosts an International Aviation and Aerospace Fair, which attracts visitors from home and abroad. Zhuhai has a well-developed infrastructure with the only deep-water port west of the PRD, five international ports and twenty small to medium size ports

2.3.2 The industrial zones in selected cities

Over the past fifteen years, shippers in the PRD region like to use Hong Kong as their preferred loading port due to it having a better sailing schedule and customer service. Trucks that provide PRD/Hong Kong cross-border service are strictly regulated as the PRD government intend to protect their local trucking industry.

The management of the trucking industry by the local PRD Government takes a different view from the world's norm. The local Government must know the level of freight volume before they issue the truck licence to the operator. The cross-border trucking service between Hong Kong and PRD interrupts this arrangement. For the ease of management, the local PRD Government will encourage manufacturers to settle in the industrial park or district, the transport department will then issue the cross border licence according to their own calculations.

The areas designated for manufacturing, processing and service industries in China under the open door policy as stated in the Guangzhou meeting (GZM meeting 1980) are segregated into the following categories:

a. **Economic and Technological Development Districts**, which are approved by the State Council and offer favorable tax policies for its development zones. These districts are further subdivided into other zones serving various functions

b. **New & High-Tech Development Zones**, which are also approved by the State Council and offer preferential policies to enterprises with new and high technology, with the tertiary industry offering added value to the other industries. These zones are also subdivided into other zones and industrial parks with different functions. Note: it is possible to invest in some Hi-tech zones even if your company does not engage in hi-tech products.

c. **Free Trade Zone, Export Processing Zones or Bonded Zones** are approved by the national Customs Bureau and provide a greater degree of freedom in the importation and exportation of goods, semi- or finished products without tariff. If these are exported, consumption tax and VAT are refunded.

d. **Industrial Zones** are organized by the municipal governments and may have favorable tax policies depending on if the city is in the Special Economic Zone or a coastal city.

There are various industrial zones, bonded zones and industrial parks throughout all nine cities in the PRD region. This research concentrates on shippers and freight forwarders from Guangzhou, Dongguan, Shenzhen and Zhongshan. Therefore only these four cities will be discussed in detail here.

2.3.2.1 Shenzhen

Between 1980 and 2003, the GDP of Shenzhen enjoyed an average annual growth of 33.3%. In 2004, its GDP reached $42.8 billion, ranking fifth among all mainland cities, while GDP per capita was ranked top in the country. Its total import and export amount was $147.3 billion, including an export value of $77.9 billion which gave it top ranking among all mainland cities for 12 consecutive years. Its import value was $69.5 billion. By the end of 2004, the FDI (Foreign Direct Investment) reached $41.2 billion (NAROS 2006). Over 50 of the Fortune 500 companies are present in Shenzhen.

Shenzhen has the following industrial zones, bonded zones and industrial parks:

- Longgang Greater Industrial Estate
- Shatoujial Bonded Zone
- Futian Bonded Zone
- Yantian Port Bonded Zone
- New & High Tech Industrial Park

- **Longgang Greater Industrial Estate**

The Longgang Greater Industrial Estate, established by the municipal government, covers an area of 174.4 sq. km. of which 10 sq. km. is allocated for the formation of an export-processing zone to serve as the export base for high tech products. The industrial estate encourages manufacturing industries using state-of-the-art technology. The industrial estate also encourages tertiary industries in the finance, trade, software development, microelectronics sectors and other sectors that support the manufacturing industry.

- **Shatoujial Bonded Zone**

The Shatoujial Bonded Zone occupies 300,000 sq. m., nearly two thirds of the land is allocated for advanced products mainly for export purposes and is now expanding into the logistics sector.

- **Futian Bonded Zone**

The Futian Bonded Zone has a total area of 1.35 sq. km. and has high-tech industries with supporting service industries, warehousing, international trade facilities and 0.63 sq. km. allocated for accommodation.

- **Yantian Port Bonded Zone**

The Yantian Port Bonded Zone has an area of 0.85 sq. km. and has warehousing facilities, material production and packaging. It is also used for commodity trading and expos.

- **New & High-Tech Industrial Parks**

An industrial park assigned at state-level with a total area of 11.5 sq. km. is planned to be an advanced high-tech park of great international standing. The local government has given priority to four lines of industry, these are IT, biotech, new materials and optical electromechanical integration. Large multi-nationals such as Compaq and Lucent have established operations in the park.

2.3.2.2 Dongguan

Dongguan has four major industrial areas which are listed as follows:

- High-Tech Development Zone
- Xin'an Industrial Park
- Anli Science & Technology Compound
- Zhen'an Industrial Park

The Xin'an Industrial Park, Anli Science & Technology Compound and Zhen'an Industrial Park are located in the new industrial city of Chang An. 31 of the Fortune 500 companies have invested in Dongguan for example Dupont, General Electric, Hitachi, Thompson, Nestlé and others.

- **High Tech Industrial Development Zone**

A state-level industrial development zone with an area of 10 sq. km. is located in Huangcun town. It is 70% developed and there are already more than 47 multinationals and domestic companies present such as Dupont, Tanate of Japan and others.

- **Xin'an Industrial Park**

Xin'an Industrial Park has over 373,000 sq. m. of land area. It encourages manufacturing of electronics products and computer parts and accessories. It is still under development and only 23,300 sq. m. has been completed with over 250,000 sq. m. of workshops.

- **Anli Science & Technology Compound**

Anli Science & Technology Compound has a land area of 532,800 sq. m. of which 133,200 sq. m. has been developed as Phase I. 120,000 sq. m. of workshops, 30,000 sq. m. of living quarters and a large dining hall accommodating 3,000 diners have been completed in Phase I. Manufacturing of advanced technology products, capital intensive industries and added value services is encouraged.

- **Zhen'an Industrial Park**

Zhen'an Industrial Park is a relatively new addition in Dongguan. A land area of 666,000 sq. m. has been allocated and 133,200 sq. m. has been developed under Phase I. The infrastructure such as roads, power and water has been installed under Phase I. 80,000 sq. m. of workshops and staff/workers accommodation is under construction. Capital intensive and high tech projects are encouraged.

2.3.2.3 Guangzhou

Guangzhou has the largest industrial areas in the province including three state-level industrial development industrial zones. The following four industrial areas are described in detail:

- Guangzhou Economic & Technological Development District (GETDD)
- Guangzhou High-Tech Industrial Development Zone (GHIDZ)
- Nansha Development & Technological Zone (ETDZ)
- Lianhuashan Bonded Processing Zone

Over 110 multinational companies such as Warner-Lambert, P&G, Air Products, Casio, Sumitomo, Honda, Linde, TOTAL, ICI Omicron, etc. have set up operations in the GETDD and GHIDZ.

- **The Guangzhou Economic & Technological Developing District (GETDD)** was one of the first state-level development districts and is subdivided into four parts. It consists of the Western Section where the administration office is located, the Eastern Section including the Guangzhou Export Process Zone, the Yonghe Section (Taiwanese Investment Zone) and the Donghui Plaza. It has a cumulative land area of 30 sq. km. The GETDD has approved more than 1,100 foreign invested enterprises. Over 386 industrial plants have been put into operation. There are over 55 of the Fortune 500 companies operating in the GETDD. Enterprises are operating in the fine chemicals industry, food and beverage, electronics, machinery manufacturing, packaging manufacturing and other industries.

- **Guangzhou High-Tech Industrial Development Zone (GHIDZ)** is a state-level high-tech industrial development zone comprising of the Guangzhou Science Park, Tianhe Science & Technology Park, Civil Science & Technological Park and the Nansha Information & Consultancy Park. The Guangzhou Science Park is the biggest zone with a total area of 37.47 square kilometers.

The Guangzhou Science City is designed to be oriented at computer science and related software industries, the bio-medical industry, optical electronics industry, environmental protection industry and other industries. It is striving to become the "Guangdong Photon Valley." In 1998, the administrations of the GETDD and GHIDZ were merged into one administrative force with its head office in the Western Section of the GETDD in order to simplify procedures and share economic resources.

- **Nansha Development & Technological Zone**

Nansha is located southeast of Guangzhou and on the west bank of the tiger mouth watercourse near the estuary of the Pearl River. Nansha has a total land area of 54 sq. km., and is part of the city administration. It is considered geographically to be the heart of the PRD and hub of transportation with two open (deep water) ports. It has over 300,000 inhabitants. The provincial government has nominated Nansha as a pilot city for developing a sophisticated information technology and logistics centre.

- **The Nansha Development & Technological Zone (ETDZ)** is a 200 hectare base for more than 17,000 enterprises specializing in nonferrous metal processing, building and porcelain, motorcycle assembly, intelligent household appliances, building materials and garment industries. Foreign companies such as GE, BASF, Ever-Best Printing and others have set up factories. The EDTZ is expected to become a free trade zone in the foreseeable future.

- **The Lianhuashan Bonded Processing Zone** is an export-oriented industrial base, approved by the Municipal Government of Guangzhou, which implements preferential treatment under the leadership of the Municipal Government of Panyu. The Zone is located in the east of Panyu, facing the new Huangpu Port, adjacent to the Lianhuashan Port. Its general layout has an area of three square kilometers.

2.3.2.4 Zhongshan

In Zhongshan, there is the National Torch High-Tech Industrial Development Zone jointly set up by the Ministry of Science and Technology, the provincial government and the municipal

government. It has a total land area of 70 sq. km. with the following national industrial bases:

- Torch High-Tech Industrial Park
- Electronics & IT Park
- Industrial Park for Privately-owned Businesses
- Health Technology Park
- Packaging and Printing Park

The above industrial parks enjoy the preferential policies of a state-level high-tech industrial development zone.

1 **The Torch High-Tech Industrial Park** covers a total area of 5.3 sq. km. of which 287 hectares have been developed.. A number of high-tech companies such as Grand Coating Glass, Toray Sanyo Precision, UPC, Weifu Technologies and others have set up operations in the park.

2 **The Electronics and IT Park** set up in 2000 has a total land area of 2.4 sq. km. of which 200 hectares have been developed. Acer has set up operations in the park followed by 35 computer and optical fibre companies such as Ambit, Sufunai Iritani, Browave and others.

3 **Industrial Park for privately-owned businesses**, which was set up in 1997 has a total land area of 131.6 hectares of which 64.9 hectares have been developed. Several large domestic companies have set up business in the park such as Jie Xiaofeng Electronics, Baoli Timber, Kaisheng Technologies and others.

4 The Health Technology Park, established in 1994 and the first on a national level, has a total land area of 13.5 sq. km. of which 1.8 sq. km. has been developed. Some 20 projects are under construction by multinational companies like Glaxo Smith Klein, French Ferring, Sunny medicine and others.

5 The Packaging and Printing Park has been set up by the Zhang Jia Bian Enterprise Group and approved by the China packaging Technology Association and China Packaging General Company. It covers a total land area of 200 hectares of which 133.3 hectares have been developed. There are more than 30 packaging and printing companies and research organizations operating in the park.

2.4 Summary of the PRD cities

After reviewing the general background of nine cities that compose of the PRD region, four cities were identified as suitable for the survey. Table 2.6 summarises the major industrial sectors of the four selected cities, namely, Shenzhen, Dongguan, Guanzhou and Zhongshan. . The access and the type of cargo available from these industrial estates are assessed. This assessment helps to develop the potential industries located in the selected cities.

Table 2.6 Major industrial areas of selected cities in the PRD					
Area	**Access**	**Policies**	**State level**	**Industrial sector**	**Logistics comments**
Shenzhen					
Longguang Greater Industrial Estate	fair	good	X	Micro-electronics, Service Industries	Hi-tech projects
Shatoujia Bonded Zone	fair	good	X	Logistics & Export-Oriented Industries	Logistics companies & warehousing
Futian Bonded Zone	good	good	X	Warehousing, Supporting Service Industries, High-Tech	Excellent for export processing
Yantian Port Bonded Zone	fair	good	X	Material production, Packaging, Warehousing	Good for processing and re-packaging
New & High-Tech Industrial Park	good	good	√	IT, Biotech, New Materials, Optical-Electromechanical Integration	High value and high-tech cargoes
Dongguan					
High-Tech Development Zone	fair	good	√	Fine Chemicals, High-Tech Materials, Plastic Injection, Moulding	High value cargo – possible for bulk
Xin An Industrial Park	fair	fair	X	Electronic products, computer parts, Accessories, Plastic Injection	Infrastructure insufficient
Anli Science & Technology Compound	fair	fair	X	Capital Intensive Industries, Added Value Services	High tech and time sensitive cargoes
Zhen An Industrial Park	good	fair	X	Capital Intensive Industries, High-Tech Projects	Infrastructure insufficient
Guangzhou					
Guangzhou Economic & Technological Development District	good	good	√	Fine Chemicals, Food & Beverage, Machinery, Packaging	High value and time sensitive cargoes
Guangzhou High-Tech Industrial Development Zone	good	good	√	Computer Science, Optical electronics, Pollution control	High tech and time sensitive cargoes
Nansha Development & Techno-logical Zone	fair	good	√	Nonferrous processing, Building materials, Garments, White goods	Direct sea connection. Destined to be the logistics hub overtaking Hong Kong
Lianhuashan Bonded Processing Zone	fair	fair	X	Export-oriented Industries	Good location for export-oriented processing
Zhongshan					
Torch High-Tech Industrial Park	poor	good	√	High-Tech Industries	High tech and time sensitive cargoes
Electronic & IT Park	poor	good	√	IT, Optical fiber, Electronic parts	Small consignment and time sensitive cargoes
Industrial Park for private owned business	poor	good	√	Pharmaceuticals, Electronics, High-Tech Industries	Transport cost vary and long transit time
Health Technology Park	poor	good	√	Pharmaceuticals, Health products, Biotech	Small consignment and time sensitive cargoes
Packaging and printing park	poor	good	√	Packaging, Printing, R&D	Bulky consignment
Source: feedback from industrial practitioners and various PRD Local Government websites					

2.5 Loading ports within the PRD

This thesis examines container shipments for overseas destinations within the Shenzhen, Dongguan and Hong Kong areas. Even though there are numerous ports within the PRD region, most of the shippers and freight forwarders prefer to use either Shekou, Yantian or Hong Kong for their international shipments. Figure 2.1 indicates a general layout of the cities within the PRD region.

Figure 2.1 The cities within the Pearl River Delta

2.5.1 Shekou Container Terminal

Shekou is located at the tip of Nantou Peninsula in the Shenzhen area, south of Nantou and facing Lau Fau Shan of Hong Kong across Deep Bay. It was formerly a Customs station in Bao'an County and now belongs to Nanshan District of Shenzhen. In 1979, China Merchants of Hong Kong solely developed the11-square kilometre Shekou Industrial Zone.

Established in 1989, Shekou Container Terminals Ltd. (SCT) was the first professional international container terminal in Shenzhen. It is now jointly invested in and owned by four industry-leading shareholders, namely China Merchants, DP World, Swire Pacific and Modern Terminals.

It is located at the estuary of the Pearl River and in the western Shenzhen Port. SCT is a major transportation gateway for both international and domestic cargo owners and carriers seeking access to and out of the South China hinterland.

With the improvement of its port environment and fast growth of the Pearl River Delta hinterland economy, SCT now has over forty liner services for global destinations (SCT 2007).

Since Modern Terminals in Hong Kong also holds a share in SCT, the container traffic volume between these two terminals can be viewed as controlled by one company.

There are forty-six weekly sailings from SCT to all over the world. Ten sailings depart for North America; nine schedules sail to Europe; twenty six sail to Asian countries and one for Australia.

2.5.2 Yantian International Container Terminal

The Port of Yantian, situated in the east of Shenzhen, borders on Shatoujiao to the west and Da Meisha and Xiao Mejsha to the east, faces the Kowloon Peninsula of Hong Kong across the sea. It is ten kilometres to downtown Shenzhen, thirteen kilometres to Fenling in Hong Kong, seventy two kilometres to Huizhou and one hundred and eighty kilometres to Guangzhou. It is fifty three nautical miles to Victoria Harbour in Hong Kong. Yantian Port is one of the natural ports in China. It provides a nice natural shelter for ships and with its

draft of more than sixteen metres, it is able to berth vessels that exceed 8,000 Teus. The port of Yantian is designed to be a comprehensive port, mainly engaged in the international transshipment of containers as well as bulk and general cargo. During the eighth Five-Year Plan period, six berths were completed (including four multi-use berths of 1000, 3000, 10,000 and 25,000 tons and two container berths of 50,000 tons each). Currently the port is capable of handling 5.25 million tons per year

Yantian International Container Terminals Limited (YICT), a joint venture established by the Hutchison Port Holdings (HPH) Group and Shenzhen Yantian Port Group (YPG), commenced operations in the middle of 1994. Since its opening, YICT has seen a double-digit growth rate in its annual handling over the past years. Yantian is the preferred port of call for mega-container vessels due to its natural deep draft. A total of 36 well-known shipping lines have provided over 70 weekly shipping services at Yantian, thus forming an extensive shipping network throughout the world (YICT 2007).

Similar to SCT, Hong Kong International Terminals also hold majority share in Yantian International Container Terminals Limited and belong to the Hutchison Port Holdings. Strategic allocation of resources, equipment and traffic flow are obvious in the daily operation between these two terminals.

There are seventy-nine weekly sailings from YICT to all over the world. Thirty eight weekly scheduled sailings depart for North America, three to South America, twenty seven to Europe, nine to Asian countries and one for Australia and South Africa.

2.5.3 Hong Kong Port - connected by truck

Although the Hong Kong SAR Government has launched many large-scale construction projects in order to connect Hong Kong to the PRD region, such as the Shenzhen Western

Corridor, the Hong Kong-Zhuhai-Macao Bridge and the Guangzhou-Shenzhen-Hong Kong Express Rail Link, none of them will be available until the year 2010.

At present, the modes of freight transport between Shenzhen / Hong Kong to overseas destinations are road, rail and barge. Since there is heavy road traffic between the PRD and Hong Kong, the following sections are mainly aimed at providing a better understanding of the cross-border truck operation between Hong Kong and Shenzhen.

- **The Role of the Cross-Border Truck**

The following sections are based on trade figures from the Census and Statistics Department (CSD 2007) and Marine Department (MD 2007) in the Hong Kong Special Administration Region Government. The proportion of exports in Hong Kong's land-freight transport industry to total export of services was only 1.3% to 2% during the period 1995-2002. The percentage of total business receipts for cross-border trucks to total business receipts of the land-freight transport industry was estimated at around 31.3% to 38.6% during the same period. The cross-border road freight industry is an important part of Hong Kong's trade with Mainland China.

Since the mid-1980s, cross-border freight trucks have been the most important transport mode for goods moving between Hong Kong and southern China. During the period 1990-2004, the average proportion of the value of Hong Kong's exports by road to the total value of its exports to Mainland China was 67%. In the same period, the average proportion of the value of imports by road to the total value of imports from Mainland China was 79%.

During the period of 1990-2003, the average proportion of the value of total outward freight movements from Hong Kong to Mainland China by road to total outward freight movement to Mainland China was 42%. The average proportion of total inward freight movement from

Mainland China by road to total inward freight movement from Mainland China was 38%. Between the years 1990-1998, freight trucks were the most important transport mode for moving shipments between Hong Kong and Southern China. After 1998, the proportion of freight moved by river barge increased rapidly and gradually replaced movement by road as the most important traffic mode for freight movement between Hong Kong and Southern China.

The rapid development in adjacent PRD ports supports a direct transshipment locally instead of using trucks to bring consignments all the way to Hong Kong. Since Hong Kong has the best international sailing schedule, any consignment moving out from the PRD has to come to Hong Kong for a connection. But with more international liner companies setting up their sailings at PRD ports, the transshipment can now be done locally.

The proportions of transshipment and direct shipment to total freight moved by various transport modes in 2003 indicated that transshipment cargo moved by river, the major source of growth in recent years, represented about half of the total freight moved. However, the proportion of transshipment cargo moved by road has declined, standing at only 8% in 2003. Bottlenecks induced by the cross-border road freight industry caused a significant proportion of Guangdong's external trading firms to no longer move cargo by road.

For road freight, the amount of cargo mainly comes from that:

- Imported by air and re-exported to Mainland China by land or
- Imported from Mainland China by land

Most cross-border road freight is destined for port terminals, which develop a close relationship with seaborne cargo throughput Hong Kong. The traffic volume growth of cross-border freight trucks is proportional to the flow of seaborne cargo throughput of container terminals. This indicates the close correlation between the cross-border road

freight and Hong Kong ports. Without an efficient cross-border road freight industry, Hong Kong ports will be less effective in reaching their potential.

- **The scale down of Hong Kong's cross-border road freight industry**

All cross-border freight trucks can be classified as either goods vehicles (non-container trucks)

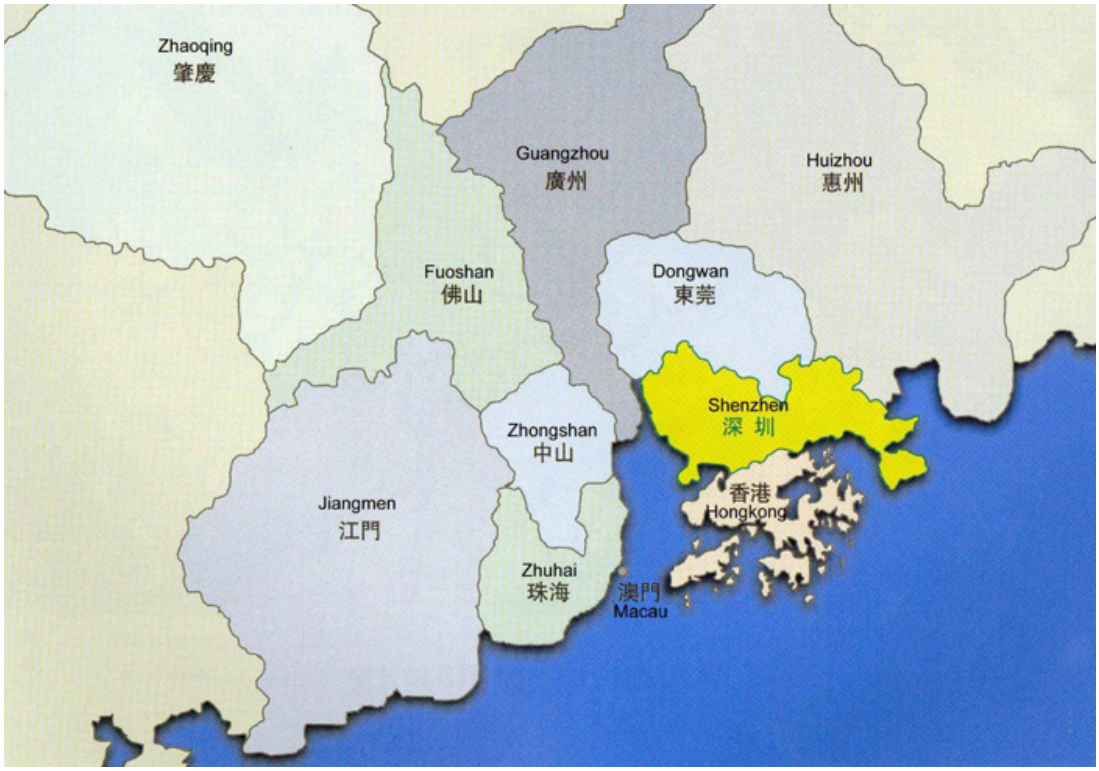


Figure 2.2 Hong Kong - PRD map

or container trucks. The goods vehicle to container trucks ratio was 4 to 1 in 1991. In 1999, the ratio was approximately 1 to 1, and it remains so to the present day. Since 1992, the flow of goods vehicles has seen steady growth, whereas the flow of container trucks has increased dramatically. These changes are mainly caused by the structural changes in cargo volume of PRD shippers. In the early days, overseas buyers were concerned about the capabilities and standard of performance for factories in the PRD. The quantity of cargo was small for each factory and it needed to use goods vehicles to transport the cargo to Hong Kong for consolidation before shipping it overseas. Factories in the PRD gradually built up their

reputation and received large orders from overseas buyers. Finished products from these factories can fill up one full container hence the demand for goods vehicles has declined.

Since the opening of ports around Shenzhen after 1995, Hong Kong cross-border truckers no longer enjoy a quasi-monopoly but have to compete with Mainland China truckers. Despite strong growth in Guangdong's external trade, the traffic volume of cross-border freight trucks has maintained only single-digit growth over the past 10 years. The traffic volume growth of container trucks has slowed down more significantly than that of goods vehicles.

- **Imbalanced flow of road traffic**

There are more heavy southbound trucks than northbound loaded trucks. The proportion of one-way loaded trucks to total traffic flow of cross-border trucks is ever increasing. In the year 2003-2004, according to the Statistics Department, for every four southbound container trucks, three were loaded. For every five northbound container trucks, two were loaded. There is a discrepancy between the demand for incoming and outgoing container trucks, with more loaded trucks travelling south and fewer travelling north. The number of empty trucks varies with the season and the volume of imports and exports.

Despite simplified Customs procedures at the border and an improved road traffic network, the proportion of one-way loaded trucks to total traffic flow has not decreased. This may reflect difficulties with or inefficiency in the road system for short-distance transportation for two-way loaded trucks.

Despite the fact that the open-door policy has been in force in Hong Kong for decades, in addition to the launch of the Mainland and Hong Kong Closer Economic Partnership Arrangement (CEPA) in 2003, over 80% of all incoming and outgoing cargo is mainly loaded and unloaded in the Shenzhen and Dongguan areas. This has a negative impact on the development of the Hong Kong road freight industry because carriers are no longer able to

provide a value added service to their customers. It is also out of line with the rapidly expanding road network in Mainland China, especially in Guangdong.

Over 80% of cross-border road freight companies have fewer than five employees. The small-scale operations and fierce competition within the industry has left relatively few resources with which these companies can analyze the industry and lobby the government for restriction relaxations. In fact, restrictions placed on the development of the road network, the licensing system, cross-border road freight and the Customs and quarantine systems, along with transport constraints on cross-border freight trucks, all hamper the efficiency of the cross-border road freight industry.

- **The Licensing System of Cross-Border freight trucks**

Information on cross-border truck traffic is scarce. Neither the Guangdong provincial government nor the HKSAR government regularly makes public relevant statistics. In year 2004, about 18,900 Hong Kong cross-border freight trucks owned a valid closed road permit. According to The Hong Kong Transport Department, about 800 Mainland China truckers can operate in Hong Kong in accordance with an agreement reached by both governments in 1997. On the other hand, it is estimated that about 1,000 Hong Kong truckers can operate between Hong Kong and the Shenzhen Futian Tax Free Zone without applying for a cross-border licence.

- **The licensing regulations.**

Before 1993, a Hong Kong transport company, having established a joint venture company with its Chinese counterpart could apply for and obtain cross-border freight truck licences from the provincial government. This arrangement is open only to Chinese-foreign joint

venture companies. The licences lasted for up to three to six years. Before the mid-1980s, 20 to 30 licence holders would form a group, owned by an independent "licensing company" and each "licensing company" might have up to 100 licences. However, this type of licensing arrangement is rare nowadays as more truck drivers leave the industry.

In 1993, the Guangdong provincial government held two public auctions to invite bidding for new licences. The first was held in March and the second in September. In the same year, the Guangdong provincial government abandoned the charge-free policy and imposed a fee of HK$180,000 every three years on cross-border freight trucks when these trucks renewed their licences. The downturn of economic situation in 2001 (9-11 incident) and 2003 (Severe Acute Respiratory Syndrome (SARS)), has pushed the fee down to HK$100,000.

- **The Development of Licensing Regulations**

All Guangdong-Hong Kong joint venture transport company contracts have to be approved by the Department of Foreign Trade and Economic Co-operation of Guangdong Province (FTEC, 2007). The following summarizes policy changes and comments on the industry since 1984:

(1) Mainland partners are primarily enterprises related to the local government. Hong Kong transport companies are required to pay a fixed fee to their Mainland partners. In 1984, every cross-border freight truck owner paid HK$300 per month to its Mainland partner. Since then the fee has increased to HK$1,667 per month. In 1993, the Guangdong provincial government introduced a licence fee on cross-border freight trucks (see above).

(2) In the 1980s and the early 1990s, cross-border freight trucks were allowed to pass through only one of the Mainland-Hong Kong crossings. It was inflexible as the truck driver must return to the same check point when he first crossed the

border. Since the mid-1990s, restrictions have been steadily relaxed. Cross-border freight truck owners can now apply to use the three crossings.

(3) During the 1990s, there were regulations prohibiting the leasing of licences, but a lot of transactions were carried out illegally. Since the late 1990s, 30% of licences have been eligible for leasing. The remaining 70% must be used by truck owners.

(4) The licensing system is mainly for owners of cross-border freight trucks. For every 20 licences, the licensing company is allowed one to two backup drivers. Under these regulations, the truck driver once allocated to the truck then they are in pairs whenever they cross the border because the Customs at the border will inspect the truck licence as well as driver's own licence. This arrangement is to ensure the trailer and the driver will enter and leave China at the same time. If these documents are not presented to the Customs office at the same time, they are not allowed to cross the border. However, 90% of cross-border freight truck owners lease their licences from licensing companies. Thus most of them have fewer than 20 licences and therefore cannot have backup drivers.

(5) Under the Closer Economic Partnership Arrangement, the Mainland road freight industry was opened up to Hong Kong and Macao investors. This arrangement allows Hong Kong and Macao service providers to wholly own cross-border freight truck companies not just in Guangdong but in other parts of Mainland China. This has meant that from 2004 onwards, all cross-border freight trucks are able to operate across the whole country. In reality, the trucks are still unable to operate in all of China's destinations. They are not allowed to pick up empty or loaded containers within the country and are restricted to

routes from Hong Kong ports to factories/storage facilities in the Mainland. Although the licenses do not restrict the routes that trucks can use, departments of communications within local governments impose restrictions that prevent cross-border freight trucks from operating in any Guangdong ports.

- **High fees for cross-border freight trucks**

The HKSAR government charges a licence fee and a closed-road permit fee only for cross-border truckers. According to the information obtained from the Hong Kong (Cross Border) Transportation Driver's Association, the fee is approximately HK$774 per month, or about 1.4% of the total cost of operating a container truck. Fees charged by various levels of government in the Mainland amount to 15.8% of monthly costs (or not less than HK$8,993). These fees include a highway-maintenance fee, a licence fee, an operation fee, a seasonal tax, an industry and commercial consolidated tax, a fixed profit tax, and other charges for obtaining necessary documents. In addition, truck owners need to pay additional fees because of the two governments' different insurance and vehicle examination requirements. There may be cases in which cross-border freight truck owners end up with unnecessary double insurance coverage and vehicle examination fees, thus adding to their fixed costs.

In contrast to other transport related industry in Hong Kong, cross border trucking companies can refill their tank, at a much cheaper fuel price in Shenzhen area, before they return to Hong Kong. Consequently, the main cost of operating a container truck is truckers' salaries, which account for approximately 36% of total costs. Recently, the industry has not been able to attract young people to join it due to the low pay and long working hours involved.

Overall truck drivers, whose educational level remains low, lag behind what is needed to the new requirements of the modern logistics industry. Especially, truck drivers are required to

update their position, receive consignments and upload the data via in-house communication systems and this will accelerate the demise of the freight truck industry.

Before the mid-1990s, manufacturers could determine how their merchandise would be loaded and transported. This situation has been reversed. With more Chinese inland ports modernizing their services and with the increased use of outsourcing in their merchandise to logistics companies and agents, the service provider that cannot offer a "one-stop shop "will be phased out gradually.

2.6 Customs Regulations

The word Customs is defined, in the Collins dictionary, as the official organization responsible for collecting taxes on goods coming into a country and preventing illegal goods from being brought in. However, the meaning of customs takes a new twist for most shippers and freight forwarders in China as equivalent to a [hurdle] in cargo shipment.

Under the Communist regulations in China over past fifty years, the Customs Office not only needs to prevent illegal goods from being imported into the country but it also needs to check those so-called "Western materials that will pollute the minds of people in China". The same practice is still applicable today even after China started the Open-door policy twenty years ago and has become an official member of the WTO in 2001.

Working under such a mentality, the Customs office in China literally checks everything that is imported into China. In order to encourage the Customs officers to work harder, the monetary value of infringing goods seized is linked to their pay. This method ensures Customs officers will not tolerate anyone who tries to escape from paying tax.

- **The structure of the Chinese Customs Office**

On their official website (CS 2007), China Customs is described as a government agency that supervises and manages all arrivals in and departures from the Customs territory of the People's Republic of China. China Customs uses a vertical and three-tiered management structure. The top tier is the General Administration of Customs (i.e. the headquarters in Beijing). The middle tier is composed of the Guangdong Sub-Administration of Customs (in charge of 7 Customs regions located in Guangdong Province), two (2) Supervising Offices (located in Tianjin and Shanghai respectively), 41 Customs regions and two (2) Customs educational institutions. The third tier refers to the 562 Customs houses or offices under those 41 Customs regions. In addition, it has overseas offices or officials in Brussels, Moscow, Washington D.C. and Hong Kong. Its staff numbers over 48,000.

Currently China Customs operates at 253 first-class ports (including airports, sea ports and land passes) approved by the central government and around 200 second-class ports approved by provincial governments.

The General Administration of Customs is a full-ministerial-level government agency that reports directly to the State Council of the People's Republic of China and manages all the Customs regions nationwide.

According to the Customs Law (CCustoms 2006) of the People's Republic of China and other relevant laws and regulations, China Customs is in charge of undertaking four essential duties:

- To control inward and outward means of transportation, goods and articles;
- To collect Customs duties, taxes and related charges;
- To combat smuggling;
- To compile Customs statistics and handle other Customs matters.

The working guidelines practised by China Customs are to "exercise law-based administration, safeguard the national gateway, serve the national economic interests and promote social development". Its team-building principle is to make Customs personnel "politically staunch, professional and reliable".

- **China's Customs and Quarantine System**

The Chinese government uses a variety of measures to regulate different types of trade, which are classified as general trade (一般貿易), processing and assembling with customers' materials (來料加工), processing and assembling with imported materials (進料加工), processing equipment (加工設備), foreign-funded equipment (外資投資), bonded warehouses (保税倉庫), and so forth. General trade and processing trade accounts for most of Guangdong Province's trade. In 2004, these two types of trade accounted for 23% and 69% of Guangdong Province's total trade, respectively.

Depending on the economic situation and attitude of the Central Government towards trade policy, additional methods to encourage/discourage the import or export goods are implemented from time to time. Most of the shippers are confused by these changing regulations; hence they will employ an in-house qualified Customs broker to deal with the formality for their shipments. Shippers with small volume consignments, will send the documents to the Customs broker company for processing.

There are seven Customs areas in Guangdong, including Shenzhen, Huangpu, Guangzhou, Gongbei, Jiangmen, Shantau, and Zhanjiang (CCustoms 2006). In 2004, goods cleared at Shenzhen Customs accounted for 48% of all Guangdong Province's exports and imports,

while goods cleared at Huangpu and Guangzhou Customs accounted for 24% and 13%, respectively. The remaining 15% were cleared at Gongbei, Jiangmen, Shantau, and Zhanjiang Customs.

The difference between total trade in Guangdong Province and total trade by Guangdong's Customs districts should more or less reflect the total trade of other provinces that make use of the various ports in the Guangdong Province for imports and exports. The proportion of the volume of goods from other provinces that make use of various ports in the Guangdong Province for imports and exports dropped from 13% in 1995 to 6.4% in 2004. The value of goods rose only from US$15 billion in 1995 to US$24 billion in 2004. Over the past 10 years, the average annual growth rate of total imports and exports of Hong Kong, Macau, the Guangdong Province, and the other eight provinces in the Pan-Pearl River Delta has sunk lower than that of the country as a whole. This indicates that the nature of goods that are imported/exported to Guangdong tend to be higher in cargo value than volume.

Different trade modes and different Customs areas have different clearing practices in handling the shipments. For example, if the consignment is shipped by air then cargo must arrive at the Customs office at the airport twenty four hours before loading. For cross-border consignment by truck, there is no time restriction at all.

The above paragraphs have described the structure of Customs office in China generally. However, it is more complicated in operation as each Customs district does not communicate well with the others. This shortfall may be a side effect that the Central government want to prevent collusive corruption among Customs districts. It is difficult to describe fully the underlying circumstances in China’s Customs but if we treat each Customs district as a separate country then it will be easier for the traders to visualise how difficult it will be.

- **Cross-border trucking under the Customs regulations**

In last section, it was mentioned that there is no specific time restriction for Customs declaration at the cross-border check point. An inefficient Hong Kong-China cross-border road-freight industry will decrease the efficiency of the logistics industry in the Pan-Pearl River Delta and will have a negative effect on attracting goods from other provinces to make use of ports in Hong Kong and the Guangdong Province. According to customs and quarantine procedures now in effect, the restrictions on cross-border road freight companies are as follows:

The four-up, four-down policy

Beginning in 1994, China Customs stipulated that each cross-border trucker and his truck, trailer, or container must go "northbound" to the Mainland and come back "southbound" together. This regulation was abolished only very recently, on January 1, 2005. Shenzhen Customs has indicated that from 1998 onwards, this regulation, although still in place, was not strictly followed. When electronic information bundling is implemented, it will be possible to separate the trucker from his truck, trailer, or container. Customs did its part to repudiate this outdated regulation, nevertheless, very few truckers operated separately from their trucks. This is because other departments did not follow suit in allowing the improvement to take place over other areas in China. For example, the licensing department still bundles a driver with his truck into one licence, making it impossible for the trucker and the truck to be separated. Thus, without parallel relaxations in this and to obtain cooperation from other relevant departments, the freight truck industry was still very much constrained by other related restrictions.

Restrictions on depots of international containers

The Shenzhen Municipal Bureau of Communications has stipulated that all containers used for international trade must use special designated depots for transshipments and re-exports. Hence, from 2002 onwards, cross-border truckers have been able to unload their containers and pick up empty containers in these designated depots. Several port operators and liner companies in previous years have tried to set up inland depots to provide a matching service for the trucking industry but the results have been disappointing. One of the reasons is the location of these depots which are far from major routes so few cross-border truckers make use of them.

The bottleneck at vehicle examination centres

Cross-border trucks carrying goods from the processing trade must go through Customs and quarantine procedures at vehicle examination centres. Despite the fact that many vehicle examination centres have become more efficient, some still operate in an outdated fashion that was implemented in the 1980s. Officially, truckers can clear Customs between 8:00 a.m. and 10:00 p.m., but the actual hours of operation are much shorter because Customs officers take time off for meals and shift changes, and no backup personnel are available to relieve them. This periodic understaffing situation results in frequent congestion.

Twenty-four-hour counters

Since 2002, the number of 24-hour counters available for cross-border truckers has increased from one to four at Lok Ma Chau – Huanggang check point. However, many cross-border truckers are reluctant to use these counters at night due to the reason that Customs units for checking documents and examining cargo operate separately. The night Customs unit only checks documents. The drivers, chosen for inspection, are required to wait until 6:00 a.m.,

when the cargo examination unit opens, to complete the Customs process. If the trucker is so unlucky and picked up for inspection then this overnight crossing turn out to take much longer time than a daytime crossing owing to an increased chance of being inspected and a longer waiting time. This explains why most cross-border truckers do not choose to clear Customs at night but would rather wait until morning if they think they cannot clear customs by 10:00 p.m each day.

The Huanggong Depot

The Huanggong depot can accommodate only 30 container trucks. Hong Kong cross-border freight trucks must arrive at the depot on time so that China cargo trucks can unload their containers, unseal them for Customs inspection, and then load the cargo onto Hong Kong container trucks. Truckers complain that the depot is too small to make such operations efficient and to meet their demands. By the end of 2007, the Guangdong Province will open its outgoing road network to other provinces in the country. If everything goes as plan, Customs clearance of cargo from other provinces to the Guangdong Province and then to Hong Kong can be simplified, the cost of re-exporting cargo via Hong Kong will fall, and this should attract more re-exporting business to the Guangdong Province.

- **Customs declaration of various types of enterprises.**

The content in the following sections mainly comes from various China Customs Regulation handbooks and other related publications (Lian, 2004).

Not every enterprise in China can export products to overseas markets. Likewise, not every enterprise can import materials into China. The former type of enterprise is controlled by the Customs regulations that they must be a recognised enterprise eligible to make a Customs

declaration. The latter type of enterprise is controlled by The State Administration of Foreign Exchange under the Foreign Exchange regulations.

Those enterprises that are eligible to make a Customs declaration are termed as "Customs declaration enterprises" and they fall into three categories, (see table2.7).

Table 2.7 Category of Customs declaration enterprises

Category		Description	Example
1	Professional Customs declaration enterprises	Enterprise providing professional service of Customs declaration of import/export goods	Customs declaration firms or service companies
2	Proxy Customs declaration enterprises	Enterprises, without the right of import/export operations, providing warehousing/transportation agent service, and also proxy service of Customs declaration	International frieght forwarders, and international freight vehicle agent companies
3	Self-servicing Customs declaration enterprises	Enterprises, with the right of import/export operations, entitled to handle procedures of Customs declaration for themselves only	Professional foreign trade companies, industrial trade companies, production enterprises and commercial enterprises with the right of import/export operations, and foreign-invested enterprises.

Source: translate from the China Customs Regulations 2001, China Customs Press

When other enterprises need to import/export goods, they must consign professional or proxy Customs declaration enterprises to handle the declaration procedures of import/export goods.

Foreign-invested enterprises in the processing trade are usually self-servicing Customs declaration enterprises after their registration with the Customs office. However, plants processing materials supplied by clients are not self-servicing Customs declaration enterprises and have no Customs declarers, since they are not legal entities and have no right of import/export operations. The detailed registration procedure with the Customs office is listed in Appendix A.

After examination and approval, the Customs office will issue the Registration Certificate of Self-servicing Customs Declaration Enterprise. Any enterprise with the aforementioned certificate can handle Customs declaration procedures with Customs offices of various ports

within its Customs region. However, self-servicing Customs declaration enterprises can handle the Customs declaration procedures of their own imports/exports only, rather than those of other enterprises.

- **Annual assessment**

The Customs office implements annual assessment systems to self-servicing Customs declaration enterprises. They must submit Annual Assessment Reports to competent Customs authorities of their own Customs regions for yearly assessment.

In China, since 1998, foreign-invested enterprises, are under the scrutiny of various government authorities comprised of the former Ministry of Foreign Trade and Economic Cooperation, the State Administration for Industry and Commerce, the State Economic & Trade Commission, the Ministry of Finance, the State Administration of Exchange Control, the state and local taxation bureaus and the General Administration of Customs. Together, they will carry out an annual assessment on capital contribution, operations, finance, foreign exchange, and imports/exports of the enterprises. The time for the annual assessment is fixed from 1 January to 30 April and the examination work must finish before 31 May each year.

Any enterprise that fails to participate in the annual assessment is deemed to be discarding the qualification for Customs declaration automatically. If it hopes to resume the work of the Customs declaration, it must resubmit the registration application to the Customs office. For unqualified enterprises in the annual assessment, as the case may be, the Customs office shall require those enterprises to improve themselves within a given period to meet its requirements. Enterprises that fail after the grace period, will lose the qualification for Customs declaration.

Enterprises with the following criteria shall be deemed as failing to pass the annual assessment, namely those:

1. Having no import/export business for more than 1 year;

2. Being late for an annual assessment for more than 1 month;

3. Failing to contribute the statutory capital.

Enterprises with the above first or second case are deemed to be waiving the right of Customs declaration automatically and shall not be manpowered with Customs declarers. For enterprises with the third case, the Customs office shall not accept their annual assessment reports until they fully contribute the registered capital.

- **Variation of registration**

As all the cargoes imported and exported to/from China incur the levy of tax, in order to track the origin and destination in the flow of cargo, the Customs Office will require shippers, exporters and importers to register with a particular local office. In case the particulars under registration contents in the Customs office changes (e.g. enterprise name, legal representative, registered address, corporate nature, registered capital, operation scope, contact numbers, or registered office), the enterprise shall handle the various registration procedures with the Customs office as follows:

1. The enterprise shall handle the variation registration procedures with the administration on industry and commerce;

2. The enterprise shall handle the variation procedures with the Customs office of the original registration place carrying the varied business licence within 1 month after transacting variation registration with the administration of industry and commerce.

3. The Customs office shall re-issue the Registration Certificate on Customs Declaration after examining and approving the documental data on the variation application;

4. Enterprises having transacted Customs declaration registration in another place, after handling variation registration procedures with the Customs office of the registration place, with the approval of the said Customs office, shall handle corresponding variation registration procedures with the Customs office of the said other place.

- **Cancellation**

When an enterprise goes bankrupt or its operation term ends, it shall, carrying relevant approval documents issued by the authority approving its establishment originally, apply to cancel its registration with the Customs office of the registration place. This will recall and cancel the Registration Certificate on Customs Declaration originally issued by it.

After bringing forward the application for cancellation of the Customs declaration registration, if the enterprise has goods under the supervision of the Customs office and the said goods are within the supervision term, it shall handle matters relating to duty, paying at first to relieve the supervision by the Customs office.

For enterprises having transacted with the Customs declaration in another place, after transacting procedures of registration cancellation with the Customs office of its registration place, they shall inform the Customs office of the first registration to cancel the said recorded registration.

- **Corporate archive**

Detailed Customs clearance can easily identify businesses which submitted wrong corporate archive data. If it is found, it will influences normal import/export activities, especially the

settlement of exchange and Customs clearance, of the enterprise. The major problem with these wrong corporate archive data comes from its own internal management.

a. False Registration.

The enterprises always pay attention to the integrity of materials submitted to the Customs office while ignoring the authenticity and validity of the materials. For example, according to provisions of the Customs office, enterprises must submit corporate financial and accounting systems and import/export-related account books to the Customs office during registration. However, some enterprises manipulate corporate financial and accounting systems of other enterprises in order to cope with the registration with the Customs office, or even fleece the said Customs office. As a result, when the Customs office performs detailed investigations into the import/export goods of the enterprises in accordance with the systems supplied by the enterprises, it finds that the enterprises have not set up relevant account books as per the requirements of the systems. Therefore, the enterprises will be penalised by the Customs office for their provision of false data.

b. Late Annual Assessment

The enterprises are reluctant to participate in annual assessment and are late for annual assessment arranged by the Customs office. Some enterprises fail to think of handling the annual assessment procedures with the Customs office until goods for import/export materialise, some have no permanent staff responsible for such procedures or they do not participate in the assessment.

c. Failure to Apply for Corporate Data Modification

In the event of variation occurring to some registered contents, some enterprises do not apply for corporate archive data modification with the Customs office, which results in a delay in the data or even incurs errors. For example, in a joint-venture enterprise, when the Chinese partner withdraws its contribution and the enterprise converts itself to a sole-investor enterprise and the 10-digit Customs code changes accordingly, if it does not apply for modification with the Customs office, the enterprise will encounter a lot of trouble with respect to future Customs clearance, settlements of exchange and tax reimbursement.

d. Inconsistency in Customs Declaration

If an enterprise wants to import/export goods via the Customs office of another place, it must settle the Customs declaration in another place at first. In normal cases, contents in the chief Customs office and the Customs office of the record place must be consistent. However, since the said procedures are mostly handled through local agent companies, mistakes often occur to the maintenance and management work of corporate archive data, which will complicate the declaration process.

2.7 Summary and Conclusion

This chapter has set the background for this study. Hence, it is written on the assumption that readers are not familiar with situation in PRD region.

The PRD is the biggest economy in the world. More and more foreign companies have set up their businesses in the region hence there is strong competition among enterprises. With the increase in annual income per capita in many cities, cargo for export has changed to high value production.

This chapter has provided a general description of all nine cities within PRD region. Four major cities namely, Dongguan, Zhongshan, Shenzhen and Guangzhou were chosen for

further study in the following chapters. The location of major industrial areas in these four selected cities is described in detail.

The option of loading ports available for overseas shipment has been fully described. They are Shekou Port and Yantian Port. The option to use Port of Hong Kong is not included in this chapter because:

1. Hong Kong is the world number one container port; there is no point to describe how efficient it can be in container handling.
2. The majority of cargo generated in PRD would use Hong Kong port as their preference loading port. The problem in getting to Hong Kong mainly comes from the cross-border section.

Therefore, a lengthy section has been devoted to cover the cross-border freight truck industry. The operation, concern and impediments that can hinder the cross-border freight truck industry have been described.

The last section in this chapter has described the China Customs office procedures in detail. Topics on Customs regulations are carefully selected in order not to make this section too technical or difficult to read. As the original regulations are written in a legal format, many keywords need to be reproduced direct into this section so that the original meaning is intact. During the process in translation of the original text from Chinese into English, the official English version sometime gives a completely deviated expression from the original (Chinese) text.

With increasing emphasis being given to reducing overall transit time and transport costs for cargo delivery in the container era, the importance of carrier selection criteria and mode choice has become more widely recognized. Traditional transport mode selection has been focused only on the reduction of transportation costs. However, one of the key concepts in

supply chain management is that cost is not the only element that determines mode choice and carrier selection.

The present trend is that shippers in the Pearl River Delta and Shenzhen areas who have infrequent and small consignments generally prefer to arrange their own transport to deliver cargoes to the container freight station (CFS) to be consolidated for onward movement. On the other hand, more substantial shippers with regular and large consignments generally prefer to outsource their transport needs to third party logistics providers. The close proximity of Hong Kong to Southern China means that shippers occasionally prefer to switch to different modes of transport to optimize the efficiency of delivering their cargoes (Cullinane and Kwan, 2000).

At present there is no suitable model for the analysis of carrier selection in these circumstances. As a general statement, the major shortcomings of previous mode choice and carrier selection studies is that they have been focused solely on European, Australian or US markets where the transport infrastructure and related regulations of each mode are well established and defined. These have much reduced relevance in the market situation that has been described above.

This research therefore is intended to extend the understanding of carrier selection in the freight transport market conditions expected to prevail in the Pearl River Delta areas in the coming years. While other local studies have examined the differences between the perceptions of carriers and shippers in this region, this research will go further by examining and measuring some intangible elements in the decision making process.

In addition, previous literature only focused on carrier selection or mode choice based on the transport of homogenous bulk cargo. From the Parcel Size Distribution Function (PSDF) as

mentioned by Stopford (1997), the size of the consignment will usually dominate the mode choice and for comparatively low values of cargo, transport cost becomes one of the prime considerations in carrier selection. This research is the first empirical study of mode choice and carrier selection for container cargoes. In this respect, it makes an important contribution to the area of freight logistics.

In the next chapter, a study of the literature written about mode and carrier choice will be reviewed.

Chapter three - Literature Review

3.1 Introduction

This chapter provides a review of previous literature on the issues and factors influencing the decision-making process which results in a shipper choosing a particular mode of transport or a particular carrier for a consignment. With increasing emphasis being given to reduced overall transit time and lower transport costs for cargo delivery in the container era, the importance of carrier selection criteria has become more commonly recognised over the last thirty years. Early carrier selection studies were mainly focused on shipper oriented studies. Evans and Southard (1974) carried out the first shipper-carrier studies. Their study of the shipper-carrier relationship was further elaborated by various scholars such as; Jerman, Anderson and Constantin (1978), Burdg and Daley (1985), Foster and Strasser(1990), Abshire and Premeaux (1991) and Murphy and Hall (1995). Many studies have examined the carrier selection process by exploring the differences in perception of carriers' and shippers in terms of choice criteria. It is likely that when differences are found to exist in the perception of important characteristics between shippers and carriers, the result will be a gap in the satisfaction level between what service is provided by the carrier and the shippers' service expectations. These gaps should not be overstated given the generally high level of satisfaction with the services on offer as explained by Whiteing and Stantchev (2004).

The major shortcoming of all of these studies is that they have focused only on either European or US markets where the transport infrastructure and related regulations of each mode have been well established and defined.

The aims of this research are to extend the carrier selection literature into the local freight transport market of Hong Kong and Shenzhen. While other studies have examined the perceptual differences between carriers and shippers, this research further expands the

literature base by examining and measuring the performance level of the carriers so that any gaps can be reduced or even eliminated.

3.2 Theoretical framework

To fully understand transport mode and carrier selection, it is vital to understand the nature of both the supply of transport services and the demand for those services. On the supply side, the principal explanatory variables that have been included in models as suggested by Gray (1982) and Widlert and Bradley (1992) are transport cost, transit time, frequency and damage rates. However, on the demand side, few studies have been undertaken to systematically establish a relationship between modal choice and freight demand characteristics as explained by Ortuzar and Willumsen (1994). This relative lack of research into modelling freight demand is largely due to the lack of data which is time consuming and expensive to obtain and is sometimes confidential. Thus, the influence of demand characteristics on freight mode choice has not been sufficiently researched and understood. Despite this we know that the demand for freight movement is mainly driven by the derived demand from the shippers. Unless there is a need, it is impossible for carriers to provide their service to just coincide with need.

Freight modal choice and carrier selection depends not only on the demand for transport but also on infrastructure and service supply characteristics. The latter will influence quality of service provision and hence will affect other key logistics variables such as company inventory levels and the order cycle. Therefore, mode and carrier choice will hinge not only simply on general transportation costs but on the impact on the total logistics costs facing the particular shipper.

Slater (1990) suggested that there are three methods available to logistics managers to determine the optimum mode for their requirements: judgment of the manager, the evaluation

of cost trade-offs, and the application of distribution models. McKinnon (1989a) quoted Sharp's early (1970) findings that shippers re-evaluate their choices only rarely, and suggested that these processes, as listed above, are not routinely applied in practice. In his later paper, Sharp (1971) suggested optimal decisions will vary according to the size of the firm. Krapfel and Mentzer (1982) illustrated these processes within a general model of transportation choice. The criteria stage of the model, where the buying center members process the information sources, is critical to the overall approach.

Prior to 1970, carrier selection studies were very largely focused on shipper-only studies. A number of now-classic studies have been conducted. Cook (1967) indicated that transport costs were the prime concern when selecting a carrier, but Bayliss and Edwards (1970) ,by studying 500 establishments in transport intensive industries, suggested indirect costs such as carrier frequency and flexibility were more important than direct transport costs. Roberts (1971) suggested shippers were only interested in choice of market, choice of mode and quantities to be shipped. Bardi (1973) found out that carrier service performance was the most important selection determinant for domestic shippers in the USA. Gilmour (1976) analysed freight shippers in Australia and found out that the capability to control the shipment, as well as the availability of specialized equipment, ranked highest in the list of shippers requirements.

Evans and Southard (1974) carried out the first shipper-carrier studies. Shipper-carrier relationships were further elaborated by various researchers such as Murphy, Daley and Dalenberg (1991) who also suggested that shippers will ignore intermediaries such as forwarders as they place a higher emphasis on price while carriers hold a different view. Jerman, Anderson and Constantin (1978), Burdg and Daley (1985), Foster and Strasser(1990), Abshire and Premeaux (1991) and Murphy and Hall (1995) support this rationale in principle.

Foster and Strasser (1990) suggest that carriers view the criteria as independent factors that will be treated independently.

Abshire and Premeaux (1991) analysed the different shipper-carrier perceptions with thirty-five selection factors. They found the shipper-carrier hold different views on at least nineteen out the thirty-five selection factors. For example, carriers did not perceive the level of importance for factors such as "offering more flexible rates", and "importance of carrier response in emergency situations". In addition, carriers have misinterpreted the significance of certain shipper needs, namely "regular calls by carrier sales representatives", and "opinions and recommendations of employees of other firms".

Many studies have examined the carrier selection process by exploring the differences in carriers' and shippers' perceptions in terms of choice criteria. It is likely that when differences are found to exist in the perception of important characteristics between shippers and carriers, the result will be a gap in the satisfaction level between what service is provided by the carrier and the shipper's service expectation.

Kent and Parker (1999) have more recently suggested that carrier selection criteria should be further expanded into two major groupings:

- export shipper and carrier
- import shipper and carrier.

They identified that there were significant differences between the nature of the shipment in import and export consignments. Import shippers and carrier groups are more concerned about the loss and damage and equipment availability factors. For the export shipper and carrier groups, the differences were found to relate to the rate changes, service frequency, financial stability, service charges and equipment availability factors. They concluded that

the only significant difference between the import shipper and export shipper groups was in the door-to-door transportation rates factor.

3.3 Literature Review of mode selection

The methods and various modelling techniques employed in the various literature on the inter-relationship between shippers and carriers will now be discussed.

Despite the fact that "mode" and "carrier" selection are inter-related, mainstream studies such as Brand and Grabner (1985) and Stock and LaLonde (1978) have tried to differentiate the issues and make them distinguishable from each others. The process of transport selection inevitably involves the loyalty and repeat purchase behaviour as described by Wind (1970), Saleh and LaLonde (1972) and Whyte (1992). Their views have reinforced the general understanding of industrial purchase behaviour in the commercial world. However, in this dissertation the above concept will be modified slightly because the targeted interviewees are mainly Chinese shippers. Fang (2001) pointed out that in order to better understand the workings of inter-firm adaptation in business relationships in China the culture metaphor must be included. In other words, the inter-firm relationship in China is mainly treated as an inter-personal relationship.

When China started their open door policy in 1978, the incoterms widely used within the Chinese shippers' community were Free On Broad (FOB) and Ex Work/ factory (EX WORK), thus the carrier and transport mode selection were mainly controlled by overseas buyers. A decade ago, shippers in China preferred to use Cost, Insurance and Freight (CIF) or Cost and Freight (C&F) for their international shipments, as they could control the market

price of their products at the destination. The selection of transport hence fell back to the hands of the Chinese shippers.

3.4 Mode Selection

This section is divided into three parts. First, the principles of mode selection are examined. Second, the nature of the selection process is discussed, with reference to four choice models. Third, the attributes governing carrier selection are presented. Finally, various modelling methods employed in previous literature will be discussed and assessed.

3.4.1 Mode Selection Principles

Faller (1985) indicated that in general, goods of high value (general time sensitivity) tend to use the faster modes. The selection of mode may also be based on the nature of the product (specific time sensitivity) and the selling price (circumstantial time sensitivity) of goods in destination countries.

Traditional mode selection has been focused simply on determining the mode which achieves the lowest transportation cost. However, current supply chain management concepts mean transportation involves multimodal combination and the goal of mode selection has been stated as obtaining the cheapest option that meets service requirements as well as production and marketing strategies.

McKinnon (1989*a*) summarised the basic principles of mode selection as:

- Compare alternatives;
- Compare options at regular intervals;
- Use a broad range of criteria for evaluation; and
- Employ a rigorous selection procedure

However, at a later date, McKinnon (1989*b*) suggested that these principles are not widely applied in practice. For example, it is considered desirable to evaluate mode options at regular intervals, but Sharp (1970) found that firms tend to re-evaluate modes in response to changes in their internal organisation or the external mode performance.

Krapfel and Mentzer (1982) illustrated these principles within a general model of transportation choice. The buying centre member with information sources is the ultimate decision maker on the mode choice. Similarly, Slater (1990) showed three methods available to the logistics manager to find the "optimum" mode. They are judgement, a cost trade-off or utilising distribution models. A buyer can combine all three of these in a systematic selection process.

3.4.2 Mode Selection Process

Following the research of McGinnis (1989) and Cunningham (1982), four approaches are explored. These are the Classical Economic Model, Inventory Theoretic Model, Revealed Preference Approach and Behavioural Models.

a. The Classical Economic Model

Established from the theory of the firm, Cook (1967) tried to find out the inter-relationship between the range of transport decisions and types of transport mode used. He found out that the use of transport depended on the facilities (own transport for example) available to the firm and also past experience on handling similar types of cargo. Consequently, the selection of transport mode becomes a part of management policy of the firm.

Heralded by McGinnis (1989), this approach evaluates fixed and variable costs of competing modes, excluding factors such as value of service to the shipper. A comparative study (Woods and Domencich 1971) of road and rail freight movements found that,

notwithstanding estimates of road's superior service levels, two-thirds of road traffic could be moved by rail, at no service or cost penalty. However, criticism of this model is strong, as it ignores many relevant criteria. For example, Morton (1972) said it lacks shipper policy and competition variables. In addition, it is suggested that shipment weight is more significant than distance in mode choice. Moreover, other studies suggest that a cost-oriented approach does not attach enough importance to service related variables. Accordingly, service defects have a cascading effect through the supply chain.

b. The Revealed Preference Approach

This approach acknowledges that selection is dependent on a number of movement-related factors, including shipment size and length of haul. The shortfall in this approach is on the focus of whether a mode could be replaced by another on the same route. Contrasting results have been shown with this approach. In addition, Watson et al (1974) tested different models using the revealed preference approach, concluding that carriers seeking to divert traffic from a competing mode can best do so by improving service reliability.

Two problems are obvious. First, although a route may be defined as "competitive", one mode may have a significant advantage over another, making it competitive in name only. Second, "non-competitive" routes could be made competitive by small changes in technology or market conditions.

c. The Inventory-Theoretic Model

In order to gain a better understanding of the customer's rationale for mode selection, Baumol and Vinod (1970) initiated the total distribution cost approach. This considers the characteristics of the consignment based on value, density, insurance risk and spoilage rate. They resolved that freight rate, transit time, service interval, service reliability and damage & loss are major factors in modal choice. Empirically, Baumol found that transport users are relatively insensitive to small differences in cost between modes but very sensitive to large

differences in relative cost. They concluded that this approach could also be used to assess the impact of new pricing policies.

Based on the EOQ-type optimal trade-off between inventory carrying costs and transportation cost, Sheffi et al's (1988) model is designed to achieve the lowest delivery cost, including the opportunity cost of lost orders and the cost of higher safety stock that is the consequence of slower speeds and delays.

Total logistics costs are affected by inventory costs (dependant on shipment size), and safety stock costs (dependant on carrier reliability). However, this model pre-supposes that the shipper is willing to trade-off reliability. By assuming the shipper trades off service criteria, this approach yields more realistic results than the Classical Economic Model. In addition more recently, discriminant analysis, logit models, analytical hierarchy process models and computerised "adaptive" stated preference tools have been used to forecast the demand for new freight services.

More recently, Tyworth (1998) has presented a method of estimating the effects of carrier transit-time performance on logistics cost and service and claimed that this method enables users to develop accurate estimates when abnormal shapes characterise the probability distribution of both demand and lead time.

c. Behavioural Models

When it comes down to the final decision in selecting the transport mode, the behavioural characteristics of decision-makers need to be observed. It has been suggested that choice models are incomplete in the absence of variables reflecting the shipper perceptions of the mode. Accordingly, Craig's (1973) model shows that buyers obtain information from a variety of sources, but have a tendency to distort stimuli that are forced upon them. An inverse relationship exists between satisfaction and information seeking. Therefore, a routine

decision-making process could have opposite outcomes depending on the information obtained beforehand.

Furthermore, the logistics manager judges not only the fixed characteristics of each mode; his confidence level for each mode is relevant. Information is sought, subjected to bias, screened by constraints and decision evaluators, and weighed against motives. If the transport choice is satisfactory, it will become fixed and a routine will develop. However, if the mode is not satisfactory, it is rejected and the selection process will continue until a satisfactory one is found.

In addition, Gray's (1982) review of previous research led to the development of a rationale for developing a "perceptual approach" to mode choice. He contrasted the utility obtained from freight transport with the easily identifiable individual passenger, who is the decision-maker in passenger travel models. The approaches are:

- **Economic Positivism:** Mode choice is determined by economic or cost principles
- **Technological Positivism:** Mode choice is based on relationships between physical aspects of the transport system and physical aspects of the product
- **Perceptual Approach:** Mode choice is based on the perceptions of shipping managers.

The behavioural approach more accurately reflects the realities of decision-making for Chinese shippers as they treat the transport selection more closely to inter-personal purchasing activities (Fang 2001). When logistics managers compare available alternatives, they do not act rationally. Indeed, there is general agreement that shippers have a perception of a mode different from its true performance. For example, Evers et al (1996) describe past experience, shipper expectations, and misinformation as key influences. Furthermore, one study found less than half the firms asked knew the costs of transport by alternative modes.

However, this approach requires a large volume of inputted information, and stockout costs are very difficult to measure as there are many unquantifiable elements. Moreover, Gray (1982) criticises the nature of the model, stating that complicated mathematical decision models are readily developed without knowing exactly who the decision-makers are.

It must be appreciated that traditional consumer decision-making has been valuable in marketing and in the field of consumer science in providing theoretical frameworks for the study of various aspects of consumer behavior in recent years (Erasmus, Boshoff & Rousseau 2002). The fact is that scripts, also known as event schemata, are memory structures that are well-known in the field of cognitive psychology. It contains generic information (thus free from cluttering) and that it is temporal in nature and sequentially ordered, provides the opportunity to elicit and organize a more specific representation of a consumer decision-making event. Because scripts reflect the perspective of the consumer and specify all participants and role players (Schurr, 1985) a more realistic scenario of a specific event such as consumer decision-making could be deduced from a script. Scripts are hereby proposed as an alternative to or, at least, the enhancement of an effort to address many of the problems associated with traditional models (Erasmus et al, 2002).

d. Partnering Relationships

The relationship between ship and carrier can be viewed under the concept of a partnership. Ellram and Hendrick (1995) defined a partnership as an ongoing relationship between two firms that involves a commitment over an extended time period, and a mutual sharing of information and the risks and rewards of the relationship. Researchers examining partnering relationships (Porter, 1980; Anderson and Narus, 1990; Mohr and Spekman, 1994; Kozak, 1997; Vlosky and Wilson, 1997; Ganesan, 1994) defined the relationship as a purposive relationship between independent firms who share compatible goals, strive for mutual benefit,

and acknowledge a high level of mutual interdependence (Mohr and Spekman, 1994). Partnership formation is motivated primarily to gain competitive advantage in the marketplace (Bleeke and Ernst, 1991). Partnerships can provide a firm access to new technologies or markets and the ability to provide a wider range of services (Powell, 1987).

There are six specific types of relationships identified as arm's length, Type I partnership, Type II partnership, Type III partnership, joint ventures, and alliance (Coyle et al., 1999; Lambert and Stock, 1993). Some research has proposed that relationship styles are positioned on a continuum, with one end anchored by the arm's length relationship and the other anchored by a true partnership (Gardner et al., 1994). This situation exists because an arm's length relationship between a carrier and a shipper can be implemented with a contract (such as a leasing agreement) or without one (such as common carriage), whereas a partnership can have a formalized document managing the relationship.

At times, it may be advantageous for a firm to contract with a specific carrier to service a tackle a particular market segment, even though it has a large private carrier fleet. Some shippers may be situated in remote areas where servicing them with the firm's private fleet may be too costly. In such a case, it would be more beneficial for the firm to have a common or contract carrier service for those customers rather than to do it itself (Lambert and Stock, 1993).

From a marketing perspective, strategic alliances are defined as partnerships between organizations that create competitive advantages. Companies form many types of strategic alliances today. Some create horizontal alliances between firms at the same level in the supply chain; others define vertical links between firms at the adjacent stage (Boone and Kurtz, 2001).

3.3.3 Review of Mode Factor Selection Studies

McGinnis's (1989) six-category taxonomy includes, carrier considerations, freight rates, over, short, and damaged, reliability, shipper market considerations and transit time. Table 3.1 is a composite review of previous related studies. Although sample size, location factors and targeted interviewees in each study are different, a broad summary is still possible.

Table 3.1 Main top factors for carrier selection

Authors	Main Finding / top 3 factors
Saleh and Das (1974)	▪ Consistent on time service ▪ Reliable pickup and special order handling ▪ Shipment tracing
Cunningham and Kettlewood (1976)	▪ best service with acceptable rate
Stock and LaLonde (1978)	▪ On time pick up and delivery ▪ Freight charges ▪ Transit time
McGinnis (1979)	▪ Pick up and delivery reliability ▪ Delivery reliability ▪ Speed of delivery
Chow and Poist (1984)	▪ Door-to-door rates ▪ Equipment availability ▪ Total transit time
Burdg and Daley (1985)	▪ Satisfies customer ▪ Dependable transit time ▪ Low freight charges
Foster and Strasser (1990)	▪ Schedule reliability ▪ Negotiate services ▪ Negotiate rates
Whyte (1993)	▪ Ability of representative ▪ Promotional material ▪ Physical facilities

Murphy (1995) ranked the major factors, see table 3.2, used by shippers for considering mode selection. This evidence reinforces the contention that service is more important to shippers than low cost. Moreover, three trends in the studies emerge. First, reliability has remained the most important factor. Second, speed of delivery has reduced in importance. Third, carrier considerations have increased in importance.

Table 3.2 Freight mode ranking

Category	1970's ranking	1980's ranking	1990's ranking
Reliability	1	1	1
Carrier considerations	6	4	2
Freight rates	4.5	2	3.5
Shipper market considerations	4.5	4	3.5
Over, short and damaged	3	4	3.5
Transit time	2	3	5.5
Source: Murphy and Hall 1995			

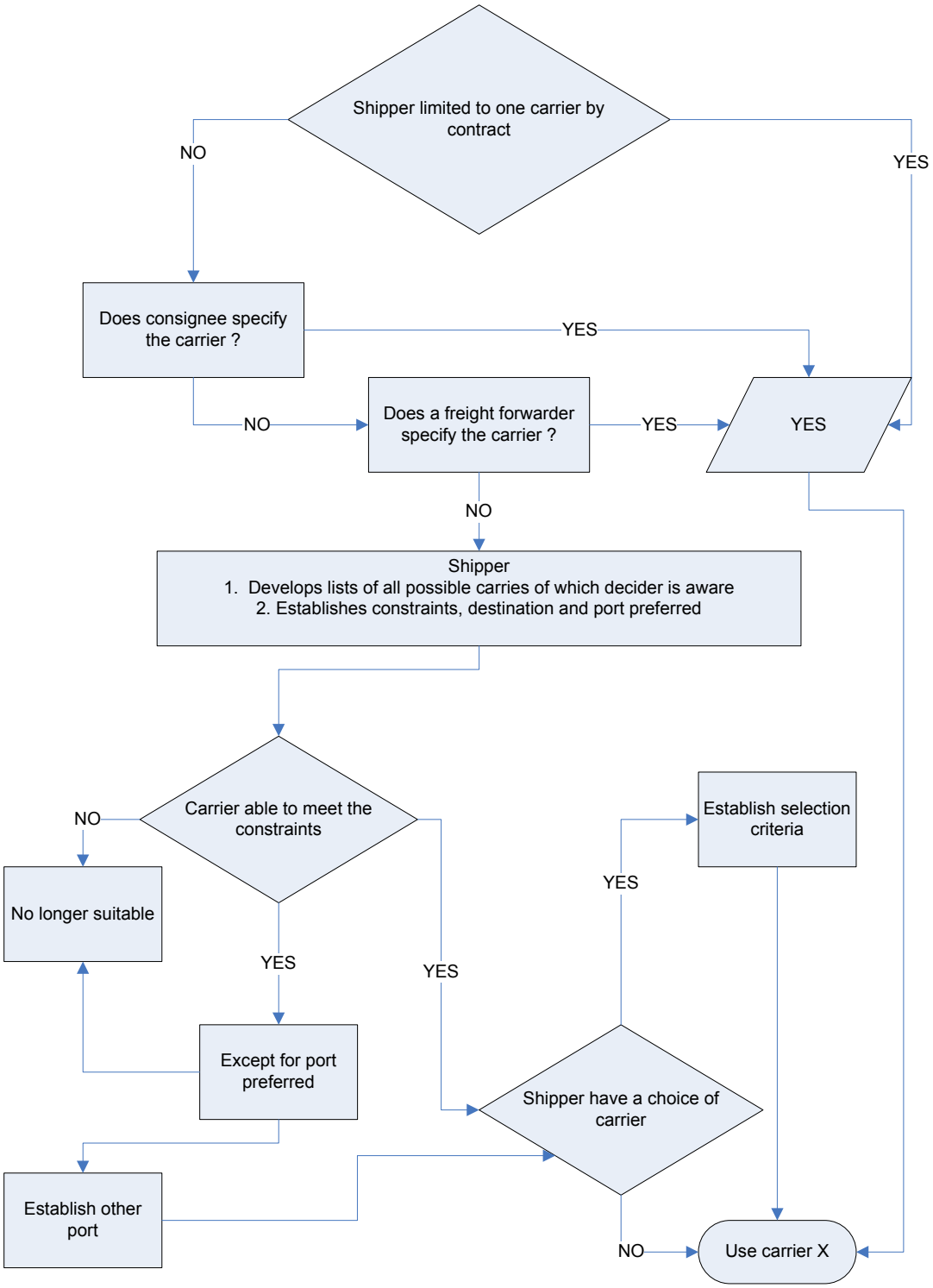
3.5 Carrier selection

This section focuses on studies specifically related to carrier selection. Many of the models and references to mode selection apply to carrier selection. The mission of this section is to summarise these criteria and examine the relationship between shipper-carrier perceptions.

3.5.1 Carrier Selection Process

Brooks (1984) used the "Buygrid Theory" to construct a three-stage decision tree model and found that only one-third of the shippers interviewed reached the third stage of the model, meaning that half did not make the decision as to which carrier is used (Figure 3.1).

Figure 3.1 Carrier Choice process



Compiled from Brooks M.R.,(1984), Limitations in the Carrier Choice Process: A study of Eastern Canadian Containerisable Cargo,

- **The Early Studies**

In early studies, the selection of carrier was mainly considered from the shippers' point of view. Transportation cost was the prime factor on the list of carrier selection (refer to table 3.3).

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Table 3.3 Top 3 factors in Carrier selection	
Authors	**Top 3 Factors**
Traffic Management (1966)	▪ Time in transit ▪ On time performance ▪ Shipment tracing
Bardi (1973)	▪ Meeting estimated pickup ▪ Meeting estimated delivery ▪ Frequency of damage
Jones (1975)	▪ Reliability ▪ Total transit time ▪ Claim settlement
Pearson (1980)	▪ Flexibility by the carrier ▪ Preference given to shipper ▪ Fast transit
Brand and Grabner (1985)	▪ Consistency of service ▪ Competitive rates ▪ Pick-up/delivery times

Further evidence as to the importance of non-cost-related criteria is provided by McGinnis (1979). He found that service variables were more important than rates. The ranking of the attributes in order are: Speed of delivery; On time performance; Shipment Tracing; Freight Charges; Door to Door Delivery; Claims settlement; Availability of equipment; Frequency of service and degree of damage.

- **Recent Studies**

More recent studies have continued the trend of the importance of reliability as a selection factor. Table 3.4 is a summary of these studies.

Table 3. 4 Top 3 factors of Carrier Selection

Authors	*Top 3 Factors*
Quinn (1987)	▪ Pick-up and delivery schedules ▪ Tracing ▪ Flexibility
Foster and Strasser (1990)	▪ Schedule reliability ▪ Willingness to negotiate service ▪ Willingness to negotiate rates
Murphy, Daley, and Dalenberg (1991)	▪ Equipment availability ▪ Shipment information ▪ Frequency of cargo loss and damage
Hall (1992)	▪ On time pick up and delivery ▪ Equipment condition ▪ Willingness to improve service
Lambert, Lewis and Stock (1993)	▪ Quality of dispatch personnel ▪ On-time pickup and delivery ▪ Competitive rates
Brooks (1995)	▪ Freight rates as the top priority. ▪ Transit time was not a significant factor.
Murphy, Daley, and Hall (1997)	▪ Reliability ▪ Equipment availability ▪ Transit time/Operating personnel
David Simchi-Levi (2000)	▪ Price ▪ Short transit times ▪ Service reliability

From this literature, three points can be observed: shippers are using sophisticated and evaluatory methods in selecting a carrier. Second, the selection factors are re-ranked from the previous literature. Finally, vitality of transport cost is diminishing in rank. Pisharodi (1991) used the "script analysis" approach to assist the process of carrier selection. The activities are broken down as: receive shipper instruction; identify special handling and shipment requirements; discuss special requirements with shipping; establish list of carriers serving destination; gather information on the service capabilities; select qualified carriers; evaluate

past experience with qualified carriers; evaluate the record of qualified carrier; determine the list of acceptable carriers; rate quotation and select carrier.

- **Intermodal era - New selection factors**

Murphy, Daley and Hall (1997) highlighted an increase in the number of selection studies**,** as "new" carrier selection factors are emerging. Accordingly, the authors suggest not relying on the established literature for variables - new ones should be sought and included. The new factors, under the intermodal transportation needs, for consideration are:

- Willingness to negotiate rate changes,
- Service negotiation ,
- Carrier response in emergencies,
- Shipment information,
- Computerised billing and tracing ability
- Willingness to improve service quality,
- Quality of despatch personnel,
- Commitment to service excellence,
- Online and e-commerce services, and finally
- Y2K (millennium bug) readiness

The above findings of new attributes for carrier selection indicated that shippers have taken subtle changes in their decision making processes. Lambert (1993), by testing the importance of over one hundred and fifty selection factors, found that "lowest rates" came only 40^{th}. In contrast, "timeliness" and "accuracy of information" dominated the list of important variables. Furthermore, these studies reflect important variables that have been diversified into service related areas. Baker (1984) found that service differentiation is more important to shippers than low rates.

US studies by Minahan (1998) found that shippers needed to know that they were dealing with a quality carrier before considering price. Secondly, Milligan (1999) established that "on-time pick up and delivery" was more important than rates.

But, contradictory evidence shows cost to be important. For instance, McGinnis 's (1990) review of selection studies upheld the finding of Quinn (1987), in that price is important. More specifically, McGinnis found that price becomes a major factor after service objectives have been met, and in some instances it is the most important factor. This conclusion is supported by Bardi et al (1989), who found rates were second only to transit time reliability as a selection factors. Further evidence from Gentry (1991) shows how the trend towards service related variables is tempered with the commercial reality that price is important.

Juang and Gray (2002) used the gravity model to study the traffic flow within the hub and spoke port configuration under the container era. In his study, he found there was statistical evidence of a declining effect of distance in the port-hinterland relationship.

Empirically, therefore, reliability has remained consistently important, whereas cost has received both high and low importance rankings. In addition, new value-added factors are becoming increasingly important. An examination of comparative shipper-carrier studies will identify significant differences in the perceptions of the two parties.

3.6 Comparative Shipper-Carrier Perception Studies

In defining the relationship between shippers and carriers, Murphy, Daley and Dalenberg (1991) pointed out that previous literature has focused too narrowly on shippers without any consideration on the existence of intermediaries. They claimed that intermediaries place a higher emphasis on price while shippers concern more on service. Usually, carriers view the selection criteria as an independent factor rather than services in the package (Foster and Strasser 1990).

A comparative study carried out by Evans and Southard (1974) found that:

- shippers see the proximity of the carrier office to be more important than the carrier
- carriers see routing by shippers as being more important than do shippers
- carriers see vehicle courtesy to be more important than do shippers
- carriers see regular salesmen's calls to be more important than shippers.

So far in this chapter, the process of carrier selection has been simplified by only putting up shippers versus carriers at the ends of the scale. In the actual scenario, the number of players capable of providing transport services is numerous. With the adoption and implementation of Just-In-Time (JIT) and zero inventory management in many industries, the delivery time and frequency of delivery become one of those vital and critical competitive advantages of many companies. Manufacturers now face steadily escalating customer demands for better, fast, cheaper logistical services. While realizing that logistics/distribution support is critical to remaining competitive (Bowersox et al., 1989; Coyle and Andraski, 1990; Stock and Lambert, 1992), manufacturers find that their resources and skills are stretched to the limit. Many have attempted to solve the dilemma by focusing on their core competencies, i.e. making products, and turning to outside specialists for all or part of their logistical needs. Outsourcing logistics activities to specialized service providers often presents an economically viable method of achieving productivity and/or service enhancements. Nevertheless, due to the proximity of the PRD to Hong Kong, the alternatives of carrier and transport mode available are limited.

3.7 Summary

Due to the nature and limitations of the various designs and measures which have been suggested by researchers, there is no easy way to address the issues raised. However, it is a further objective of this research to start a bridge building process between theory and practice once the proposed research has been completed.

At present, local shippers who have infrequent and small consignments generally prefer to arrange their own transport for the delivery of cargoes to the consignee. On the other hand, renowned shippers with constant and large consignments would generally prefer to outsource their transport needs to third party logistics providers. However, due to the close proximity between Hong Kong and Southern China, Cullinane & Kwan (2000) found that shippers occasionally prefer to switch to different modes of transport to optimize efficiency in delivering their cargoes.

Over decades, the understanding between shipper-carrier (freight forwarder) on mode choice selection is focusing on the gap that exists between service provider (carrier) and customer (shipper). The rapid development of supply chain management encourages shippers to take the carrier as partner in the logistics flow of their consignments. They should not put themselves in the opposite position; on the contrary, they should team up and develop a close business partnership. The partnership formation between shipper-carrier will ensure a full utilisation of their resources and offer maximum flexibility in their shipments.

Chapter Four – Methodology

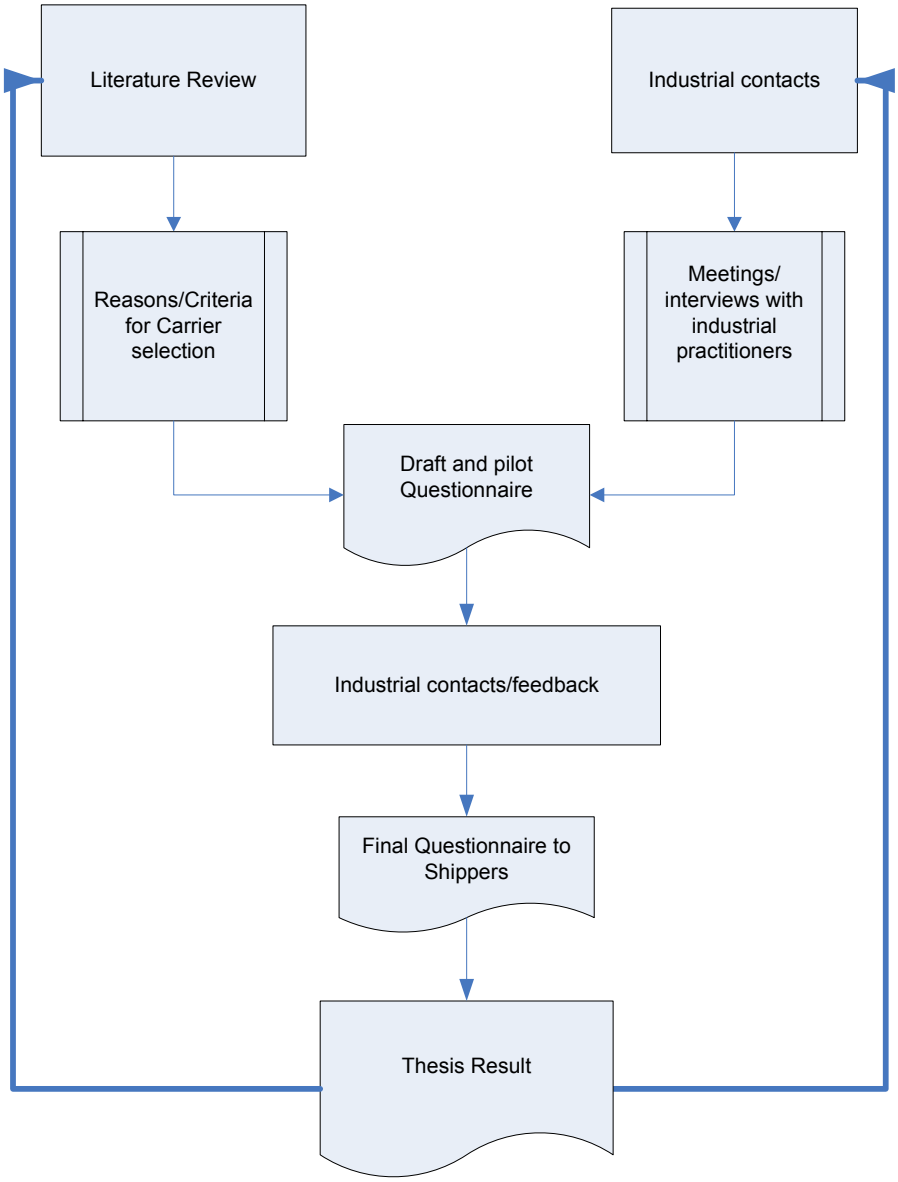
4.1 Methodology

In this research, the initial analysis has been carried out by using the Statistical Package for the Social Sciences (SPSS) 12.0 package. The research initially aims to examine the perceptions of carriers and their clients with respect to mode choice. The first step in this research is the selection of the parameters that affect the mode and carrier choice from literature as indicated in previous chapter. Telephone interviews to carriers/shippers have been carried out to form the scoping stage for this research work. Telephone interviews can facilitate valid responses and allow the free discussion of sensitive issues. A preliminary letter was sent to the identified carriers/shippers prior to the telephone interview in order to reduce the non-response rate.

The schematic workflow of the research methodology is indicated in Figures 4.1 and 4.2. Basic parameters that relate to mode and carrier selection were collected from various published sources referred to in the last chapter. These parameters were reviewed and selected by the industrial practitioners so that these parameters could be grouped under different categories. The combined parameters form the basic structure of the questionnaire. Completed questionnaires were converted into data format and processed.

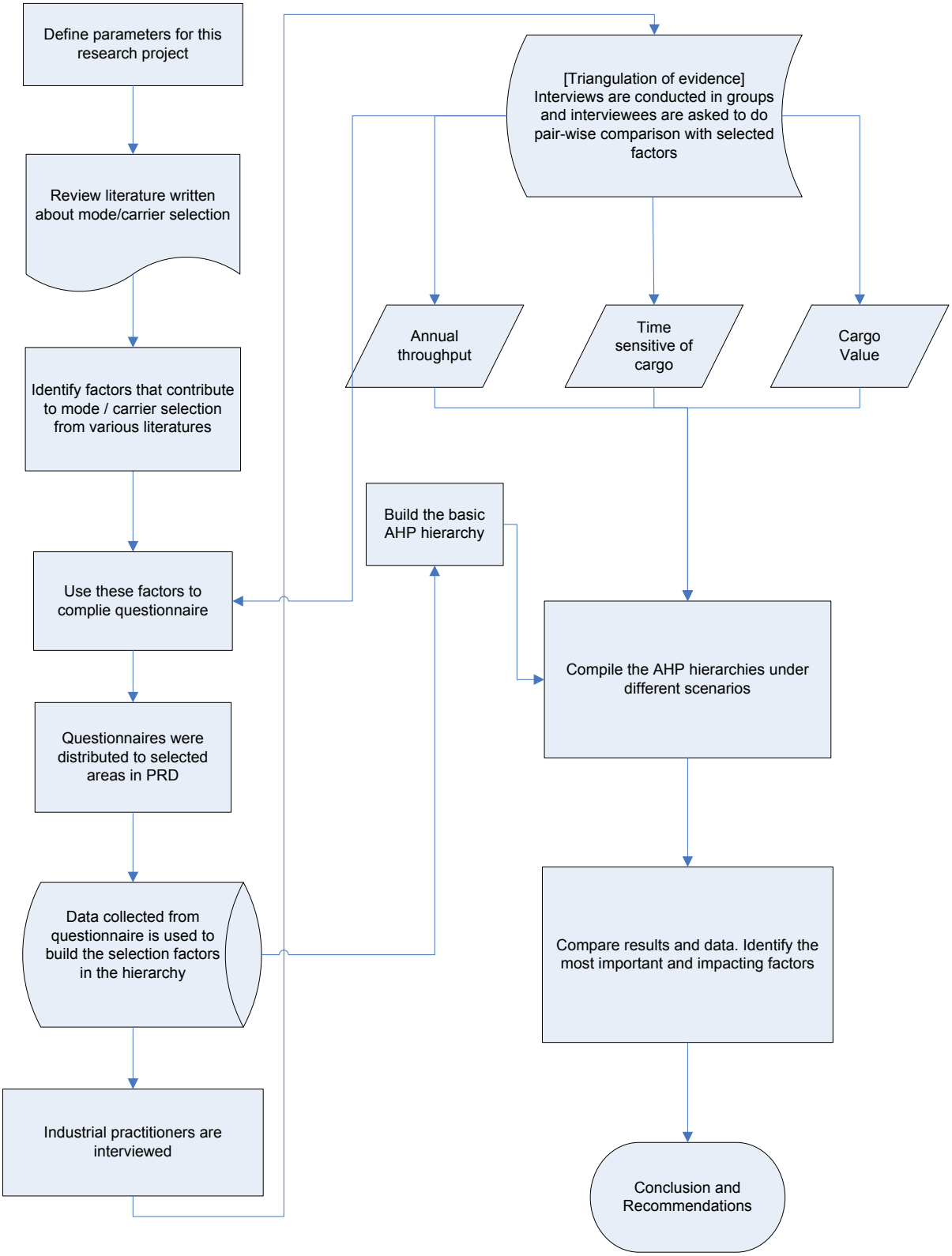
Parameters that are correlated in nature were identified and triangulated with industrial practitioners from the transport industry. A name is given to the group of parameters that are strongly correlated.

Figure 4.1 Triangulation of evidence



Industrial practitioners, either as shippers or freight forwarders, were invited to give a pair wise comparison of the factors under the Analytical Hierarchy Process (AHP) model. The ultimate goal designed under the AHP model is to fulfil the **satisfaction** of shippers/freight forwarders of their shipment. The lowest level of alternatives in the AHP model are the combination of modes available for selection to the loading port.

Figure 4.2 Research Methodology Design



Parameters about carrier selection collected via telephone interview are used to add to those parameters in carrier selection from various publications to enrich the scope of this study. These parameters were then compiled to form the first version of Pearl River Delta (PRD) carrier selection mode questionnaire.

Non-probability sampling has been applied in order to identify a sufficient number of carriers willing to be interviewed and to participate in this study. A validity test of the questionnaires has been conducted with the carriers to ensure that the data collected are free from systematic variance and sampling error. A set of questionnaires was posted direct to the identified carriers as well as other carriers who have branch offices in Hong Kong.

The data collected provides ample opportunity for data analysis and inferences in this yet uncharted area of research. The type of data generated has facilitated the application of various analytical data techniques that culminate in the identification of different interrelationships between the variables under study. Such techniques have included:

- **Factor analysis** - to reduce the number of variables and collected data into a manageable number.
- **Principal components analysis** – to transform a set of variables into a new set of composite variables or principal components that are not correlated with each other.
- **Cluster analysis** – to distinguish groups of carriers who differ in various factors
- **Discriminate analysis** – to examine differences between two or more groups of objects with respect of several variables simultaneously

Factor analysis is a multivariate statistical technique used to identify factors that statistically explain the variation and co-variation among measures. The number of factors is considerably smaller than the number of measures, and it can be viewed as a data-

reduction technique since it reduces a large number of overlapping measured variables to a much smaller set of factors (Green, Salkind and Akey, 2000)

SPSS was initially developed as a statistical package for the social sciences. It is widely adopted in education institutes and business organisations and includes OLAP cubes, descriptive statistics and tabulations, various parametric and non-parametric tests, regression techniques (including general linear, non-linear, mixed-effects, logistic, ordinal, log-linear), multivariate analyses (including cluster, discriminant, principal components and scaling analyses), and survival analysis (including Cox proportional hazards with and without time dependent variables).

SPSS provides a number of facilities for data manipulation, allowing a variety of data transformations and restructurings to be simply performed. It is also capable to exchange data through import and export in different file formats, including Microsoft Excel and Microsoft Access. Graphs and chart formats are provided, and tools exist to allow output formats to be tailored for specific user requirements.

The method employed in SPSS is Factor Analysis and as previous stated, this is a statistical data reduction technique used to explain variability among observed random variables in terms of fewer unobserved random variables called **factors**. In this method, the observed variables are modelled as linear combinations of the factors, plus "error" terms.

The reasons for using factor analysis are as follows:

- To sort out the returned questionnaire data in a systematic and readable format
- To reduce of number of variables by combining two or more variables into a single factor.
- To identify groups of inter-related variables, to see how they are related to each other.

4.2 Data Analysis

As discussed in the preceding Literature Review chapter, all the parameters from previous research have been established and the interrelationships among each parameter group has been determined, therefore a number of factors can be extracted by using the exploratory factor analysis.

According to Kim and Mueller (1978), there are three steps in obtaining a solution to exploratory factor analysis:

1. Preparation of an appropriate correlation matrix
2. Extraction of initial factors
3. Rotation to a terminal solution

Before carrying out an exploratory factor analysis, it is better to decide the method for obtaining the factor solution. According to Kim and Muller (1978) and Green, Salkind and Akey (2000), there are several methods in the extraction of initial factors, and the two most commonly used are principal component analysis and maximum likelihood. In this research, principal component analysis is used in the preparation of an appropriate correlation matrix and the extraction of initial factors. Cudeck (2000) indicated that it is easily obtainable, and maximum likelihood is only used when assumed that the distribution of variables is normal or at least roughly symmetric. In this research, preliminary analysis of the returned data observed that the data is not symmetric, so maximum likelihood is not suitable to be used in this thesis.

In order to find out the key dimensions of factors that affect the selection of mode and carrier choice for the sample population, Factor Analysis was used to analyze the selection criteria items contained in the questionnaire. A detailed explanation of the method is

attached as Appendix D. Factor analysis is a statistical method that is able to discover simple patterns in the pattern of relationships among the variables. Therefore, it is used to identify whether there are significant differences between the satisfaction level to the factors which are important for the users of a mode and carrier selection. All the numeric data on the questionnaire will be analyzed with the above method. Before performing the process of analysing the data, the vital analysis method extensively used in this study - Analytical Hierarchy Process - will be introduced in this section.

4.3 Introduction to AHP

In this research, an analytical ranking process was used to evaluate the linkage formats called Analytic Hierarchy Process (AHP). The AHP developed by Saaty (1985) provides a powerful tool that can be used to make decisions in situations where multiple objectives are present (Saaty 1985). The main theme is the decomposition by hierarchies and synthesis by finding relations through informed judgment. Saaty (1985) emphasized that to be realistic the AHP model must include and measure all both important tangible and intangible; quantitatively measurable, and qualitative factors. Scholars such as Song and Yeo (2004), Lirn, Hathanopoulou and Beresford (2004), and Ugboma and Ogwude (2006) have conducted successfully in port selection study with the AHP method yet it proved AHP is a suitable method in both subjective and objective selections.

- **Analytical Hierarchy Process (AHP)**

AHP is an effective approach to decision making involving both objective and subjective judgements. It is designed to cope with both the rational and the intuitive, to select the best from a number of alternatives evaluated with respect to several criteria (Saaty and Vargas, 1997). The main theme is decomposition by hierarchies and synthesis by finding relations through informed judgment (Saaty and Hu, 1998). According to Saaty, the theory is to

provide a methodology for modeling unstructured problems in the economic, social, and management sciences. The AHP is a mathematical decision making technique that allows consideration of both qualitative and quantitative aspects of decisions. It reduces complex decisions to a series of one-on-one pair-wise comparison and then synthesizes the results.

Compared to other techniques like ranking or rating techniques, the AHP uses the human ability to compare against individual alternatives. It not only helps decision makers to choose the best alternatives, but also provides a clear rationale for the choice. Though AHP is not used to choose the best alternative in this research, the ranking approach is implemented to analyze data to identify the advantages and disadvantages of the alternatives.

According to Saaty and Vargas, the Analytic Hierarchy Process is a general theory of measurement. It is used to derive ratio scales from both discrete and continuous paired comparisons in a multilevel hierarchy structure. These comparisons may be taken from actual measurements or from a fundamental scale set by the researcher that reflects the relative strength of preferences and feelings (Saaty and Vargas, 1997).

There are four axioms of AHP theory. Informally they are concerned with the reciprocal relation, comparisons of homogeneous elements, hierarchic and a systems dependence and with expectations about the validity of the rank and value of the outcome and their dependence on the structure and its extension (Saaty, 1994a ,b).

The AHP is also defined as a general theory of measurement. It is used to derive ratio scales from both discrete and continuous pared comparisons in multilevel hierarchical structures. These comparisons may be taken from actual measurements or from a fundamental scale that reflects the relative strength, preferences and feelings.

In the general form, the AHP is a nonlinear framework carrying out both deductive and inductive thinking without use of the syllogism. This is made possible by taking several

factors into consideration simultaneously, allowing for dependence and for feedback, and making numerical tradeoffs to arrive at a synthesis or conclusion.

In attempting to include everything in the measurments, normative theories treat intangible criteria as tangibles by postulating a convenient economic scale. In this case, it means it will be difficult to minimize all intangibles to economics in order to give the complete acceptance. AHP is a descriptive theory in the sense of the physical science. It is a tool to construct a complete order through which optimum choice is derived, and is to assist decision makers to organize their thoughts and judgments to make more effective decisions. The architecture of AHP is based on observations of how influences are transmitted and its arithmetic is derived from psychologists' observations of how people function in attempting to understand their behavior.

In short, AHP begins with the traditional concept of ordinal ranking to satisfy a hierarchy and advances further into numerical paired comparisons from which a ranking of the elements in each level is derived. AHP infers behavioral characteristics of judgments (inconsistency and intransitivity) from its basic framework of paired comparisons. It begins by taking situations with a known underlying ratio scale and hence known comparisons ratios, and shows how its method of deriving a scale uniquely through the eigenvector give back the original scale, then through perturbation the AHP shows that a derived scale should continue to approximate the original scale providing that there is high consistency. Fundamentally, AHP provides the objective mathematics to process the inescapably subjective and personal preferences of an individual or a group in making decisions (Kinoshita, 1999).

There are seven pillars in the AHP process:

1) Ratio scales, proportionality and normalized ratio scales - these are central to the generation and synthesis of priorities.

2) Reciprocal paired comparisons, which are used to express judgments semantically, automatically linking them to a numerical fundamental scale of absolute numbers from which the principal eigenvector of priorities is then derived

   AHP has at least three modes of ranking of the alternatives;

   i) Relative, which ranks a few alternatives by comparing them in pairs, and is used mostly in new and exploratory decisions. This mode will be used in this research since selecting the optimized linkage format is new.

   ii) Absolute, which rates an unlimited number of alternatives one at a time on intensity scales constructed separately for each covering criterion and is particularly useful in decisions where there is considerable information to judge the relative importance of the intensities and develop priorities.

   iii) Benchmarking where it ranks alternatives by including a known alternative in the group and comparing the others against it. In this research,

3) Sensitivity of the principal right eigenvector to perturbation in judgments limits the number of elements in each set of comparisons to a few and requires that they be homogeneous.

4) Homogeneity and clustering which are used to extend the fundamental scale gradually from cluster to adjacent cluster.

5) Synthesis that can be extended to dependence and feed back which is applied to derived ratio scales to create a uni-dimensional ratio scale for representing the overall outcome.

6) Rank preservation and reversal which can be shown to occur without adding or deleting criteria

7) Group judgments which need to integrate one at a time carefully and mathematically, taking into consideration when the desired experience, knowledge, and power of each person involved in the decision, without the need to force consensus, or to use majority or other ordinal ways of voting. (Saaty and Vargas, 1997).

- **Structure of Hierarchy**

According to Saaty, the most creative part of decision-making that has a significant effect on the outcome is that of modeling the problem. In the AHP, a problem or objective is structured as a hierarchy. It is then followed by a prioritization process and ranking.

According to Saaty, a hierarchy is a particular type of system, which is based on the assumption that the entities, which we have identified, can be grouped into dis-join sets, with entities of only one other group, and being influenced by the entities of only one other group (Saaty, 1987). The hierarchical structure or ranking is used to describe how changes in priority at the upper echelon influence the priority of elements in the lower echelon. Saaty ‘s Hierarchy model gives detailed information on both the structure and function of a system in lower levels and provides an overview of the actors and their purposes in the upper level. In actual practice, when using AHP, there is no formal procedure for creating objectives, criteria and activities to be included in a hierarchy or a more general system. The practical and realistic advantage is that it is purely a matter of what objectives are chosen to decompose the complexity of that hierarchical system.

It is due to the merits of the AHP hierarchical structure, that this structure will be adopted to develop a set of criteria based on the alternatives, the linkage models and to rank them to

identify the most impacted factors to the linkage formats. These impacted factors are those factors that are affecting the effectiveness and efficiency of the linkage.

- **Judgment and Comparison**

A judgment or comparison is the numerical representation of a relationship between two elements that share a common parent (Saaty and Hu, 1998). All such elements can be represented in a square matrix in which the set of elements is compared with itself. The judgment will be the input from a group of professional experts. A scale of absolute numbers is used to assign numerical values to judgments made by comparing two elements with the smaller element used as the unit and the larger one assigned a value from this scale as a multiple of that unit.

- **Structure of the objective or decision problem**

The most creative task is making a decision to determine what factors to include in the hierarchical structure. By considering the environment surrounding the problem, identifying the issues or attributes that one feels should contribute to the solution or objectives, and who are the participants associated with the problem or objective, are all important considerations when constructing the hierarchy.

Arranging the goals, attributes, issues and stakeholders in a hierarchy serves two purposes: it provides an overall view of the complex relationships inherent in the situation and in the judgment process, and it also allows the decision maker to assess whether issues of the same order of magnitude are being compared. A practical approach to proceed in structuring a decision is to come down from the goal as far as one can by decomposing it into most general and most easily controlled factors or criteria. Then, it goes up from the alternatives beginning

with the simplest sub criteria that they must satisfy and aggregating the sub criteria into generic higher level criteria until the levels of the two processes are linked in such a way as to make comparison possible.

4.4 AHP in this Research

Saaty‘s AHP model sets out the backbone for this research. AHP is not used for ranking the purpose of decision making to select the best alternatives nor to find the optimal solution. AHP ‘s hierarchy ranking process is used to identify the advantages and disadvantages or the strength and weakness of the carrier selection. From the ranking process, it is possible to compute and analyze the data to find out the most impacted factors or criteria. These sets of identified impacted factors will be those that have direct impact on the effectiveness and efficiency involved in both the shippers and carrier/freight forwarder industries. They are also the most significant factors that will affect a business distribution model. This will be a new research application using the AHP ranking process, not ranking for the best, but to identify factors that have impacted most to a distribution linkage model in the inter industries. Moreover, AHP is used to analyze the subjective parameters in the hierarchy model.

4.5 Design of the Questionnaire

A questionnaire is widely use in most empirical research so that field data can be studied in order to validate theoretical assumptions. This thesis aims at gathering data on modal selection from shippers/freight forwarders that operate in the target locations within PRD.
A questionnaire is simple to use, easy to deliver and is widely accepted by interviewees. In our daily life, everyone will come across interviews in a form of questionnaire on various occasions. During the interview, interviewees quickly accept the method and are able to focus on the questions. Furthermore, a questionnaire in the form of a document can be

distributed easily via email, fax or by post. However, this type of data collection method has the following shortfalls (Brace 2004);

- The questionnaire must not be too lengthy in content. The norm is for a questionnaire to be limited to four pages as maximum
- The wording used in the questionnaire must be brief and concise. It is difficult to put footnotes/remarks alongside questions. Obviously, it is difficult to obtain results correctly if one asks for some broad or abstract ideas, such as customer satisfaction.
- The response rate can be affected if the duration of the interview is too long. However, it is difficult to determine this duration as it depends on the external environment during the interview. If the questionnaire is answered in someone's office then the interviewee may be more patient to understand the meaning of the questions.
- Ample time must be allowed for the interviewee to respond to the questionnaire; time is a crucial factor in that the opinion of interviewee may change.

In order to overcome the shortfalls listed above the questionnaire was limited to four pages and sections were to confine the questions into a particular category. Since most of the interviewees were Chinese, the questionnaire was written and proof read by the local industry practitioners before distribution.

The questionnaire was posted to the interviewee's office address and followed up by phone confirmation. In order to avoid any ambiguity in the meaning of the wording, the questionnaire used a Likert Scale so that data collected from that person was consistent.

4.6 The ground work

With the parameters collected from the literature on mode/carrier selection, tables 4.2-4.4 lists the top three factors mentioned by different authors arranged in chronological order according to the date of publication of their papers. A list of factors that were considered relevant to this study in mode/carrier selection are listed below in table 4.1.

Table 4.1Alphabetical listing of reasons/criteria for carrier selection

• Ability of representative • Assistance in obtaining rate changes • Ability to control the shipment • Availability of origin & destination point • Availability of specialised equipment • Care in handling • Claim settlement • Commercial obligations • Competitive rates • Consistency of service • Consistent on time service • Cost of service • Costs related to level of stocks • Customer satisfaction • Delivery reliability	• Delivery time • Dependability/ reliability of service • Distance • Door-to -door rates • Door-to-door transit time • Equipment availability • Existence of substitutes • Flexibility • Freight charges • Frequency of damage/ loss • Geographical coverage • Line haul performance • Low freight charges • Meet estimated pickup & delivery • Negotiate services & rates • On time performance • Physical facilities	• Pickup & delivery schedules • Pickup service • Preference given to shipper • Promotional material • Quality of dispatch personnel • Reliable pickup & special order handling • Required delivery date • Response in emergency • Satisfies customer • Service quality • Shipment information • Shipment tracing • Susceptibility to loss / damage • Time in transit • Transit time reliability • Transportation costs • Value/ nature for commodity • Willingness to negotiate service & rates

These parameters were used to form the content of the questionnaire. Industrial practitioners were invited to give comments on the grouping.

The questionnaire was drafted in the late 2002. Through my colleague Dr Jimmy Ng , Assistant Professor of Department of Logistics, The Hong Kong Polytechnic University, a meeting was arranged with the Shenzhen Maritime Shipping Association and a sample questionnaire was distributed to those attending and feedback and comments were collected in order to modify the questionnaire.

Thereafter, several meetings were conducted with various parties in the related industries with the assistance of the Shenzhen Maritime Shipping Association in Shenzhen as well as

Table 4 - 2 Studies which examine carrier selection factors (1963-1985)

Authors	TOP 3 Factors																				
	Time in transit	On time performance	Shipment tracing	Meet estimated pickup & delivery	Frequency of damage/ loss	Pickup service	Delivery time	Dependability/ reliability of service	Claim settlement	Assistance in obtaining rate changes	Flexibility	Preference given to shipper	Care in handling	Transit time reliability	Transportation costs	Door-to-door transit time	Line haul performance	Consistency of service	Competitive rates	Satisfies customer	Low freight charges
Traffic Management (1966)	■	■	■																		
Bardi (1971)				■	■																
Saleh & Lalonde (1972)	■					■	■														
Evans & Southard (1974)	■		■					■													
Jones (1975)	■							■	■												
Anderson, Jerman & Constantin (1976)	■				■					■											
Pearson (1980)	■										■	■									
Dunn (1982)		■											■	■							
Chow & Poist (1984)	■														■	■					
Bruning & Lynagh (1984)				■													■		■		
Brand & Grabner (1985)				■														■	■		
Burdg & Daley (1985)														■						■	■

BROOKS, M.R., "Limitations in the carrier choice Process: A Study of EASTERN Canadian Containerisable Cargo",

International Journal of Physical Distribution & Materials Management, Vol. 15 No.3 1984, p. 38-46

Table 4-3 Studies which examine mode selection factors

(1966-1996)

Authors	Main Finding / TOP 3 Factors																									
	Time in transit	On time performance	Shipment tracing	Consistent on time service	Reliable pickup & special order handling	Distance	Value/ nature for commodity	Susceptibility to loss / damage	Existence of substitutes	Ability to control the shipment	Availability of specialised equipment	Delivery reliability	More shippers selected "best service with acceptable rates" than "lowest rate with acceptable service"	Freight charges	Door-to -door rates	Customer satisfaction	Commercial obligations	Costs related to level of stocks	Negotiate services & rates	Required delivery date	Cost of service	Service quality	Ability of representative	Promotional material	Physical facilities	Availability of orgin & destination point
Traffic Management (1966)	■	■	■																							
Saleh & Das (1974)			■	■	■																					
Stenger & Cunningham (1976)						■	■	■	■																	
Gilmour (1976)										■	■	■														
Cunningham & Kettlewood (1976)													■													
Stock & Lalonde (1977)	■	■												■												
McGinnis (1979)	■				■							■														
Chow & Poist (1984)	■										■				■											
Burdg & Daley (1985)	■													■		■										
Hayuth (1985)	■						■							■			■	■								
Foster & Strasser (1990)												■							■							

Gentry (1991)												■								■	■	■					
Whyte (1993)											■												■	■	■		
Ever, Harper & Needham (1996)											■																■
KRAPFEL, R. E. & MENTZER, J.T., *"Shippers Transportation Choice Processes Under Deregulation"* Industrial Marketing Management, No. 11 1982, p. 117-124																											

Table 4-4 Studies which examine carrier selection factors (1986-1999)

Authors	TOP 3 Factors																														
	Time in transit	On time performance	Shipment tracing	Meet estimated pickup & delivery	Frequency of damage/ loss	Pickup service	Delivery time	Dependability/ reliability of service	Claim settlement	Assistance in obtaining rate changes	Flexibility	Preference given to shipper	Care in handling	Transit time reliability	Transportation costs	Door-to-door transit time	Line haul performance	Consistency of service	Competitive rates	Satisfies customer	Low freight charges	Pickup & delivery schedules	Willingness to negotiate service & rates	Response in emergency	Geographical coverage	Equipment availability	Shipment information	Quality of dispatch personnel	Ability of representative	Promotional material	Physical facilities
Quinn (1987)			■								■											■									
Bardi, Bagchi & Raghunathan (1989)	■													■	■							■									
Foster & Strasser (1990)																							■								
Abshire & Premaux (1991)	■							■																■							
Gentry (1991)		■																	■						■						
Morash & Calantone (1991)		■			■			■																							
Murphy, Daley & Dalenberg (1991)					■																					■	■				
Hall (1992)				■																			■			■					
Lambert, Lewis & Stock (1993)		■																	■									■			
Whyte (1993)																													■	■	■
Brooks (1995)																					■										
Murphy, Daley & Hall (1997)	■							■																		■		■			
Murphy & Daley (1997)								■																			■	■			
David Simchi-Levi (2000)	■							■													■										

the Institute of Sea Transport in Hong Kong. The sample correspondence between Shenzhen Maritime Shipping Association is attached as Appendixes C-2 and C-3 and the questionnaires are shown in Appendixes B-1, B-2 and B-3.

As mentioned in the previous chapter, the target group of this survey was shippers/freight forwarders, especially those in the container export trade. In order to obtain a larger sample size and higher response rate to enhance its representation of the population, the distribution of the questionnaire was carried out in two phases:

- Summer 2003: A targeted group of shippers (277 companies) from the Zhongshan area was randomly selected from the trade directory - *The latest directory of Taiwanese investment in Guangdong, China 2002* (*Guangdong Sheng Tai zi qi ye da quan, 2002 nian*. 廣東省臺資企業大全，2002 年) Questionnaires, written in simplified Chinese, with a covering letter (Appendix C-1 indicates an English version) were posted out, and collected later.

  Data collected from this pilot survey was evaluated and the questions modified into a revised second version of the questionnaire.
- Summer 2004: Another group of (targeted) shippers (900 in total) in the predominant production areas in Dongguan and Shenzhen, PRD were selected from *The latest directory of foreign investment in China 2000*.; *Guang Dong communication book* , *The latest directory of foreign investment in China 2000* and *D&B major corporations in P.R. China (2000)*. Modified questionnaires were distributed via post and collected later.
- 2005-2006: personal interviews were conducted on several occasions with Shenzhen freight forwarders/shippers and open-ended questions were asked.

A research helper was recruited during summer 2003 from the Shenzhen area to administrate, collect and follow up the questionnaires that were distributed. A stamped address envelope was included in each questionnaire despatched. Fax numbers for both Hong Kong, direct to Department of Logistics of The Hong Kong Polytechnic University, and Shenzhen, direct to the research helper, were printed on the cover page of the questionnaire.

Questionnaire Development

Before sending off the questionnaires to respondents, a pilot study was needed to ensure that the questionnaire was appropriate for its purpose. According to Cooper and Schindler (1998), content validity is a measuring instrument to test whether the questionnaire provides adequate coverage of the topic under study, and it can be determined from a panel of persons to judge how well the questionnaire meets the standards.

The questionnaire is divided into six parts. This is attached in Appendix B-2 (for the Chinese version) and Appendix B-3 (the English version). The first version of questionnaire is also attached in Appendix B-1 for information.

Part I consists of general questions about the background information of the respondents. Questions are asked about their annual export volume, preferred loading port/airports and role in the delivery of the consignment. The aim of these questions is to have general background trade related information of the respondents. It can also give an indication of the representative nature of respondents with respect to shippers and service providers. By using the data collected in this section, it is possible to further group the shipper/freight forwarder by their cargo volume and value.

Part II consists of seven questions. Their aim is to find out the overall trade transaction of the consignment. The concept of five–point Likert-Scale is adopted to measure the views

of respondents. According to Brown (2000), the Likert-scale is used to investigate how respondents rate a series of statements (Shown in Table 4.5). The Likert-scale is a uni-dimensional scaling method for gathering respondents' feelings, opinions and attitudes.
Each selection is given a numerical score in order to make the qualitative data into quantitative data. Then the results can be used to compute by SPSS.

Table 4.5 Five-point Likert Scale used in Part II

1	*2*	*3*	*4*	*5*
Most Important	*Very Important*	*Important*	*Less Important*	*Not Important*

Part III investigates the parameters that will affect the loading port selection in terms of transport cost of the consignment. As the trade term in China changed over past decades, mainly from FOB or Ex-work to CIF, the selection of carrier/loading port is now mainly controlled by the shippers/freight forwarders. These shippers will view the cost involved in the consignment as a whole sum of expenses
Part IV obtains information on the service level expected from the freight forwarders/service providers in the delivery of the consignment. Seventeen questions are asked to cover a wide range of service level that is commonly referred in the selection process.

Part V examines the relationship between shippers and freight forwarders/service providers. A partnership, as described by Ellram & Hendrick (1995), is an ongoing relationship between two firms that involves a commitment over an extended time period, and a mutual sharing of information and the risks and rewards of the relationship. However, this is not the common scenario between shippers and freight forwarder in China. The

selection of a partnership is sometimes decided purely on the friendship between key personnel in each company rather than gaining competitive advantage in the marketplace.

Part VI was added after the pilot survey due to strong feedback from the respondents that the relationship with the Customs Office is very important in selection of loading ports.

In the questionnaire, open-ended questions were added in various parts. An open-ended question asks the respondent to answer some questions, or to offer some suggestions or opinions, but to do so without any pre-set categories being provided for the answer. There are at least six reasons for including some open-ended questions in a survey:

- such questions are used when there are too many possible responses;
- open-ended questions are preferable if the researcher does not wish to impose response categories on the respondent;
- the researcher uses such questions when he or she wishes to create the sense that the respondent is really being consulted by being asked to offer his or her opinions;
- the researcher wishes to provide a qualitative dimension to the study. Open-ended questions provide this dimension, along with materials which may be used as a source of quotations for the final report;
- a pilot study is being done and the appropriate response categories have not been determined;
- such questions are used to provide a change in pace for the reader.

While open-ended data is not always analyzed when writing the final report on a project, they can provide information to the researcher, which might be missed if such questions were not asked.

4.6 Sampling Design

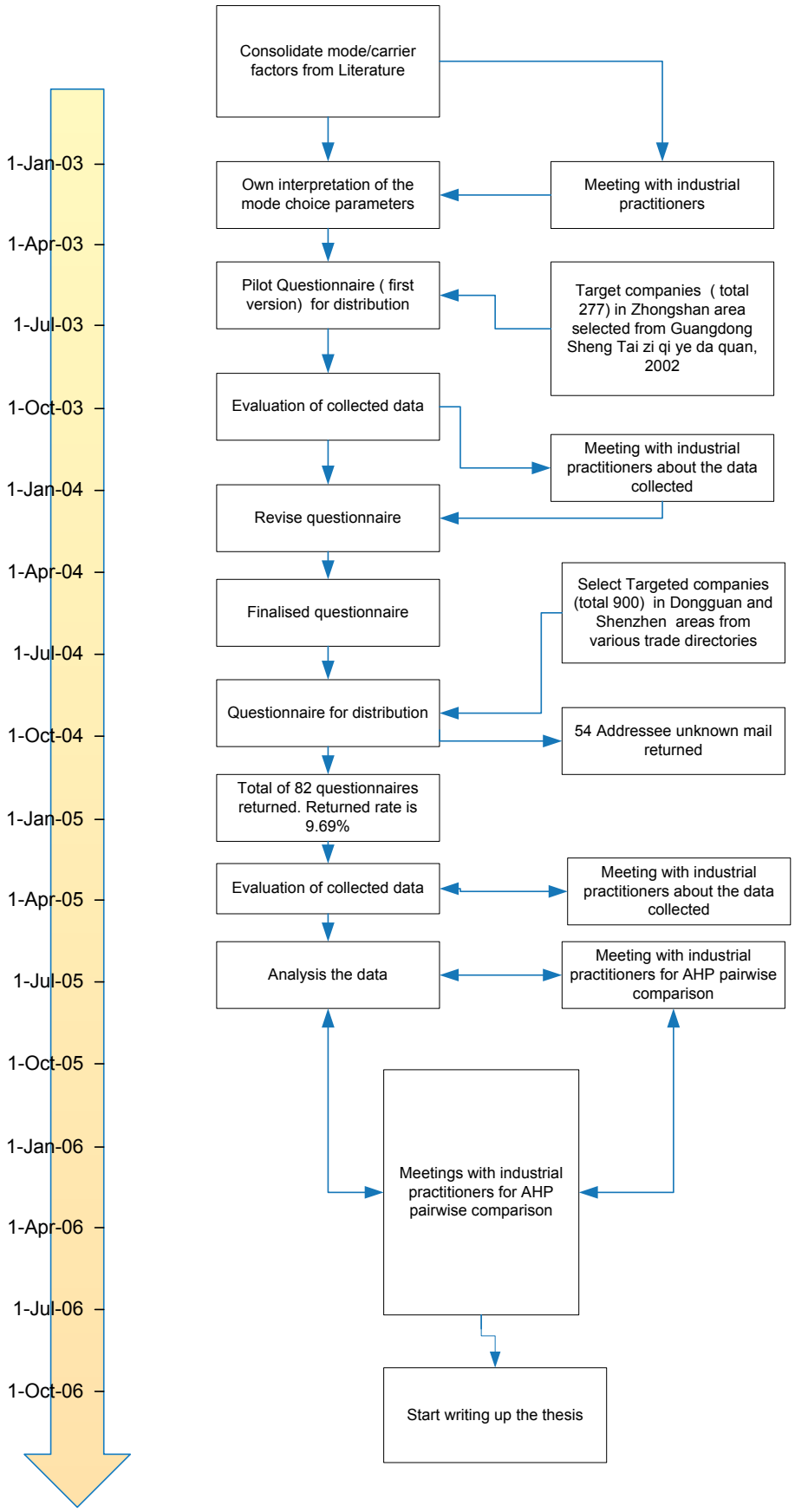
Since this study focuses on the loading port selection by shippers/freight forwarders in the PRD, the questionnaires were sent to shippers/freight forwarders that operate in either all or one of the target areas.

To make the data more realistic to the practice of the industry and to reduce the chance that the questionnaire is completed by inappropriate respondents, such as those who hold no authority or knowledge to make decisions on selection of loading port, the questionnaires were addressed to the director or general manager of the companies. Most respondents were at the managerial level as they may have better knowledge about the actual operation in the target loading ports.

After establishing the target population, in order to increase the accuracy and response rate of the survey, potential respondents were informed by phone by the research helper before the questionnaire was actually delivered. This process ensured that companies were willing to help with the questionnaire. Also, follow-up calls were made, after one week of the first mailing and follow-up questionnaires were sent to the non-responding person as a reminder to complete the questionnaire.

A website was setup at http://myweb.polyu.edu.hk/~lgtpwong/ so that interested parties could login and answer the questionnaires, in both Chinese and English, online. A total of eighty two questionnaires were received from the respondents after the two survey periods. These included those questionnaires collected over various meetings and face-to-face interviews. There was no response to the website questionnaire. The detail workflow of the questionnaire is show in figure 4.3. In the actual survey, 900 target companies were selected and 54 questionnaires were returned by post due to incorrect postal address or address relocated elsewhere. The return rate of the survey was 9.69%.

Figure 4.3 Questionnaire flow chart with timescale



4.7 Data Collection

Generally, information sources can be categorized to three levels: 1) Primary Source, 2) Secondary Source and 3) Tertiary Source. The data collected for this study is primary and secondary data. The primary data was obtained from the questionnaire to shippers/freight forwarders. The secondary data was from textbooks, magazines, journals, newspaper articles, and research from other scholars, government reports, press release and statistics. They provide background information for this study and the survey instruments.

Overall, eighty two questionnaires were returned out of 900 sent out, and the final usable response rate was 9.69%, which were used for conducting a comprehensive statistical analysis in Chapter five, Data Analysis and Finding. The number of returned questionnaires out of the total distributed still provides a valid sample size because:

1. The questionnaire was used for information collection on some intangible elements in the mode/carrier selection. The number of returned questionnaires will not jeopardise the validity of the results.
2. In a practical survey, a return of 10% of the questionnaires is acceptable for the study.
3. The data collected in the returned questionnaires was studied further with input from the related industries. Hence the reliability of data is ensured.

Data collected from the questionnaires were compiled with SPSS and tables were generated.

Industrial participation

Throughout the whole process of this survey, industrial practitioners from transport related industries were invited to attend the meetings over a time span of three years. This type of support and participation from the industry really contributes to the validity of the results in this study. However, the practitioner may change his mode of selection from time to time due to changes in the external environment. The changes in external environment can form one of the new parameters in this study; however, it is very difficult for the industrial practitioner to explain the situation fully. Overall, the selection of mode choice indicates a good consistency in the results.

The busy schedule of practitioners who participated in this survey forced them to shorten their total time involved in this survey. It is nearly impossible to ask for more data from individual participants after they have done the survey in both filling in questionnaire and pair wise comparison. Follow up phone calls may help if further clarification is required.

Chapter 5 - Data Analysis and Finding

In this chapter, a detailed analysis of the mode selection process, as analysed in Chapter four, will be presented. The analytical methods used in this thesis are Factor Analysis and AHP (Analytical Hierarchy Process)

5.1 Data Analysis

Data from the questionnaire survey will be used to5 carry out various statistical analyses in this section. All the data were entered and computed using the Statistical Package for Social Science Program (SPSS, 12.0 for Windows), and also all the analysis in the first half of this research was carried out using this method in order to utilise this program.

A number was assigned to each blank slot and question in the questionnaire. Data collected from the questionnaires were entered as variables. The resulting output is analysed below.

5.1.2 Process of Factor Analysis

Factor analysis was used to find latent variables or factors amongst observed variables. In other words, if data contains many variables, the factor analysis reduces the number of variables into meaningful factors. Factor analysis groups variables with similar characteristics together. Sometimes factor analysis is used solely for data reduction, simply because such reduction may be needed for subsequent analysis. With factor analysis, a small number of factors are produced from a large number of variables, which is capable of explaining the observed variance in the larger number of variables. The reduced number of factors can also be used for further analysis.

There are three stages in factor analysis:

1. A correlation matrix is generated for all the variables. This is a rectangular array of the correlation coefficients of all of the variables with each other.

2. Factors are extracted from the correlation matrix based on the size of 53 correlation coefficients of the variables.

3. The factors are rotated in order to maximize the relationship between the variables and some of the factors.

In each questionnaire, fifty questions about the mode selection criteria for the loading port were asked of respondents. The correlation matrix was produced, which is a square, symmetrical matrix in which the number of rows and the number of columns equal the number of variables. Because the correlation matrix is symmetrical, it is often depicted in one of several abbreviated forms. The correlation matrix summarises information in the raw data matrix. It is smaller, with fewer rows and fewer elements than the raw data matrix. This is the beginning of the data-reduction process.

After the correlation matrix, the Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were used to measure the sampling adequacy, which should be greater than 0.5 for a satisfactory factor analysis to proceed. The KMO measure is based on the principle that if variables share common factors, then partial correlations between pairs of variables should be small when the effects of other variables are controlled. The KMO measure provides an approach to comparing the zero-order correlations to the partial correlations. The KMO measure may vary between zero and one with larger numbers indicating a greater difference between the zero-order correlations and the partial correlations. If a KMO measure in the 0.80s or 0.90s is achieved, this supports the use of factor analysis for the data.

Raw data was input into the system and the procedures in SPSS operation were as follows:

- Select Analyze
- Data Reduction
- Factor
- Variables (input variables)
- Descriptive
- Under Correlation Matrix,
- Check KMO and Anti-image to get overall and individual KMO statistics

- Extraction
- Method (principal components)
- Analyze (correlation matrix)
- Display (Scree Plot)
- Extract (eigenvalues over 1.0)
- Continue –
- Rotation - under Method, choose Varimax
- Continue - Scores - Save as variables
- Continue - OK.

The Kaiser-Meyer-Olkin (KMO) test =0.823>0.8 and this result supports the use of factor analysis for the data. Bartlett's Test of Sphericity is 4,942.40 with statistical significance 0.000 < 0.01, which also supports the use of factor analysis as an appropriate procedure. Then the eigenvalue (*characteristic roots*.) for a given factor measures the variance in all the variables, which is accounted for by that factor, is checked. The ratio of eigenvalues is the ratio of explanatory importance of the factors with respect to the variables. If a factor has a low eigenvalue, then it is contributing little to the explanation of variances in the variables. Therefore, it may be ignored and considered redundant compared with more important factors. Based on the criterion that the minimum eigenvalue (for rotated factors) is one, the first seven factors are rotated. Rotation is the step in factor analysis that allows you to identify meaningful factor names or descriptions.

5.1.3 Formation of factors

The formation of factors is obtained by setting the sampling adequacy to above 0.5 after it has been computed from the SPSS. When the data is measured by the Kaiser-Meyer-Olkin (KMO) statistics, sampling adequacy predicts if data are likely to factor well, based on correlation and partial correlation. The rationale behind this method believes that there is a KMO statistic for each individual variable, and their sum is the KMO overall statistic. KMO varies from 0 to 1.0 and KMO overall should be 0.5 or higher to proceed with factor analysis.

In this thesis, seven factors are identified and each questionnaire item within each factor grouping is studied. If one questionnaire item appears several times under different factors then the sampling adequacy of that questionnaire item is compared with its own score under different factors. The questionnaire item with lowest sampling adequacy is removed from that factor grouping. Hence, all questionnaire items will only appear once within the seven factors. By undergoing this filtering process, questionnaire items left within the factor group will have a better correlated nature compared with other items within the factor group.

The factor groups were sent to selected industrial practitioners and they were asked to give one indicative name for that factor. The names (criteria block) were identified after five meetings. These criteria were further grouped under two main categories, namely, internal and external factors. The internal factors are concerned with the elements which are controllable by the shippers/freight forwarders and will eventually affect the mode choice. External factors refer to those factors that are beyond the control of the shippers themselves and are mainly controlled by the Customs broker or freight forwarder selected for the shipment. To summarise,

- **Internal factors**
    - Shipper's reputation,
    - Cargo location ,
    - Shipper's own capabilities
- **External factors**
    - Customer service
    - Cargo handling capabilities
    - Relationship with Customs office
    - Comprehensive Global service

The results of finding these factors may seem quite puzzling for people brought up in Western cultures and educational backgrounds. It was observed that during the naming process, the majority of practitioners considered themselves (the person in charge of the company) able to settle any problem occurring during the transit of the shipments by their own personal connections with shippers, freight forwarders and even with the Customs office. This is a common phenomenon in China within the business community. However, in this study this phenomenon has not been given as high a weighting as it should have been when building the hierarchy model. Nevertheless, it is an interesting point that further study of this type can be considered.

5.1.4 Grouping of the factor

The questionnaire items under each factor are listed in the following tables. In order to elaborate on the rationale behind this naming, the following sections will explain two questionnaire items for each factor.

Table 5.1 - Shipper's own capabilities

Quest Number	Questionnaire items	Loadings
41	Dependability/reliability of service	0.84
45	Special preference given to shipper	0.82
42	Response in emergency	0.79
34	Punctual performance	0.78
37	Claim settlement	0.77
44	Flexibility in handling documents/equipment	0.77
38	Provision of freight forwarding services	0.77
36	Ability to be representative of the buyer	0.77
46	Existence of substitutes in the neighbouring areas	0.75
43	Willingness to negotiate service & rates	0.75
35	Relationship with shipper/cargo owner	0.73

Table 5.1 shows that the practitioners collectively think the questionnaire items can be resolved under the shippers' own control. For example, question number 42: **response in emergency**, practitioners concluded that shippers could resolve a problem with their own internal arrangements. Actions such as making several telephone calls can easily fix the

problem. Question number 37: **Claim settlement**, under Chinese law even the plaintiff is awarded with compensation after the trial, the plaintiff needs to apply for his compensation from the court separately. If the plaintiff does not take any action, compensation will not be given to him. Therefore questionnaire items that are included in this factor can be grouped under internal factors.

Table 5.2 – Comprehensive Global Service		
Quest Number	Questionnaire items	Loadings
23	Provide geographical coverage	0.71
29	Equipment availability	0.66
24	Shipment information	0.63
20	Consistency of service	0.62
18	Care in handling	0.58
21	Assistance in obtaining lower rate charges	0.53
3	Cargo will pass through another customers district	0.50
16	Low freight charges	0.50

Table 5.2 refers to the Comprehensive Global Service offered by the freight forwarders. The reason for questionnaire items grouped under this factor is obvious. For example, question number 23: **Provide geographical coverag**e and question 29: **Equipment availability** will ensure the freight forwarder can provide a genuine global freight service with adequate equipment available in every location.

Table 5.3 – Customer Service		
Quest Number	Questionnaire items	Loadings
39	Quality of dispatch personnel	0.76
9	(District) to the loading port	0.73
50	Service quality of "Customs declaration" company	0.68
51	Past Customs record of the shipper	0.65
40	Past record in satisfying customers	0.63
4	Registration with the local Customs office	0.50

Table 5.3 refers to Customer Services offered by the freight forwarders. When the location of shippers are not in close proximity to the loading port, especially those shippers with small

cargo volume, good customer service provided by freight forwarders distinctly helps in the smooth transition of the cargo. For example, question number 39: **Quality of dispatch personnel** refers to the special knowledge possessed by the dispatch personnel. Question number 4: **Registration with the local Customs Office** indicates that the freight forwarders can import and export cargoes easily within the destined areas. Under China's Customs regulations, shippers or their representatives must register at a particular Customs office before they can load/discharge the cargo in that Customs District.

The situation can be further clarified by using an example. If someone sent an air freight consignment to a consignee in Shenzhen from London and the aircraft landed at Guangzhou airport and the shipment was detained due to the consignee not being registered with the Guangzhou Customs office, this cargo, under the Customs regulations, should have arrived at Shenzhen airport instead because the consignee was registered with the Shenzhen Customs office there. In this circumstance, the consignee needs to ask another freight forwarder or broker who is registered with the Guangzhou Customs office to apply for Customs clearance on his behalf. Of course, extra costs will be involved in addition to the normal transport costs. Obviously, this factor is beyond the control of the shippers and it is classified as one of the external factors in mode choice.

Table 5.4 – Cargo Handling Capabilities

Quest Number	Questionnaire items	Loadings
31	Pickup service	0.86
30	Physical facilities	0.81
6	Value of the cargo	0.76
55	Good relationship with the customs office	0.75

In table 5.4, Cargo handling capabilities is one of the external factors in the mode choice. The questionnaire items listed under this factor are self-explanatory.

Table 5.5 – Cargo Location		
Quest Number	Questionnaire items	Loadings
32	Promotional materials	0.88
26	Susceptibility to loss/damage of cargo	0.83
48	Physical distance between depot/factory and Customs office	0.66
47	Trusted by local Customs office	0.65

Cargo location, in table 5.5, is one of the internal factors that can be controlled by the shippers. Even though it looks simple for questionnaire items to be put under this factor, an explanation will provide an in depth understanding of this issue. For example: question number 32: **promotional materials** indicate the special promotional items that are offered by the freight forwarders. In order to achieve a better consolidation ratio, freight forwarders will offer shippers free storage facilities in their depot. In recent years, many so-called "logistics parks" (big warehouses) opened for operation in the PRD region. However, they are invariably empty because either the location of the "park" is too far away from the main road or no one has used it before. By giving free storage facilities to shippers, the stored cargo will become one of the displayed items in the warehouse. This effect of filling up the warehouse with displayed items will be very impressive when other shippers come to visit the "park". Question number 48: **Physical distance between depot/factory and Customs office** is important for time-sensitive cargos. If the location of the cargo is close to the Customs Office then Customs clearance time will be minimised.

Table 5.6 – Shipper's Reputation		
Quest Number	Questionnaire items	Loadings
49	Shipper is classified as a "Trustworthy enterprise"	0.86
7	Tax rebate arrangement	0.82
56	Frequency of cargo inspection from the Customs office	0.70

The Shipper's reputation contains items that are related to the shippers' own reputation in the eyes of Customs Office. For example: question number 49: **Shippers are classified as a**

"Trustworthy enterprise". Under this classification, regulations for cargo import/export to/from this shipper being relaxed depend on the local Customs office. It is the norm that only those international enterprises who export a high weekly volume of cargo can enjoy this type of swift inspection from the Customs office.

Table 5.7 – Relationship with Customs Office

Quest Number	Questionnaire items	Loadings
54	Use paperless technology to handle documents and cargo	0.56
53	Change own cargo flow path to accommodate Customs office's instructions	0.55
52	Homogenous cargo type- easy for Customs inspection	0.47

The relationship with the Customs Office is one of the external factors beyond the control of the shippers. For example: question number 52 **Homogenous cargo type - easy for Customs inspection** will assure a quick inspection time from the Customs Office. Question number 53: **Change own cargo flow path to accommodate Customs office's instructions**. This item may need further explanation. In China's Customs system, the salary of the Customs Officer is linked with the amount of tax obtained in that office/district. This arrangement is to ensure Customs Officers will try their best to tax all the imported cargoes. If a consignment transits from one Customs district to another, the Customs office where the consignment transits will not be able to levy any tax on the cargo. In order to safeguard the salary of the officers in the transit Customs district, shippers will be asked to arrange part of the consignment to carry out Customs clearance at the transit Customs office. Part of the consignment is checked, taxed and sealed again to continue on the rest of the journey.

5.2 Formation of the hierarchy

This is shown in Figure 5.1, Mode selection flow chart. The freight costs between overseas destinations and the Port of Hong Kong, Shekou and Yantian are assumed to be similar hence shippers do not need to consider the ocean freight between the loading ports to final destinations. The selection of transport modes for shippers, therefore, mainly focuses on the distance and cost between the factory and the port of loading at either Hong Kong, Shekou or Yantian. Within each loading port, transport modes can be selected accordingly. Three basic modes of transport, namely sea (barge), rail and road (truck) are available at each port except in Shekou where rail is not available. Consequently, there are a total of eight alternatives available for shippers/freight forwarders to transport their cargos overseas.

Figure 5.1 Mode selection flow chart

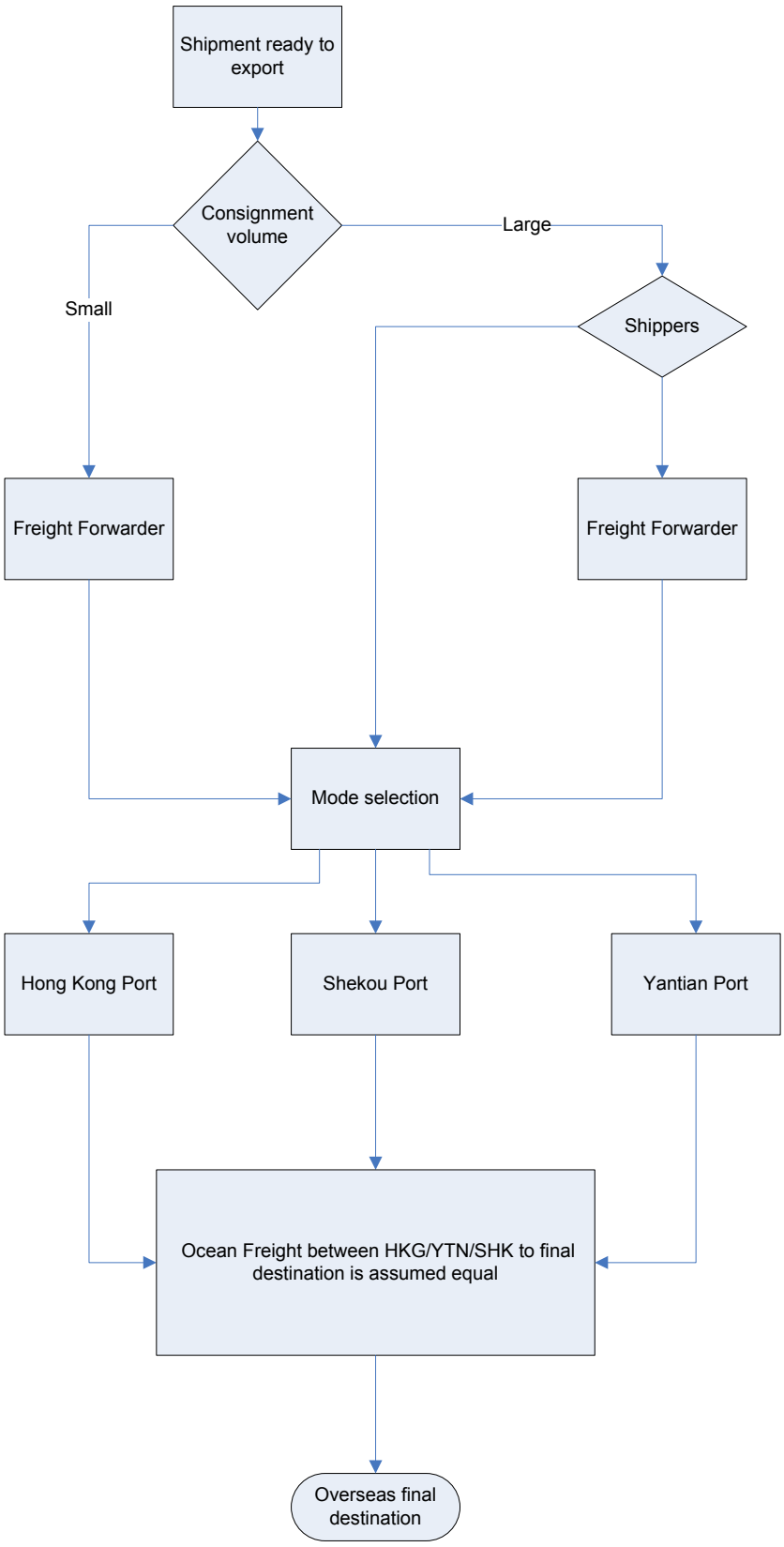


Table 5.8 lists all the available alternatives in the transport mode selection for shippers/freight forwarders in PRD.

Table 5.8 Alternatives of mode choice	
Alternatives	**Description**
HKG - Truck	Factory to Port in Hong Kong by truck
HKG - Rail	Factory to Port in Hong Kong by rail
HKG - Barge	Factory to Port in Hong Kong by barge
YTN - Truck	Factory to Port in Yantian by truck
YTN - Rail	Factory to Port in Yantian by rail
YTN - Barge	Factory to Port in Yantian by barge
SHK - Truck	Factory to Port in Shekou by truck
SHK - Barge	Factory to Port in Shekou by barge

HKG-Truck refers to the mode of transport from the factory to the loading port by truck. In China this type of transport is considered as "overseas" transport because Hong Kong is considered as "another country" as far as the Customs office is concerned. A detailed description of the cross-border trucking service was made in chapter two. The advantages for using trucks to carry containers and to load at Hong Kong are:

1. Hong Kong is literally a "free port" and export containers can be loaded onto ships just minutes before terminal cut-off time.
2. If the cargo is needed urgently, it can be unconsolidated from an ISO container and consolidated into ULD for air transport at the Hong Kong International Airport. Such flexibilities in cargo handling procedures and processes are not possible in China due to strict Customs regulations.
3. It is much easier to consolidate into one full container load (FCL) in Hong Kong if the consignment is less than a container load (LCL) due to the logistics hub at Hong Kong being so well developed.
4. If there is any delay in the processing of cargo at the factory, the 24 hours advance declaration will definitely hinder the shipment. Trucking the cargo to Hong Kong will

mean not having to encounter such restrictions. Therefore, this mode of transport is welcomed by many shippers who have just managed to finish their production process at the last minute.

HKG-Rail is possible for shippers/freight forwarders as the Kowloon-Canton Railway Corporation together with the Guangshen Railway provide a daily (through freight) service between the Hong Kong, Shenzhen and Guangzhou areas. There are four scheduled departures daily and this service is used by shippers whose cargos are heavy and hazardous in nature.

HKG-Barge is offered by terminal operators in Hong Kong. They provide daily barge services sailing between ports in the PRD to Hong Kong. This is convenient to those shippers/freight forwarders who are faced with a congested road and who are located near to one of the ports in the PRD region.

YTN-Truck provides a direct delivery route from factories to the Yantian port. Yantian Port is the second largest deepwater container terminal in China and the fourth largest in the world. Since YICT commenced operations in 1994 (YICT 2007), the port has undergone a massive port expansion project. Hence heavy traffic and severe congestion in and out of the port area have always brought port operations to a standstill in past years. Recently, the infrastructure around the port has been upgraded from just one road and one tunnel to four roads, four tunnels and one interchange. The major highways that are connected to the Yantain port are: the Yanpai Highway; Yanba Highway; Huiyan Highway; Wutongshan Tunnel; Luosha Road—Wutongshan Tunnel and Mingzhu Interchange. With this sophisticated transport network, road transport at Yantian actually integrates the port with highways to the port and the economic hinterland of the Pearl River Delta.

YTN-Rail offers shippers/freight forwarders a service directly connected to the State-owned Rail Pingyan Railway from the port. The Railway joins the Beijing-Guangzhou Railway and Beijing-Kowloon Railway via the Guangzhou-Shenzhen Railway, making it possible to extend port services to inland areas including Hunan, Sichuan, Yunnan and Guizhou.
Rail services are welcomed by shippers who have a large amount of cargo. They are highly cost-effective whilst employing highly sophisticated security systems. The advantages in using the rail connection are:

- Rail transport is safer than road transport and avoids disruptive traffic jams;
- A more cost-effective transportation method;
- Yantian also provides a one-stop Customs declaration service;
- It's more convenient to pick up empty containers;
- Customers receive better arrangements and planning assistance;
- Planning for laden container deliveries and pre-notification of arrival is easy;
- Saves energy and protects the environment.

Furthermore, both import and export procedures involving Customs declarations and booking container space on vessels can now be handled at inland offices.

Besides the Pingyan Railway, there are also the Dalang, Guangzhou – Yantian Container Rail Service and Changping, Dongguan – Yantian Container Rail Service.

YTN-Barge is a feasible option for the shippers/freight forwarders who are located close to one of the ports along the Pearl River. There is a scheduled barge operation from local barge companies that sail daily direct to Yantian port.

SHK-Truck offers a direct link between shippers' factory/warehouses to the port. Due to the topography of adjacent land close to the port area, the infrastructure connected to the port can be described as hilly and winding. With an increase in the number calling from international liner companies, trucking is a mode for shippers located nearby.

SHK-Barge offers access for shippers/freight forwarders to use their port. In 2001, Shekou Container Terminals (SCT) and Chiwan Container Terminals (CCT) jointly with leading barge operators, launched the PRD Shuttle service between the Western Shenzhen Port and main river ports alongside the Pearl River, aimed at providing the local users and liner companies with a more convenient and cost-effective transportation alternative.

South China Shuttle Barge Services, (Table 5.9) has covered most of the major PRD and South China coastal ports including Guangdong province's Huangpu, Shunde, Jiangmen, Zhongshan, Nanhai, Foshan, Panyu, Zhaoqing, Zhanjiang, Maoming, Zhuhai and Guangxi province's Fangcheng, Beihai and will extend to other cities like Haikou, Huadu and Macau etc. Table 5.9 indicates the frequency of services provided by the SCT and CCT.

Table 5.9 Shekou barge schedule			
Loading port		**Service to South China Port**	**Service to SHK**
Huangpu	Huangpu Old Port	Mon.--Fri.	Tue. Thu.
	Shi Gang'ao	Mon. Wed. Thu. Fri.	Tue. Thu.
	Ji Si	Tue. Wed. Fri.	Tue. Thu.
	Sui Gang	Mon. Tue. Wed.	Tue. Thu.
Shunde	Rongqi	Daily	Daily
	Beijiao		
	Leliu		
Jiangmen	Waihai	Mon. Wed. Fri.	Tue. Thu. Sat.
	Gaosha	Mon., Wed., Fri.	Tue. Thu. Sat.
Zhongshan	Waimao	Daily	Daily
	ZhongshanHuangyun	Daily	Daily
	Xiaolan	Tue. Fri.	Wed. Sat.
Foshan	Xingang	Mon.-Sat.	Tue.- Sun.
	Lanshi	Mon.-Sat.	Tue.- Sun.
Nanhai	Sanshan	Thu. Fri.	Fri. Sat.
		Mon. Thu.	Tue. Fri.
Zhanjiang	Xiashan	Tue. Thu.	Thu. Sat.
Maoming	Shuidong	Wed. Fri.	Sat. Mon.
Zhuhai	Jiuzhou	Mon. -Fri.	Tue. - Sat.
Guangxi	Fangcheng	Tue. Fri.	Sat.
	Beihai	Wed. Sat.	Tue.
Source:Shekou Container Terminal. http://www.sctcn.com/english/sct_service/list.aspx?cid=7			

5.3 The building of a hierarchy

The ultimate goal of mode selection is to achieve "Satisfaction" for the shippers/freight forwarders requirements in exporting their overseas shipments. Hence, the hierarchy of this study is indicated in the chart in Figure 5.2.

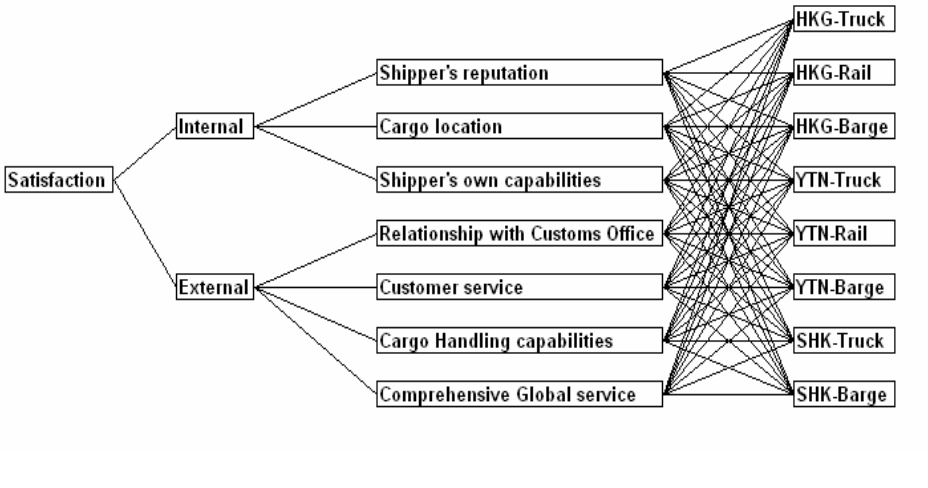


Figure 5.2 Basic Hierarchy structure for this study

Under this hierarchical structure, the various types of cargos will go through the selection process differently. Consequently, shippers/freight forwarders with different cargo values, transit times and weekly volumes are divided into six major groups as listed in Table 5.10.

Table 5.10 - Shippers with different cargo nature	
Group 1	Shippers with large weekly volume – over 6 Teus per week
Group 2	Shippers with low weekly volume – less than 2 Teus per week
Group 3	Shippers with consignment of high value cargo – such as computer
Group 4	Shippers with consignment of low cargo value – such as footwear
Group 5	Shippers with consignment of time sensitive – such as fashion
Group 6	Shippers with consignment of no time sensitive attached – such as textile

Group 1 is assigned to Shippers with large weekly volumes. The cut-off point is set at 6 Teus per week so shipper/freight forwarders need to consider their mode choice every day.

Group 2 is assigned to shippers/freight forwarders who only have less than 2 Teus consignments per week. It is difficult for these shippers/freight forwarders to select transport modes as they must send the consignment to another freight forwarder for consolidation. The choice of transport mode will therefore be determined instead by the freight forwarder or third parties.

Group 3 is assigned to shippers/freight forwarders with high value cargo. High value cargo does not necessarially imply that it is time sensitive. It is likely that, shippers/freight forwarders prefer high value cargo that can be despatched to loading ports as soon as possible in order to minimise security concerns.

Group 4 is reserved for consignments of low value cargo. The major factor in the consideration of low value cargo is usually the cost. Group 5 shippers are assigned to a consignment that is time sensitive and requires an urgent delivery. Usually, ports with better flexibility in terms of cargo handling will be the first choice for those shippers. Finally, Group 6 is reserved for consignments that are not time sensitive at all.

Eight meetings were conducted and industrial practitioners were divided and invited according to the above groupings. The attendees in each group were required to do a pair wise comparison between the seven factors in respect to their own consignment's nature against weekly volume, cargo value and time sensitivity. The average time taken to complete the pairwise comparison was around 45-60 minutes. If consignments possessed two or more cargo characteristics, then shippers were required to do an extra comparison for the other cargo type.

5.4 The AHP software

Decision Plus was developed by Criterium Decision of InfoHarvest, Inc. USA. The software is a decision management tool that can help to organize, complete and communicate complex decision-making tasks. Many decisions are tough and involve many different criteria against

which various options or alternatives are compared. Tracking and rating the importance of those criteria and maintaining control of the decision problem are major functions of this software. DecisionPlus is specifically designed to make tough decisions easier, easier to formulate, easier to understand, and easier to communicate with guided window users interface.

DecisionPlus runs as a Windows application and requests just a list of the criteria and alternatives directly onto the computer screen with the mouse and keyboard. Once each of decision criteria is weighted, DecisionPlus will rationally choose between alternatives. It synthesizes the inputs and presents the results in order of preference. The users are in full control of accepting the results and making the final decision.

- **Criterium DecisionPlus: Introduction**

DecisionPlus builds decisions as hierarchies of criteria, and the specifications are as follows:

- 7 levels (including the goal level and the alternatives).
- Maximum of 500 blocks in the model (a block is a goal statement, a criterion, or an alternative).
- Maximum of 200 blocks on any level (not including the alternative level).
- Maximum of 50 subcriteria per criterion.
- Maximum of 200 alternatives (alternatives count against the 500 total blocks).

Although DecisionPlus possesses fewer capabilities than other AHP software such as Expert Choice 11, it is good enough to perform the calculations for this study. The data entry format is easier in DecisionPlus and it can provide:

- Speedier construction and elucidation of the decision.
- Deeper insight into factors affecting the decision.

- Confidence that all factors have been considered within the decision framework.
- Understanding of how sensitive the decision results are to judgments employed.
- Identification of criteria that are key in breaking an impasse (assuming no clear preference in alternatives occurs).
- Identification of the preferred alternative and how likely that alternative will remain the preferred one given uncertainty.
- Identification of information that would be most effective in producing an unambiguously superior choice if its uncertainty were reduced.
- A greater consensus and commitment from group members to a chosen course of action.
- Real-time presentations to persuade others of your recommendations

By using the AHP software CDPlus 3.0, attendances in the pair wise comparison meetings were required to go through the factors comparison individually. The software generates each pair of factors. Verbal phrases are selected in the pairwise comparison process to avoid numerical comparison because 5 may mean average for someone in a scale of 10 but someone may think 4 is also good enough. The process of pairwise comparison just uses verbal phrases to compare each factor in turn. The verbal phrases are:

- Equal (Rate 1);
- Barely Better (Rate 2);
- Weakly Better (Rate 3);
- Moderately Better (Rate 4);
- Definitively Better (Rate 5);
- Strongly Better (Rate 6);

- Very Strongly Better (Rate 7) ;
- Critically Better (Rate 8) and
- Absolutely Better (Rate 9).

5.5 Results

The software runs the programme with the inputs, giving the following results.

5.5.1 Group 1 Shippers

Shippers, who have a high weekly volume, prefer to use trucks for all loading ports in the PRD. HKG-Truck, SHK-Truck and YTN-Truck are the preferred choice of delivery. The alternatives then go to HKG-Barge, SHK-Barge and YTN-Barge. The HKG-Barge receives a higher ranking than the SHK-Barge due to high cargo volume that can fill up the barge easily. Rail connections receive the lowest ranking in this group of shippers. In the sensitivity test for satisfaction and internal and external factors, the results indicate that the ranking of alternatives under internal factors (figure 5.4) are: HKG-Truck, HKG-Barge, YTN-Truck, YTN-Barge and SHK-Barge. The ranking under external factors (figure 5.5) are HKG-Truck, HKG-Barge, YTN-Truck, YTN-Barge and SHK-Barge for external factors. When the shippers combined both factors for consideration, the ranking in graphic (figure 5.3) and numeric formats (table 5.11) are HKG-Truck, SHK-Truck, YTN-Truck, HKG-Barge, SHK-Barge, YTN-Barge, HKG-Rail and YTN-Rail.

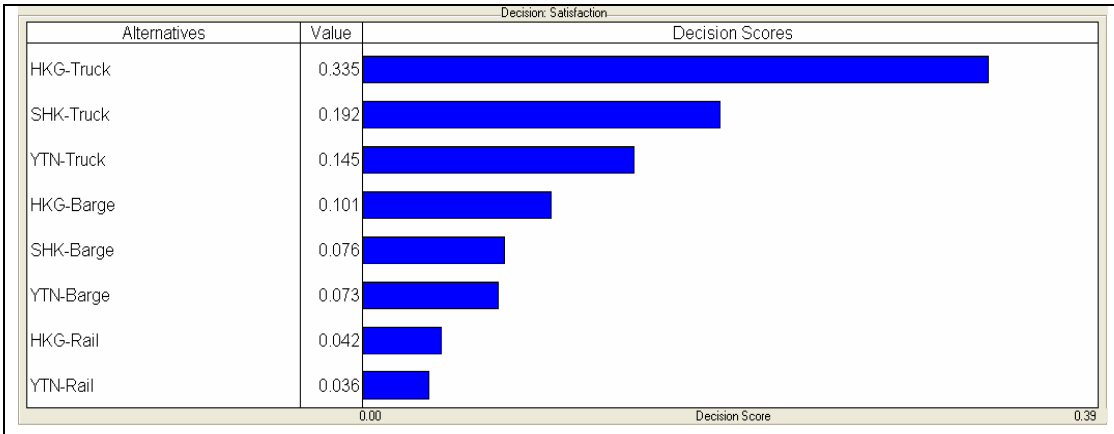


Figure 5.3 Overall ranking for mode selection of shippers with High weekly volume

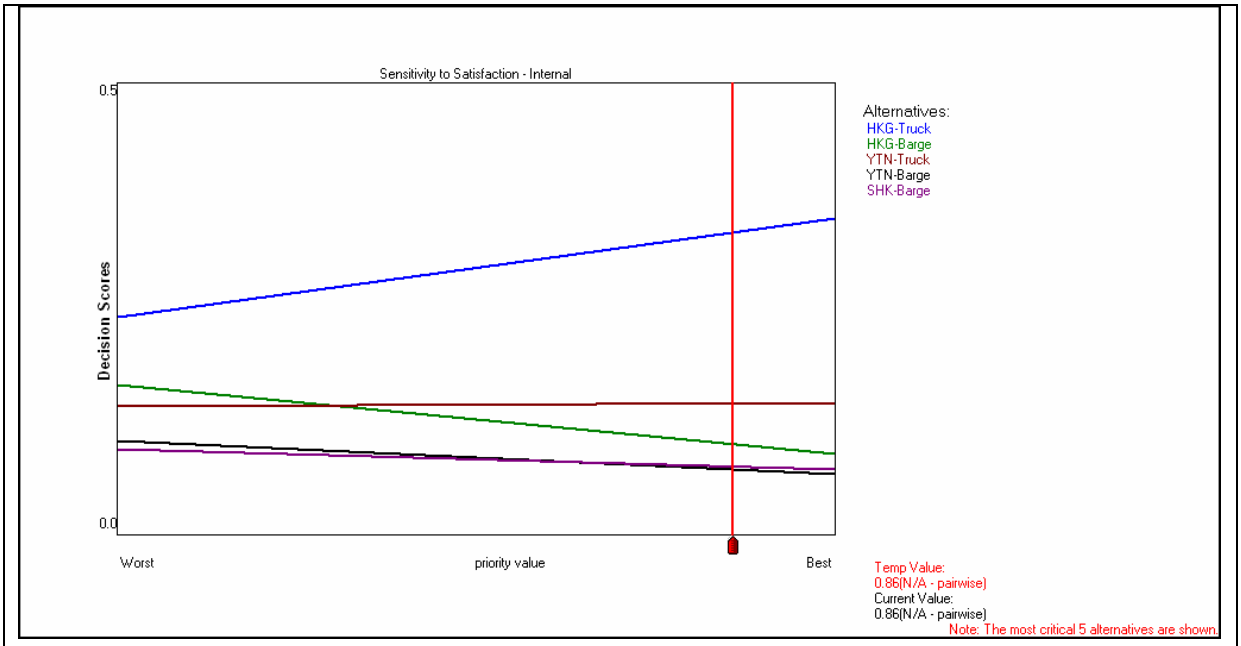


Figure 5.4 Sensitivity test on internal factors to satisfaction for shippers with high weekly volume

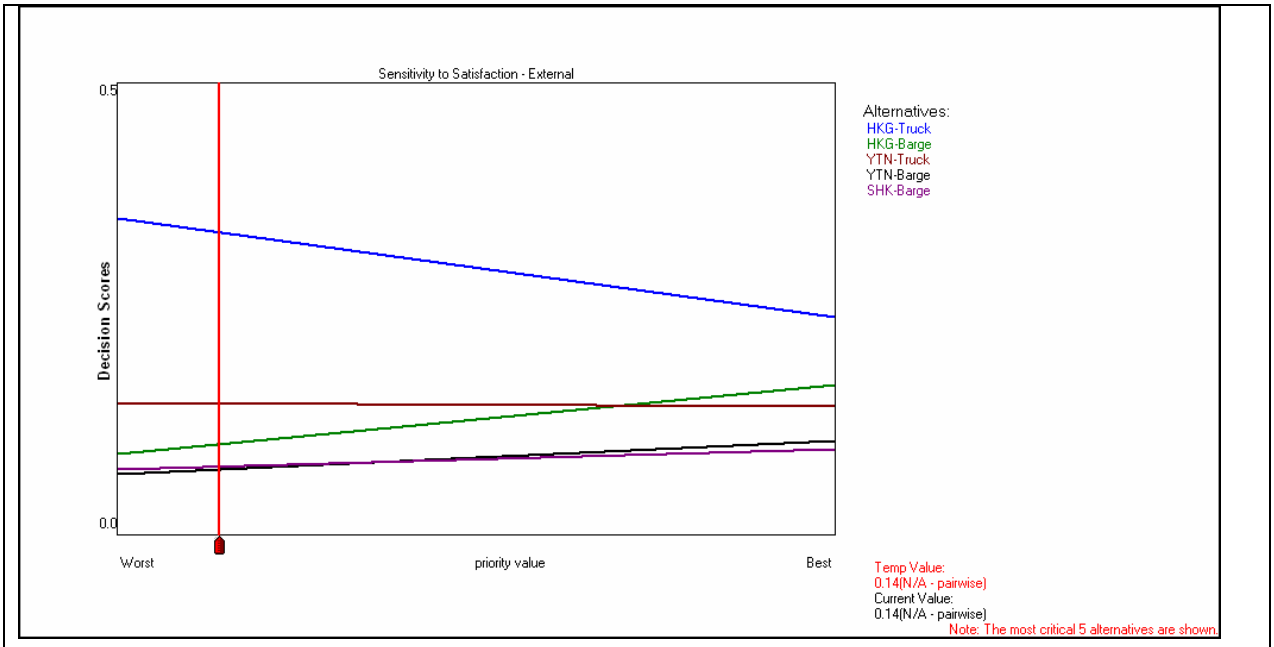


Figure 5.5 Sensitivity test on external factors to satisfaction for shippers with high weekly volume

Table 5.11. Decision score for shippers with high weekly volume

Lowest Level	***HKG-Truck***	***HKG-Rail***	***HKG-Barge***	***YTN-Truck***	***YTN-Rail***	***YTN-Barge***	***SHK-Truck***	***SHK-Barge***	***Model Weights***
Shipper's reputation	0.372	0.032	0.091	0.143	0.022	0.061	0.213	0.067	0.66
Cargo location	0.353	0.023	0.06	0.21	0.027	0.068	0.193	0.065	0.089
Cargo Handling capabilities	0.313	0.033	0.134	0.147	0.029	0.072	0.217	0.054	0.006
Shipper's own capabilities	0.222	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.108
Relationship with Customs Office	0.212	0.061	0.212	0.114	0.061	0.114	0.114	0.114	0.095
Comprehensive Global service	0.397	0.023	0.058	0.187	0.024	0.059	0.192	0.058	0.014
Customer service	0.25	0.021	0.072	0.215	0.024	0.099	0.259	0.06	0.028
Results	0.335	0.042	0.101	0.145	0.036	0.073	0.192	0.076	

5.5.2 Group 2 Shippers

Shippers who have small weekly volumes to export and require freight forwarders to provide consolidation rank HKG-Truck as their first priority. This type of cargo which is Less-than-container load (LCL) will be treated as high value cargo because it is charged by Cubic

Meters (CBM) instead of on a per container rate. Freight forwarders have to bring this LCL to a depot for consolidation. In the sensitivity test for Satisfaction and internal and external factors (figure 5.8 and5.7), the ranking of alternatives for external factors is: HKG-Truck, HKG-Barge, YTN-Truck, YTN-Barge and SHK-Barge. The ranking for internal factors is HKG-Truck, HKG-Barge, YTN-Truck, YTN-Barge and SHK-Barge.

The overall mode choices for this type of cargo ranked in graphic (figure 5.6) and numeric (table 5.12) formats are: HKG-Truck, SHK-Truck, HKG-Barge, YTN-Truck, YTN-Barge, SHK-Barge, HKG-Rail and YTN-Rail.

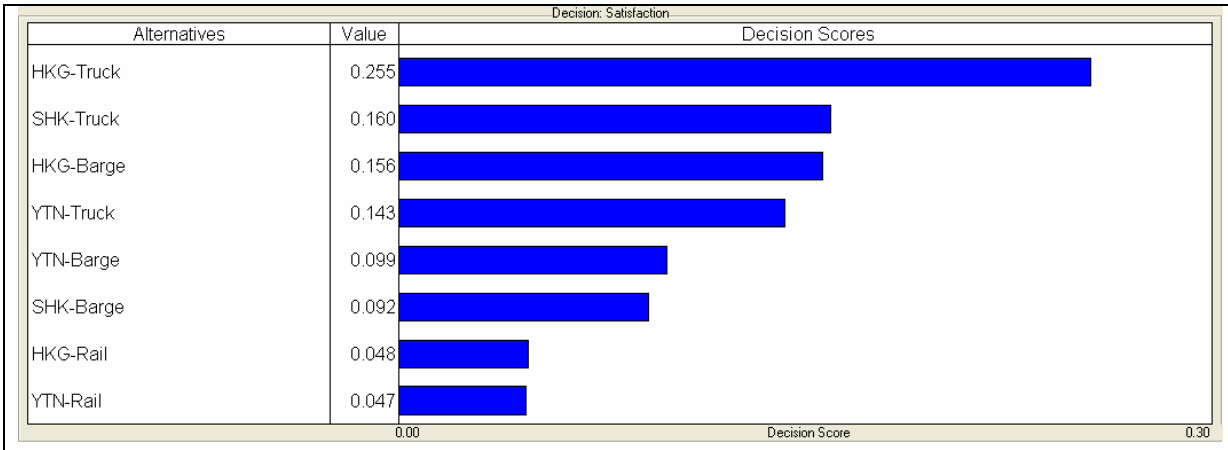


Figure 5.6 Hierarchy graph for shippers with Low weekly volume

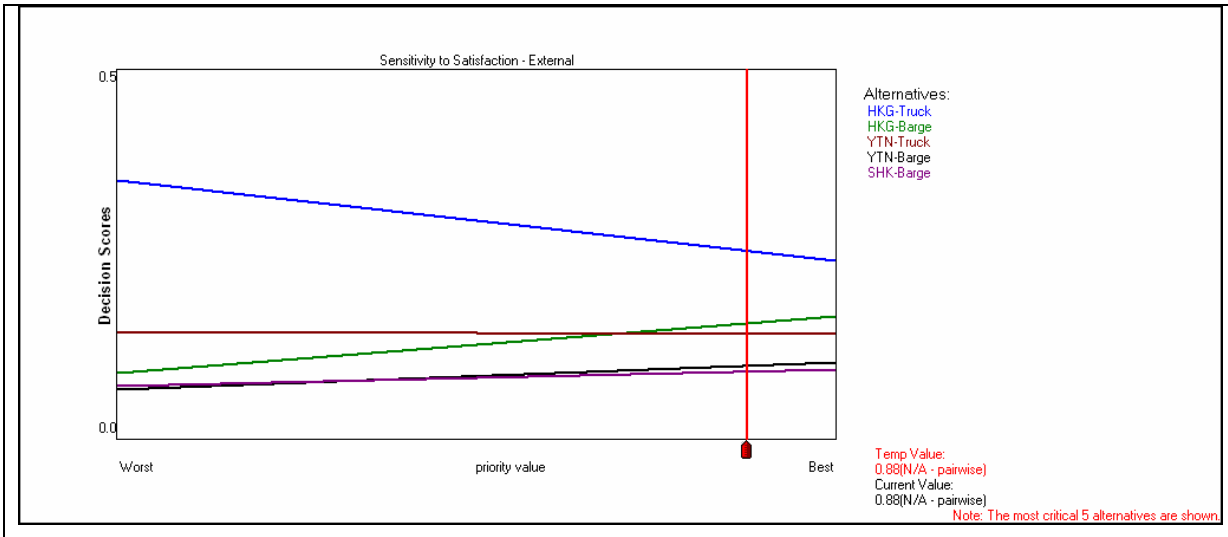


Figure 5.7 Sensitivity test on external factors to satisfaction for shippers with low weekly volume

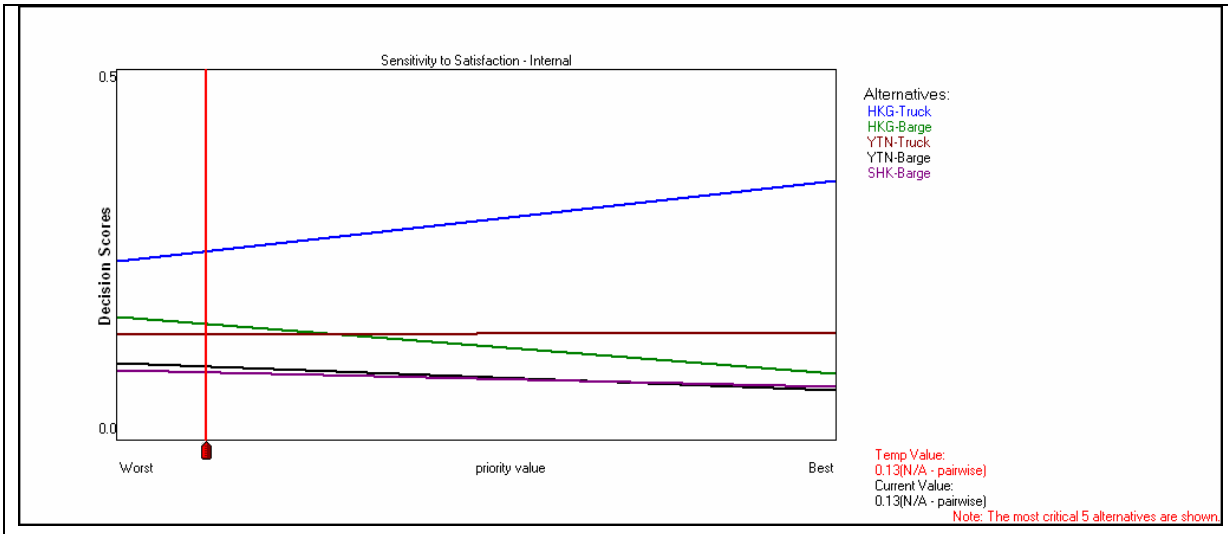


Figure 5.8 Sensitivity test on internal factors to satisfaction for shippers with low weekly volume

Table 5.12. Decision score for shippers with low weekly volume

Lowest Level	***HKG-Truck***	***HKG-Rail***	***HKG-Barge***	***YTN-Truck***	***YTN-Rail***	***YTN-Barge***	***SHK-Truck***	***SHK-Barge***	***Model Weights***
Shipper's reputation	0.372	0.032	0.091	0.143	0.022	0.061	0.213	0.067	0.096
Cargo location	0.353	0.023	0.06	0.21	0.027	0.068	0.193	0.065	0.013
Cargo Handling capabilities	0.313	0.033	0.134	0.147	0.029	0.072	0.217	0.054	0.034
Shipper's own capabilities	0.222	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.016
Relationship with Customs Office	0.212	0.061	0.212	0.114	0.061	0.114	0.114	0.114	0.581
Comprehensive Global service	0.397	0.023	0.058	0.187	0.024	0.059	0.192	0.058	0.087
Customer service	0.25	0.021	0.072	0.215	0.024	0.099	0.259	0.06	0.173
Results	0.255	0.048	0.156	0.143	0.047	0.099	0.16	0.092	

5.5.3 Group 3 Shippers

Shippers with high value cargo will have comparatively small quantity of consignment and usually the cargos are time sensitive in nature. In the sensitivity test, when comparing between satisfaction and external/internal factors (Figures 5.10 and 5.11), the ranking of shipments for external factors is HKG-Truck, HKG-Barge, YTN-Barge, SHK-Barge and YTN-Rail. For internal factors the ranking is HKG-Truck, HKG-Barge, YTN-Barge, SHK-Barge and SHK-Truck.

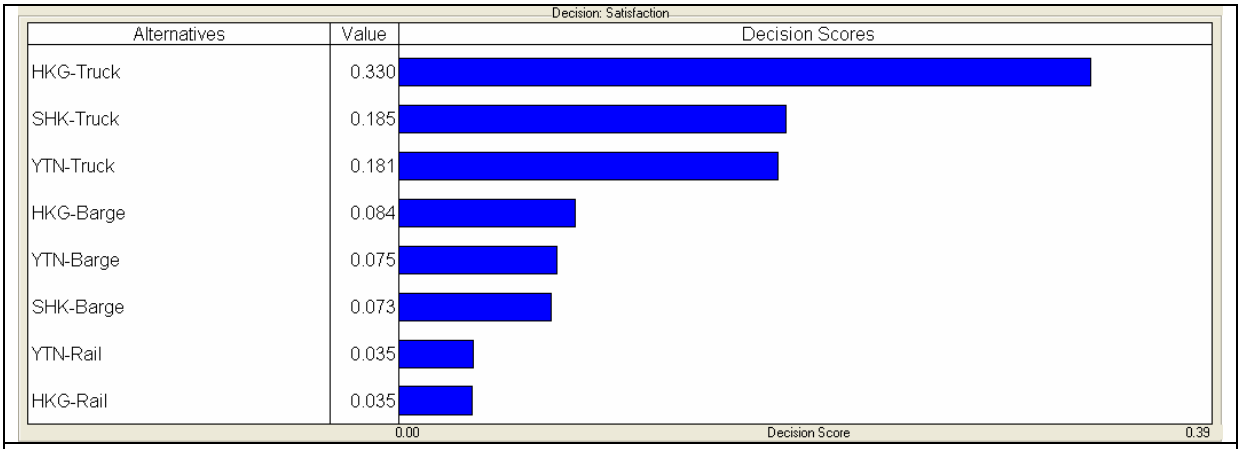


Figure 5.9 Hierarchy graph for shippers with high value cargo

Figure 5.9 and table 5.13 indicate that for high value cargo where trucking services connected to HKG, SHK and YTN scored the highest amongst others. The ranking is HKG-Truck, SHK-Truck, YTN-Truck, HKG-Barge YTN-Barge, SHK-Barge, YTN-Rail and HKG-Rail.

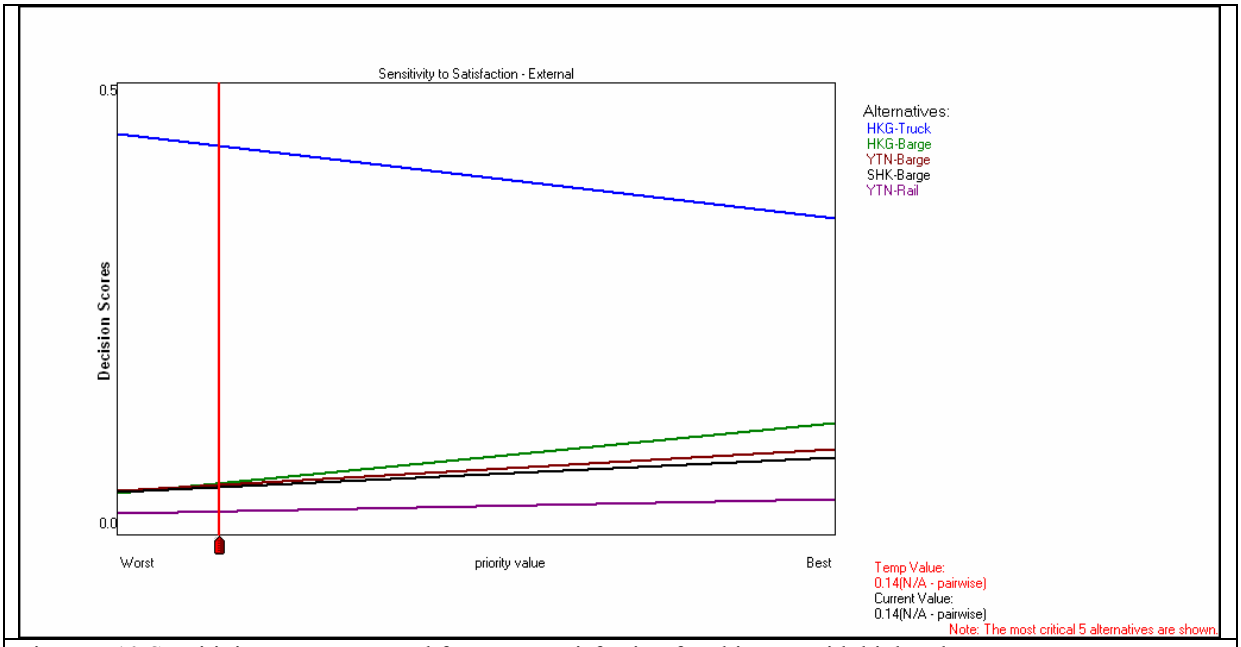


Figure 5.10 Sensitivity test on external factors to satisfaction for shippers with high value cargo

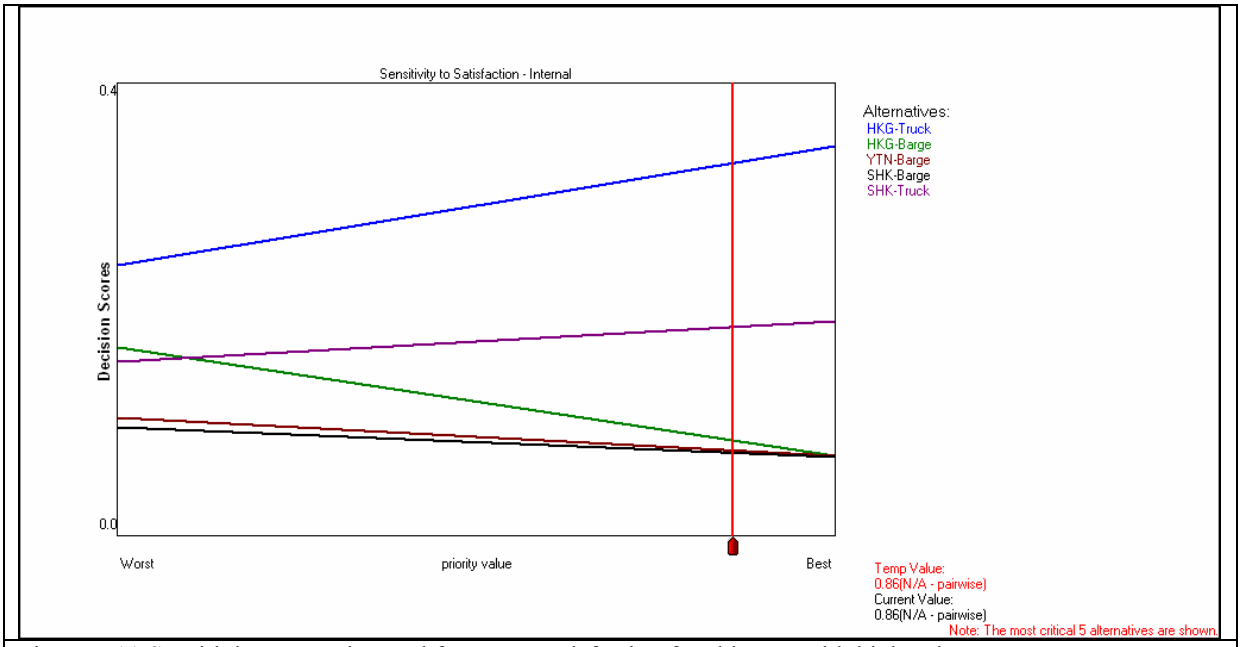


Figure 5.11 Sensitivity test on internal factors to satisfaction for shippers with high value cargo

Table 5.13. Decision score for shippers with high value cargo									
Lowest Level	***HKG-Truck***	***HKG-Rail***	***HKG-Barge***	***YTN-Truck***	***YTN-Rail***	***YTN-Barge***	***SHK-Truck***	***SHK-Barge***	***Model Weights***
Shipper's reputation	0.409	0.025	0.043	0.236	0.021	0.053	0.156	0.057	0.178
Cargo location	0.456	0.023	0.044	0.183	0.023	0.048	0.178	0.045	0.605
Cargo Handling capabilities	0.313	0.033	0.134	0.147	0.029	0.072	0.217	0.054	0.004
Shipper's own capabilities	0.433	0.055	0.071	0.169	0.046	0.04	0.147	0.039	0.073
Relationship with Customs Office	0.465	0.027	0.054	0.174	0.028	0.043	0.159	0.049	0.096
Comprehensive Global service	0.397	0.023	0.058	0.187	0.024	0.059	0.192	0.058	0.013
Customer service	0.256	0.021	0.071	0.213	0.024	0.098	0.257	0.06	0.029
Results	0.439	0.026	0.048	0.191	0.025	0.05	0.173	0.048	

5.5.4 Group 4 Shippers

Figure 5.12 and table 5.14 show the results for low value cargo where trucking services connected to HKG, SHK and YTN scored the highest. SHK-Truck obtained a higher rank than YTN-Truck because the road connections to the YTN port were so congested that shippers would prefer to use SHK even if their cargo was of low value. Rail connections to all ports remain at the bottom of the ranking list.

In the sensitivity test, when comparing between satisfaction and external and internal factors (figure 5.13 and 5.14), the rank of shipments under internal factors is listed as HKG-Truck, HKG-Barge, SHK-Truck, YTN-Barge and SHK-Barge. With regards to the external factors, the ranking is HKG-Truck, HKG-Barge, SHK-Truck, YTN-Barge and SHK-Barge.

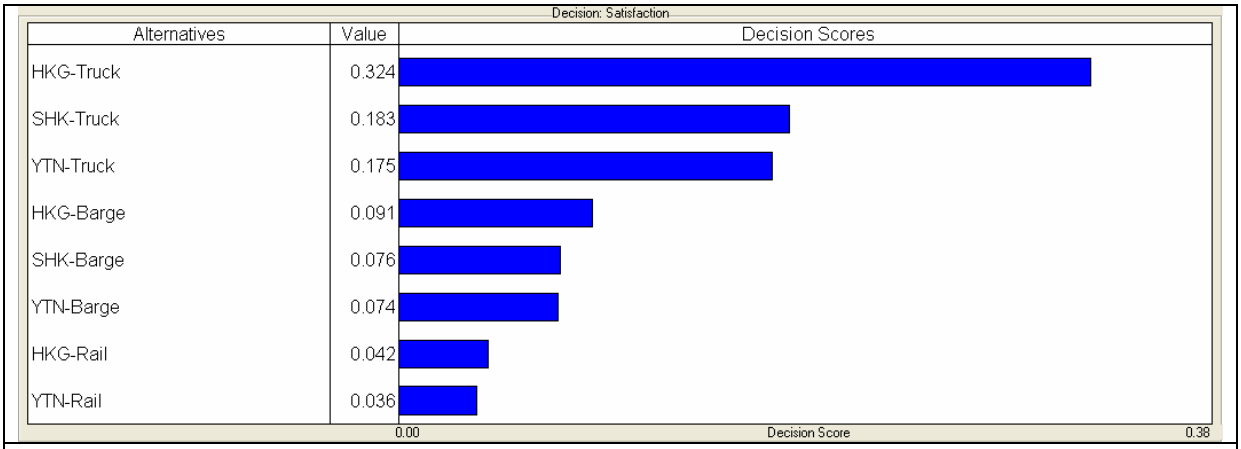


Figure 5.12 Hierarchy graph for shippers with Low value cargo

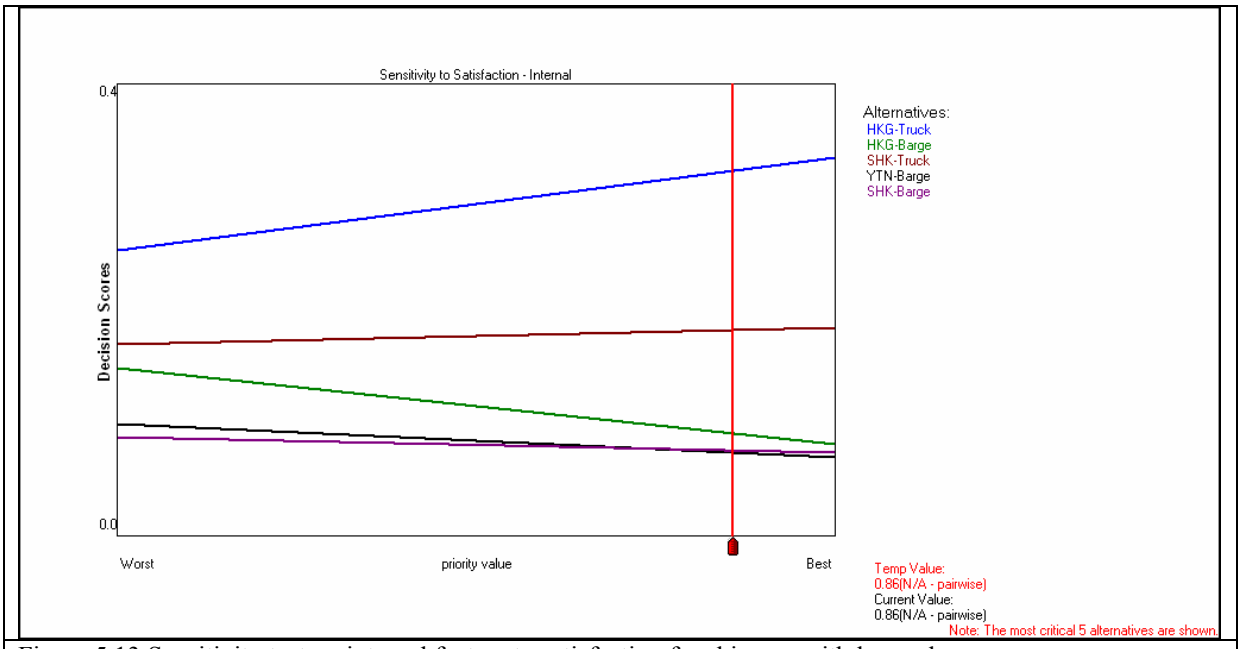


Figure 5.13 Sensitivity test on internal factors to satisfaction for shippers with low value cargo

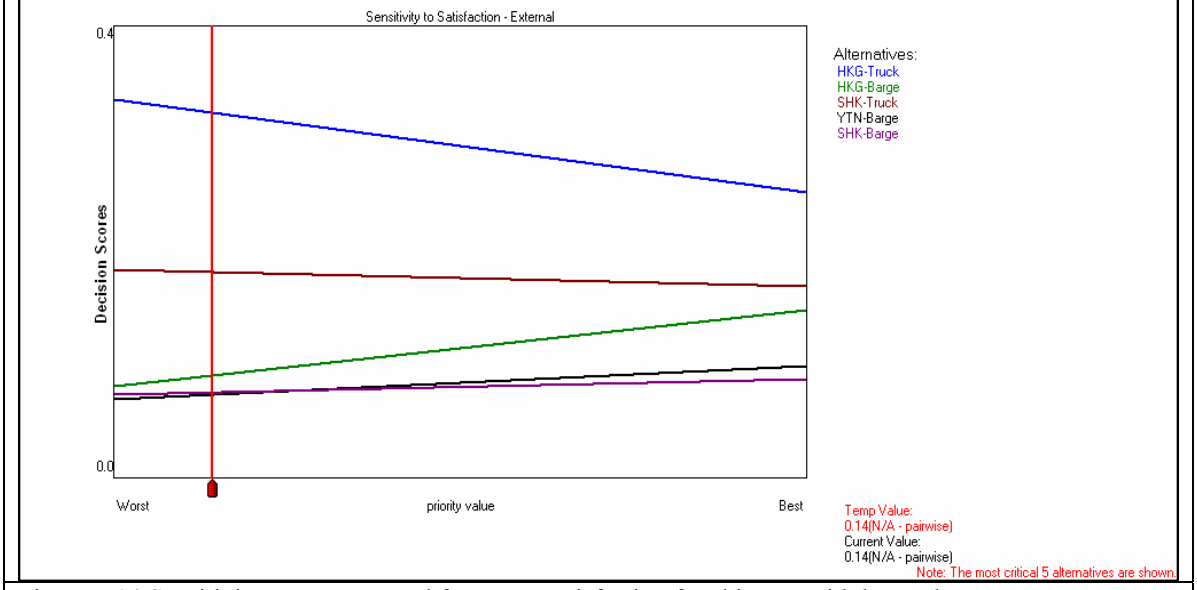


Figure 5.14 Sensitivity test on external factors to satisfaction for shippers with low value cargo

Table 5.14. Decision score for shippers with low value cargo

Lowest Level	***HKG-Truck***	***HKG-Rail***	***HKG-Barge***	***YTN-Truck***	***YTN-Rail***	***YTN-Barge***	***SHK-Truck***	***SHK-Barge***	***Model Weights***
Shipper's reputation	0.344	0.053	0.116	0.135	0.02	0.056	0.199	0.077	0.23
Cargo location	0.353	0.023	0.06	0.21	0.027	0.068	0.193	0.065	0.527
Cargo Handling capabilities	0.313	0.033	0.134	0.147	0.029	0.072	0.217	0.054	0.01
Shipper's own capabilities	0.222	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.1
Relationship with Customs Office	0.212	0.061	0.212	0.114	0.061	0.114	0.114	0.114	0.076
Comprehensive Global service	0.397	0.023	0.058	0.187	0.024	0.059	0.192	0.058	0.019
Customer service	0.25	0.021	0.072	0.215	0.024	0.099	0.259	0.06	0.038
Results	0.324	0.042	0.091	0.175	0.036	0.074	0.183	0.076	

5.5.5 Group 5 Shippers

Figure 5.15 and table 5.15 show the results for time sensitive shipments. Trucking and barge services connected to HKG were preferred and followed by SHK-Truck and YTN-Truck.

The selection of HKG-Truck and HKG-Barge is mainly due to the flexibility available for shipments that cannot meet the 24 hours advance Customs regulations. In the sensitivity test, when comparing between satisfaction, the ranking (figure 5.16) of shipment is listed as HKG-Truck, HKG-Barge, SHK-Truck, YTN-Truck, and YTN-Barge in external factors. The sequence of order between satisfaction and internal factors (figure 5.17) is HKG-Truck, HKG-Barge, SHK-Truck,YTN-Truck and YTN-Barge.

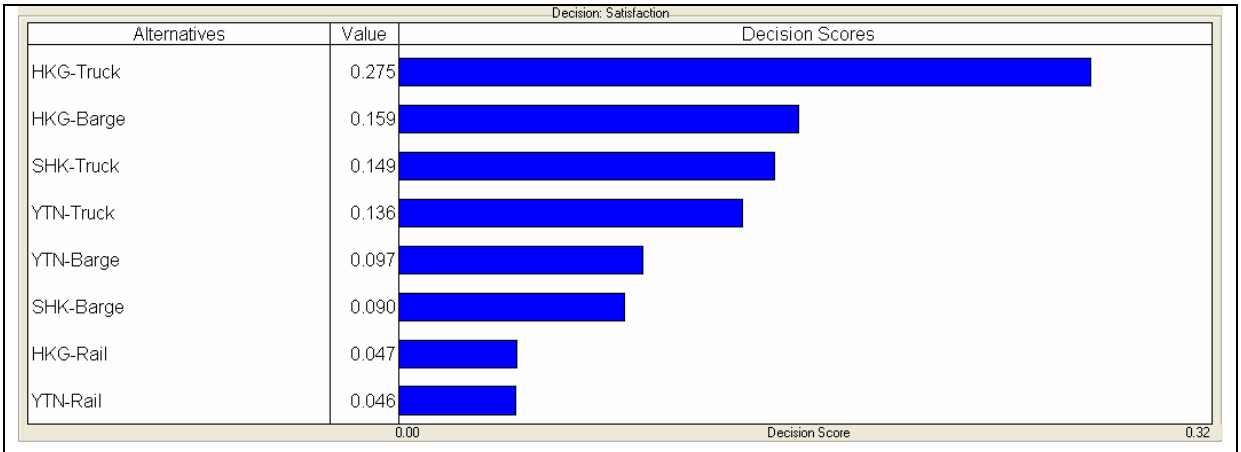


Figure 5.15 Hierarchy graph for shippers with time sensitive cargo

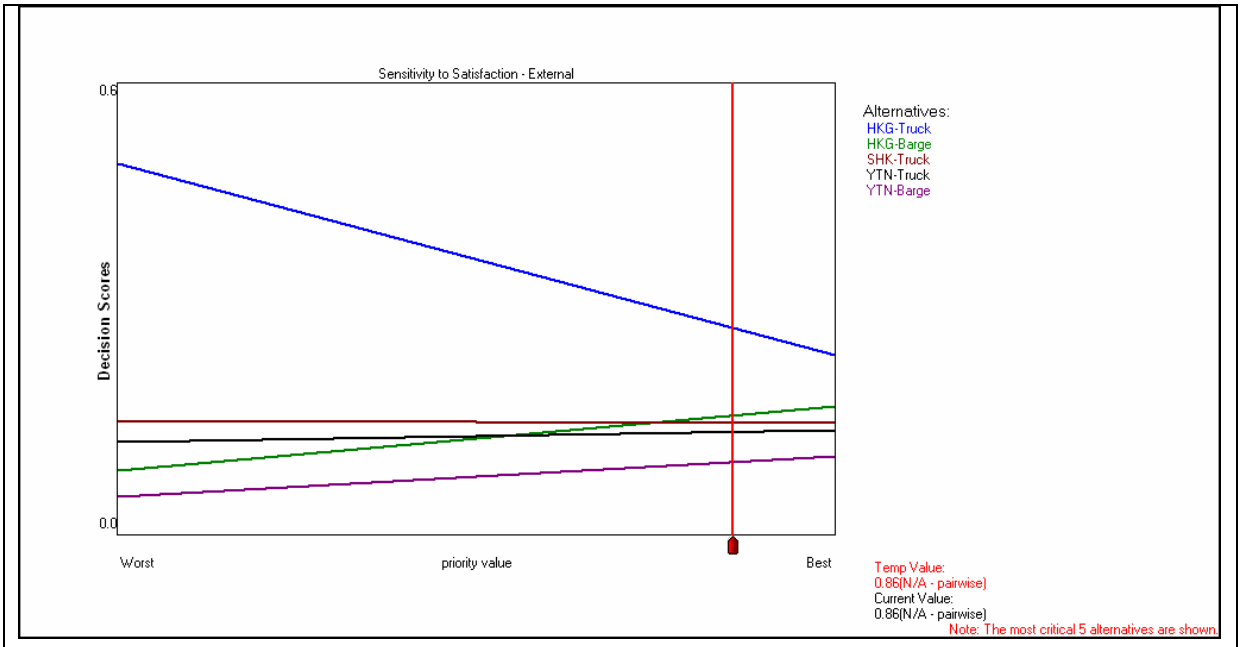


Figure 5.16 Sensitivity test on external factors to satisfaction for shippers with time sensitive cargo

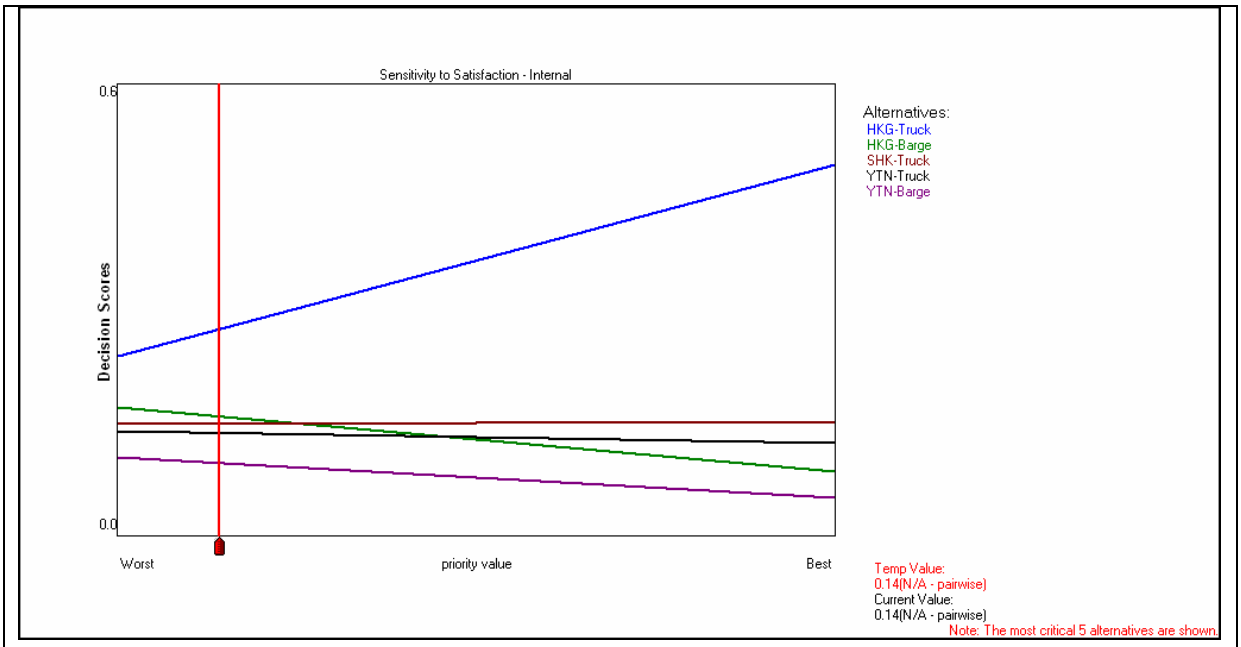


Figure 5.17 Sensitivity test on internal factors to satisfaction for shippers with time sensitive cargo

Table 5.15 Decision score for shippers with time sensitive cargo									
Lowest Level	***HKG-Truck***	***HKG-Rail***	***HKG-Barge***	***YTN-Truck***	***YTN-Rail***	***YTN-Barge***	***SHK-Truck***	***SHK-Barge***	***Model Weights***
Shipper's reputation	0.372	0.032	0.091	0.143	0.022	0.061	0.213	0.067	0.66
Cargo location	0.353	0.023	0.06	0.21	0.027	0.068	0.193	0.065	0.089
Cargo Handling capabilities	0.313	0.033	0.134	0.147	0.029	0.072	0.217	0.054	0.006
Shipper's own capabilities	0.222	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.108
Relationship with Customs Office	0.212	0.061	0.212	0.114	0.061	0.114	0.114	0.114	0.095
Comprehensive Global service	0.397	0.023	0.058	0.187	0.024	0.059	0.192	0.058	0.014
Customer service	0.25	0.021	0.072	0.215	0.024	0.099	0.259	0.06	0.028
Results	0.335	0.042	0.101	0.145	0.036	0.073	0.192	0.076	

5.5.6 Group 6 Shippers

The overall score for non-time sensitive shipments, (see figure 5.18 and table 5.16), trucking services connected to HKG, SHK and YTN scored the highest. SHK-Truck obtained a higher rank than YTN-Truck because the road connection to the YTN port was so congested that shippers prefer using SHK even if their cargo was not time sensitive. Rail connections to all ports continue to have the lowest score in the ranking list.

In the sensitivity test, when comparing between satisfaction and external factors (figure 5.19), the rank of shipment is listed as HKG-Truck, HKG-Barge, YTN-Truck, SHK-Truck and YTN-Barge. The sequence of order between satisfaction and internal factors (figure 5.20) is HKG-Truck, HKG-Barge, YTN-Truck, SHK-Truck and YTN-Barge.

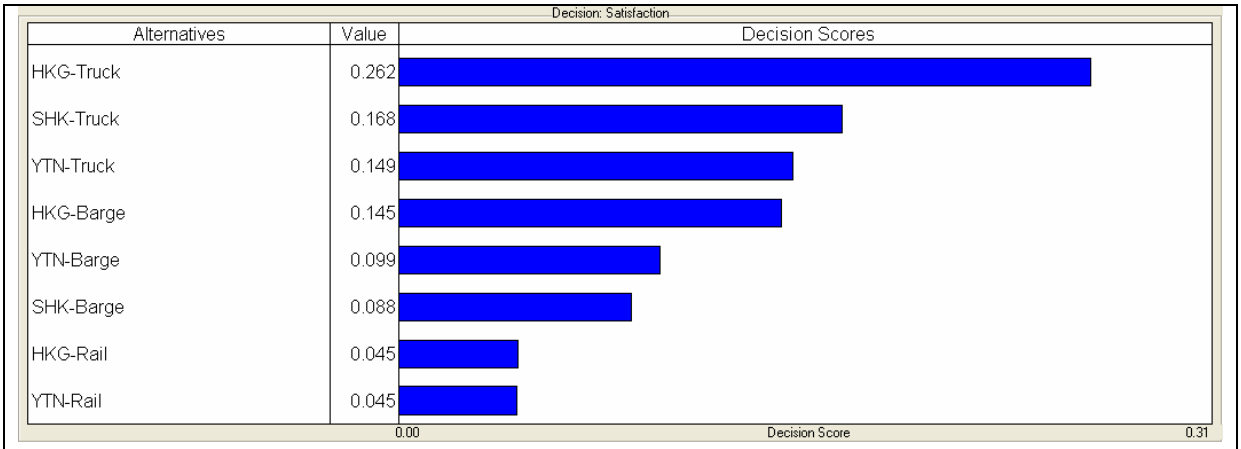


Figure 5.18 Hierarchy graph for shippers with non-time sensitive cargo

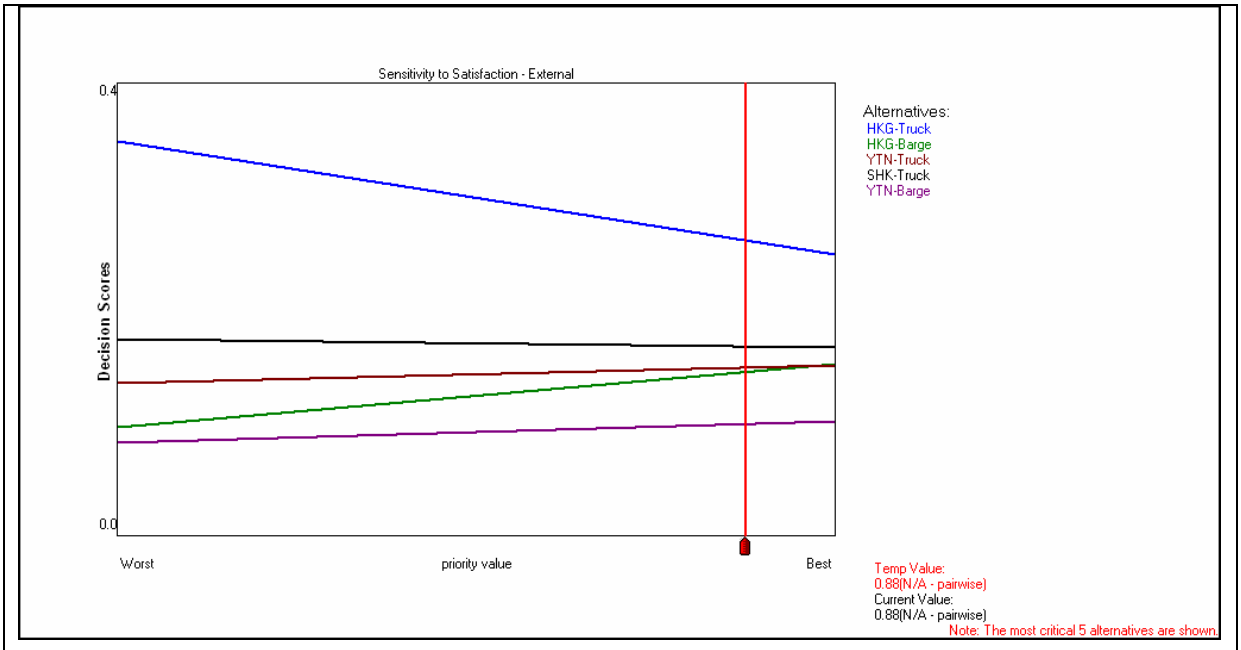


Figure 5.19 Sensitivity test on external factors to satisfaction for shippers with non-time sensitive cargo

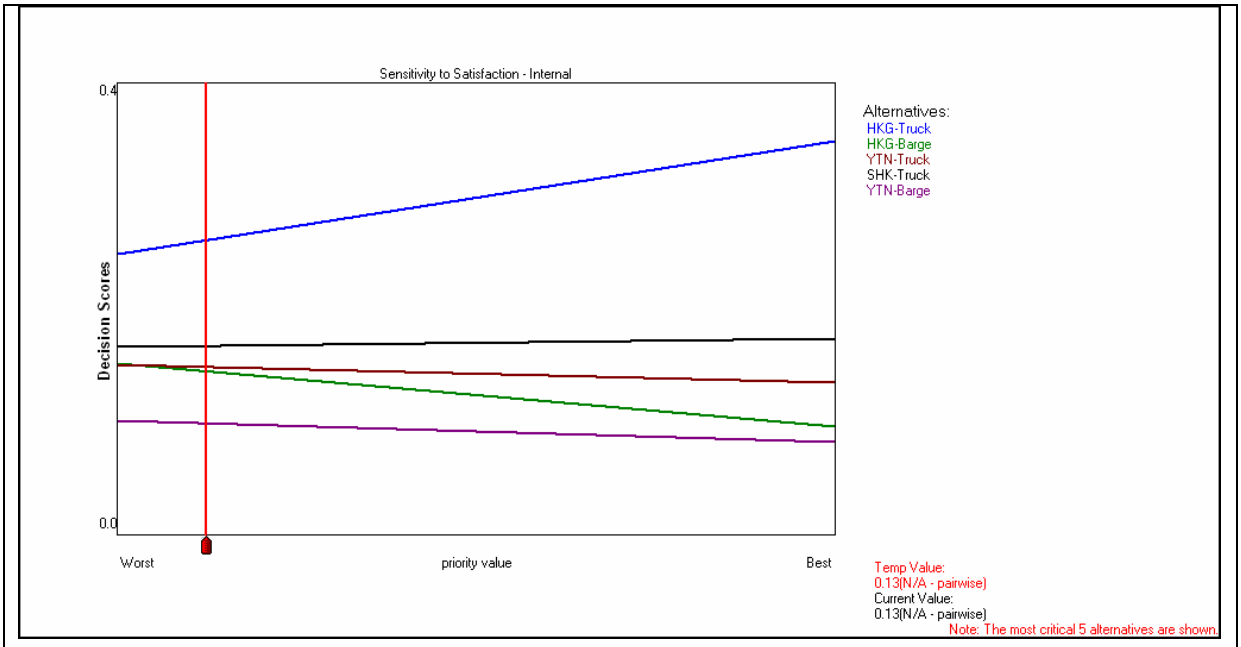


Figure 5.20 Sensitivity test on internal factors to satisfaction for shippers with non- time sensitive cargo

Table 5.16 Decision score for shippers with non- time sensitive cargo

Lowest Level	***HKG-Truck***	***HKG-Rail***	***HKG-Barge***	***YTN-Truck***	***YTN-Rail***	***YTN-Barge***	***SHK-Truck***	***SHK-Barge***	***Model Weights***
Shipper's reputation	0.384	0.041	0.096	0.126	0.028	0.071	0.183	0.071	0.08
Cargo location	0.312	0.038	0.088	0.167	0.039	0.1	0.179	0.077	0.032
Cargo Handling capabilities	0.313	0.033	0.134	0.147	0.029	0.072	0.217	0.054	0.038
Shipper's own capabilities	0.222	0.111	0.111	0.111	0.111	0.111	0.111	0.111	0.013
Relationship with Customs Office	0.212	0.061	0.212	0.114	0.061	0.114	0.114	0.114	0.494
Comprehensive Global service	0.397	0.023	0.058	0.187	0.024	0.059	0.192	0.058	0.108
Customer service	0.25	0.021	0.072	0.215	0.024	0.099	0.259	0.06	0.235
Results	0.262	0.045	0.145	0.149	0.045	0.099	0.168	0.088	

5.6 Summary of the findings

The results from the alternatives clearly reflect the mode choice preference of most shippers/freight forwarders in the PRD region.

Trucking is the top mode choice for any loading port in the PRD. However, Shekou trucking is preferred to Yantian trucking due to the road congestion around the port areas of the Yantian port. Since this study was carried out between the years 2004 and 2006, the traffic condition at Yantian port has greatly improved. If a similar study is conducted in the future, the ranking may be different to the findings obtained in this thesis.

Barge operations are also welcomed by shippers whose factory or depot is situated near to the river bank of the PRD. If the cargo volume is big, then the sailing schedule becomes quite flexible as the shippers can easily fill up the barge and start sailing. Barge operation is one of the popular mode choices for shippers mainly due to terminal operators from Hong Kong deploying dedicated barge services along PRD ports in order to extend the catchment areas for the port.

Rail is not favoured by many shippers/freight forwarders mainly due to the location of the railway terminal and the fixed departure schedule of the service. Rail services are controlled by the Minister of Railways in China so shippers have to match their shipment with the published schedule. This mode is favoured by shippers with:

- heavy and hazardous cargos
- who are situated far away from the loading ports
- close by the railway station
- very high value cargo – the Rail provides security guarding service if needed.
    - A security guard will travel along with the cargo from origin to final destination. His duties are look after the cargo and tighten up the lashing on the cargo.

In conclusion, we can observe that option HKG/Truck, table 5.17, is most preferred mode choice despite the fact that Hong Kong is situated at the furthest location from those inland factories. Overall, when it comes to mode selection, the shippers will try to use the most

Table 5.17: Top three mode choice of shippers in PRD

	First choice	**Second Choice**	**Third Choice**
Shippers with high weekly volume	HKG/Truck	YTN/Truck	HKG/Barge
Shippers with low weekly volume	HKG/Truck	HKG/Barge	YTN/Truck
Shippers with high value cargo	HKG/Truck	YTN/Truck	SHK/Truck
Shippers with low value cargo	HKG/Truck	SHK/Truck	YTN/Truck
Shippers with time sensitive cargo	HKG/Truck	SHK/Truck	HKG/Barge
Shippers with non-time sensitive cargo	HKG/Truck	SHK/Truck	YTN/Truck

effective means to deliver their cargos to the loading port. Trucking is the preferred choice among other modes due to its flexibility and short notice time. However, this mode is hindered by the constraint of sharing the infrastructure with other road users.

Chapter 6 – Conclusions

6.1 Summary of the research findings

When China started the open door policy in the 1980s, carrier selection was left in the hands of overseas buyers. The most common trade term used at that time was Free On Broad (FOB), Ex Work (ExWork) or Ex Factory (Ex Factory). Overseas buyers sent their representatives to inspect the product before, during and after it was loaded into the container at the factory. At that time, as the inland and port infrastructure was so poorly constructed throughout the Pearl River Delta (PRD), sellers would be happy to have someone else take care of the transport needs of their factory.

The overall infrastructure in the PRD has improved greatly over the past ten years. Sellers realised that they could have better profit margins if they included the freight charge in their overseas quotations. Therefore, the trade term changed from FOB to Cost, Insurance and Freight (CIF) or Cost and Freight (C&F). This trade term is becoming more and more popular and is now widely adopted in the manufacturing industry and export sector. Mode selection has become one of the issues that requires the sellers (now known as shippers) to pay more attention to it.

The stringent and complicated Customs regulations as well as the tax rebate system in China forced shippers and freight forwarders at different locations to adopt different strategies in dealing with their mode choice. When consignments need to pass through two adjacent Customs districts, formal Customs declarations and clearance have to be followed through. Obviously, shippers located in different cities within the PRD will transport their consignments (similar to the same procedure) as it passes through different countries.

Even though there are numerous terminals, including bulk, break bulk and container terminals situated along the riverbank of the PRD, for rapid and direct overseas connections, most of the shippers in the PRD area prefer to use the ports in Hong Kong, or Shekou or

Yantian. A correct mode selection definitely enhances profit margins for the shippers. The rapid increase of traffic volume in the PRD area has led to another problem for the shippers and freight forwarders, that of road congestion. This brings up another issue for the shippers in selecting their mode of transport.

This thesis, has established that trucking is the top mode choice for shippers to deliver their cargos for loading, irrespective of a local or Hong Kong ports. On using the trucking issue, shippers will tend to pay attention to the transit time from factory to loading port which explains why Shekou is more preferable than Yantian. Barge is another option for shippers to deliver their cargoes at the loading ports however the sailing frequency is a vital factor for consideration. Unless the location of the factory is close to a railway station, only shippers with heavy or odd sized cargoes will select this mode for their overseas consignment.

6.2 Evaluation of Research Process

In this research, data was collected from the field in the form of original form from a questionnaire. With the aid of computer software, data was computed and sorted into seven factors (detailed criteria) for further investigation. These seven criteria were then grouped under two main categories (main criteria), namely internal and external. The internal category contains those criteria that are controllable and can be altered by the shippers while the external category contains those criteria that are beyond the control of shippers. These two categories are then grouped together to form the Goal Level (Satisfaction of shipments). At the other end of the selection structure, eight transport mode/loading port pairs (alternatives) were connected to form the complete hierarchy as shown in diagram 1. Starting from the goal level, each criterion is compared (pair-wise comparison) with respect to others in turn with

AHP software DecisionPlus.

In the process of transport mode selection, the nature of cargo such as time sensitive, value and volume of shipment will definitely affect the mode choice. Therefore, the AHP pair-wise comparison was repeated six times under different nature of consignments so that the mode selection could be clearly ranked under different scenarios. The general hierarchy structure of this thesis is shown in figure 6.1.

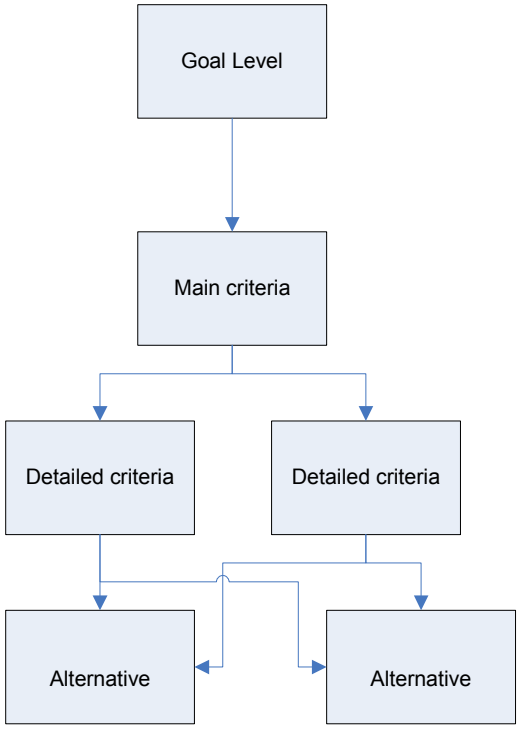


Figure 6.1: Hierarchy structure

This thesis took nearly five years to complete in its present form and a vast number of data collected over that period had to be re-checked and re-validated due to the rapid changes in external environments.

6.3 Evaluation of the research objectives

In this research, the following objectives have been achieved.

Aims and Objectives	Achieved results
To describe the freight / transport system in the region and to analyse the reasons for its recent development.	Completed as in chapter Two
To establish the factors that determines the modal choices of shippers for their containerized cargo movements.	Through the distribution of questionnaires to the related freight industries, seven factors have been summarised by applying statistical factor analysis on the information collected from this survey.

to assess the importance of (customer) service in the choice of carrier	Through various meetings with the industrial practitioners
To produce a taxonomy /hierarchy of the variables in the carrier selection process and to assess their relative importance	To construct a hierarchy structure for model selection based on elements mentioned above.
To model these variables and to evaluate the use of the model to gain a fuller understanding of transport carrier selection.	To set up an analytical hierarchy process (AHP) with the industrial practitioners involved in the pair-wise comparison, AHP software DecisionPlus was used for making decisions.
	To construct a framework for transport mode selection
	To develop a generalised model. Although the evaluation model has constructed by concentrating on the particular issue of selecting three modes to three loading ports, it is clear that the idea and method could be easily generalised and duplicated.

6.4 Contribution of the research

The rapid economic development in China under the open door policy implemented in 1980s, expedited the enormous growth as well as cluster of (light) manufacturing industries around the PRD region. The gradual changes in trade term, from ex-work to CIF, have shifted the mode/carrier choice from buyers to exporters. All of above mentioned strands formed the prime motive to carry out this research.

Even though there are numerous terminals, include bulk; break bulk and container terminals situated along the riverbank of the PRD, for rapid and direct overseas connections, most of the shippers in the PRD area prefer to use the ports in Hong Kong, or Shekou or Yantian. Under the widely practice trading term for export consignments, such as CIF, it

would definitely enhance profit margins for the shippers if a correct mode is chosen. The rapid increase of traffic volume in PRD area developed another problem for the shippers and freight forwarders which was road congestion. This brings up another issue for the shippers in selecting their mode of transport.

There are important contributions arising from this research toward Academic research; Government policy; Liner companies and inland freight forwarders as well as third party providers.

- **In the area of academic research:**
    - This thesis is the first time we have a study about carrier/mode choice of container trade in PRD region. Previously, all literature was focused on carrier/mode choice on the bulk cargo in Western countries.
    - In the conventional AHP applications, the hierarchy structures were constructed following experts' opinions and suggestions. In this thesis, a business survey in the freight related industries was undertaken to collect comments, and seven selection criteria, or factors, were determined by a statistical factor analysis process.
    - A practical mode selection problem was considered in the PRD area. The problem was used as an illustration of how to model the problem. Therefore, the thesis has provided a practical, useful mode selection procedure for the freight industry. Although the evaluation model is concentrating on the particular issue of selecting three modes to three loading ports, it is clear that the idea and method could be easily generalised and duplicated.
    - In this study , it also identified some factors such as relationship among shippers; carriers and Customs office can be further investigate for Chinese Shippers under this unique feature of Customs interference in China. The

procedure generated in this research can be generalised to other specified mode selection issues.

- **For the making of Government policies:**
    - This research indicated that shippers prefer to use **Trucking** for their overseas shipment. Despite massive investments put on the infrastructure in Yantian port, shippers still prefer to use Hong Kong for most of their consignments especially those time sensitive cargo. PRD province Government may consider putting an exclusive lane for the CY/CFS traffic to/from Yantian port so that cargo can move quickly in/out of the port.
    - The top preference for PRD shippers to use HKG truck for their consignments indicates that most of the shippers have difficulties in meeting the 24 hours advance export declaration. They are willing to pay extra freight charges to get their cargoes exported via HKG. In this situation, the total logistics costs for PRD export cargo will be much higher that it should be. If the PRD province Government can change the Customs regulations about advance export declaration from 24 to 12 hours then it may channel most of the shipments back to use local PRD ports and lower the overall logistics costs.
    - The popular trucking option by most of the shippers identified a serious noise and air pollutions in the region. PRD province Government should take positive measures to encourage shippers to use other more environmental friendly carrier/mode for their export consignments.
    - One of the reasons, as observed during the study, export tax refund is the major factor that contributes to the overall tilted results (HKG/Truck) that PRD shippers wish to despatch their consignments soonest. The amendment to

export taxing system should be addressed by the Government in future policy planning.

- **For the liner companies that provide services among HKG/YTN/SHK ports**:
    - This study indicated that despite high THC imposed in HKG port, PRD shippers still prefer to use HKG as their prime loading port. The major reason for using HKG is not due to its efficiency but due to poor performance in inland haulage performance with PRD region. This study will be benefited to liner companies when they select the port of calls within the PRD region in future.
- **For the inland freight forwarders and third party providers in PRD region:**
    - This study indicated that any close business tag with any particular port in PRD will not give them any advantages in capturing the cargos. It is because PRD shippers prefer to use the most efficiency inland haulage section to the loading port.
    - PRD shippers do not have any strong preference in selection of loading ports as well as mode of transport.

6.5 Limitation of the research

Despite every effort to ensure the validity of findings in this thesis, this research faced several difficulties. Since the research was carried out over a time span of five years, information collected at initial stages became irrelevant when the research was approaching its conclusion. Factors that had been considered valid became less relevant when discussed with industrial practitioners.

The rapidly changing of external environment created a lot of confusion in determining whether this particular parameter should merit more attention or not. For example, the

changes in government policy, such as the abolition of export tax rebate in 2006 will challenge the argument that shippers would like to export their cargoes soonest in order to obtain the rebate for increased cash flow. Physical changes in the logistics industry also pose difficulties. For example, the completion of infrastructure at Yiantain port, around 2005, from one road and one tunnel to four roads (Huiyan Highway, Yanpai Highway, Yanba Highway and Wutongshan Road) four tunnels (Wutongshan Tunnel, Luosha Road—Wutongshan Tunnel) and one interchange (Mingzhu Interchange) will enhance the traffic flow in that area and attract more shippers to divert their truck to use this port.

This perception of mode selection among shippers/freight forwarders differs from company to company as well as from person to person. The exact wordings were translated from English into Chinese which may also pose ambiguity in the understanding of the meaning for shippers/freight forwarders. In the final pair wise comparison, the exercise was carried out over several months hence it may face the problems of consistency of the interviewers.

6.6 Scope for further research

Due to time and cost constraints, this thesis has provided a study for understanding what carrier selection factors influence the mode choice by shippers in PRD area. However, developing a full understanding and appreciation of the process of mode selection will require further study on the interaction between shippers, carriers (freight forwarders/3PL) and government authorities since each of them hold a vital share in the final outcomes in carrier mode selection. In addition, further research could usefully examine types of relationship, in contrast to rationale mode selection, that is special in the commercial setting in China. The unique personal relationship that exists among Chinese enterprises will offer an interesting research area for the comparison with the industrial buying theory as well as loyalty in freight industry.

List of references

Abshire, R. D. and Premeaux, S. R., (1991), Motor carriers and shippers perceptions of the carrier choice decision*, Transportation Journal,* 31(1), 31-35

Anderson, J., Narus, J., (1990). A model of the distributor firm and manufacturer firm working partnership. *Journal of Marketing,* 54, 42–58.

Baker, G. H., (1984), The Carrier Elimination Decision-Implications for Motor Carrier Marketing, *Transportation Journal*, 24, 20-29

Bardi, E. J., Bagchi, P. K. and Raghunathan, T. S., (1989), Motor Carrier Selection in a Deregulated Environment, *Transportation Journal*, 29(1),4-11

Bardi, E., (1973), Carrier Selection from One Mode, *Transport Journal*, 12(4), 23-29

Baumol, W.J. and vinod, H.D., (1970), An Inventory Theoretic Model of Freight Transport Demand, *Management Science*, 16(7), 413-421

Bayliss, B.T. and Edwards, S.L., (1970), Industrial demand for transport, *Ministry of Transport*, London

Bleeke, J., Ernst, D., (1991). The way to win in cross-border alliances. *Harvard Business Review*, 127–135.

Boone, L.E., Kurtz, D.L., (2001). Contemporary Marketing, 10th ed., Forth Worth, Harcourt College Publishers, USA.

Bowersox, D.J., Daugherty, P. J., Droge, C. L., Rogers, D. S. and Wardlow, D. L., (1989), Leading Edge Logistics Competitive Positioning for the 1990's, *The Council of Logistics Management,* Chicago, IL

Brace, I., (2004), *Questionnaire design: how to plan, structure, and write survey material for effective market research*, Kogan Page, London

Brand, R.R. and Grabner, J. R., (1985), An examination of the Carrier selection process in a Deregulated Economy, *23rd Annual Conference Proceedings* – Council of Logistics Management, St Louis, 1, 173-196

Brooks, M.R., (1984), Limitations in the Carrier Choice Process: A Study of Eastern Canadian Containerisable Cargo, *International Journal of Physical Distribution and Materials Management,* 15 (3), 38-46

Brooks, M.R., (1995), Understanding the Ocean Container Market - a Seven Country Study, *Journal of Maritime Policy and Management*, 22(1), 39-49

Brown, J.D.,(2000),What issues affect Likert-scale questionnaire formats?, Shiken: JALT Testing & Evaluation SIG Newsletter, 4 (1), 18-21

Burdg, H. B. and Daley, J.M., (1985), Shallow water transportation: marketing implications of user and carrier attribute perceptions, *Transport Journal,* 24(3), 55-67

CCustoms, (2006), information obtained from the website of China Customs Office (available at http://www.customs.gov.cn/YWStaticPage/3387/7a8882f1.htm)

Chow, G. and Poist, R.F., (1984), The Measurement of Quality of Service and the Transportation Purchase Decision, *The Logistics and Transportation Review*, 20(1), 25-43

Cook, W.R., (1967), Transport Decisions of Certain Firms in the Black Country, *Journal of Transport Economics and Policy,* 1(3), 325-344

Cooper and Schindler, (1998), *Business Research Methods*, 6th Edition, McGraw-Hill International Editions

Coyle, J.J. and Andraski, J. C., (1990), *Management Channel Relationships,* Annual Conference Proceedings, The Council of Logistics Management, Oak Brook, IL, 245-257

Coyle, J.J., Bardi, E.J., Novack, R.A., (1999). *Transportation*, .fifth ed. South-Western College Publishing, USA.

Craig, T., (1973), A Behavioural Model of Modal Selection, *Transportation Journal*, 24-25

CSD, (2007), Hong Kong SAR Government Census and Statistics Department, (available at http://www.censtatd.gov.hk/)

Cudeck,R.,(2000), *Exploratory Factor Analysis: In handbook of Applied multivariate statistics and mathematical modelling*, Academic Press, San Diego

Cullinane, K. and Kwan, R., (2000), Freight mode choice in Guangdong province, Department of Shipping and Transport Logistics, The Hong Kong Polytechnic University.

Cunningham, M.T. and Kettlewood, K., (1976), Source Loyalty in the Freight Transport Market, *European Journal of Marketing*, 10(1), 60-79

Cunningham, M.T., (1982), International Marketing and Purchasing of Industrial Goods – Features of a European Research Project, *European Journal of Marketing*, 14 (5/6), 322-38

Ellram, L.M., Hendrick, T.E., (1995). Partnering characteristics: a dyadic perspective, Journal *of Business Logistics* 16(1), 41–64.

Erasmus, A.C., Boshoff, E. & Rousseau, G. (2002). The potential of using script theory in consumer behaviour research. *Journal for Family Ecology and Consumer Sciences* , 30, 1-9.

Evans, R. E. and Southard, W. R., (1974), Motor Carriers and Shippers Perceptions of the Carrier Choice Decision, *The Logistics and Transportation Review*, 10(2),.145-147

Evers, P.T., Harper, D.V. and Needham, P.M., (1996), The Determinants of Shipper Perceptions of Modes, *Transportation Journal*, 36(2), 13-25

Faller, P.,(1985), Changes in Transport users' motivations for modal choice: Freight Transport, European Conference of Ministers of Transport, Paris, 7-17

Fang, T., (2001), Culture as a Driving Force for Interfirm Adaptation: A Chinese Case, *Industrial Marketing Management*, 30, 51–63

FHK, (2003), Made in PRD study: The Changing Face of Hong Kong Manufacturers, Federation of Hong Kong

FHK, (2007), Made in PRD study: Challenges and Opportunities for Hong Kong industry, Federation of Hong Kong

FIC, (2000), The latest directory of foreign investment in China 2000, Beijing : Zhongguo Hua qiao chu ban she, (北京 : 中國華僑出版社, 2000)

Foster, J. R., and Strasser, S., (1990), Carrier/Modal Selection Factors: The Shipper/Carrier Paradox, *Journal of the Transportation Research Forum*, 31(1), 206-208

FTEC, (2007), The Department of Foreign Trade and Economic Cooperation of Guangdong Province, China. (available at website : http://www.gddoftec.gov.cn/en/index.html)

Ganesan, S., (1994). Determinants of long-term orientation in buyer–seller relationships. *Journal of Marketing,* 58, 1–19.

Gardner, J.T., Cooper, M.C., Noordewier, T., (1994). Understanding shipper–carrier and shipper–warehouse relationships: partnerships revisited. *Journal of Business Logistics* 15 (2), 121–143.

Gentry, J., (1991), Purchasing's Involvement in Transportation Decision-Making, Centre for Advanced Purchasing Studies/National Association of Purchasing Managers, USA

Gilmour, P., (1976), Some policy implications of subjective factors in the modal choice for freight movements, *The logistics and transportation review*, 12(1), 39-57

Gray, R. (1982), Behavioral Approaches to Freight Transport Modal Choice, *Transport Reviews* 2(2), 161-184

Green, Salkind and Akey, Samuel, B., Neil,J. and Theresa, M., (2000), Using SPSS for windows: Analysing and Understanding Data, PrenticeHall Inc. USA

GZM meeting, (1980), The category of industrial area was established when Deng Xiaoping visited Guangzhou on 31-3-1980. The news was reported from various newspapers (available at http://big5.china.com.cn/zhuanti2005/txt/2002-09/22/content_5208123.htm)

Hall, P.K., (1992), Service Quality as a Differentiating Feature in Bulk Chemical Transportation: An Empirical Investigation, Ph.D. dissertation, University of Missouri, Columbia, USA

HKSAR, (2006), HKSAR Government publication: Cross-boundary Traffic, November 2006. (available at http://www.info.gov.hk/info/hkin/cross_boundary.pdf)

Jerman, R. E., Anderson R. D. and Constantin, J. A., (1978), Shipper versus Carrier Perceptions, *International Journal of Physical Distribution and Marketing Management*, 7,60-64

Jerman, R. E., Anderson, R. D. and Constantin, J.A., (1978), Shipper versus carrier perceptions of carrier selection variables, *International Journal of Physical Distribution and Material Management*, 9(1), 29-38

Jones, J.R.,(1975), Industrial Shipper Survey Plant Level, U. S. Department of Transportation, Washington D. C.

Juang, YC. And Gray, R. (2002), Modelling intermodal transport systems: A methodology for inland container traffic, Logistics Research Network Conference 2002, Birmingham.

Kent, J.K. and Parker, R. S., (1999), International containership carrier selection criteria, *International Journal of Physical Distribution & Logistics Management*, 29 (6), 398-408

Kim & Muller, (1978), Factor Analysis: Statistical Methods and Practical Issues, London, SAGE Publication

Kinoshita, E. and Masatake Nakanishi, (1999), Proposal of New AHP Model in Light of Dominant Relationship Among Alternatives, *Journal of the Operations Research Society of Japan,* 42(2),180-197

Kozak, R.A., (1997). Distributor-supplier partnering relationships: a case in trust. *Journal of Business Research* 39, 33–38.

Krapfel, R. E. and Mentzer, J. T., (1982), Shippers Transportation Choice Processes Under Deregulation, *Industrial Marketing Management*, 11, 117-124

LaLonde, B. J., (1991), Whatever happened to one-stop transportation shopping, Transport Topics, 13, 1-4

Lambert, D.M., Lewis, M.C., and Stock, J. R., (1993), How Shippers Select and Evaluate General Commodities LTL Motor Carriers, *Journal of Business Logistics*, 14(1), 131-143

Lambert, D.M., Stock, J.R., (1993). *Strategic Logistics Management*, third ed. Irwin, USA.

Lian L, (2004), *China Processing Trade All-in-One Guide* (中國加工貿易完全手冊), Chinese Manufacturers' Association (CMA), Hong Kong

Lirn, T.C., Thanopoulou, H.A.,Beynon, M.J., and Beresford, A.K.C. (2004), *An application of AHP on Transhipment Port Selection: A Global Perspective, Maritime Economics & Logistics,* 6, 70-91

McGinnis, M. A., (1979), Shipper Attitudes Toward Freight Transportation Choice: A Factor Analytic Study, *International Journal of Physical Distribution and Materials Management*, 10(1), 31-33

McGinnis, M. A., (1989), A Comparative Evaluation of Freight Transportation Choice Models, *Transportation Journal*, 29 (2), 36-41

McGinnis, M. A., (1990), The Relative Importance of Cost and Service in Freight Transportation Choice: Before and After Deregulation, *Transportation Journal*, 30 (1), 12-19

McKinnon, A. C., (1989*a*), *Physical Distribution Systems*, Routledge, London, 151-178

McKinnon, A. C., (1989*b*), *The Growth of road freight in the UK,* International Journal of Physical Distribution and Materials Management, 19(4)

MD, (2007), Hong Kong SAR Government Marine Department, (available at http://www.mardep.gov.hk)

Milligan, B., (1999), Global economic rally puts heat on shippers and carriers, *Purchasing Online*, 15 July 1999.

Miminahan, T. (1998), It pays to know your options, *Purchasing Online*, March 12 1998.

Mohr, J. and Spekman, R., (1994). Characteristics of partnership success: partnership attributes, communication behavior, and conflict resolution techniques. *Strategic Management Journal* 15, 135–152.

Morton, A. L., (1972), Intermodal Competition for Intercity Transport of Manufacturers, *Land Economics*, 48(4), 357-366

Murphy, P. R., Daley, J.M. and Hall, P. K., (1997), Carrier Selection: Do Shippers and Carriers Agree or Not ? *The Logistics and Transportation Review*, 33 (1), 67-72

Murphy, P. R., Daley, J.M. and Hall, P.K., (1997), Carrier Selection: Do Shippers and Carriers Agree or Not?, *The Logistics and Transportation Review*, 33(1),67-72

Murphy, P.R. and Hall, P. K., (1995), The relative importance of cost and service in freight transportation choice before and after deregulation: an update, *Transportation Journal*, 35(1), 30-38

Murphy, P.R., Daley, J. M. and Dalenberg, D. R., (1991), Selecting Links and Nodes in International Transportation: An Intermediary's Perspective, *Transportation Journal*, 31(2), 33-40

Murphy, P.R., Daley, J. M. and Dalenberg, D.R., (1991), *Selecting Links and Nodes in International Transportation: An Intermediary's Perspective,* Transportation Journal, 31(2), 33-40

NAROS, (2006), North American Representative Office of Shenzhen (available at http://www.shenzhenoffice.org/aboutsz/business_climate.htm)

Ortuzar, J. D. and Willumsen, L.G. (1994), *Modeling Transport*, , John Wiley & Sons, England

Pearson, R., (1980), *Container line Performance and Service Quality*, University of Liverpool, Marine Transport Centre, Liverpool

Pisharodi, R., (1991), The Transport Choice Decision Process: The Potential Methodology and Applications of Script-theoretic Modelling, *International Journal of Physical Distribution and Logistics Management*, 21(5), 13-22

Porter, M.E., (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. Free Press, New York.

Powell, W., (1987), Hybrid organizational arrangements: new form or transitional development, *California Management Review*, 30 (1), 67–87.

Quinn, F.J., (1987), How Shippers Choose a Motor Carrier, *Traffic Management*, 26(11), 43-48

Roberts, P.,(1971), The Logistics Management Process as a model of Freight Traffic Demand, *PTRC*, "Freight Traffic Models" Symposium

Saaty T L., (1994a) Highlights and critical points in the theory and application of the Analytic Hierarchy Process, *European Journal of Operational Research*, 74(3,5), 426-447

Saaty T. L., and Vargas, L. G. (1997*),* Implementing neural firing: towards a new technology*,* Mathematical and Computer Modelling, 26(4), 113-124.

Saaty T. L.,(1994b), Homogeneity and clustering in AHP ensures the validity of the scale, *European Journal of Operational Research*, 72(3), 598-601

Saaty, T. L and Vargas, L. G. (1997), Implementing neural firing: Towards a new technology, *Mathematical and Computer Modelling*, 26(4), 113-124.

Saaty, T. L. and Hu, G (1998), Ranking by Eigenvector versus other methods in the Analytic Hierarchy Process, *Applied Mathematics Letters*, 11(4), 121-125

Saaty, T. L., (1987)*,* New macroeconomic forecasting and policy evaluation method using the analytic hierarchy process, *Mathematical Modeling*, 9(3-5), 219-231

Saaty, T.,(1983), *The Analytic Hierarchy Process*, McGraw-Hill, New York

Saleh, F. A. and Das, C., (1974), Transport Service Choice, *International Journal of Physical Distribution*, 4(5),297-304

Saleh, F. and La Londe, B. J., (1972), Industrial Behaviour and the Motor Carrier Selection Decision, *Journal of Purchasing*, 8(1), 18-33

Schurr**,** P. H., Stone, H. and Beller, L (1985) Effective selling approaches to buyers' objections , *Industrial Marketing Management*, 14(3), 195-202

SCT, (2007), Shekou Container Terminals, Hong Kong (available at http://www.sctcn.com/english/default.aspx)

Sharp, C.,(1970), *The Allocation of Freight Traffic,* Ministry of Transport, London, 1970

Sharp, C.,(1971), The Optimum Allocation of Freight Traffic, *Journal of Transport, Economics and Policy*, 5(3), 344-356

Sheffi, Y., Eskandari, B. and Koutsopoulos, H. N., (1988), Transportation Mode Choice Based on Total Logistics Costs, *Journal of Business Logistics*, 9(2), 143-150

Simchi-Levi, D., Kaminsky, P. and Simchi-Levi, E., (2000), *Designing and Managing the Supply Chain – concepts, strategies and case studies,* McGraw-Hill, U.S.A.

Slater A., (1990), Choice of the transport mode*, The Gower Handbook of Logistics and Distribution Management,* GATTORNA, J., Gower, Aldershot,.314-339.

Song, D. W. and Yeo, K. T. (2004), *A competitive Analysis of Chinese Container Ports using the analytic Hierarchy Process, Maritime Economics & Logistics*, 6, 34-52

Stock, J. R. and Lambert, D. M. (1992) Becoming a "world" class company with logistics service quality, *The International Journal of Logistics Management* 3 (1), 73-81

Stock, J. R., and La Londe, B. J., (1978), The purchasing approach to Transportation Mode Selection, *Journal of Purchasing and Materials Management*, 3-7

Traffic Management, (1966), *How Do You Choose A Carrier?,* November, 70-72

Tyworth, J. E., and Zeng, A. Z., (1998), Estimating the effects of carrier transit-time performance on logistics cost and service, *Transportation Research* – A, 32(2), 89-97

Ugboma, C., Ugboma, O. and Ogwude,I. (2006), An analytic Hierarchy Process Approach to port selection Decisions – Empirical Evidence from Nigerian Ports, *Maritime Economics & Logistics*, 8, 251-266

Vlosky, R.P., Wilson, E.J., (1997). Partnering and traditional relationships in business marketing: an introduction to the special issue. *Journal of Business Research* 39, 1–4.

Watson, P. L., Hartweg, J. C. and Linton, W.E., (1974), Factors Influencing Shipping Mode for Intercity Freight: A Disaggregate Approach Proceedings, 15th Annual Meeting, American Transportation Research Forum, Oxford, Indiana, pp.138-144

Whiteing, T. & Stantchev, D. (2004), Freight Transport and Logistics in the Yorkshire and Humber Region: Addressing the Skills Gaps, UTSG, Newcastle Upon Tyre.

Whyte, J. L. (1992), Characteristics of Transport Managers Which Influence Haulier Selection, *International Journal of Physical Distribution and Logistics Management*, 22(5), 14-24

Whyte, J. L., (1992), Characteristics of Transport Managers which influence Haulier Selection, *International Journal of Physical Distribution and Logistics Management*, 22(5), 14-42

Widlert, S. and Bradley, M. (1992), Preference of freight services in Sweden, *Sixth World Conference in Transport Research*, Lyon, France.

Wind, Y.,(1970), Industrial Source Loyalty, *Journal of Marketing Research*, 7, 450-457

Woods, D.W. and Domencich, T. A., (1971), Competition Between Rail and Truck in Intercity Freight Transportation Proceedings, Twelfth Annual Meeting, *American Transportation Research Forum*, Oxford, Indiana, pp.257-288

YICT, (2007), Yantian International Container Terminals (available at http://www.yict.com.cn/2006en/AboutYICT/index.asp)

YRD&PRD, (2004), *Yangtze River Delta & Pearl River Delta and Hong Kong & Macao SAR Statistical Yearbook 2000-2004*, China Statistics Press, Beijing

Appendix A

Registrations procedures for self-servicing Customs declaration enterprises:

The following documents must be submitted to their local Customs authorities:

1.	Application for Registration of Self-servicing Customs Declaration;
2.	Copy of the official document approving the right of import/export operations by the Ministry of Business, or copy of the Certificate on Approval of Foreign-Invested Enterprise;
3.	Copy of Business License for Enterprise as Legal Person issued by industrial and commercial administration;
4.	Copy of the Tax Registration Certificate issued by the taxation administration;
5.	Contract and Articles of Association (sole-investor enterprises may exclude their contracts);
6.	Imported equipment list sealed by the foreign trade administration;
7.	Detailed Form of Enterprise;
8.	Detailed Form of Customs Declarers;
9.	Detailed Form of the Management;
10.	Corporate financial management system and account books settings;
11.	Report on the verification of capital and account number of the deposit bank;
12.	Certificate of bank creditworthiness;
13.	Names, contact numbers and ID numbers of the legal representatives, authorized people in charge of Customs declarations, and Customs declarers;
14.	Impressions of the corporate seal and the designated seal for Customs declarations, and seal (signature) record documents of leading officials, people in charge of Customs declaration and Customs declarers

Appendix B-1

To: Peter Wong, Department of Logistics, Hong Kong Polytechnic University
Fax: (852)23302704 or (755)25599156

The PRD freight mode choice survey of Container traffic to the USA

Cargo Information

Business of your Company	Manufacturer / Shippers / Freight Forwarder / Others _____
Company Name:	_____
Factory/Depot Location	City A/ City B / City C / City D / Others: _____
Customs Office that serve the depot/factory	
Export Commodity:	A. _____(%) B. _____(%) C. _____(%)
Port of loading	□ GZH Airport □ SHZ Airport □ Hong Kong Airport via Road □ Hong Kong Airport via Barge □ Yantian Port – direct □ Shekou Port – direct □ Other SZH Port – direct □ Hong Kong Port via Road □ Hong Kong Port via Barge
Estimated Annual Volume to USA (2004)	_____ 20' box _____ 40' box
Daily Volume to USA :	_____ 20' box _____ 40' box

How to answer this questionnaire

Please indicate the importance of each of the listed factors below in selecting the mode of transport.
Please kindly shade your choice. Only one choice is required in each question

Overall

	Most Important	Very Important	Important	A little important	*Not Important*
Required delivery time	☐	☐	☐	☐	☐
Trade terms in the contract, such as FOB / CIF / ExWork	☐	☐	☐	☐	☐
Cargo will pass through another Customs district	☐	☐	☐	☐	☐
Registration with the local Customs office	☐	☐	☐	☐	☐
Frequency of damage/loss of cargo	☐	☐	☐	☐	☐
Value of the cargo	☐	☐	☐	☐	☐

Your comments/suggestions:

Transport Costs

	Most Important	Very Important	Important	A little important	*Not Important*
Cost of service	☐	☐	☐	☐	☐
Distance to the loading port	☐	☐	☐	☐	☐
Freight charges	☐	☐	☐	☐	☐
Competitive rates	☐	☐	☐	☐	☐
Costs related to level of stocks	☐	☐	☐	☐	☐
Door-to-door rates	☐	☐	☐	☐	☐
Transportation costs	☐	☐	☐	☐	☐
Trucking cost to the loading port	☐	☐	☐	☐	☐
Low freight charges	☐	☐	☐	☐	☐

Your comments/suggestions:

Service Level

	Most Important	Very Important	Important	A little important	*Not Important*
Ability to control the shipment	☐	☐	☐	☐	☐
Care in handling	☐	☐	☐	☐	☐
Availability of origin and destination points	☐	☐	☐	☐	☐
Consistency of service	☐	☐	☐	☐	☐
Assistance in obtaining rate changes	☐	☐	☐	☐	☐
Availability for specialized equipment	☐	☐	☐	☐	☐
Geographical coverage	☐	☐	☐	☐	☐
Shipment information	☐	☐	☐	☐	☐
Delivery reliability	☐	☐	☐	☐	☐
Susceptibility to loss/damage	☐	☐	☐	☐	☐
Service quality	☐	☐	☐	☐	☐
Shipment tracing	☐	☐	☐	☐	☐
Equipment availability	☐	☐	☐	☐	☐
Physical facilities	☐	☐	☐	☐	☐
Pickup service	☐	☐	☐	☐	☐
Promotional material	☐	☐	☐	☐	☐
Reliable pickup and special order handling	☐	☐	☐	☐	☐
On time performance	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

Your comments/suggestions:

Relationship with Carrier

	Most Important	Very Important	Important	A little important	*Not Important*
Ability to be representative of the buyer	☐	☐	☐	☐	☐
Claim settlement	☐	☐	☐	☐	☐
Provide freight forwarding services	☐	☐	☐	☐	☐
Quality of dispatch personnel	☐	☐	☐	☐	☐
Past record in satisfying customers	☐	☐	☐	☐	☐
Dependability/reliability of service	☐	☐	☐	☐	☐
Response in emergency	☐	☐	☐	☐	☐
Willingness to negotiate service & rates	☐	☐	☐	☐	☐
Flexibility in handling documents/equipment	☐	☐	☐	☐	☐
Special preference given to shipper	☐	☐	☐	☐	☐
Existence of substitutes in the neighbouring areas	☐	☐	☐	☐	☐

Your comments/suggestions:

Information for Future Communication

Contact person Name: _____ Position _____

Tel: _____ Fax _____

Email: _____

I would like to take part in further interview, if needed.

_____

Signed

THANK YOU FOR YOUR HELP

Appendix B-2

致: 黄治中 - 物流学系，香港理工大学

传真： 香港 (852)23302704 或 深圳 (755) 25599156

珠三角往国外运输方式调查

货物资料

公司属性： 制造商/托运人/货代/其它 _____

公司名称: _____

公司位置: 城市：_____

公司所属关区:

出口货品:

甲. _____占公司出口货量_____ %

乙. _____占公司出口货量_____ %

丙. _____占公司出口货量_____ %

装卸港:

□ 广州机场

□ 深圳机场

□ 经陆路到香港机场

□经驳船到香港机场

□ 直接到盐田港

□ 直接到蛇口港

□ 直接到深圳其它港口

□经陆路到香港港口

□经驳船到香港港口

去年(2004)全年到美国货量: _____20’ 箱 _____40’ 箱

去年(2004)全年到欧洲货量: _____20’ 箱 _____40’ 箱

怎样回答这份调查表

请指出下面关于运输的重要性因素.

请指出你的选项，每个问题要求只有一个选项．

总体

	非常重要	很重要	重要	重要一点	不重要
交货日期	☐	☐	☐	☐	☐
合约的贸易条款，例如 FOB / CIF / ExWork	☐	☐	☐	☐	☐
货物会通过另一个海关	☐	☐	☐	☐	☐
与本地海关的登记	☐	☐	☐	☐	☐
货物损坏/遗失频率	☐	☐	☐	☐	☐
货物价值	☐	☐	☐	☐	☐
货物出口退税安排	☐	☐	☐	☐	☐

您的意见/建议:

运输成本

	非常重要	很重要	重要	重要一点	不重要
额外服务费	☐	☐	☐	☐	☐
与装卸港的距离	☐	☐	☐	☐	☐
海运部份运费	☐	☐	☐	☐	☐
有竞争能力的费率	☐	☐	☐	☐	☐

货物保价	☐	☐	☐	☐	☐
能提供门到门运费	☐	☐	☐	☐	☐
整体运输成本	☐	☐	☐	☐	☐
到装卸港的货车费	☐	☐	☐	☐	☐
低廉的运费	☐	☐	☐	☐	☐
您的意见/建议:					

承运人的服务标准

	非常重要	很重要	重要	重要一点	不重要
承运公司处理运货的能力	☐	☐	☐	☐	☐
承运公司能否在装卸時小心处理貨物	☐	☐	☐	☐	☐
在始发地和目的地设有输送网络	☐	☐	☐	☐	☐
能提供综合服务	☐	☐	☐	☐	☐
协助付货人获得较优惠运费	☐	☐	☐	☐	☐
能提供专业货物装卸设备	☐	☐	☐	☐	☐
在较多地区提供承运服务	☐	☐	☐	☐	☐
货物资料的准确性	☐	☐	☐	☐	☐
货物交付可靠性	☐	☐	☐	☐	☐
货物损失或损坏的敏感度	☐	☐	☐	☐	☐
服务质量	☐	☐	☐	☐	☐
提供货物跟踪	☐	☐	☐	☐	☐
设备可用性	☐	☐	☐	☐	☐

装卸貨物的设备	☐	☐	☐	☐	☐
收货服务	☐	☐	☐	☐	☐
承运人在推广期的特别优惠服务	☐	☐	☐	☐	☐
处理特别提/存货的可靠性	☐	☐	☐	☐	☐
准时付运及兑现服务承诺	☐	☐	☐	☐	☐
与货主之间的关系	☐	☐	☐	☐	☐

您的意见/建议:

与承运人关系

	非常重要	很重要	重要	重要一点	不重要
能获得买家的信任	☐	☐	☐	☐	☐
理赔	☐	☐	☐	☐	☐
提供货代服务	☐	☐	☐	☐	☐
指派人员素质	☐	☐	☐	☐	☐
客户满意记录	☐	☐	☐	☐	☐
服务可靠性	☐	☐	☐	☐	☐
紧急事故反应	☐	☐	☐	☐	☐
愿意经过协商服务及收费	☐	☐	☐	☐	☐
弹性处理货物提单及设备	☐	☐	☐	☐	☐

给发货人特别优先权	☐	☐	☐	☐	☐
在相邻地区有类似承运人	☐	☐	☐	☐	☐

您的意见/建议:

与关区的关系

	非常重要	很重要	重要	重要一点	不重要
能获得当地关区的信任	☐	☐	☐	☐	☐
关区与工厂/仓库的实质距离	☐	☐	☐	☐	☐
企业本身为 **信得过企业**	☐	☐	☐	☐	☐
报关人员素质	☐	☐	☐	☐	☐
关区对企业过去的满意记录	☐	☐	☐	☐	☐
出口货物种类单一及便于海关检查	☐	☐	☐	☐	☐
愿意更改货物流程以配合海关抽检	☐	☐	☐	☐	☐
便用电子报關处理货物及提单	☐	☐	☐	☐	☐
与该关区负责人关系良好与否	☐	☐	☐	☐	☐
关区抽验货物的次数或频密度	☐	☐	☐	☐	☐

您的意见/建议:

联系人 姓名 _____ 职位 _____

电话 _____ 传真 _____

电子邮件 _____

如果需要，我想做进一步的接见。

_____

签署

感谢您的帮助

Appendix B-3

To: Peter Wong, Department of Logistics, Hong Kong Polytechnic University
Fax: (852)23302704 or (755) 25599156

The PRD freight mode choice survey of Export Container traffic

Cargo Information

Business of your Company	Manufacturer / Shippers / Freight Forwarder / Others _____	
Company Name:	_____	
Factory/Depot	City A/ City B / City C / City D / Others: _____	
Customs Office that serve the depot/factory		
Export Commodity:	A. _____(%) B. _____(%) C. _____(%)	
Port of loading	□ GZH Airport □ SHZ Airport □ Hong Kong Airport via Road □ Hong Kong Airport via Barge	□ Yantian Port – direct □ Shekou Port – direct □ Other SZH Port – direct □ Hong Kong Port via Road □ Hong Kong Port via Barge
Estimated Annual Volume to USA (2004)	_____ 20' box	_____ 40' box
Daily Volume to USA :	_____ 20' box	_____ 40' box

How to answer this questionnaire

Please indicate the importance of each of the listed factors below in selecting the mode of transport.

Please kindly shade your choice. Only one choice is required in each question

Overall

	Most Important	Very Important	Important	A little important	*Not Important*
Required delivery time	☐	☐	☐	☐	☐
Trade terms in the contract, such as FOB / CIF / ExWork	☐	☐	☐	☐	☐
Cargo will pass through another Customs district	☐	☐	☐	☐	☐
Registration with the local Customs office	☐	☐	☐	☐	☐
Frequency of damage/loss of cargo	☐	☐	☐	☐	☐
Value of the cargo	☐	☐	☐	☐	☐
Tax rebate arrangement	☐	☐	☐	☐	☐

Your comments/suggestions:

Transport Costs

	Most Important	Very Important	Important	A little important	*Not Important*
Cost of service	☐	☐	☐	☐	☐
Distance to the loading port	☐	☐	☐	☐	☐
Freight charges	☐	☐	☐	☐	☐
Competitive rates	☐	☐	☐	☐	☐
Costs related to level of stocks	☐	☐	☐	☐	☐
Door-to-door rates	☐	☐	☐	☐	☐
Transportation costs	☐	☐	☐	☐	☐
Trucking cost to the loading port	☐	☐	☐	☐	☐
Low freight charges	☐	☐	☐	☐	☐

Your comments/suggestions:

Service Level

	Most Important	Very Important	Important	A little important	*Not Important*
Ability to control the shipment	☐	☐	☐	☐	☐
Care in handling	☐	☐	☐	☐	☐
Availability of origin and destination points	☐	☐	☐	☐	☐
Consistency of service	☐	☐	☐	☐	☐
Assistance in obtaining lower rate charges	☐	☐	☐	☐	☐
Availability for specialized equipment	☐	☐	☐	☐	☐
Provide geographical coverage	☐	☐	☐	☐	☐
Shipment information	☐	☐	☐	☐	☐
Delivery reliability	☐	☐	☐	☐	☐
Susceptibility to loss/damage of cargo	☐	☐	☐	☐	☐
Service quality	☐	☐	☐	☐	☐
Shipment tracing	☐	☐	☐	☐	☐
Equipment availability	☐	☐	☐	☐	☐
Physical facilities	☐	☐	☐	☐	☐
Pickup service	☐	☐	☐	☐	☐
Promotional material	☐	☐	☐	☐	☐
Reliable pickup and special order handling	☐	☐	☐	☐	☐
On time performance	☐	☐	☐	☐	☐
Relationship with shipper/cargo owner	☐	☐	☐	☐	☐

Your comments/suggestions:

Relationship with Carrier

	Most Important	Very Important	Important	A little important	*Not Important*
Ability to be representative of the buyer	☐	☐	☐	☐	☐
Claim settlement	☐	☐	☐	☐	☐
Provide freight forwarding services	☐	☐	☐	☐	☐
Quality of dispatch personnel	☐	☐	☐	☐	☐
Past record in satisfying customers	☐	☐	☐	☐	☐
Dependability/reliability of service	☐	☐	☐	☐	☐
Response in emergency	☐	☐	☐	☐	☐
Willingness to negotiate service & rates	☐	☐	☐	☐	☐
Flexibility in handling documents/equipment	☐	☐	☐	☐	☐
Special preference given to shipper	☐	☐	☐	☐	☐
Existence of substitutes in the neighbouring areas	☐	☐	☐	☐	☐

Your comments/suggestions:

Relationship with Customs Office

	Most Important	Very Important	Important	A little important	*Not Important*
Trusted by local Customs office	☐	☐	☐	☐	☐
Physical distance between depot/factory and Customs office	☐	☐	☐	☐	☐
Shipper is classified as " **Trustworthy enterprise**"	☐	☐	☐	☐	☐
Service quality of "Customs declaration" company	☐	☐	☐	☐	☐
Past Customs record of the shipper	☐	☐	☐	☐	☐
Homogenous cargo type – easy for Customs inspection	☐	☐	☐	☐	☐
Change own cargo flow path to accommodate Customs office's instructions	☐	☐	☐	☐	☐
Use paperless technology to handle documents and cargo	☐	☐	☐	☐	☐
Good relationship with the Customs office	☐	☐	☐	☐	☐
Frequency of cargo inspection from the Customs office	☐	☐	☐	☐	☐

Your comments/suggestions:

Information for Future Communication

Contact person Name: _____ Position _____

Tel: _____ Fax _____

Email: _____

I would like to take part in further interview, if needed.

_____

Signed

THANK YOU FOR YOUR HELP

Appendix C -1

XXXX Company
Shenzhen
China

30 May 2004

Ref: Survey of freight mode choice in PRD

Dear Sir/Madam,

I am a member of staff at Hong Kong Polytechnic University. The reason I am writing is to seek your kind assistance in compiling the following survey for my PhD thesis on the selection of transport mode by shippers in the Pearl River Delta (PRD).

Despite numerous journals and academic papers written on the freight mode choice in past decades, there is no paper written on the selection of freight mode choice in China, especially by container/carrier in PRD region. My thesis focuses on how the shippers in PRD region select their modal choice for exporting containers to the USA. I hope my work can bring in some new insight into the modal choice of containerized cargo.

Please kindly spare 5-10 minutes of your precious time to help me by completing the attached questionnaire. All data collected in this questionnaire will be used solely for academic research purposes. You can also access the same questionnaire on my website www.lgt.polyu.edu.hk/~pwong.

Once you completed the questionnaire, please kindly either:

1. fax it to Shenzhen 0755-123456;
2. fax it to Hong Kong 0852-23302704; OR
3. use the attached address label and post it back to me.

If you would like to be kept advised of the overall results, then please indicate this and I will send you further details of my work as it evolves. Also if you would like to discuss this work with me, please say so on the last page.

Thank you for your kind attention.

Yours faithfully,

Peter Wong
Lecturer
Department of Logistics
The Hong Kong Polytechnic University
Hung Hom, Hong Kong

Appendix D

Factor Analysis

Richard B. Darlington

Factor analysis includes both *component analysis* and *common factor analysis*. More than other statistical techniques, factor analysis has suffered from confusion concerning its very purpose. This affects my presentation in two ways. First, I devote a long section to describing what factor analysis does before examining in later sections how it does it. Second, I have decided to reverse the usual order of presentation. Component analysis is simpler, and most discussions present it first. However, I believe common factor analysis comes closer to solving the problems most researchers actually want to solve. Thus learning component analysis first may actually interfere with understanding what those problems are. Therefore component analysis is introduced only quite late in this chapter.

What Factor Analysis Can and Can't Do

I assume you have scores on a number of variables-- anywhere from 3 to several hundred variables, but most often between 10 and 100. Actually you need only the correlation or covariance matrix--not the actual scores. The purpose of factor analysis is to discover simple patterns in the pattern of relationships among the variables. In particular, it seeks to discover if the observed variables can be explained largely or entirely in terms of a much smaller number of variables called *factors*.

Some Examples of Factor-Analysis Problems

1. Factor analysis was invented nearly 100 years ago by psychologist Charles Spearman, who hypothesized that the enormous variety of tests of mental ability--measures of mathematical skill, vocabulary, other verbal skills, artistic skills, logical reasoning ability, etc.--could all be explained by one underlying "factor" of general intelligence that he called *g*. He hypothesized that if *g* could be measured and you could select a subpopulation of people with the same score on *g*, in that subpopulation you would find no correlations among any tests of mental ability. In other words, he hypothesized that *g* was the only factor common to all those measures.

It was an interesting idea, but it turned out to be wrong. Today the College Board testing service operates a system based on the idea that there are at least three important factors of mental ability--verbal, mathematical, and logical abilities--and most psychologists agree that many other factors could be identified as well.

2. Consider various measures of the activity of the autonomic nervous system--heart rate, blood pressure, etc. Psychologists have wanted to know whether, except for random fluctuation, all those measures move up and down together--the "activation" hypothesis. Or do groups of autonomic measures move up and down together, but separate from other groups? Or are all the measures largely independent? An unpublished analysis of mine found that in one data set, at any rate, the data fitted the activation hypothesis quite well.

3. Suppose many species of animal (rats, mice, birds, frogs, etc.) are trained that food will appear at a certain spot whenever a noise--any kind of noise--comes from that spot. You could then tell whether they could detect a particular sound by seeing whether they turn in that direction when the sound appears. Then if you studied many sounds and many species, you might want to know on how many different dimensions of hearing acuity the species vary. One hypothesis would be that they vary on just three dimensions--the ability to detect high-frequency sounds, ability to detect low-frequency sounds, and ability to detect intermediate sounds. On the other hand, species might differ in their auditory capabilities on more than just these three dimensions. For instance, some species might be better at detecting sharp click-like sounds while others are better at detecting continuous hiss-like sounds.

4. Suppose each of 500 people, who are all familiar with different kinds of automobiles, rates each of 20 automobile models on the question, "How much would you like to own that kind of automobile?" We could usefully ask about the number of dimensions on which the ratings differ. A one-factor theory would posit that people simply give the highest ratings to the most expensive models. A two-factor theory would posit that some people are most attracted to sporty models while others are most attracted to luxurious models. Three-factor and four-factor theories might add safety and reliability. Or instead of automobiles you might choose to study attitudes concerning foods, political policies, political candidates, or many other kinds of objects.

5. Rubenstein (1986) studied the nature of curiosity by analyzing the agreements of junior-high-school students with a large battery of statements such as "I like to figure out how machinery works" or "I like to try new kinds of food." A factor analysis identified seven factors: three measuring enjoyment of problem-solving, learning,

and reading; three measuring interests in natural sciences, art and music, and new experiences in general; and one indicating a relatively low interest in money.

The Goal: Understanding of Causes

Many statistical methods are used to study the relation between independent and dependent variables. Factor analysis is different; it is used to study the patterns of relationship among many dependent variables, with the goal of discovering something about the nature of the independent variables that affect them, even though those independent variables were not measured directly. Thus answers obtained by factor analysis are necessarily more hypothetical and tentative than is true when independent variables are observed directly. The inferred independent variables are called *factors*. A typical factor analysis suggests answers to four major questions:

1. How many different factors are needed to explain the pattern of relationships among these variables?
2. What is the nature of those factors?
3. How well do the hypothesized factors explain the observed data?
4. How much purely random or unique variance does each observed variable include?

Absolute Versus Heuristic Uses of Factor Analysis

A *heuristic* is a way of thinking about a topic which is convenient even if not absolutely true. We use a heuristic when we talk about the sun rising and setting as if the sun moved around the earth, even though we know it doesn't. "Heuristic" is both a noun and an adjective; to use a heuristic is to think in heuristic terms.

The previous examples can be used to illustrate a useful distinction--between *absolute* and *heuristic* uses of factor analysis. Spearman's *g* theory of intelligence, and the activation theory of autonomic functioning, can be thought of as absolute theories which are or were hypothesized to give complete descriptions of the pattern of relationships among variables. On the other hand, Rubenstein never claimed that her list of the seven major factors of curiosity offered a complete description of curiosity. Rather those factors merely appear to be the most important seven factors--the best way of summarizing a body of data. Factor analysis can suggest either absolute or heuristic models; the distinction is in how you interpret the output.

Is Factor Analysis Objective?

The concept of heuristics is useful in understanding a property of factor analysis which confuses many people. Several scientists may apply factor analysis to similar or even identical sets of measures, and one may come up with 3 factors while another comes up with 6 and another comes up with 10. This lack of agreement has tended to discredit all uses of factor analysis. But if three travel writers wrote travel guides to the United States, and one divided the country into 3 regions, another into 6, and another into 10, would we say that they contradicted each other? Of course not; the various writers are just using convenient ways of organizing a topic, not claiming to represent the only correct way of doing so. Factor analysts reaching different conclusions contradict each other only if they all claim absolute theories, not heuristics. The fewer factors the simpler the theory; the more factors the better the theory fits the data. Different workers may make different choices in balancing simplicity against fit.

A similar balancing problem arises in regression and analysis of variance, but it generally doesn't prevent different workers from reaching nearly or exactly the same conclusions. After all, if two workers apply an analysis of variance to the same data, and both workers drop out the terms not significant at the .05 level, then both will report exactly the same effects. However, the situation in factor analysis is very different. For reasons explained later, there is no significance test in component analysis that will test a hypothesis about the number of factors, as that hypothesis is ordinarily understood. In common factor analysis there is such a test, but its usefulness is limited by the fact that it frequently yields more factors than can be satisfactorily interpreted. Thus a worker who wants to report only interpretable factors is still left without an objective test.

A similar issue arises in identifying the nature of the factors. Two workers may each identify 6 factors, but the two sets of factors may differ--perhaps substantially. The travel-writer analogy is useful here too; two writers might each divide the US into 6 regions, but define the regions very differently.

Another geographical analogy may be more parallel to factor analysis, since it involves computer programs designed to maximize some quantifiable objective. Computer programs are sometimes used to divide a state into congressional districts which are geographically continguous, nearly equal in population, and perhaps homogeneous on dimensions of ethnicity or other factors. Two different district-creating programs might come

up with very different answers, though both answers are reasonable. This analogy is in a sense too good; we believe that factor analysis programs usually don't yield answers as different from each other as district-creating programs do.

Factor Analysis Versus Clustering and Multidimensional Scaling

Another challenge to factor analysis has come from the use of competing techniques such as cluster analysis and multidimensional scaling. While factor analysis is typically applied to a correlation matrix, those other methods can be applied to any sort of matrix of similarity measures, such as ratings of the similarity of faces. But unlike factor analysis, those methods cannot cope with certain unique properties of correlation matrices, such as reflections of variables. For instance, if you reflect or reverse the scoring direction of a measure of "introversion", so that high scores indicate "extroversion" instead of introversion, then you reverse the signs of all that variable's correlations: -.36 becomes +.36, +.42 becomes -.42, and so on. Such reflections would completely change the output of a cluster analysis or multidimensional scaling, while factor analysis would recognize the reflections for what they are; the reflections would change the signs of the "factor loadings" of any reflected variables, but would not change anything else in the factor analysis output.

Another advantage of factor analysis over these other methods is that factor analysis can recognize certain properties of correlations. For instance, if variables A and B each correlate .7 with variable C, and correlate .49 with each other, factor analysis can recognize that A and B correlate zero when C is held constant because $.7^2 = .49$. Multidimensional scaling and cluster analysis have no ability to recognize such relationships, since the correlations are treated merely as generic "similarity measures" rather than as correlations.

We are not saying these other methods should never be applied to correlation matrices; sometimes they yield insights not available through factor analysis. But they have definitely not made factor analysis obsolete. The next section touches on this point.

Factors "Differentiating" Variables Versus Factors "Underlying" Variables

When someone says casually that a set of variables seems to reflect "just one factor", there are several things they might mean that have nothing to do with factor analysis. If we word statements more carefully, it turns out that the phrase "just one factor *differentiates* these variables" can mean several different things, none of which corresponds to the factor analytic conclusion that "just one factor *underlies* these variables".

One possible meaning of the phrase about "differentiating" is that a set of variables all correlate highly with each other but differ in their means. A rather similar meaning can arise in a different case. Consider several tests A, B, C, D which test the same broadly-conceived mental ability, but which increase in difficulty in the order listed. Then the highest correlations among the tests may be between adjacent items in this list (r_{AB}, r_{BC} and r_{CD}) while the lowest correlation is between items at the opposite ends of the list (r_{AD}). Someone who observed this pattern in the correlations among the items might well say the tests "can be put in a simple order" or "differ in just one factor", but that conclusion has nothing to do with factor analysis. This set of tests would *not* contain just one common factor.

A third case of this sort may arise if variable A affects B, which affects C, which affects D, and those are the only effects linking these variables. Once again, the highest correlations would be r_{AB}, r_{BC} and r_{CD} while the lowest correlation would be r_{AD}. Someone might use the same phrases just quoted to describe this pattern of correlations; again it has nothing to do with factor analysis.

A fourth case is in a way a special case of all the previous cases: a perfect Guttman scale. A set of dichotomous items fits a Guttman scale if the items can be arranged so that a negative response to any item implies a negative response to all subsequent items while a positive response to any item implies a positive response to all previous items. For a trivial example consider the items

- Are you above 5 feet 2 inches in height?
- Are you above 5 feet 4 inches in height?
- Are you above 5 feet 6 inches in height?
- Etc.

To be consistent, a person answering negatively to any of these items must answer negatively to all later items, and a positive answer implies that all previous answers must be positive. For a nontrivial example consider the following questionnaire items:

- Should our nation lower tariff barriers with nation B?
- Should our two central banks issue a single currency?
- Should our armies become one?
- Should we fuse with nation B, becoming one nation?

If it turned out that these items formed a perfect Guttman scale, it would be easier to describe peoples' attitutes about "nation B" than if they didn't. When a set of items does form a Guttman scale, interestingly it does not imply that factor analysis would discover a single common factor. A Guttman scale implies that one factor *differentiates* a set of items (e.g, "favorableness toward cooperation with nation B"), not that one factor *underlies* those items.

Applying multidimensional scaling to a correlation matrix could discover all these simple patterns of differences among variables. Thus multidimensional scaling seeks factors which *differentiate* variables while factor analysis looks for the factors which *underlie* the variables. Scaling may sometimes find simplicity where factor analysis finds none, and factor analysis may find simplicity where scaling finds none.

A Dubious History

If a statistical method can have an embarrassing history, factor analyis is that method. Around 1950 the reputation of factor analysis suffered from overpromotion by a few overenthusiastic partisans. In retrospect there were three things wrong with the way some people were thinking about factor analysis at that time. First, some people seemed to see factor analysis as *the* statistical method rather than *a* statistical method. Second, they were thinking in absolute terms about problems for which a heuristic approach would have been more appropriate. Third, they were thinking of overly broad sets of variables ("we want to understand all of human personality" rather than "we want to understand the nature of curiosity"). Thus in three different ways, they were attempting to stretch factor analysis farther than it was capable of going. In recent decades factor analysis seems to have found its rightful place as a family of methods which is useful for certain limited purposes.

Basic Concepts and Principles

A Simple Example

A factor analysis usually begins with a correlation matrix I'll denote R. Below is an artificial 5 x 5 correlation matrix I'll call R55.

```
1.00  .72  .63  .54  .45
 .72 1.00  .56  .48  .40
 .63  .56 1.00  .42  .35
 .54  .48  .42 1.00  .30
 .45  .40  .35  .30 1.00
```

Imagine that these are correlations among 5 variables measuring mental ability. Matrix R55 is exactly consistent with the hypothesis of a single common factor *g* whose correlations with the 5 observed variables are respectively .9, .8, .7, .6, and .5. To see why, consider the formula for the partial correlation between two variables *a* and *b* partialing out a third variable *g*:

$$r_{ab.g} = (r_{ab} - r_{ag}\, r_{bg})/\mathrm{sqrt}[(1-r_{ag}^2)(1-r_{bg}^2)]$$

This formula shows that $r_{ab.g} = 0$ if and only if $r_{ab} = r_{ag}\, r_{bg}$. The requisite property for a variable to function as a general factor *g* is that any partial correlation between any two observed variables, partialing out *g*, is zero. Therefore if a correlation matrix can be explained by a general factor *g*, it will be true that there is some set of correlations of the observed variables with *g*, such that the product of any two of those correlations equals the correlation between the two observed variables. But matrix R55 has exactly that property. That is, any off-diagonal entry r_{jk} is the product of the *j*th and *k*th entries in the row .9 .8 .7 .6 .5. For instance, the entry in row 1 and column 3 is .9 x .7 or .63. Thus matrix R55 exactly fits the hypothesis of a single common factor.

If we found that pattern in a real correlation matrix, what exactly would we have shown? First, the existence of the factor is *inferred* rather than *observed*. We certainly wouldn't have *proven* that scores on these 5 variables are affected by just one common factor. However, that is the simplest or most parsimonious hypothesis that fits the pattern of observed correlations.

Second, we would have an estimate of the factor's correlation with each of the observed variables, so we can say something about the factor's nature, at least in the sense of what it correlates highly with or doesn't correlate with. In this example the values .9 .8 .7 .6 .5 are these estimated correlations.

Third, we couldn't measure the factor in the sense of deriving each person's exact score on the factor. But we can if we wish use methods of multiple regression to estimate each person's score on the factor from their scores on the observed variables.

Matrix R55 is virtually the simplest possible example of common factor analysis, because the observed correlations are perfectly consistent with the simplest possible factor-analytic hypothesis--the hypothesis of a single common factor. Some other correlation matrix might not fit the hypothesis of a single common factor, but might fit the hypothesis of two or three or four common factors. The fewer factors the simpler the hypothesis. Since simple hypothesis generally have logical scientific priority over more complex hypotheses, hypotheses involving fewer factors are considered to be preferable to those involving more factors. That is, you accept at least tentatively the simplest hypothesis (i.e., involving the fewest factors) that is not clearly contradicted by the set of observed correlations. Like many writers, I'll let *m* denote the hypothesized number of common factors.

Without getting deeply into the mathematics, we can say that factor analysis attempts to express each variable as the sum of *common* and *unique* portions. The common portions of all the variables are by definition fully explained by the common factors, and the unique portions are ideally perfectly uncorrelated with each other. The degree to which a given data set fits this condition can be judged from an analysis of what is usually called the "residual correlation matrix".

The name of this matrix is somewhat misleading because the entries in the matrix are typically not correlations. If there is any doubt in your mind about some particiular printout, look for the diagonal entries in the matrix, such as the "correlation" of the first variable with itself, the second with itself, etc. If these diagonal entries are not all exactly 1, then the matrix printed is not a correlation matrix. However, it can typically be transformed into a correlation matrix by dividing each off-diagonal entry by the square roots of the two corresponding diagonal entries. For instance, if the first two diagonal entries are .36 and .64, and the off-diagonal entry in position [1,2] is .3, then the residual correlation is .3/(.6*.8) = 5/8 = .625.

Correlations found in this way are the correlations that would have to be allowed among the "unique" portions of the variables in order to make the common portions of the variables fit the hypothesis of *m* common factors. If these calculated correlations are so high that they are inconsistent with the hypothesis that they are 0 in the population, then the hypothesis of *m* common factors is rejected. Increasing *m* always lowers these correlations, thus producing a hypothesis more consistent with the data.

We want to find the simplest hypothesis (that is, the lowest *m*) consistent with the data. In this respect, a factor analysis can be compared to episodes in scientific history that took decades or centuries to develop. Copernicus realized that the earth and other planets moved around the sun, but he first hypothesized that their orbits were circles. Kepler later realized that the orbits were better described as ellipses. A circle is a simpler figure than an ellipse, so this episode of scientific history illustrates the general point that we start with a simple theory and gradually make it more complex to better fit the observed data.

The same principle can be observed in the history of experimental psychology. In the 1940s, experimental psychologists widely believed that all the basic principles of learning, that might even revolutionize educational practice, could be discovered by studying rats in mazes. Today that view is considered ridiculously oversimplified, but it does illustrate the general scientific point that it is reasonable to start with a simple theory and gradually move to more complex theories only when it becomes clear that the simple theory fails to fit the data.

This general scientific principle can be applied within a single factor analysis. Start with the simplest possible theory (usually $m = 1$), test the fit between that theory and the data, and then increase *m* as needed. Each increase in *m* produces a theory that is more complex but will fit the data better. Stop when you find a theory that fits the data adequately.

Each observed variable's *communality* is its estimated squared correlation with its own common portion--that is, the proportion of variance in that variable that is explained by the common factors. If you perform factor analyses with several different values of *m*, as suggested above, you will find that the communalities generally increase with *m*. But the communalities are not used to choose the final value of *m*. Low communalities are not interpreted as evidence that the data fail to fit the hypothesis, but merely as evidence that the variables analyzed

have little in common with one another. Most factor analysis programs first estimate each variable's communality as the squared multiple correlation between that variable and the other variables in the analysis, then use an iterative procedure to gradually find a better estimate.

Factor analysis may use either correlations or *covariances*. The covariance cov_{jk} between two variables numbered *j* and *k* is their correlation times their two standard deviations: $cov_{jk} = r_{jk}\ s_j\ s_k$, where r_{jk} is their correlation and s_j and s_k are their standard deviations. A covariance has no very important substantive meaning, but it does have some very useful mathematical properties described in the next section. Since any variable correlates 1 with itself, any variable's covariance with itself is its variance--the square of its standard deviation. A correlation matrix can be thought of as a matrix of variances and covariances (more concisely, a covariance matrix) of a set of variables that have already been adjusted to standard deviations of 1. Therefore I shall often talk about a covariance matrix when we really mean either a correlation or covariance matrix. I will use R to denote either a correlation or covariance matrix of observed variables. This is admittedly awkward, but the matrix analyzed is nearly always a correlation matrix, and as explained later we need the letter C for the common-factor portion of R.

Matrix Decomposition and Rank

This *optional* section gives a little more detail on the mathematics of factor analysis. I assume you are familiar with the central theorem of analysis of variance: that the sum of squares of a dependent variable Y can be partitioned into components which sum to the total. In any analysis of variance the total sum of squares can be partitioned into model and residual components. In a two-way factorial analysis of variance with equal cell frequencies, the model sum of squares can be further partitioned into row, column, and interaction components.

The central theorem of factor analysis is that you can do something similar for an entire covariance matrix. A covariance matrix R can be partitioned into a common portion C which is explained by a set of factors, and a unique portion U unexplained by those factors. In matrix terminology, R = C + U, which means that each entry in matrix R is the sum of the corresponding entries in matrices C and U.

As in analysis of variance with equal cell frequencies, the explained component C can be broken down further. C can be decomposed into component matrices c_1, c_2, etc., explained by individual factors. Each of these one-factor components c_j equals the "outer product" of a column of "factor loadings". The outer product of a column of numbers is the square matrix formed by letting entry *jk* in the matrix equal the product of entries *j* and *k* in the column. Thus if a column has entries .9, .8, .7, .6, .5, as in the earlier example, its outer product is

	.81	.72	.63	.54	.45
	.72	.64	.56	.48	.40
c_1	.63	.56	.49	.42	.35
	.54	.48	.42	.36	.30
	.45	.40	.35	.30	.25

Earlier I mentioned the off-diagonal entries in this matrix but not the diagonal entries. Each diagonal entry in a c_j matrix is actually the amount of variance in the corresponding variable explained by that factor. In our example, *g* correlates .9 with the first observed variable, so the amount of explained variance in that variable is $.9^2$ or .81, the first diagonal entry in this matrix.

In the example there is only one common factor, so matrix C for this example (denoted C55) is $C55 = c_1$. Therefore the residual matrix U for this example (denoted U55) is $U55 = R55 - c_1$. This gives the following matrix for U55:

	.19	.00	.00	.00	.00
	.00	.36	.00	.00	.00
U55	.00	.00	.51	.00	.00
	.00	.00	.00	.64	.00
	.00	.00	.00	.00	.75

This is the covariance matrix of the portions of the variables unexplained by the factor. As mentioned earlier, all off-diagonal entries in U55 are 0, and the diagonal entries are the amounts of unexplained or unique variance in each variable.

Often C is the sum of several matrices c_j, not just one as in this example. The number of *c*-matrices which sum to C is the *rank* of matrix C; in this example the rank of C is 1. The rank of C is the number of common factors in that model. If you specify a certain number *m* of factors, a factor analysis program then derives two matrices C and U which sum to the original correlation or covariance matrix R, making the rank of C equal *m*. The larger you set *m*, the closer C will approximate R. If you set *m* = *p*, where *p* is the number of variables in the matrix, then every entry in C will exactly equal the corresponding entry in R, leaving U as a matrix of zeros. The idea is to see how low you can set *m* and still have C provide a reasonable approximation to R.

How Many Cases and Variables?
The clearer the true factor structure, the smaller the sample size needed to discover it. But it would be very difficult to discover even a very clear and simple factor structure with fewer than about 50 cases, and 100 or more cases would be much preferable for a less clear structure.

The rules about number of variables are very different for factor analysis than for regression. In factor analysis it is perfectly okay to have many more variables than cases. In fact, generally speaking the more variables the better, so long as the variables remain relevant to the underlying factors.

How Many Factors?
This section describes two rules for choosing the number of factors. Readers familiar with factor analysis will be surprised to find no mention of Kaiser's familiar eigenvalue rule or Cattell's scree test. Both rules are mentioned later, though as explained at that time I consider both rules obsolescent. Also both use eigenvalues, which I have not yet introduced.

Of the two rules that are discussed in this section, the first uses a formal significance test to identify the number of common factors. Let N denote the sample size, *p* the number of variables, and *m* the number of factors. Also R_U denotes the residual matrix U transformed into a correlation matrix, $|R_U|$ is its determinant, and $\ln(1/|R_U|)$ is the natural logarithm of the reciprocal of that determinant.

To apply this rule, first compute $G = N-1-(2p+5)/6-(2/3)m$. Then compute

$$\text{Chi-square} = G \ln(1/|R_U|)$$

with

$$df = .5[(p-m)^2-p-m]$$

If it is difficult to compute $\ln(1/|R_U|)$, that expression is often well approximated by r_U^2, where the summation denotes the sum of all squared correlations above the diagonal in matrix R_U.

To use this formula to choose the number of factors, start with $m = 1$ (or even with $m = 0$) and compute this test for successively increasing values of *m*, stopping when you find nonsignificance; that value of *m* is the smallest value of *m* that is not significantly contradicted by the data. The major difficulty with this rule is that in my experience, with moderately large samples it leads to more factors than can successfully be interpreted.

I recommend an alternative approach. This approach was once impractical, but today is well within reach. Perform factor analyses with various values of *m*, complete with rotation, and choose the one that gives the most appealing structure.

Rotation

In the opening example on curiosity, I mentioned individual factors that Rubenstein described: enjoyment of reading, interest in science, etc. Rotation is the step in factor analysis that allows you to identify meaningful factor names or descriptions like these.

Linear Functions of Predictors

To understand rotation, first consider a problem that doesn't involve factor analysis. Suppose you want to predict the grades of college students (all in the same college) in many different courses, from their scores on general "verbal" and "math" skill tests. To develop predictive formulas, you have a body of past data consisting of the grades of several hundred previous students in these courses, plus the scores of those students on the math and verbal tests. To predict grades for present and future students, you could use these data from past students to fit a series of two-variable multiple regressions, each regression predicting grade in one course from scores on the two skill tests.

Now suppose a co-worker suggests summing each student's verbal and math scores to obtain a composite "academic skill" score I'll call AS, and taking the difference between each student's verbal and math scores to obtain a second variable I'll call VMD (verbal-math difference). The co-worker suggests running the same set of regressions to predict grades in individual courses, except using AS and VMD as predictors in each regression, instead of the original verbal and math scores. In this example, you would get exactly the same predictions of course grades from these two families of regressions: one predicting grades in individual courses from verbal and math scores, the other predicting the same grades from AS and VMD scores. In fact, you would get the

same predictions if you formed composites of 3 math + 5 verbal and 5 verbal + 3 math, and ran a series of two-variable multiple regressions predicting grades from these two composites. These examples are all *linear functions* of the original verbal and math scores.

The central point is that if you have *m* predictor variables, and you replace the *m* original predictors by *m* linear functions of those predictors, you generally neither gain or lose any information--you could if you wish use the scores on the linear functions to reconstruct the scores on the original variables. But multiple regression uses whatever information you have in the optimum way (as measured by the sum of squared errors in the current sample) to predict a new variable (e.g. grades in a particular course). Since the linear functions contain the same information as the original variables, you get the same predictions as before.

Given that there are many ways to get exactly the same predictions, is there any advantage to using one set of linear functions rather than another? Yes there is; one set may be *simpler* than another. One particular pair of linear functions may enable many of the course grades to be predicted from just one variable (that is, one linear function) rather than from two. If we regard regressions with fewer predictor variables as simpler, then we can ask this question: Out of all the possible pairs of predictor variables that would give the same predictions, which is simplest to use, in the sense of minimizing the number of predictor variables needed in the typical regression? The pair of predictor variables maximining some measure of simplicity could be said to have *simple structure*. In this example involving grades, you might be able to predict grades in some courses accurately from just a verbal test score, and predict grades in other courses accurately from just a math score. If so, then you would have achieved a "simpler structure" in your predictions than if you had used both tests for all predictions.

Simple Structure in Factor Analysis

The points of the previous section apply when the predictor variables are factors. Think of the *m* factors F as a set of independent or predictor variables, and think of the *p* observed variables X as a set of dependent or criterion variables. Consider a set of *p* multiple regressions, each predicting one of the variables from all *m* factors. The standardized coefficients in this set of regressions form a *p* x *m* matrix called the *factor loading matrix*. If we replaced the original factors by a set of linear functions of those factors, we would get exactly the same predictions as before, but the factor loading matrix would be different. Therefore we can ask which, of the many possible sets of linear functions we might use, produces the simplest factor loading matrix. Specifically we will define simplicity as the number of zeros or near-zero entries in the factor loading matrix--the more zeros, the simpler the structure. Rotation does not change matrix C or U at all, but does change the factor loading matrix.

In the extreme case of simple structure, each X-variable will have only one large entry, so that all the others can be ignored. But that would be a simpler structure than you would normally expect to achieve; after all, in the real world each variable isn't normally affected by only one other variable. You then name the factors subjectively, based on an inspection of their loadings.

In common factor analysis the process of rotation is actually somewhat more abstract that I have implied here, because you don't actually know the individual scores of cases on factors. However, the statistics for a multiple regression that are most relevant here--the multiple correlation and the standardized regression slopes--can all be calculated just from the correlations of the variables and factors involved. Therefore we can base the calculations for rotation to simple structure on just those correlations, without using any individual scores.

A rotation which requires the factors to remain uncorrelated is an *orthogonal* rotation, while others are *oblique* rotations. Oblique rotations often achieve greater simple structure, though at the cost that you must also consider the matrix of factor intercorrelations when interpreting results. Manuals are generally clear which is which, but if there is ever any ambiguity, a simple rule is that if there is any ability to print out a matrix of factor correlations, then the rotation is oblique, since no such capacity is needed for orthogonal rotations.

REFERENCES

Darlington, Richard B., Sharon Weinberg, and Herbert Walberg (1973). Canonical variate analysis and related techniques. *Review of Educational Research*, 453-454.

Gorsuch, Richard L. (1983) *Factor Analysis*. Hillsdale, NJ: Erlbaum

Morrison, Donald F. (1990) *Multivariate Statistical Methods*. New York: McGraw-Hill.

Rubenstein, Amy S. (1986). An item-level analysis of questionnaire-type measures of intellectual curiosity. Cornell University Ph. D. thesis.

Appendix

Analytic Hierarchy Process

Abstract from Wikipedia dictionary

The **Analytic Hierarchy Process** (AHP) is a technique for decision making where there are a limited number of choices, but where each has a number of different attributes, some or all of which may be difficult to formalize. It is especially applicable when decisions are being made by a team.

AHP can assist with identifying and weighting selection criteria, analyzing the data collected for the criteria, and expediting the decision-making process. It helps capture both subjective and objective evaluation measures, providing a useful mechanism for checking the consistency of the evaluation measures and alternatives suggested by the team.

The process is based on a series of pairwise comparisons that are checked for internal consistency and then combined.

Summary

The procedure can be summarized as:

1. The alternatives and the significant attributes are identified.
2. For each attribute, and each pair of alternatives, the decision makers specify their preference (for example, whether the location of alternative "A" is preferred to that of "B") in the form of a fraction between 1/9 and 9.
3. Decision makers similarly indicate the relative significance of the attributes. For example, if the alternatives are comparing potential real-estate purchases, the investors might say they prefer location over price and price over timing.
4. Each matrix of preferences is evaluated by using eigenvalues to check the consistency of the responses. This produces a "consistency coefficient" where a value of "1" means all preferences are internally consistent. This value would be lower, however, if a decision maker said X is preferred to Y, Y to Z but Z is preferred to X (such a position is internally inconsistent). It is this step that that causes many users to believe that AHP is theoretically well founded.
5. A score is calculated for each alternative.

Criticisms

Despite its widespread use as a decision method, the AHP has received some criticisms. In spite of them, AHP remains immensely popular among private and public sector decision-makers.

AHP, like many systems based on pairwise comparisons, can produce "rank reversal" outcomes. That is a situation where the order of preference is, for example, A, B, C then D. But if C is eliminated for other reasons, the order of A and B could be reversed so that the resulting priority is then B, A, then D. It has been proven that any pairwise comparison system will still have rank-reversal solutions even when the pair preferences are consistent Proponents argue that rank reversal may still be desirable but this is also controversial. Given

the example, this would be the position that if C were eliminated, the preference of A over B *should* be switched.

Many alternatives to AHP are economically viable, especially for larger, riskier decision. Methods from decision theory and various economic modeling methods can be applied. A scoring method that has a superior track record of improving decisions was developed by Egon Brunswik in the 1950's.