SEAPORT SUPPLY CHAIN INTEGRATION AND ORIENTATION, AND THEIR IMPACT ON PERFORMANCE

by

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A thesis submitted in fulfillment of the requirements for the degree of

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in

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ABSTRACT

This thesis primarily aims to examine the causal relationships among the integration strategies of seaport terminals along the supply chain, and the antecedents and consequences of the integration strategies. In this thesis integration strategy is termed Port Supply Chain Integration (PSCI) and the antecedents and the consequences of PSCI were identified and termed as Port Supply Chain Orientation (PSCO) and Port Performance (PP). A research model representing these causal relationships was developed through a comprehensive literature review and a semi-structured interview with practitioners and academics. The research used Structural Equation Modelling (SEM) to validate the constructs and rigorously test the relationships among them. Furthermore, a multi-group analysis was conducted in order to assess the applicability of the research model to different environments. The multi-group analysis tested whether the research model can be applied to two sample ports (A and B) and two sample groups (terminal operating companies and port users). The data used in these empirical analyses were collected from terminal operating companies, shipping companies and freight forwarders in South Korea, and the number of responses was 127.

With regard to the results and findings of the empirical research, firstly, the three constructs, PSCO, PSCI and PP were successfully validated with the components identified from the literature review and interviews indicating that the three constructs are multi-dimensional concepts. Secondly, the empirical research showed that PSCO has a strong contribution to PSCI, and PSCI has a strong and positive impact on PP. Additionally PSCO, in turn, was found to influence positively and indirectly on PP through implementing PSCI. Finally the multi-group analysis showed that the research model can be equally applied to the two sample ports. However, the invariance test across two sample groups failed since a baseline model for the invariance test was not established.

In conclusion, this thesis suggests that the integration strategy of ports along supply chains (PSCI) should be firmly based on a strong orientation to supply chain integration (PSCO) within individual seaport terminals, and the successful implementation of this strategy necessarily involves significant improvement of performance of the terminals (PP). It is also emphasised that these suggestions are valid across terminals with different operational and managerial characteristics such as hub port vs. feeder port and container port vs. non-container port.

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LIST OF ABBREVIATIONS

Abbreviations	Full words
ADF	Asymptotic Distribution-Free
AIC	Aaike Information Criterion
AGFI	Adjusted Goodness-of Fit Index
AMOS	Analysis of Moment Structures
ANOVA	Analysis Of Variance
AVE	Average Variance Extracted
CAIC	Consistent Aaike Information Criterion
CFI	Confirmatory Factor Analysis
CR	Composite Reliabilities
DC	Distribution Centre
DEA	Data Envelopment Analysis
ECM	Error Correction Model
EFF	Efficiency
EFC	Effectiveness
FR	Financial Resources
FWD	Freight Forwarder
GFI	Goodness-of-Fit index
HR	Human Resources
ICS	Information and Communication Systems
IMT	Inter-Modal Transport
ISCS	Information Sharing and Communication System
IT	Information Technology
LISREL	Linear Structural Relations
LVPLS	Latent Variable Partial Least Square
LV	Latent Variable
MANOVA	Multivariate Analysis Of Variance
MCDM	Multi-Criteria Decision Making
ML	Maximun Likelihood
MO	Marketing Orientation
MSO	Multimodal System and Operation
NFI	Normed Fit Index
LTR	Long-Term Relationships

OR	Organisational Relationships
OV	Observed Variable
PCNFI	Parsimony Comparative Fit Index
PLS	Partial Least Squares
PNFI	Parsimony Normed Fit Index
TOC	Terminal Operating Comapany
PP	Port Performance
PSCI	Port Supply Chain Integration
PSCO	Port Supply Chain Orientation
PU	Port User
RMR	Root Mean Square Residual
RMSEA	Root Mean Square Error of Approximation
SC	Shipping Company
SCIP	Supply Chain Integration Practices
SCM	Supply Chain Management
SCO	Supply Chain Orientation
SMO	Supply Management Orientation
SEM	Structural Equation Modelling
SFA	Stochastic Frontier Analysis
SRMR	Standardised Root Mean Square Residual
TLI	Tucker-Lewis Index
TMS	Top Management Support
TMT	Top Management Team
ULS	Unweighted Least Squares
VAL	Value-Added Logistics
VAS	Value-Added Services
WLS	Weighted Least Squares

CHAPTER 1

INTRODUCTION

This chapter provides an overview of this thesis to delineate the problems this research intends to solve; why the problems are worth exploring, how the problems are addressed in the research, and so on. Therefore the first section presents the background of this research, and, the second section outlines research objectives and research questions. The third and fourth sections illustrate the framework and the structure of this thesis respectively.

1.1 BACKGROUND

Under the trend of globalising manufacturing and consumption, the logistics and transport industry has been challenged to meet the complicated demands of customers. Manufacturing companies realise the necessity of managing supply chains effectively in response to the globalisation of the economy and intensifying competition, and therefore the need to adopt new strategies such as Supply Chain Management (SCM), and the global sourcing and outsourcing of logistics functions. These strategies have required the logistics and transport industry to provide integrated logistics services covering wider geographical spans than the more fragmented approach which existed previously (Heaver 2001). These challenges triggered the transport industry to move towards, and integrate into, global supply chains.

In a maritime logistics context, shipping companies have shown the most proactive response, integrating horizontally through mergers, acquisitions and strategic alliances, and/or vertically through operating dedicated terminals and by providing integrated logistics and intermodal services (Heaver *et al.* 2001). The reactions of shipping companies ultimately have affected every facet of the maritime industry and have led to structural changes, in particular, in the port industry (Slack *et al.* 2002). The bargaining power of the shipping liners who are the primary customer became much more powerful, and the competition between ports has become more intense due to new entrants. Many studies suggest that ports have had to evolve across the range of their activities to cope with the challenges (Carbone and De Martino 2003; Notteboom 2004; Robinson 2002). Broadly saying, two principal strategies have emerged: first the development of global networks which can be achieved by horizontal integration, and second the integration along supply chains which relate to vertical integration.

This study concerns the latter strategy which attempts to achieve competitive advantage through enhancing customer services by providing integrated and differentiated logistics services. This is because: (1) while the former strategy may be arguably limited to Global Port Operators (GPOs), the latter can be adopted more broadly by port operators; (2) the latter may require port operators to have more complicated capability and knowledge as a variety of parties located in different levels of supply chains need to be involved and considered to implement this strategy while the former may be relatively simple to practice as this strategy concerns the same business in different locations; (3) the research regarding the latter strategy may produce more useful managerial implications, and (4) despite its strategic and managerial importance, the issues regarding this strategy have rarely been conducted, particularly, from a managerial perspective (Notteboom 2004; Panayides 2006).

Recent literature shows evidence of distinctive trends towards the integration of ports into logistics and supply chains (De Langen and Chouly 2009; Pettit and Beresford 2009). Some researchers, based on such studies, have also attempted to expand and apply the issues of port integration in supply chains to other traditional research areas (Bichou and Gray 2004; 2005; Mangan *et al.* 2008; Notteboom and Rodrigue 2005;

Pettit and Beresford 2009). However, although researchers have emphasised that the integration of ports into supply chains should be strategically adopted to improve port performance, the impact of this strategy on port performance has rarely been researched. This implies port operators may not be theoretically sure about the benefits of adopting this strategy, for example, whether this strategy can contribute to their performance, how strong the contribution is, which aspect of performance, e.g. efficiency or effectiveness, is more affected through implementing the strategy and so on. In addition it would be useful to terminal operators to investigate which organisational characteristics and attributes contribute to facilitating the implementation of integration strategies. It is true that, due to the lack of the relevant studies concerning the economic and organisational aspects of this integration strategy, further theoretical and empirical discussion on this issue has been impeded.

1.2 RESEARCH OBJECTIVE AND QUESTIONS

This research, against the background presented above, primarily aims at examining the causal relationships involved in the integration strategy of ports along supply chains: between the integration strategy and the organisational characteristics facilitating the strategy as the antecedents to the integration strategy; between the integration strategy and port performance as the consequence of the strategy. The research questions associated with this objective are as follows:

RQ1: What are the main dimensions and activities of the integration strategy of ports along supply chains?

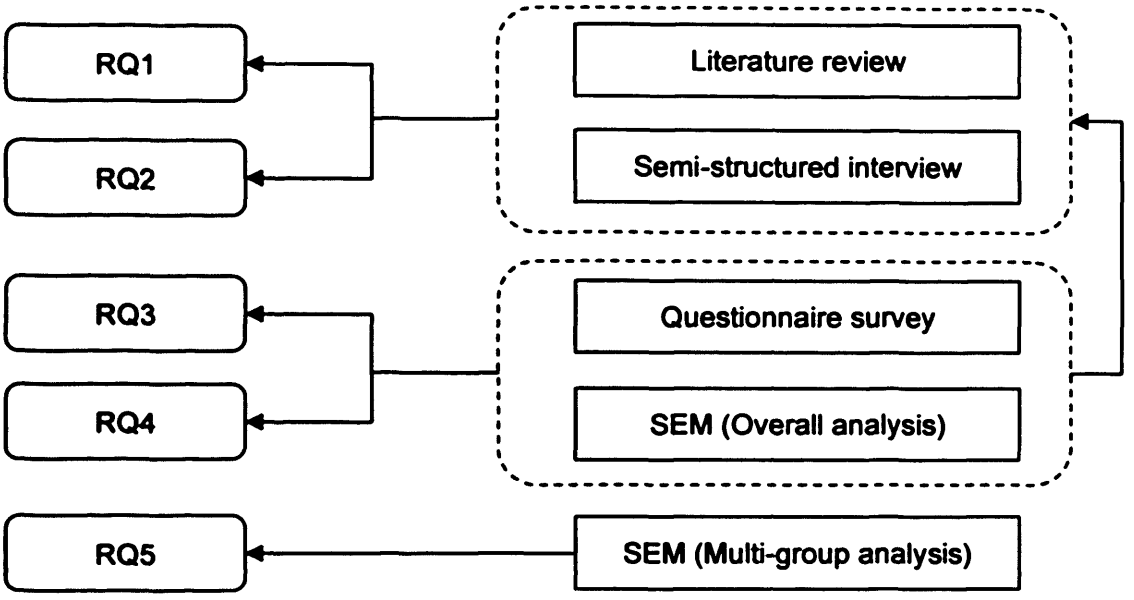
RQ2: What are the organisational characteristics and capabilities that facilitate the integration strategy of ports along supply chains?

RQ3: What is the impact of the integration strategy on port performance?

RQ4: How strongly do the organisational characteristics and capabilities contribute to the integration strategy of ports along supply chains?

RQ5: Can these relationships be equally applied to different environments?

Figure 1.1 Methods to address the research questions



This research, from the methodological view, intends to achieve the objective and to address the research questions using a quantitative approach, which measures the phenomena of interest and assesses the relationships among them using appropriate statistical tools. From this standpoint, these research questions are addressed as shown in Figure 1.1.

The first and second questions concern how the integration strategy and the antecedents to the integration strategy can be conceptualised. These two concepts are termed as Port Supply Chain Integration (PSCI) and Port Supply Chain Orientation (PSCO) respectively in the following chapters (see Chapter 3, Section 3.2.2, p. 60; Section 3.2.4, p. 70). To this end it is necessary to identify components of PSCI and PSCO, and this is achieved through both a literature review and semi-structured interview study. In addition, their conceptualisation also needs to be statistically confirmed in terms of measurement validity by Confirmatory Factor Analysis (CFA).

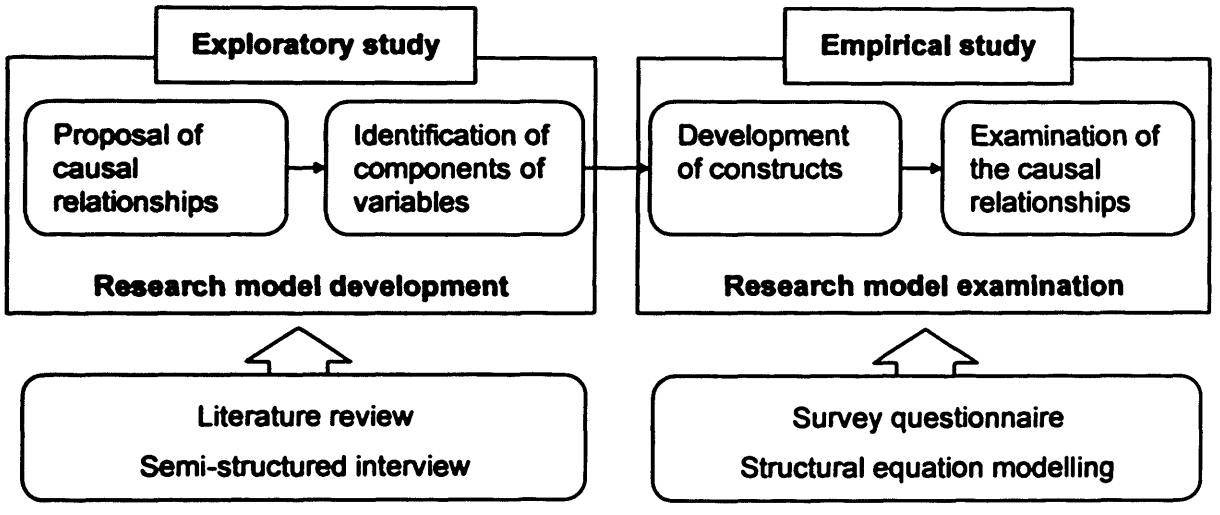
The third and fourth questions concern how PSCO contributes to PSCI and what is the impact of PSCI on Port Performance (PP). These questions are addressed by analysing the data collected from the questionnaire survey using Structural Equation Modelling (SEM). The fifth question concerns the applicability of the proposed relationships to different environments or different groups. SEM also deals with this research question

using a particular function it has, which is called multi-group analysis or model invariance test. Therefore the sample of questionnaire survey had to be designed to be appropriate for this test.

1.3. RESEARCH FRAMEWORK

The primary objective of this research is to investigate and examine the causal relationships between PSCI (Port Supply Chain Integration), PSCO (Port Supply Chain Orientation) and PP (Port Performance). To achieve the objective, firstly the causal relationships need to be hypothesised and subsequently the relationships should be examined with empirical analysis. These two main tasks are accomplished through two phases of this study as shown in Figure 1.2: exploratory study and empirical study.

Figure 1.2. Research framework in this study



1.3.1 Exploratory study

The exploratory study is primarily for developing the research model which is subsequently examined in the empirical study. The research model for this research represents causal relationships between the constructs that this research is interested in. Therefore the exploratory study, first, needs to propose causal relationships and justify the relationships. In addition measurement issues should be addressed in case that

these constructs are not measured directly or are difficult to measure. The constructs requires proxies or instruments which can measure the constructs appropriately.

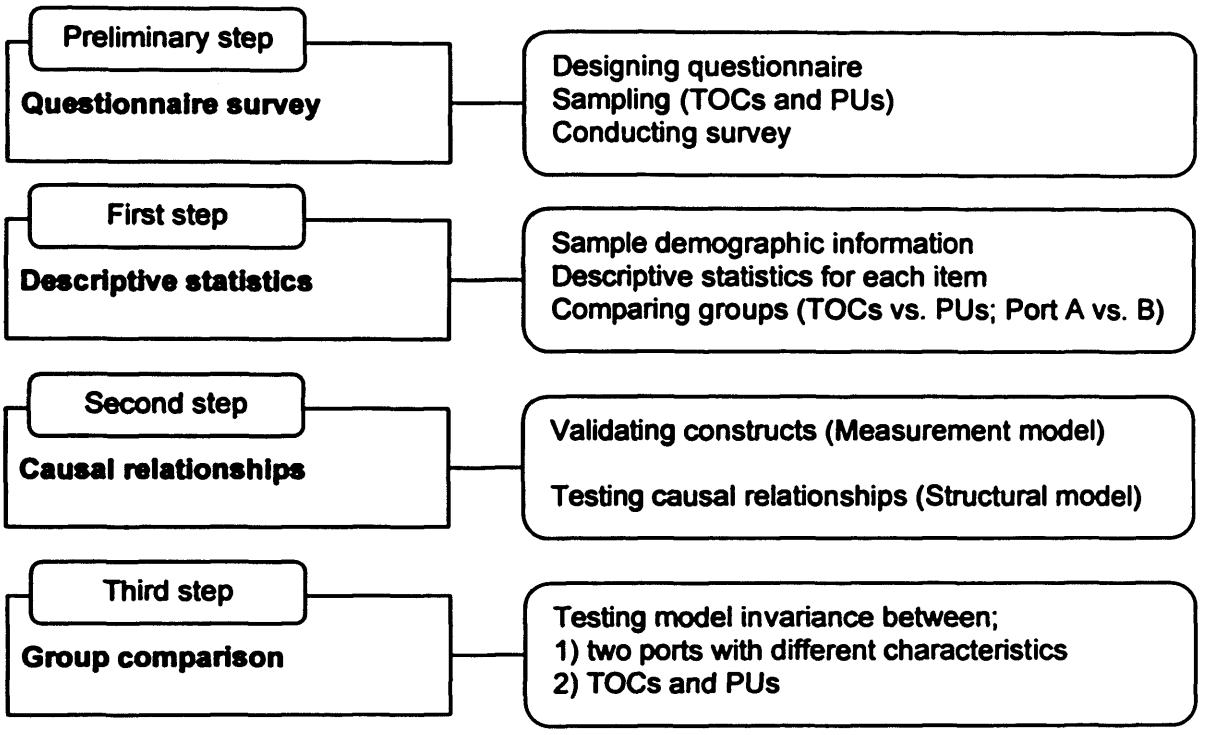
The model development process primarily relies on the existing literature because researchers strongly suggest that the model should be justified by the established theory (Byrne 2001; Hair *et al.* 2010; Garver and Menzter 1999; Gerbing and Anderson 1988; Tabachnick and Fidell 2001). In addition, researchers hope to find existing instruments or scales (i.e. questionnaire) from the existing literature and adapt the measures into the situation and context or area of the researchers' interest. However, in cases where theories are relatively undeveloped in the area of interest, the relationship specification and item generation can be supported by in-depth interviews or focus groups (Hensley 1999).

Therefore this research attempts to develop a research model through both reviewing the existing literature and interview study. The review of the existing literature provides a theoretical justification for the research model and the model is supplemented and completed through the interview study. The concepts constructed in the literature review will be confirmed or modified by interviewees. New concepts or new components for concepts can be identified in the interview. Another advantage obtained from the interview is that the content validity of this research can be improved by making sure that the terms and measures capture all aspects of the phenomenon investigated in this research and they are accepted in reality.

1.3.2 Empirical study

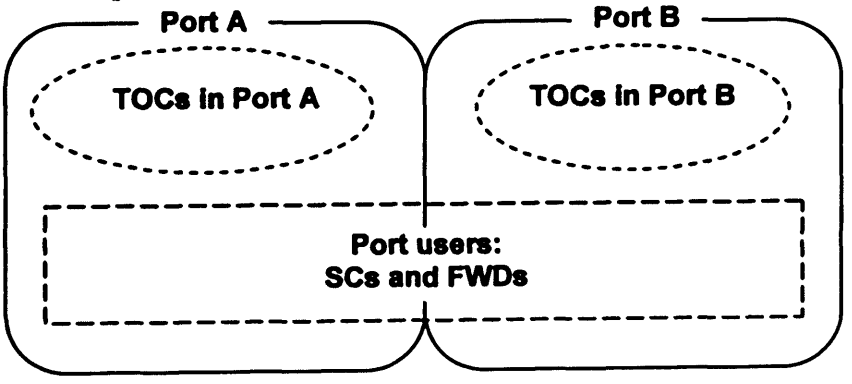
The empirical study examines the research model and hypotheses developed in the exploratory study. A preliminary step for this task is to collect data used in the empirical analysis. This study collected data through a questionnaire survey (see Appendix A and B for the details of questionnaires). The processes of questionnaire design, sampling and specific method of conducting survey are described in Chapter 4 (see Section 4.3.2, p. 99). Once data are collected, three steps of empirical analysis are implemented as shown in Figure 1.3.

Figure 1.3 Steps to examining research model



The first step is to provide descriptive statistics of the collected data: mean score, standard deviation of each item in questionnaire and the frequency percentage of response. Data of this study were collected from two ports in South Korea and the sample groups were Terminal Operating Companies (TOCs) in the two ports and Port Users (PUs) such as Shipping Companies (SCs) and Freight Forwarders (FWDs) of the two ports as shown in Figure 1.4. Therefore some comparisons can be made between different sample ports, for example, a port handling primarily containerised cargoes and the other handling non-containerised cargoes, or between different sample groups (i.e. TOCs and PUs). This initial data analysis can provide meaningful implications apart from just exploring the data and suggesting how the main analysis will proceed.

Figure 1.4 Sample groups of data collection

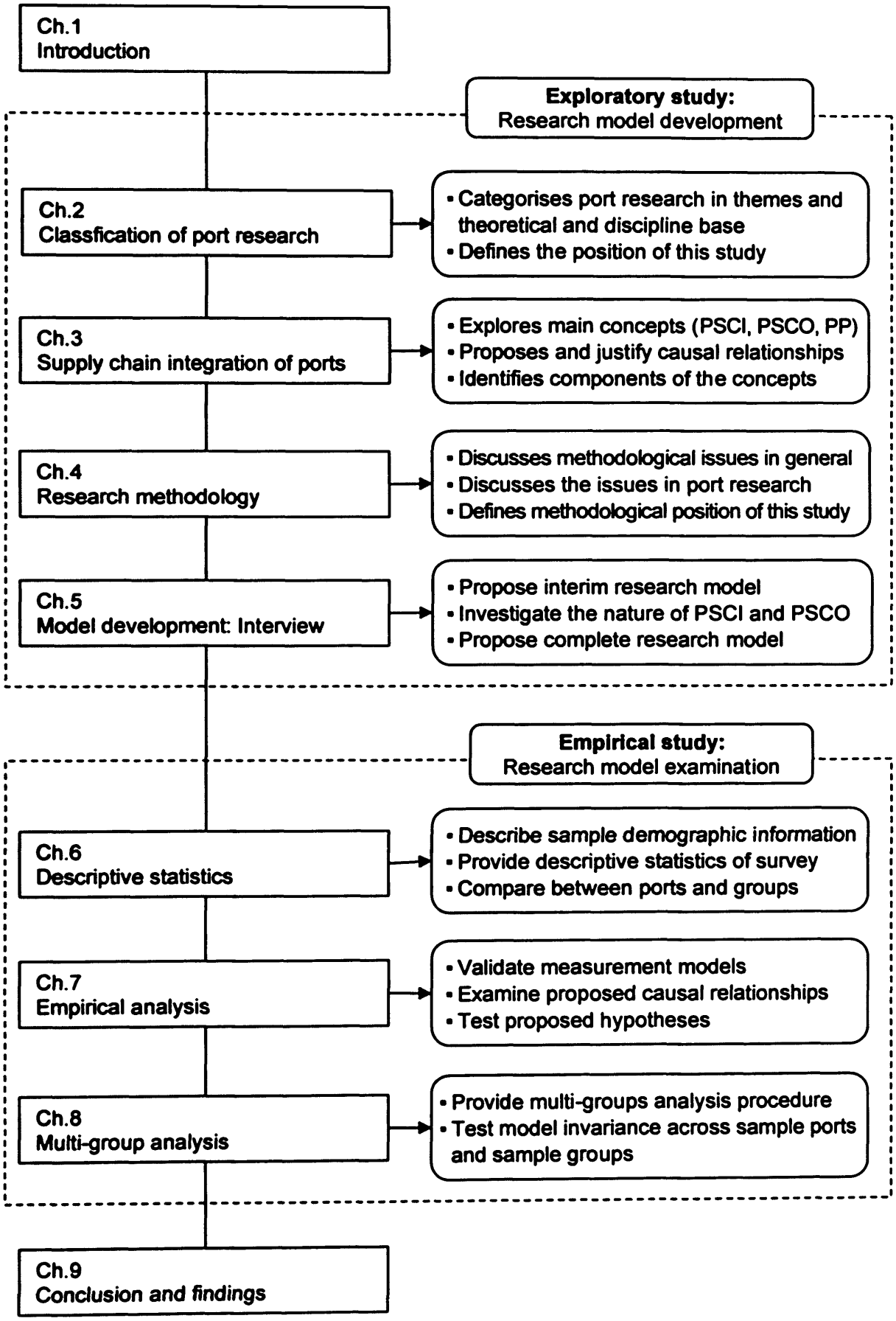


The next step is to test the model with Structural Equation Modelling (SEM) (see Chapter 4, Section 4.4.3, p. 121 for the detailed analytical process). This step firstly validates all the proposed constructs with Confirmatory Factor Analysis (CFA), the so called 'measurement model' in SEM, and subsequently tests relationships between the validated constructs with the so-called 'structural model'. The outcomes of the structural model result in rejecting or accepting the hypotheses proposed from the research model. The third step is to examine if the tested model can be applied across different ports with different characteristics and different sample groups. To this end, this step adopts a particular methodological approach which is generally referred to as a 'test of model invariance' or a 'multi-group analysis of structural invariance' in the SEM methodological literature. The port literature which applies this analytical approach has not been found while SEM itself is also a very new analytical tool in port research. This comparative approach is recommended by many researchers to ensure that practices recommended based on a developed and validated model can contribute equally in different environments (Koufteros and Marcoulides 2006; Min *et al.* 2007). The comparison scheme would be the same as that of the first step of empirical analysis (descriptive statistics): between two ports with different operational characteristics, and between port operators and port users.

1.4 STRUCTURE OF THIS THESIS

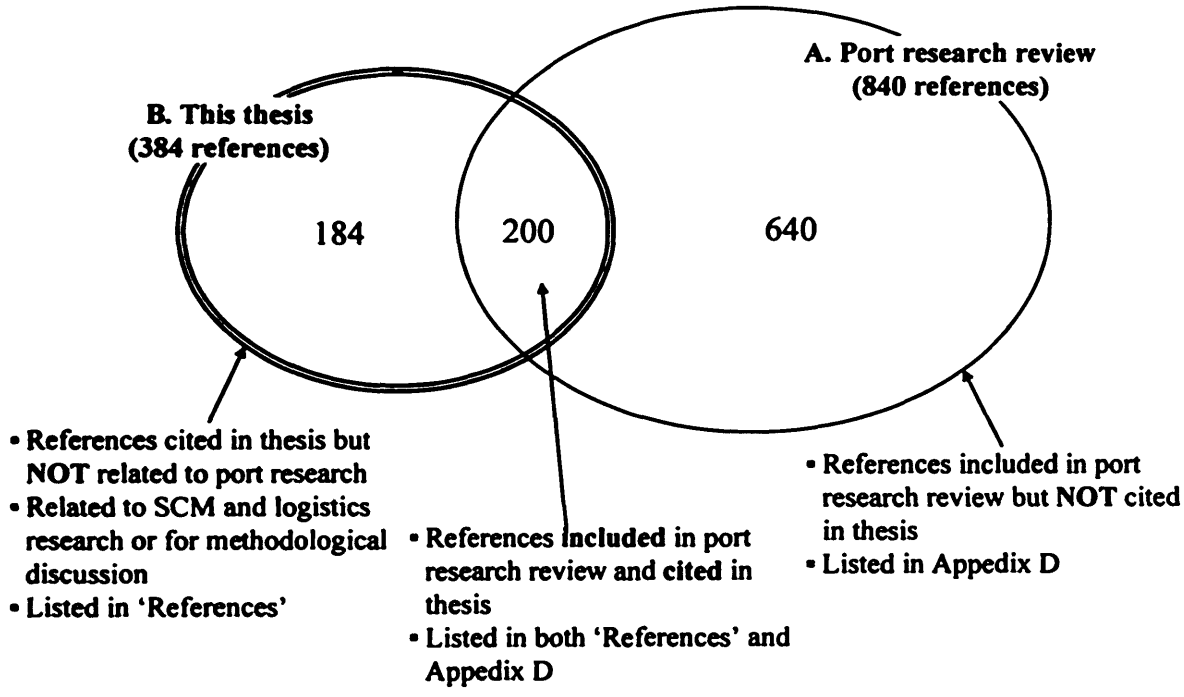
This thesis consists of nine chapters and the seven chapters (Chapter 2-8) in the body part of this thesis can be categorised into the exploratory study and the empirical study as shown in Figure 1.5. Chapter 2 provides a structured literature review of general port research to define the position of this thesis. This review classifies and analyses port literature published for the last three decades in terms of research theme and theoretical and discipline bases. Chapter 3 reviews literature relevant to the integration strategy of ports along supply chains. This review encompasses both maritime studies focusing on seaports and SCM research. This chapter aims at identifying the main concepts and justifying the relationships among them. Theoretical research gaps are also identified which can justify this research.

Figure 1.5 Research structure of the thesis



At this stage, in order to avoid possible confusion, it is useful to explain the structure of references in this thesis (see Figure 1.6). For the structured review of port research in Chapter 2, 840 references were selected and classified (Circle A in Figure 1.6). The list of the literature is provided in Appendix D along with a classification table. Among these, 200 references are cited in the text of this thesis as key references and listed in the bibliography. The remaining part of the bibliography consists of 184 references which were cited for theoretical or methodological discussion in this thesis and not included in the port research review. They are primarily literature from other disciplines such as logistics and SCM research or literature related to the analytical technique used in this thesis (i.e. SEM). The complete list of references, therefore, comprises 384 papers and articles (Circle B in Figure 1.6).

Figure 1.6 The structure of references in this thesis



Chapter 4 addresses methodological issues including research paradigm, research approach, data collection and analysis methods. Methodological state of port research is examined in association with the structured literature review of general port research in Chapter 2, and this provided a methodological justification of this research. Data collection methods and analysis techniques of this research are delineated, and, in particular, the details of SEM are presented compared with other similar analytical tools.

Chapter 5 develops a research model for this research. First, an interim model is proposed since the model is likely to be incomplete due to lack of existing literature to cover all the aspects of the three main concepts which are rather new in the port research and it is not certain that the concepts and model reflect what takes place in reality. Subsequently a complete research model developed based on the results of semi-structured interview study. The interview primarily investigates how practitioners and academics perceive the main concepts, PSCI and PSCO. It follows that the research hypotheses are proposed and all the latent variables and observed variables are presented.

Chapter 6 presents descriptive statistics of the data collected from questionnaire survey in order to provide a general picture of survey participants and their responses to the questions. It also compares the descriptive statistics between sample groups: two ports (Port A and B) and two interest groups (TOCs and PUs) in order to obtain insights for the multi-group analysis in Chapter 8.

Chapter 7 provides the results of examining the research model and testing the hypotheses. This chapter firstly validates three measurement models which are PSCO, PSCI and PP using Confirmatory Factor Analysis (CFA). Subsequently, the causal relationships among these three constructs are tested using Structural Equation Modelling (SEM).

Chapter 8 conducts multi-group analysis to assess the applicability of the proposed model. This analysis tests model invariance across sample groups which can be separated, i.e. ports with different operational characteristics; or port operators group and port user group.

Chapter 9 summarises the findings and explains their implications for both theoretical and managerial purposes, and details the contribution and limitations of this thesis.

CHAPTER 2

CLASSIFICATION AND ANALYSIS OF SEAPORT RESEARCH

Evaluating and reviewing existing literature relevant to research aims to: (1) provide a context for the research and showing where the research fits into the existing body of knowledge, (2) illustrate how the subject has been studied previously, (3) outline gaps in previous research, (4) justify the research. This section accomplishes these aims primarily focusing on the first aim by defining the positioning of this research in port research in general. To do so, it should be, first, investigated how port research is structured. Specifically a structured literature review encompassing research themes, theories and disciplines involved in port research is required to provide a framework to show where this research can fit into in port research. In addition an investigation into periodic changes of research trends is required to understand the positioning of this research in the periodic trends of port research as well.

2.1. INTRODUCTION TO REVIEW OF PORT RESEARCH

Although valuable insights could be obtained from existing reviews into maritime economics (Goss 2002; Heaver 1993; Metaxas 1983; Panayides 2006), and port management (Heaver 2006; Olivier and Slack 2006; Suykens and van de Voorde 1998), these studies did not provide a structured knowledge which this research requires.

Recently, literature reviews have been undertaken for operations research pertaining to terminal operations (Stahlbock and Vos 2008; Steenken *et al.* 2004) and port efficiency studies (Gonzalez and Trujillo 2009; Panayides *et al.* 2009). These studies provide a systematic understanding for specific research fields which have emerged as popular themes in port research. However they do not cover all areas of port research.

Pallis *et al.* (2010) analysed 395 journal papers in port economics, policy and management published during the period 1997-2008 using bibliometric techniques and content analysis. They successfully characterised the port research community and identified research themes and their coherence. However their studies do not clearly show how port research has responded to changing research demands, how the focus of research has evolved and how port research has related to the evolution of ports and the port industry. Against this background, this section investigates how seaports have been studied during the last three decades (1980s-2000s) using a structured and systematic literature review approach. This approach classifies port research into various categories in terms of research themes, disciplinary and theoretical bases, and methodological issues such as research methods and analysis techniques. The analysis of methodological categorisation is presented in Chapter 4 (Research methodology) in association with the methodological discussion for this research.

As for the literature reviewed in this section, papers published in academic journals were included. The reason is that they have been through peer review procedure and are more appropriate for the investigation of port research from both theoretical and methodological perspectives than other sources. Conference papers, contribution to edited books, dissertations and theses were excluded. While editorials in journals written by journal editors or visited editors were excluded, comments and notes were included if they had either conceptual discussions or empirical analysis. The target period was the last three decades, i.e. from 1980 to 2009. Thus papers which were available as on-line versions on 2009 in advance but of which publishing year was 2010 were not considered for this analysis. All papers relating to port policy, management and operations were searched for, beginning with maritime transport related journals such as *Maritime Policy and Management* (MPM) and *Maritime Economics and Logistics* (MEL) and extending to all journals where such papers were

published. The tables of contents of the journals in which port studies are frequently published were reviewed. Then the references of the papers identified were examined to trace the journals and papers which had not been previously identified. In addition, on-line searches were undertaken to identify, using various databases such as Scopus, SciencDirect and Swetswise.

Among papers in the journals, only those explicitly related to seaports were included. If a paper only had implications for seaports, as part of a study on a related discipline such as logistics, urban planning, infrastructure development, etc, the studies were excluded. Studies on port history, waterfront redevelopment and ocean engineering were also excluded because this research focuses on port operations and management rather than historical and technical aspects. However, although operations research for terminal operation is regarded as different from port policy and management (Pallis *et al.* 2010), this was included because the research field provides crucial information for decision-making in port planning and management. Consequently 840 papers were selected from 125 journals as shown in Table 2.1.

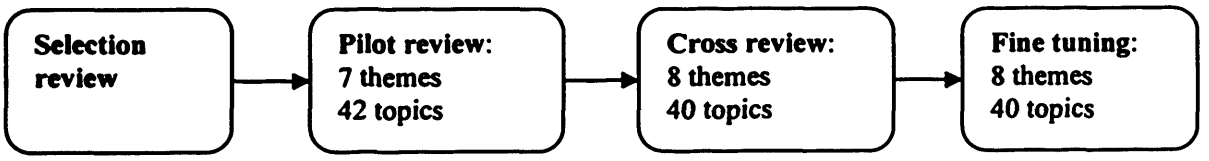
Table 2.1 Number of papers by journal and decade

Journals	1980-89	1990-99	2000-09	Total
Maritime Policy and Management	55	82	96	233
Maritime Economics and Logistics	0	2	99	101
Journal of Transport Geography	0	11	18	29
International Journal of Transport Economics	1	8	17	26
Transportation Research Part A	5	1	15	21
Geojournal	4	9	7	20
Transportation Research Part B	3	5	12	20
Tijdschirft voor Economische en Sociale Geografie	4	9	5	18
Transportation Research Part E	0	2	15	17
Transport Reviews	1	1	13	15
European Journal of Operation Research	0	0	14	14
Transportation Journal	3	3	8	14
Coastal Management	3	7	3	13
Geoforum	5	4	3	12
Marine Policy	0	4	8	12
Environment and Planning A	2	3	6	11
Journal of Transport Economics and Policy	4	3	4	11
Applied Economics	1	0	9	10
Transport Policy	0	4	6	10
Others[1]	23	56	154	233
Total (No. of journals=125)	114	213	513	840

[1] Journals in which less than 10 papers were selected for this thesis (No. of the journals = 106) and the whole list is provided in Appendix C and the full list of paper is in Appendix D.

The papers selected for this study were classified depending on research themes and disciplinary and theoretical bases. This review process was quite a demanding task since category construction is regarded as the area of content analysis requiring the most consideration and having the greatest influence over the results (Cullinane and Toy 2000). The review was undertaken rather in both an inductive way to attempt to identify converging categorisation without using *a priori* classification determined in advance and an iterative way with four rounds of review process as shown in Figure 2.1. However some existing caterories were referred to for the categorisation of disciplinary and theoretical bases (e.g. Burgess *et al.* 2006; Stock 1997). At the first review, all the selectable papers were briefly reviewed to decide whether they should be included or not. Subsequently, seven research themes and forty two research topics were devised. In the third round were revised the concept of each category and their distinctiveness, which resulted in a new structure of 8 themes and 40 topics. Finally all the papers were re-allocated according to the new categorisation.

Figure 2.1 Review process for this literature review



2.2. GENERAL OBSERVATION

Figure 2.2 shows that there has been an increasing trend in the number of papers in port research during the last three decades. Most papers were published in 2008 (=84) and the least in 1980 (=2). Port researchers have, on average, produced 28 papers annually over the last thirty years. For the first decade, the increasing trend was not obvious, however during the 1990s there was moderate growth in output, with exponential growth in the third decade, peaking in 2008. Decadal trends are also worth observation. Table 2.2 presents general statistics for the database of port research for this study. The number of papers has roughly doubled decade by decade: 114 were produced in the 1980s, increasing to 213 in the 1990s and in the 2000s 513 papers were published.

Figure 2.2 The number of papers in port research by year

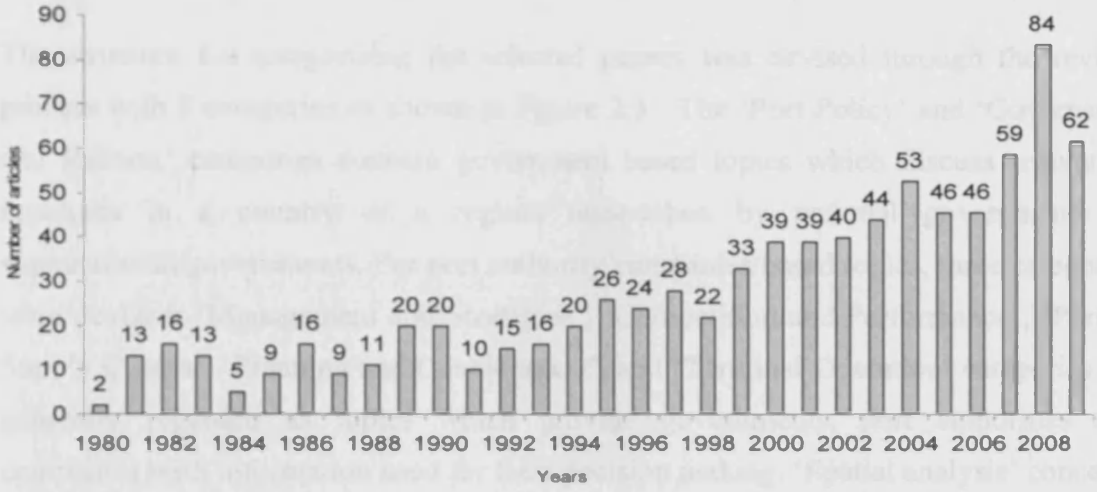


Table 2.2 Descriptive statistics of the data base by decade

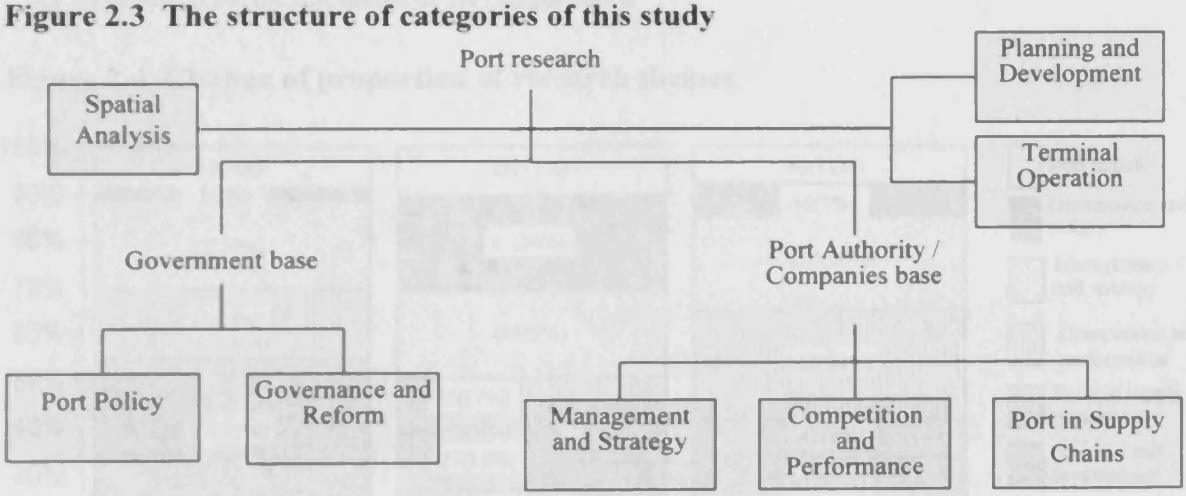
	1980s	1990s	2000s	Total
No. of journals	27	50	107	125
No. of authors	104	208	633	871
No. of papers	114	213	513	840
(Single-authored)	(89/78%)	(130/61%)	(238/46%)	(457/54%)
(multi-authored)	(25/22%)	(83/39%)	(275/54%)	(383/56%)
Average No. of paper per author	1.1	1.0	0.8	0.9

Similar patterns were observed in the number of journals in which port studies have been published and in the number of authors. In the 1980s, port research was published in 27 different journals but by the 2000s the number of journals had increased to 106. In addition, in the 1980s, 104 different authors produced 114 papers and thus, on average, each author published 1 paper. In the 1990s, although the number of papers doubled, so did the number of authors, resulting in the same annual average publications per author as in the 1980s. In the 2000s, while the number of papers doubled, the number of authors tripled with 160 researchers no longer publishing and 585 new researchers becoming active, which resulted in the average number of paper per author fall to 0.85. However, it should be pointed that this decreasing trend of the average number of the papers per author may be attributed to the increase of the collaborative works in port research. Table 2.2 shows that the proportion of multi-authored papers has risen from 22% in the 1980s to 56% in the 2000s.

2.3 RESEARCH THEMES OF PORT RESEARCH

The structure for categorising the selected papers was devised through the review process with 8 categories as shown in Figure 2.3. The 'Port Policy' and 'Governance and Reform' categories concern government based topics which discuss regulatory measures in a country or a region, undertaken by national governments or supranational governments. For port authority/companies based topics, three categories were devised: 'Management and Strategies'; 'Competition and Performance'; 'Port in Supply Chains'. 'Planning and Development', and 'Terminal Operation' categories are generally regarded as topics which provide governments, port authorities and companies with information used for their decision making. 'Spatial analysis' concerns issues on spatial distribution and change and is relevant to all port policy and activities.

Figure 2.3 The structure of categories of this study



The question emerging from this categorisation is whether all the papers can be classified in a mutually exclusive way. For some papers, the objectives are clear and fit into a specific category, with the contents and analyses being consistent with the objectives. However, for some studies which attempt to incorporate various perspectives encompassing governments, port authorities and private companies, and various topics, for examples, regulations and performance, policy and terminal operation, such categorisation is both difficult and demanding. For the latter, even though there was often more than one dimension of research interests and focus of analysis, the research aims presented in the studies and the main results of analyses played the most important role as factors affecting categorisation.

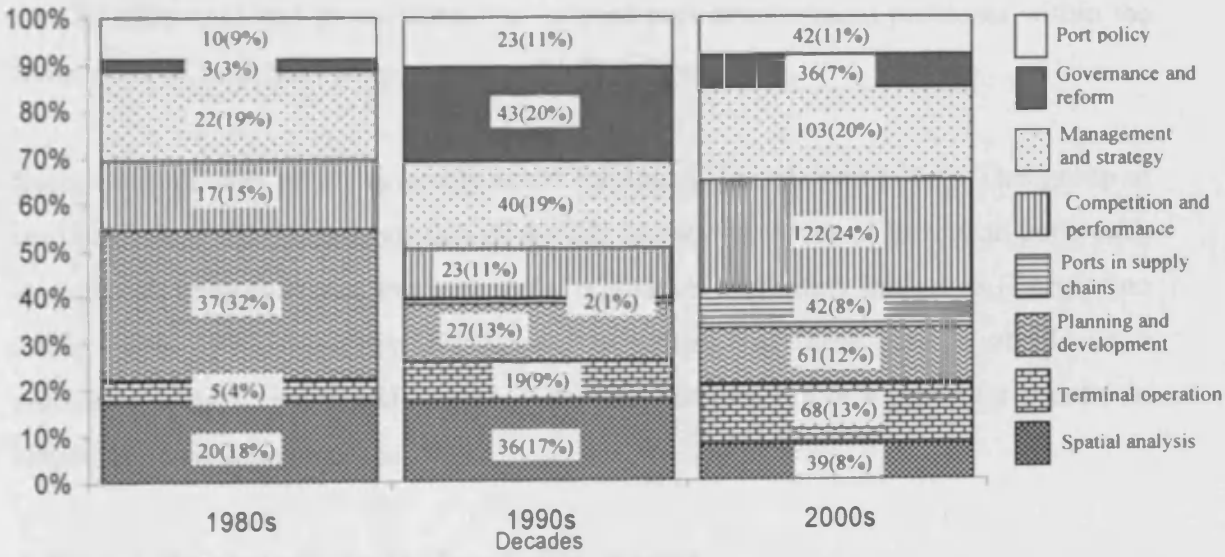
The result of categorising the selected papers in the categories is provided in Table 2.3. For the three decades, the themes researched the most extensively researched are 'Management and Strategy (19.6%)', 'Competition and Performance (19.3%)' and 'Planning and Development (14.9%)'. The category with the least publications is the 'Ports in Supply Chains' (5.2%).

Table 2.3 The number of papers in research theme categories

Research themes	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total (%)
Port Policy	1	9	5	18	20	22	75 (8.9)
Governance and Reform	2	1	17	26	19	17	82 (9.8)
Management and Strategy	12	10	20	20	47	56	165 (19.6)
Competition and Performance	6	11	10	13	50	72	162 (19.3)
Port in Supply Chains	-	-	1	1	10	32	44 (5.2)
Planning and Development	20	17	8	19	29	32	125 (14.9)
Terminal Operation	2	3	8	11	33	35	92 (11.0)
Spatial Analysis	6	14	12	24	8	31	95 (11.3)
Total	49	65	81	132	216	297	840

* See Appendix D for the full details of the categorisation

Figure 2.4 Change of proportion of research themes



Decadal changes in the proportions of papers in each category are presented in Figure 2.4. 'Port Policy' and 'Management and Strategy' studies have maintained a consistent position in port research for three decades (around 10% and 20% respectively). 'Planning and Development' and 'Spatial Analysis' studies were very popular in 1980s, but they have declined since the 1990s. 'Competition and Performance' and 'Terminal Operation' studies showed increasing trends. Interestingly 'Governance and Reform' studies showed a markedly high proportion in the 1990s compared to the other decades

and 'Ports in Supply Chains' studies appear only in the 2000s. Since each category includes a variety of topics, an investigation at a level of research themes may not be able to produce outcomes this section intended to obtain. Therefore research topics in each research theme and their decadal changes are investigated.

2.3.1 Port Policy

Although port policy was interpreted by Van Hooydonk (2002) as 'any decision that could influence the future of development of port activities', this thesis concerns decisions and activities undertaken at the government or state level. Studies in this category account for 9% of the selected port literature. Among them, a group of studies is about how national port policy has changed and how its changes have shaped and influenced port development and industry in the country (Goss 1998; Pettit 2008; Ridolfi 1995) (see Table 2.4). These studies also discuss how changes in the political preferences in particular governments have influenced the governments' attitudes to port development and investments and address port development problems within the framework of national transport policy (Mak and Tai 2001).

Supra-national port policy is mostly about European Union's port policy. This group of studies discuss the current position of the EU to various issues of European ports such as state aid, market access, environmental regulation and safety initiatives (Bergantino 2002; Pallis 1997; Psaraftis 2005a), and the impact of these actions of EU on a particular country (Pallis and Vaggelas 2005) or the position of a particular country in respect of these actions (Hinz 1996).

Table 2.4 Research topics in 'Port Policy' studies

Research topic	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Supra-national port policy	1	-	-	2	3	3	9
National port policy	-	-	3	8	3	3	17
Regulation and market	1	1	1	2	8	12	25
Public involvement	-	8	-	-	3	1	12
Safety and security regulation	-	-	-	-	-	3	3
Environmental regulation			1	6	3	-	10
Total	2	9	5	18	20	22	76

* See Appendix D for the full details of the categorisation

Government intervention or involvement can take place for various reasons: externalities, market failures, monopoly and regulation, economic development such as public financing for infrastructure expansion (Heaver 1993). In particular, issues on the regulatory role of government to market access and state aid have been the main topic in 'Port Policy' with regard to promotion or distortion of competition. Public involvement using state aid was well discussed in the 1980s. Regulation and competition drew researchers' attention throughout the 2000s. This issue became more important in those countries which experienced privatisation, generally undertaken in the 1990s. Researchers addressed this issue incorporating concession methods with market entry barriers because, in many cases, concession or lease agreements were used for private participation and involvement (Defilippi 2004; Ferrari and Basta 2009). Some studies discussed market entry barriers in the port industry generally and policy initiatives to lower the barriers (De Langen and Pallis 2007; Kent and Ashar 2001). A group of studies investigated whether policy and regulation can achieve or have achieved their goals, in particular, improvement of efficiency (Barros 2003; Pettitt 2007).

The number of studies on policies and regulations pertaining to port safety and security were not as great as expected. Rather, a majority of studies relating to this topic were management studies on how to manage safety and security in port operations under new legal and institutional environments (see Table 2.6). Studies on environmental policy and regulations were largely published throughout the late 1990s and the early 2000s with the introduction of supranational and national environmental measures. EU Directives on port reception facilities led researchers to evaluate availability and adequacy of reception facilities in EU ports and compliance with the regulations (Ball 1999; Carpenter and Macgill 2003). The impact of new legislation for coastal management in Canada and the US on port administration and their effectiveness were also researched (Burroughs 2005; Yarnell 1999). Decadal trends are not clear in this category, as the number of papers (=75) is small considering the number of research topics (= 6). However a few aspects are observed: (1) national policy has been consistently researched since 1990; (2) regulations pertaining to competition and market barriers were well researched in the 2000s; (3) environmental policy studies drew researchers' interests due to newly introduced initiatives at national and supranational levels in the late 1990s.

2.3.2 Port Governance and Reform

Reforms in port management continue to take place in various ways depending on the situation of a country or region, to varying degrees. Studies in this category are concerned mainly with the port governance system and governance reform and include labour reform. This category accounted for 10% of port research in this analysis. The topic of the most interest was port governance reform (see Table 2.5). Most of studies pertaining to this topic described the experience or necessity of port reform in a port, a country or regions. It was in the more recent past (2000s) when researchers characterised port reform trends worldwide (Baird 2002; Chen 2009), and undertook empirical studies to assess the consequences of port reform (Castillo-Manzano *et al.* 2009; Serebrisky and Trujillo 2005).

Port labour reform was researched mainly in the 1990s and led by a few core researchers. The geographical focus was mainly limited to UK and Commonwealth countries such as New Zealand and Australia. Academics and practitioners re-evaluated port reforms in their countries 10 years or more after port labour reforms were introduced (Coffey 2009; Rayner 1999). The structuring of port governance (Brooks 2004), investigating governance models in a port or a country (Ircha 1993; Wang and Slack 2004), and evaluating a variety of governance models (Brooks and Pallis 2008; Cullinane *et al.* 2005) are some of the main topics in this category.

Recent approaches have tried to devise new types of governance model and explore their applicability (Chlomoudis *et al.* 2003; Lambrou *et al.* 2008). This category of studies shows clear periodical trends: governance reform and labour reform were researched mainly in the 1990s with the evaluation of the reforms and further discussions following in the 2000s.

Table 2.5 Research topics in 'Port Governance and Reform' Studies

Research topic	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Port governance model	1	1	3	-	6	5	16
Port governance reform	1	-	5	16	10	9	41
Port labour reform	-	-	9	10	3	3	25
Total	2	1	17	26	19	17	82

* See Appendix D for the full details of the categorisation

2.3.3 Port Management and Strategies

This category covers such a wide range of port management topics that it accounted for around 20% of the papers reviewed. Studies in this category generally discuss managerial and strategic issues at the level of port authorities and TOCs. Port strategy drew researchers' attention throughout the past three decades (see Table 2.6). This includes: strategies of port authorities under changing environments (Heaver 1995; Slack 1993; Sletmo 1999); analysis of the role of port authority within context of the port community and cluster (De langen and Visser 2005; Martin and Thomas 2001); and strategic and long-term planning for development of a port or port in a country (De Langen 2005; Priemus 2001). Developing the capabilities of human resources is an area which has not been well researched in port research, and the reason that the number of studies in this topic is relatively high is because studies on industrial relationships management were included (Ircha and Gary 1992; Turnbull 1992). However some researchers have paid some attention to port training and human resources development (Ahn and McLean 2008; Kent 1992; Paixao-Casaca 2006).

Emerging managerial issues include environmental management, safety and security management and information and knowledge management. The former is primarily about how port authorities can or should effectively deal with the challenges and pressures imposed by regulations or institutional changes (Bichou 2004; Stojanovic *et al.* 2006) and developing measures to reduce terrorist risks and accidents (Ronza *et al.* 2003; Price 2004). The latter concerns how ports adapt advanced information technology and how such technology and management can improve port operations (Kia *et al.* 2000; Lee-Partridge *et al.* 2000).

Table 2.6 Research topics in 'Port Management and Strategies' studies

Research topic	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Port strategy	5	5	6	7	8	8	39
Human resources management	3	-	7	3	5	4	22
Information and knowledge management	-	1	2	2	5	2	12
Safety and security management	-	1	-	-	6	9	16
Environmental management	2	1	3	7	2	8	23
Port pricing	2	1	2	1	14	9	29
TOC strategy	-	1	-	-	5	14	20
Total	12	10	20	20	45	54	161

* See Appendix D for the full details of the categorisation

Port pricing is a traditional research topic in line with port financing for infrastructure and port charges (Dowd and Fleming 1994; Talley 1994b). This drew researchers' attention in the 2000s with a series of actions by the European Commission on seaport and maritime infrastructure (Haralambides 2002; Meersman *et al.* 2003). More attention was focused on this topic due to the necessity of discussion on the pricing of strategic infrastructure in privatised ports (Ashar 2001; Psaraftis 2005b).

A very distinctive trend was the growing attention being focused on the strategy of Terminal Operating Companies (TOCs) in the 2000s. Rapid development of trans-national TOCs through private investments in the world's container terminals changed the unit of analysis from the port as a whole to TOCs (Olivier and Slack 2006). Geographical and sequential expansion and coverage of the TOCs was studied (Olivier *et al.* 2007; Parola and Veenstra 2008). In addition, understanding new market structures in the port industry became an important issue to develop competition strategies (Midoro *et al.* 2005; Parola and Musso 2007). Some studies investigated dynamics in port-shipping lines relationships in implementing TOCs' strategies (Olivier 2005; Soppe *et al.* 2009). De Langen and Chouly (2009) showed variance of TOCs' strategies. This trend is also clearly shown in port efficiency studies in the 'Port Competition and Performance' category.

2.3.4 Port Competition and Performance

This category accounted for almost as large a proportion of studies as the 'Port Management and Strategies' category (20%). Port competition studies begin with conceptualising and characterising seaport competition (Verhoeff 1981) and can be advanced with new concepts of seaport competition such as co-opetition and intra-port competition (Song 2003; De Langen and Pallis 2006). However the number of these studies is limited (see Table 2.7). A substantial number of papers are devoted to analysing the current situation and development of port competition of a region or country in the 2000s (Comtois and Dong 2007; Yap *et al.* 2006). Advanced methods, analytical tools and new measures helped researchers analyse and assess the complex nature of competition dynamics and relationships among competing ports (Lam and Yap 2008; Notteboom 2009).

Table 2.7 Research topics in 'Port Competition and Performance' studies

Research topic	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Port competition	3	3	-	2	8	9	25
Port selection	-	3	3	-	7	12	25
Port performance	2	3	4	4	5		18
Port efficiency	-	1	1	3	18	28	51
Port competitiveness	1	1	2	4	12	23	43
Total	6	11	10	13	50	72	162

* See Appendix D for the full details of the categorisation

Port selection is a traditional topic analysing shipping liners or shippers' port choice behaviour, generally using interview or survey (Murphy *et al.* 1989; Slack 1985). This topic showed an observable advance with the introduction of a variety of methodologies in the 2000s, such as Analytical Hierarchy Process (AHP) (Lirn *et al.* 2004), Factor Analysis (Chang *et al.* 2008; Wong *et al.* 2008), and Multinomial Logit Model (Malchow and Kanafani 2001; 2004; Tiwari *et al.* 2003).

A topic relatively well researched throughout the 1980s and 1990s is port performance. Studies on this topic primarily aim to discuss what and how to measure port performance (Talley 1994a), evaluation of existing measures and the proposal of new measures and approaches (Marlow and Paixao-Casaca 2003; Bichou and Gray 2004). This topic evolved in the 2000s in two distinctive ways. One was to conduct relative comparison studies in terms of technical efficiency using a particular group of analytical methods called the frontier approach such as Data Envelopment Analysis (DEA) (Wang and Cullinane 2006; Barros 2003) and Stochastic Frontier Analysis (SFA) (Cullinane and Song 2003).

The other is to assess the competitiveness of a port or ports in a country. This topic includes: competitive status and positions (Haezendonck *et al.* 2000; Teurelincx 2000), assessing the competitiveness of ports in terms of cost (Lam and Yap 2006), geographical advantage (Caillol 1981), service quality (Ugboma *et al.* 2007; Pantouvakis *et al.* 2008) and accessibility (Wang and Cullinane 2008; Cullinane and Wang 2009), etc. Studies in this category commonly have taken advantage of advanced approaches and research methodologies, which took place mostly in the 2000s.

2.3.5 Ports in Supply Chains

The papers in this category were separately classified even though the proportion in all the papers was the lowest (=5.2%) among 8 categories. The reason for this is that they have different view on seaports from those of traditional studies which see seaports as a node between sea and land transport. They argue that seaports should be viewed as parts of supply chains (Robinson 2002; Bichou and Gray 2005) and as an extended system which can interact with other members in the supply chain. In this context, a number of papers investigate the integration strategies and practices of seaports along supply chains (Carbone and De Martino 2003; Tongzon *et al.* 2009) and their impact on performance (Song and Panayides 2008) (see Table 2.8).

It is worth commenting that the recently increasing trend in studies in this area is related to the increasing interest in TOCs' strategies along supply chains and the activities of container terminals or TOCs rather than the port as a whole. Further, a group of studies about inland logistics connected to port logistics has gained increasing attention (Rahimi *et al.* 2008; Walter and Poist 2004) as seaports increasingly rely on intermodal solutions through rail corridors and inland ports to cope with volume growth and the imperatives of global supply chains.

Table 2.8 Research topics in 'Ports in Supply Chains' studies

Research topic	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Redefining port in supply chain context	-	-	-	1	3	11	15
Integration along supply chain	-	-	-	-	2	11	13
Land-side logistics	-	-	1	-	5	10	16
Total	0	0	1	1	10	32	44

* See Appendix D for the full details of the categorisation

2.3.6 Port Planning and Development

This category includes studies about the planning and development of port infrastructure and decision making related to them. Thus, topics in this category include demand and supply analysis of infrastructure, financing and risk management, project appraisal analysis and the economic impacts of seaports. These accounted for 15% of all the papers. A considerable number of studies were undertaken in the 1980s

when port expansion and reconstruction was spurred by the acceleration of international trade and technological change in maritime transport in many countries, to reduce congestion in ports or to adapt to the technological changes (see Table 2.9).

Demand analyses are basically forecasting studies of cargo throughput and growth. Some studies addressed this topic using an explanatory approach (Heikkila 1995; Walker 1985). However, most applied statistical methods such as regression (Tongzon 1991; Zohil and Prijon 1999), time series analysis (Schulze and Prinz 2009), error-correction methods (Fung 2001; Fung 2002; Hui *et al.* 2004), and mathematical modelling such as linear programming (Jones *et al.* 1995), mixed integer modelling (Kim *et al.* 2008: Zografos and Martinez 1990) and simulation (Luo and Grigalunas 2003). Logit modelling was also used for forecasting demand through analysing port selection behaviour (Anderson *et al.* 2009; Veldman and Buckmann 2003). Supply analysis is primarily concerned with determining the optimum terminal size (Musso *et al.* 1999; Noritake and Kimura 1990) and capacity (Huang *et al.* 2008; Kia *et al.* 2002).

Economic impact analysis is also a topic which has been considered as important in providing state and local budgeting agencies with a rationale for, and useful information in, the determination of capital and operating budgets for port facilities (Stevens *et al.* 1981; Yochum and Agarwal 1987). There was also a continuing debate into the validity and efficacy of normally applied methodology such as input-output analysis, income-expenditure approach and multiplier approach (Castro and Coto-Millan 1997; Kinsey 1981). However, researchers have consistently addressed this topic due to a possible imbalance problem between local and global benefits in globalising environments, applying various approaches to various situations (Musso *et al.* 2000; Hall 2009).

Table 2.9 Research topics in 'Port Planning and Development' studies

Research topic	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Demand analysis	3	3	2	4	9	6	27
Supply analysis	3	1	1	3	4	6	18
Optimal investment modelling	2	3	2	-	1	2	10
Financing, risk, and project appraisal	3	4	-	-	5	5	17
Economic impact studies	3	4	1	7	7	10	32
Strategic planning and Decision making	3	-	-	-	3	2	8
Development cases	2	2	2	5	2	3	16
Total	19	17	8	19	31	34	128

* See Appendix D for the full details of the categorisation

2.3.7 Terminal Operations

This approach seeks optimal solutions in terminal operations and appears to be a separate field from port management and policy studies. It is indispensable in coping with increasing container transportation and achieving higher efficiency in seaports. Its importance is also shown by the 11% proportion of total papers for this category, even though a number of optimisation studies were classified in other categories such as demand and supply analysis and port selection.

Table 2.10 Research topics in 'Terminal Operation' studies

Research topic	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Review and methodology	-	-	2	-	3	3	8
Terminal as a whole	1	1	2	2	8	3	17
Seaside operation	-	2	2	2	12	17	35
Yard operation	1	-	2	7	10	9	29
Landside operation	-	-	-	-	-	3	3
Total	2	3	8	11	33	35	92

* See Appendix D for the full details of the categorisation

With the increasing interest in optimised terminal operations, a variety of review studies and methodological discussions have been provided in recent times (Monaco *et al.* 2009; Stahlbock and Vos 2008; Steenken *et al.* 2004). Research topics were identified according to the processes of terminal operation, thus they are not as detailed as the review studies are (see Table 2.10). The sea-side operation subset is concerned with ship planning processes and loading/unloading processes such as berth allocation, stowage planning, quay crane scheduling, and queueing problems.

The yard operation subset includes storage space design, yard cranes and carriers transport. Land-side operations deal with rail and truck operations and modal split optimisation. A group of studies adopted an integrative approach which views port operations as terminal operations as a whole, based on the awareness that improved terminal performance cannot necessarily be obtained by solving isolated problems but by an integration of various operations connected to each other. In this category, sea-side operations and yard operation studies has shown an increasing trend in the 2000s.

2.3.8 Spatial Analysis of seaports

While this category accounted for 11% for the past three decades, higher proportion was shown in 1980s and 1990s (see Table 2.11). Spatial analysis of port system of a country or a region or the world, in some cases, is a main topic in this category. This concerns current spatial situation of a port system, spatial change of the port system and the causes of the change. Several theoretical modelling led this group of studies (Hayuth 1981; 1988; Notteboom and Rodrigue 2005). They were followed by a number of empirical studies applying the theories to countries or regions (Charlier 1988; Slack and Wang 2002). Studies on the reason for spatial changes in port systems include: containerisation (McCalla 1999; Rimmer and Comtois 2009), technological change (Kuby and Reid 1992; Todd 1993), and trade patterns (Lee and Rodrigue 2006). Port-city relationship studies developed the theoretical models of Hayuth (1982) and Hoyle (1989) and formulated spatial relationships between port and city. These models were applied to various port cities and advanced by some researchers (Lee and Ducruet 2009; Ducruet and Lee 2006). Some studies viewed port-city relationship, incorporating sustainability concepts and the role of the actors of the port community in the relationship (Hall 2007; Wakeman 1996).

Table 2.11 Research topics in 'Spatial Analysis of seaports' studies

Research topic	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Port system	3	8	8	16	6	11	52
Network analysis	1	1	2	3	2	9	18
Port-city relationships	2	5	2	5	-	11	25
Total	6	14	12	24	8	31	95

* See Appendix D for the full details of the categorisation

2.4 DISCIPLINARY AND THEORETICAL BASES

Discipline bases of port research were investigated to identify the disciplinary characteristics of port research and academic territory covered by port research. In addition, theories, theoretical models and concepts which have been applied to port research were examined to show how port research has theoretically interacted with other relevant disciplines. Review studies and literature concerning theory development and academic disciplines in other research fields such as logistics and

SCM (e.g. Arlbjon and Halldorsson 2002; Burgess *et al.* 2006; Harland *et al.* 2006; Stock 1997), transport economics (e.g. Winston 1985) and economic geography (e.g. Krugman 1998; 1999) were also referred to.

2.4.1. Disciplines involved in port research

The term 'discipline' was used by Burgess *et al.* (2006) as 'a body of practice that is well supported by occupational groupings that identify with or defend a territory of activity'. In addition, Fabian (2000) distinguished 'discipline' and 'paradigm' by discussing that 'a discipline is the common focus of a set of researchers who might perform research in varied paradigms and/or theoretical perspectives'. Seaports are regarded as either economic units providing a service or nodes between various transportation modes, or a place where cargoes pass through, or a part of logistics and supply chain (Cullinane and Talley 2006). Therefore problems in seaports can be viewed and addressed from various perspectives, and researchers who have different disciplinary backgrounds can be involved in port research.

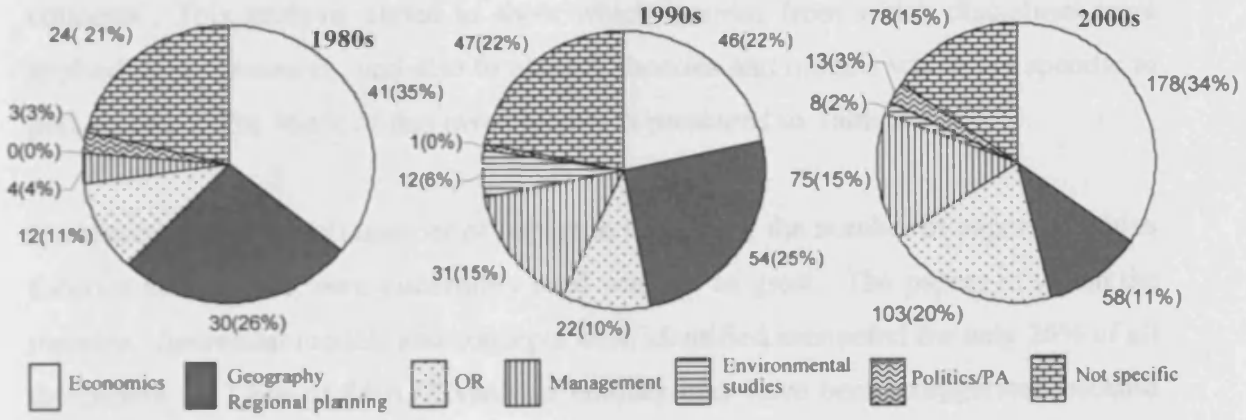
This section, thus, categorises the literature into disciplines which appear to form the basis for the papers. In this categorisation, the disciplinary backgrounds of the authors of the papers tell much and could not be disregarded. However, theoretical models, analytical approaches and concepts used in the papers were the factor which most clearly influenced the approach taken. When disciplinary characteristics were not discernible from the paper's authors' view, those papers were defined as 'Not specific' (17.7%) and the result is presented in Table 2.12. Three disciplines have primarily dominated port research: economics, geography, and operation research (31.5%, 15.7% and 16.3% respectively). Various disciplines or research fields relating to management studies also contributed considerably to port research, with an aggregated proportion of 13.2%. It is clearly observed that disciplines involved in port research became more diverse in the 2000s than the 1980s and the 1990s. This trend is distinctive in the 'Management' category. In the 1980s, 'Management'-based studies showed little appearance, and, in the 1990s, studies concerned with industrial relations in the port industry were relatively extensive. In the 2000s, strategic management, marketing and logistics based research began to be conducted and the number of these studies increased.

Table 2.12 Discipline bases in port research

Strategy	1980-85	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Economics	16	25	15	31	85	93	265 (31.5%)
Geography	8	18	16	35	14	41	132 (15.7%)
Operation research	4	8	9	13	47	56	137 (16.3%)
Management							
Industrial relations	1	-	14	6	8	5	34 (4.0%)
Strategic management	-	-	2	-	12	15	29 (3.5%)
Logistics / SCM	-	-	-	-	2	15	17 (2.0%)
Marketing	-	-	-	1	1	9	11 (1.3%)
Information/communication	-	1	2	2	1	2	8 (1.0%)
HRM	2	-	2	2	-	2	8 (1.0%)
Organisational studies	-	-	-	-	1	2	3 (0.4%)
Regional planning	3	1	-	3	2	1	10 (1.25%)
Environmental studies	-	-	2	10	2	6	20 (2.4%)
Politics	1	-	-	-	-	3	4 (0.5%)
Public administration	2	-	-	1	6	4	13 (1.5%)
Not specific	12	12	19	28	34	44	149 (17.7%)
	49	**65**	**81**	**132**	**215**	**298**	**840**

* See Appendix D for the full details of the categorisation

Figure 2.5 Proportion of disciplines involved in port research



Decadal trends are presented in Figure 2.5. Economics has been dominant throughout the past three decades with the proportion ranging from 22% to 35%. Geography and regional planning also account for a high proportion of papers, but showed a decreasing trend from 26% in the 1980s to 11% in the 2000s. Operations research and Management disciplines showed increasing trends. Operations research accounted for 11% of papers in the 1980s, increasing to 20% in the 2000s. The proportion of papers in the management disciplines was 4% in the 1980s but this had increased to 15% in the 2000s.

2.4.2 Theories, theoretical models and concepts

Theory building and knowledge creation in a research field or discipline is a core part for its development (Arlbjon and Halldorsson 2002; Burgess *et al.* 2006; Wacker 1998). Researchers suggested several ways to develop theories and create knowledge. It is suggested that researchers have 'borrowed' and 'imported' existing theories from other disciplines, and will or should continue to do so due to the various benefits from these practices (Amundson 1998; Stock 1997). Some researchers, however, argue that new innovative theories should be developed rather than 'borrowing' (Van Maanen 1995).

According to Arlbjon and Halldorsson (2002), theories can have different levels of abstraction. Grand theory is concerned with 'lines of thoughts and interpretations representing a science such as classical economics and philosophy of science'. This study focused on middle-range theories 'reflecting connections between a set of concepts' or 'small-scale theories reflecting connections between a small number of concepts'. This analysis aimed to show which theories from which disciplines were applied in port research, and also to identify theories and models which are specific to port research. The result of this investigation is presented in Table 2.13.

Compared to the overall number of papers in this study, the number of papers in which theories and models were discernibly used was not as great. The papers in which the theories, theoretical models and concepts were identified accounted for only 26% of all the papers (217 out of 840). Even this number may have been exaggerated because some types of papers were counted only because they have applied analysis techniques which were developed based on particular theories.

For example, disaggregate choice model using the multinomial logit model or multinomial probit model applies the utility function used in micro-economics. Papers applying disaggregate choice model thus, were counted for utility theory. Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) formulates production function or cost function in the analysis, so papers using DEA or SFA were counted for production theory.

Table 2.13 Theories, models and concepts used in port research

Disciplines	1980s	1990s	2000s
Economics	Benefit-cost analysis (2) **Input-output analysis (7)** Demand-supply (1) Welfare theory (1) **Production theory (4)**	Agency theory (1) Economic rents (1) Collective bargaining (1) Game theory (1) **Input-output analysis (5)** Price differentiation (1) **Production theory (6)** Demand-supply (1) Externality (1)	Cournot model (2) Contestable markets theory (3) Coase theorem (1) Consumer theory (1) Economic base analysis (2) Game theory (5) **Input-output analysis (3)** Marginal cost pricing (5) Price differentiation (3) Price-cap regulation (2) **Production theory (53)** Transaction cost theory (1) Utility theory (12) Value added (1) Worlds of production (1)
Geography	**Hayuth model (2)** Hinterland concept (2) Port-city model (2) **Site and situation (1)**	Centrality, intermediacy (1) **Hayuth model (4)** **Site and situation (4)**	**Hayuth model (1)** Port-city model (3) Rimmer model (1) **Site and situation (2)** TMG (1)
Operations Research	Queuing theory (2)	Queuing theory (1)	Inventory theory (3) Queuing theory (3)
Management		Learning curve (1) Life-cycle theory (1) Strike model (3)	Agility (1) Competitive advantage (3) Co-opetition (1) E-markets model (1) ERP (1) Leanness (2), Marketing channel (2) Portfolio analysis (1) Resource-base theory (2) SERVQUAL (3) SCM (3) Strategic positioning (1) Social responsibility (1) System theory (1) Technology Acceptance Model (1)
Computer science		**Network analysis (3)**	**Network analysis (11)** Neural network model (1)
Port management		**Port administration model (1)**	**Port administration model (5)**
Sociology, Psychology, Politics, others			Collective action (2) Institutional theory (2) Structure of provision (2) Power (1) Trust (2)
No. of papers	**24**	**37**	**156**

* See Appendix D for the full details of the categorisation

It was also observed that there were few theoretical models which have been applied dominantly or consistently. The items highlighted in Table 2.13 indicate theoretical models and concepts applied to port research in a consistent manner and they are

'Input-output analysis', 'Production theory', 'Hayuth model', 'Site and situation' and 'Port administration model'.

The disciplines which the theories and models were borrowed from were similar to those observed in the discipline bases categorisation. Theories and models from economics were applied the most. The number of theories and models used in geography was not as great, but they showed consistency in application. They were introduced in port research in the 1980s and continued to be applied to empirical studies and to be extended to further stages of existing models. The outstanding trend is the increased involvement of concepts and models from the management disciplines in the 2000s. Although these concepts and models were applied in only a few papers respectively, the variety they show may entail further application in port research.

The models or concepts which have been developed for port research specifically were also examined but only a few were identified. An obvious example was the port administration model (Baird 1995), sometimes named the port function matrix. Others were theoretical models developed based on geography. One is the Hayuth model (Hayuth 1981) which can be regarded as a generic model used in transport geography. However according to his work, it is reasonable to understand that this model was developed to conceptualise the stages of spatial development in seaports based on Taaffe *et al's* model (TMG model) (1963). A similar model was also developed by Rimmer (1967) but it was not frequently used. Port-city relationships suggested by Hayuth (1982) and Hoyle (1989) were also examples of theoretical models developed specifically for seaports.

2.5 SUMMARY OF PORT RESEARCH REVIEW

2.5.1 Transition of research themes and topics

Table 2.14 shows the popular topics in port research in each decade in terms of proportion of each topic in all the papers in each decade. In the first decade, it is

clearly shown that many topics in the list are from the 'Planning and Development' category (financing, risk and project appraisal; economic impact studies; demand analysis; optimal investment modelling) and 'Spatial Analysis' category (port system; port-city relationships). Port research in the 1980s appears to have been led by issues both relating to port infrastructure investment and was also concerned about how port investment and cargo throughput was spatially located.

Table 2.14 Main research topics in port research by decades

1980s		1990s		2000s	
Research topic	%	Research topic	%	Research topic	%
Port system	9.6	Port system	11.3	Port efficiency	9.0
Port strategy	8.8	Port governance reform	9.9	Port competitiveness	6.8
Public involvement	7.0	Port labour reform	8.9	Seaside operation	5.7
Project appraisal	6.1	Port strategy	6.1	Port pricing	4.5
Economic impact studies	6.1	National port policy	5.2	Regulation and market	3.9
Port-city relationships	6.1	HRM	4.7	Port governance reform	3.7
Port competition	5.3	Environmental management	4.7	Yard operation	3.7
Demand analysis	5.3	Yard operation	4.2	Port selection	3.7
Port performance	4.4	Economic impact studies	3.8	TOC strategy	3.7
Optimal investment modelling	4.4	Port performance	3.8	Port system	3.3
Proportion of Top 10 topics	63.2	Proportion of Top 10 topics	62.4	Proportion of Top 10 topics	48.0
29 topics involved		32 topics involved		39 topics involved	
Development-led		**Policy-led**		**Management-led**	

In the 1990s, it is not surprising that topics of port governance reform and port labour reform ranked high. In line with this, national port policy and human resource management topics appear in the list. 'Environmental Management' also drew attention due to national and supra national level environmental actions. It can be seen that port research in this decade was dominated by issues relating to governmental initiatives such as port privatisation and labour reform and environmental actions at national and supranational level. It should be, however, noted that port system analysis was still the most researched area in the 1990s.

In the 2000s, port efficiency became the most researched topic and related topics such as port competitiveness and port selection appeared in the list. 'Regulation and Market' and 'TOC strategy' were well researched as topics emerging after the privatisation era. Two topics in terminal operations research also ranked high. Therefore, it can be

concluded that port research in the 2000s was led by topics mainly relating to the management of port authorities and TOCs to improve efficiency and competitiveness and to seek optimised terminal operation.

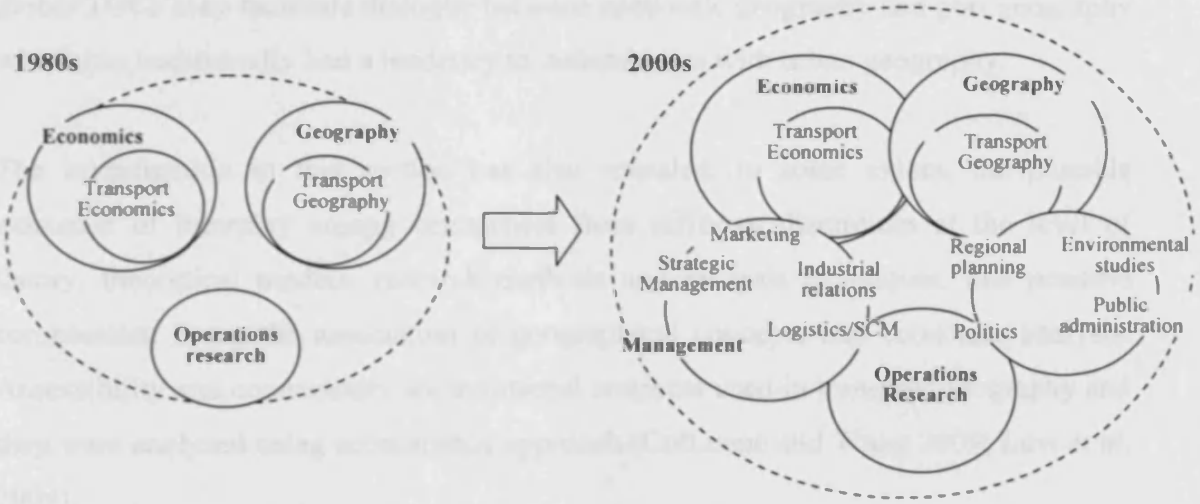
The trend of research theme transition has been from '**development-led**' in the 1980s via '**policy-led**' in the 1990s to '**management-led**' in the 2000s. This transition pattern primarily reflects the evolution of the port industry: from expansion-era via reform-era to post-reform era. However the details of Table 2.14 are not sufficiently explained only by the research demand stemming from the evolution of port industry. A considerable part of the transition of research themes and topics can be explained by theory development and research methodology application. Phenomena cannot be easily explained and analysed without the development of appropriate theories and methodologies. For the further development of port research it will be inevitable that research not only has to proactively respond to research demands to address new issues such as TOCs' strategy and management and integrating activities of seaport in supply chains, but also introduces a wider range of advanced methodologies to build theory in order to address them in an appropriate manner.

2.5.2 Theoretical bases and disciplinary characteristics of port research

A terminology provided by Morillo *et al.* (2003) citing the OECD (1998) is adopted to identify the disciplinary characteristics of port research, which are multidisciplinarity, interdisciplinarity and transdisciplinarity. In 'multi-disciplinary research', 'the subject being studied is approached from different angles, using different disciplinary perspectives and integration is not accomplished. Interdisciplinary research leads to the creation of theoretical, conceptual and methodological identity, so more coherent and integrated results are obtained. Transdisciplinarity goes one step further and it refers to a process in which convergence among disciplines is observed'. In other words, given the situation that different disciplines are present in a research field, the difference between multidisciplinarity and both interdisciplinarity and transdiscipliarity is whether integration between involved disciplines is attained or not.

It was clearly shown from the investigation into the discipline bases and theoretical bases of port research that port research has multidisciplinary characteristics and the intensity has become stronger as shown in Figure 2.6. In the 1980s, three primary disciplines, economics, geography and operations research were involved. In that decade, seaports were studied as a part of transport economics and transport geography, while this recognition is still generally accepted. Therefore theories and analytical tools used in transport economics and transport geography were applied to seaports by transport economists and transport geographers. This implies that economic and geographical theories were applied to seaports through sub-disciplines such as transport economics and transport geography rather than directly.

Figure 2.6 Disciplinary evolution of port research



In the 1990s, industrial relations and environmental studies began to be involved in port research due to port reform undertaken throughout the world and the increase in environmental concerns. In the 2000s, substantially more disciplines have been involved in port research. Management discipline areas such as strategic management, and information / communication appeared in the picture of port research. The involvement of these new disciplines had an important influence on theory transfer and application. Researchers, in this decade, tended to 'borrow' theories and knowledge directly from other disciplines, and apply them to seaports independently of traditional primary disciplines such as transport economics and transport geography. This may

have resulted in a blurring of territorial boundaries of the traditional disciplines, and led to interaction between them and with the newly-involved disciplines.

Then, the question which arises is, is port research moving towards being an interdisciplinary research field? Researchers suggest that interdisciplinary research is increasing since greater specialisation in science and complicated phenomena result in a greater necessity of combining knowledge from different fields (Lariviere and Gingras 2010; Morillo *et al.* 2003). It is generally accepted that seaports services have become complicated and a more integrated research approach is necessary (Heaver 2006). Panayides (2006) suggested a variety of research agendas to reflect the convergence of maritime transport and logistics, including the integration of ports in the concept of supply chains. Olivier and Slack (2006) argued that the emergence of global TOCs may facilitate dialogue between economic geography and port geography which has traditionally had a tendency to maintain ties with urban geography.

The investigation in this section has also revealed, to some extent, the possible existence of interplay among researchers from different disciplines at the level of theory, theoretical models, research methods and analysis techniques, one possible combination being the association of geographical concepts and economic analysis. Accessibility and connectivity are traditional concepts used in transport geography and they were analysed using econometric approach (Cullinane and Wang 2009; Low *et al.* 2009).

Another is the combination of economic concepts and geographical context. Complements and substitutes which are basic concepts used in consumer theory in micro economics were applied to investigate relationships between load centres located in a single gateway region (Notteboom 2009). Geography and public administration /politics is a further possibility (Hall 2003), showing a spatial variation of institutional changes derived from common technological impacts such as containerisation. Interplay between economics and management disciplines is clearly very likely given their real-world association.

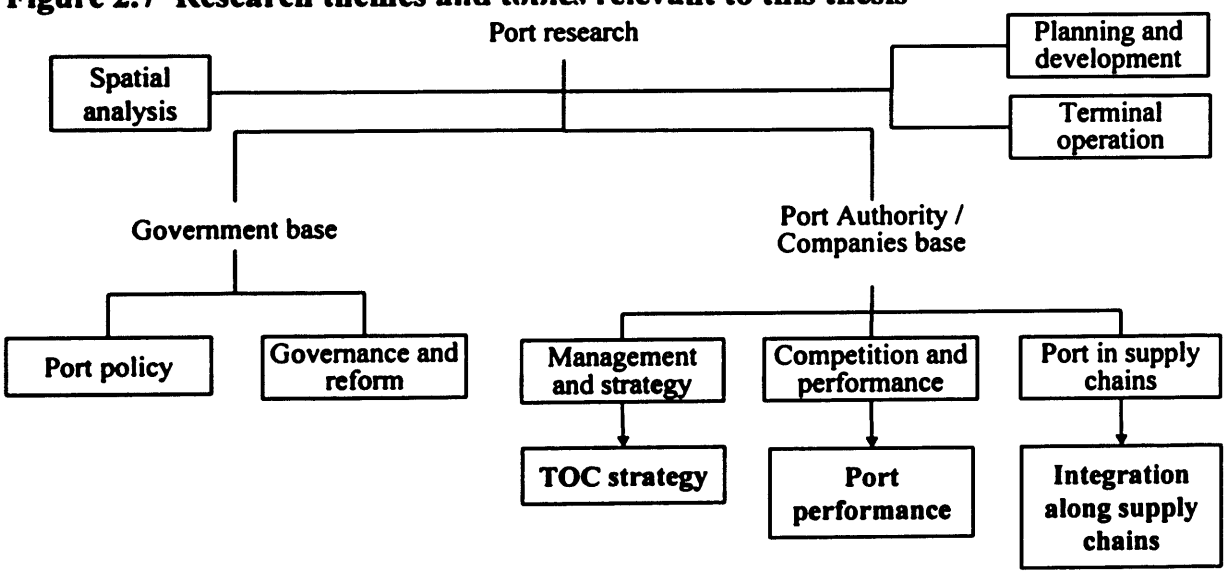
2.6 POSITIONING THIS THESIS IN PORT RESEARCH

Through the literature review of port research, a structure of research themes used in port research was constructed, and theoretical bases and disciplinary characteristics were identified. This section defines the positioning of this thesis in port research concerning these features of port research.

2.6.1 Research theme and topics of this thesis: Ports in supply chains

Figure 2.7 shows how this thesis fits into port research in terms of research themes and topics. This thesis is basically concerned with TOCs' strategy to achieve performance improvement and competitive advantage through integration along supply chains. Therefore three research topics of Port Authority/Companies based research: TOC strategy, Integration along supply chains, and Port performance. Strategies of TOCs are pursued, in broad sense, into two directions which are expansion of global coverage through horizontal integration and integration along logistics and supply chains through vertical integration (De Langen and Chouly 2009). The latter strategy is a main concern of this thesis. In addition, 'Port performance' topic is involved because this thesis assesses the impact of this strategy on performance of TOCs. As for the performance measurement and evaluation, an index approach is used rather than frontier approach which is used in the studies categorised in 'Port efficiency'.

Figure 2.7 Research themes and topics relevant to this thesis



Although the three topics are involved, this thesis falls on the category 'Port in Supply chains'. The previous section (see Section 2.3) briefly discussed how the studies in this category have been conducted. However, the discussion was not so exhaustive and limited to research topics. This section, therefore, further discusses the involvement of Supply Chain Management (SCM) concepts in port research and varying approaches of port research to SCM practices in order to show a view of this thesis concerning SCM concepts.

In port research, the term 'supply chain' or 'SCM' did not often appear until the early 2000s as discussed in Section 2.3. (see Section 2.3.5, p. 25) Although the evolving role of seaport terminals from a gateway into a logistics hub has been recently discussed relatively well, it is not easy to associate SCM issues with port operation and management. Kuipers (2005) shows how current container operations do not match well with SCM characteristics, which he names the SCM-maritime transport paradox as shown in Table 2.15. He points out that maritime transport is too rigid and unlikely to be differentiated, flexible, or of a high enough speed to be integrated into specific supply chain, while SCM strategy strives for differentiated, highly flexible, high speed and integrated services.

Table 2.15 The SCM-maritime transport paradox

SCM characteristics	Maritime transport characteristics
High differentiation for logistics services	Limited possibilities for service differences
High flexibility related to unique customer demands	Container operations are a mass market with very little possibilities for unique customer demand
High speed	Slow speed
Increased knowledge intensity and need for developing industrial relations and high levels of trust	Container operations hardly integrated in specific industrial processes and supply chain

(Source: Kuipers 2005)

However he also highlights the possibilities for maritime transport to be flexible in terms of sea operation, transhipment operations and inland transport operations to deal with the requirements of SCM. In addition researchers indicate that the increasing demand for integrated logistics and transport services makes maritime transport and

port operation inseparable from logistics and supply chain management (Panayides 2006; Robinson 2002). Thus, maritime researchers increasingly have addressed port-related issues from the SCM context or associated SCM issues with port studies in several ways. Three approaches to address the SCM philosophy and practices could be identified from these studies: studies on (1) the influences of SCM on shipping and port industries, (2) the applications of SCM concepts and models to port research, (3) the integrating activities along supply chains.

(1) Approach 1: Studies on the influences of SCM on port industry

The first approach investigates the influence of SCM strategies adopted by manufacturing companies on port industry. This approach tends to regard SCM as phenomenon which takes place outside of port operation, and analyses the dynamics among market players when the impact is made from outside. Table 2.16 describes the influences of new logistics strategies on shipping and port industries and the response adopted in the literature.

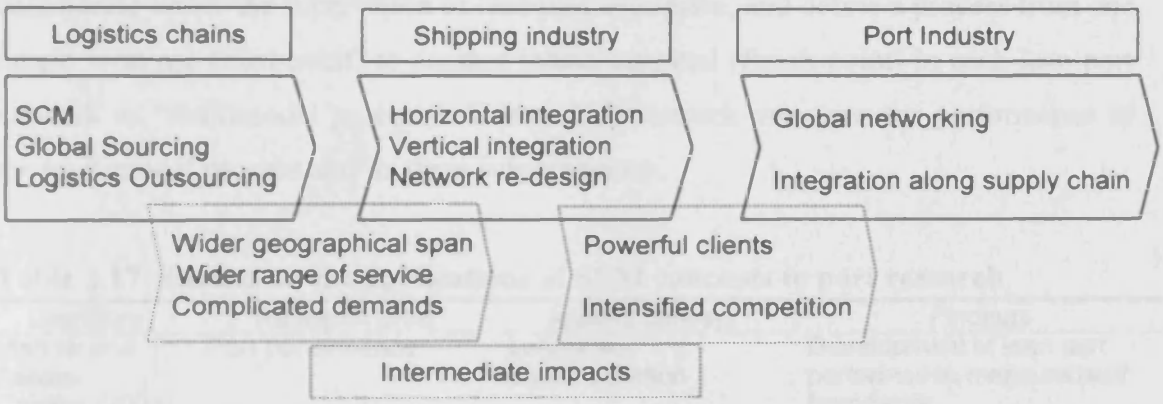
Table 2.16 Studies on the influences of SCM on port industry

Literature	Influences	Responses/Strategies
Notteboom and Winkelmans (2001)	Structural change in transport industries (esp. Shipping industry) Intensified port competition Liners' greater bargaining power	Service differentiation Value-added logistics Information system Port networking
Notteboom (2004)	Structural change in container shipping market	International terminal network development Integration along supply chain
Wang and Cullinane (2006)	Structural change in container shipping market Intensified port competition	Operational efficiency improvement
Robinson (2002)		Intervention in value chains
Heaver *et al.* (2001)		Horizontal expansion Internationalisation

Figure 2.8 summarises the dynamics among supply chain members presented in the sampled literature, focusing on maritime transport. Manufacturing companies realize the necessity of managing supply chains effectively in response to the globalisation of the economy and intensifying competition, and therefore adopt new strategies such as

SCM, global sourcing and outsourcing of logistics functions (Cho and Kang 2001; Lambert and Cooper 2000; Rabinovich *et al.* 1999). Such new strategies require transportation companies both to cover a wider geographical area and to provide a wider range of services to meet increasingly diversified demand patterns with lower price and higher quality than before (Heaver 2001; Slack *et al.* 1996). To deal with these requirements, shipping companies have integrated horizontally through mergers, acquisitions and strategic alliances, and vertically through operating dedicated terminals and by providing integrated logistics and intermodal services (Notteboom 2004). Additionally, shipping companies have rearranged service networks with the dual aim of global coverage and diversification. The reactions of shipping companies ultimately affect every facet of the maritime industry, especially port operations (Slack *et al.* 2001).

Figure 2.8 Influences of new logistics strategies on shipping and port industries



The main challenges ports face from this structural change are that their main customers, i.e. shipping lines, are becoming more powerful with stronger bargaining power, and that competition between ports is more intense both at inter-port and intra-port levels. Many studies suggest that ports have had to evolve across the range of their activities to cope with the challenges (Notteboom and Winkelmans 2001; Robinson 2002). However, two strategies are primarily suggested: development of global networks which can be achieved by horizontal integration, and integration along supply chains which relates to vertical co-ordination.

(2) Approach 2: Studies on the applications of SCM concepts to port research

The second approach regards SCM concepts and models as analytical tools to address and expand the issues of port operation and management as shown in Table 2.17. This approach is also based on the standpoint that the port industry has been substantially affected by SCM practices and accepts the SCM approach as dominant logistics perspective. The basic reason that the researchers adopt SCM approach is that they view the port system as the extended system which connects and actively interacts with other actors in supply chains beyond the traditional system which simply services ships and cargoes, and stays in passive position in supply chain.

Marlow and Paixao-Casaca (2003) develop a 'lean port performance measurement framework' through applying the 'leanness' concept to port performance. Using this concept they introduce the lean port network in which a number of lean ports collaborate under the supervision of lean port enterprise, and define a process from one inland terminal (start point) to another inland terminal (finish point) in each lean port network as "multimodal process". This new framework measures the performance of the multimodal process and its three sub-processes.

Table 2.17 Studies on the applications of SCM concepts to port research

Literature	Research area	Applied concept	Findings
Marlow and Paixao-Casaca (2003)	Port performance	Leanness Lean operation	Development of lean port performance measurement framework
Lee *et al.* (2003)	Port operation Simulation	Supply chain modelling	Development of simulation system for port supply chain
Carbone and De Martino (2003)	Port operation and integration	Lambert tri-dimensional model	Roles of ports in each business process of specific supply chain
Bichou and Gray (2004)	Port performance	SCM approach	Development of KPI on SCM approach
Bichou (2004)	Port security	SCM approach	Development of port security assessment framework
Bichou and Gray (2005)	Port classification Port terminology	Channel approach	New conceptualization of port on channel approach
De Martino and Morvillo (2008)	Port competitiveness	SCM network model (Dubois' model)	Identification of key factors in port competition
Pettit and Beresford (2009)	Port development	Global supply chain strategies	Suggestion of different roles of ports in different supply chain strategies

Bichou and Gray (2004) also apply the SCM approach to port performance. The SCM approach, in their study, extends a traditional ports system to an integrated channel management system where port stands as a key location linking different channels which are trade channel, supply channel and logistics channels. Under their integrated port system, "the actors and operators within the port community such as stevedores, multimodal transport operators and logistics providers are sub-members of the port management system, not part of the external world". In addition, their port management system encompasses internal and external integration of port, and the port performance management system considers both values for customer and operational productivity. Using the SCM and the channel approach, Bichou (2004) and Bichou and Gray (2005) also present a new port security assessment framework and a new conceptualisation of port system respectively.

Carbone and De Martino (2003) analysed the business processes of a French car manufacturing company (Renualt)'s supply chain in Port of Le Havre, applying the Lambert tri-dimensional model. They, subsequently, investigated the role of port operators in the processes in terms of mutual relationship, supplied services, ICT (Information and Communication Technology) and performance indicators. De Martino and Morvillo (2008) analyse port's value creation system within supply chain network adopting the interrelated supply chain network models. They review several research models used in SCM study from a network perspective, and select one model, Dubois' model which is found appropriate for representing port's value creation in supply chain network. Pettit and Beresford (2009) adopt Christopher *et al.* (2006)'s taxonomy to select supply chain strategies such as lean, agile, leagile, to suggest different roles of ports within different supply chain strategies.

(3) Approach 3: Studies on the integrating activities along supply chains

This approach also views ports as an extended system which interacts with other members in supply chains. Furthermore, this approach recognizes SCM and supply chain integration as phenomena which can take place throughout ports along supply

chains, and regards ports as an integral party which proactively participates in the phenomena.

Table 2.18 Studies on the integrating activities of ports along supply chains

Literature	Objective	Findings
Carbone and De Martino (2003)	To analyse how port operators deal with the challenge of integration	Port operators are involved in several processes, but higher integration is required for stronger competitiveness
Notteboom and Rodrigue (2005)	To extend port development model with port integration	The existing model is extended to port regionalisation phase
Panayides and Song (2008)	To develop measures for integration of seaport terminals	Four measures are validated (ICS, VAS, MSO, SCIP)
Song and Panayides (2008)	To test the impact of terminal integration on port competitiveness	Positive relationship between terminal integration and port competitiveness is statistically proved
Rodrigue and Notteboom (2009)	To discuss how logistics service providers use terminals in their supply chains	Logistics service providers actively use terminals as DC, so terminals are additionally integrated in supply chains (i.e. terminalization of supply chains)
De Martino and Morvillo (2008)	To identify key factors of port competitiveness	Activities, resources and Inter-organisational relationships among actors in supply chain networks are critical source of port competitiveness
Pettit and Beresford (2009)	To identify port logistics activities in recent port development stage	Logistics activities of ports vary depending on types of supply chain strategies and distribution facilities

Note: ICS-Information and Communication Systems; VAS-Value-Added Service; MSO-Multimodal System and Operation; SCIP-Supply Chain Integration Practices; DC-Distribution Centres

At first, researchers attempted to explore how ports get involved and integrated in supply chains, and conceptualise what the integration represents in the port context as shown in Table 2.18. Carbone and De Martino (2003) identify four SCM components: mutual relationships, supplied services, information and communication technologies and performance measurement, and investigate how port operators in the Port of Le Havre get involved with Renault's supply chain in terms of the components. They found that port operators were more involved in outbound logistics than inbound logistics, because Renault manages the inbound logistics through vertical integration to keep freight rate and transit time under its control.

Rodrigue and Notteboom (2009) show that ports become increasingly embedded by supply chain practices because logistics service providers actively use ports as 'extended distribution centres'. Pettit and Beresford (2009) demonstrate that, depending on the strategies of supply chains ports belong to, the distribution facilities of the ports can be variably developed and different types of logistics activities take place. Panayides and Song (2008) conceptualise the integration of seaport terminals along supply chains, and develop instruments to measure the degree of the integration. They derive four variables from relevant literature: information and communication systems; value-added service; multimodal system and operation; supply chain integration practices, and empirically validate them using confirmatory factor analysis.

On the other hand, researchers look into the implication of integration on port performance and competitiveness. Panayides and Song (2006) conclude that the integration practices positively influence port performance using preliminary analysis of data collected, and Song and Panayides (2008) empirically show that some components of the integration have positive contribution to port performance. De Martino and Morvillo (2008) presented a new framework of port competitiveness relating to supply chain integration. They suggest that inter-organisational relationships are another crucial source of port competitiveness which the integration of activities and resources along the supply chain has been considered as a source of competitive advantage.

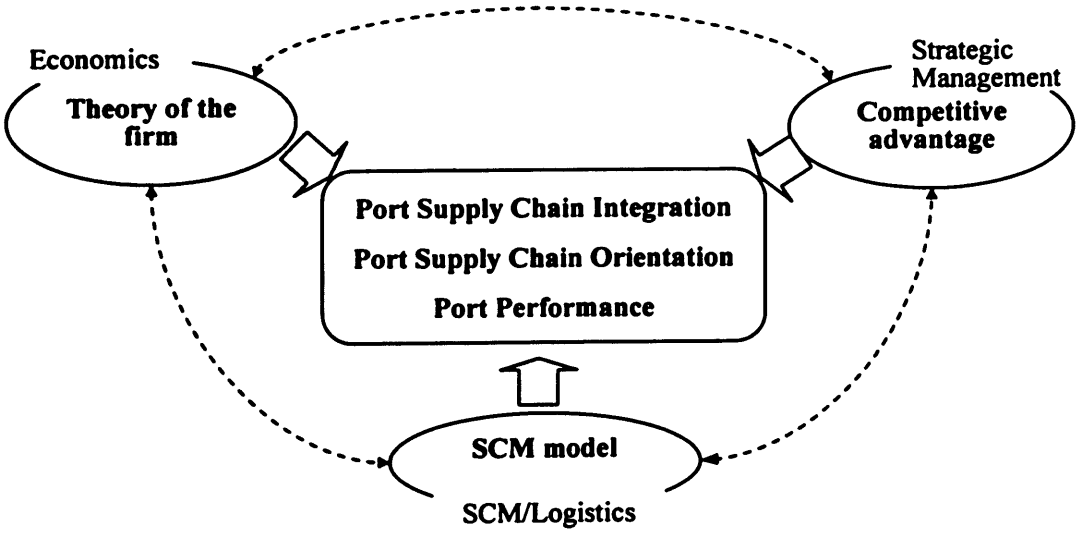
When it comes to categorising this thesis, the third approach is the category in which this thesis belongs because of the focus on a port's integration practices along supply chains. However, the second approach is also partly applied in developing the research model which relates the antecedents and consequences of PSCI. Investigating supply chain integration of ports is a research area which is still rarely conducted but closely related to SCM research. It is unlikely to be able to identify the antecedents of PSCI without help from the existing theories and models used in SCM research. For example, this thesis refers to the conceptual model which relates SCM, supply chain orientation as an antecedent of SCM, and firm performance as a consequence of SCM to explore what can be the antecedents for PSCI during the literature review.

2.6.2. Theoretical and disciplinary bases of this thesis

Theoretical positioning of literature is a difficult part of writing the literature and there is no 'one-best way' (Barney 2001). When the literature involves several theories and insights, an emphasis on some particular theories and insights would change the argument substantially. This thesis aims to investigate the integration strategies of seaport terminals along supply chains to improve their competitive advantage and its relationships with antecedents and consequences. Given that the topics of this thesis are relatively new and interdisciplinary, it requires involvement of various theories from other disciplines to explain the complicated phenomena.

Therefore the theoretical positioning of this thesis is defined by explaining which theories are involved and how they relate to this thesis rather than by clarifying differences and similarities of this thesis and the theories. Figure 2.9 illustrates which theories and theoretical models are involved in this research. Theories primarily used in 'Economics' and 'Management' disciplines are directly or indirectly applied to this thesis. Some theories and theoretical models provided this thesis with a direct contribution to developing the research model, while some theories provided theoretical foundation to understand the phenomena.

Figure 2.9 Theoretical and disciplinary bases of this thesis



(1) Theory of the firm

'Theory of the firm' is concerned with the nature of the firm including its existence, and its behaviour and its relationships with the market (Hodgson 1998). There are two contrasting approaches in this theory, which are 'contractual perspective' and 'competence-based perspective' (Foss 1993; Hodgson 1998). Transaction Cost Theories (TCT) is a subset and representative of the former. In TCT, a firm is viewed as a governance structure rather than production function and 'transaction costs' are considered when making decisions on governance structure of the firm between the 'market' (a buy decision) and 'vertical integration' (a make decision) (Grovar and Malhotra 2003). Therefore TCT has provided researchers with a powerful theoretical foundation to explain this decision making.

In transport research, Panayides (2002) applied TCT to discuss the optimal governance structure in intermodal transport. In SCM research, TCT has been used to explain the reason of SCM and vertical integration of organisations (Maltz 1993; Skjoett-Larsen 1999). Grovar and Malhorta (2003) also suggested that TCT can be applied in operation and SCM research in various topics such as 'outsourcing and make versus buy decisions', 'supply chain co-ordination' and 'supply chain integration'. However, the limitations of TCT (or contractual perspective) have been also pointed out by researchers that it assumes i) given atomistic individuals and ii) a uniformity of technology over different governance, and iii) neglects technological innovation and dynamic change (Hodgson 1998). As an alternative to TCT, competence-based perspective is suggested, which explains the existence, structure and boundaries of the firm by individual or team competences.

These two main perspectives in the theory of the firm provide a theoretical foundation to understand and conceptualise the phenomena of this thesis' interest. The reason and the nature of integration strategy of seaport terminals can be understood with the help of TCT. In particular, with the awareness that SCM is viewed as lying between fully vertically integrated and those where each channel member operated completely independently, TCT is useful to discuss the integration strategy along supply chains.

However this discussion should be supplemented with a competence-based perspective since TCT has weaknesses in explaining cooperative relationships, strategic collaboration and long-term relationships which have been emphasised in SCM research. In addition, competence-based perspective will be used to identify capabilities, resources and competences in seaport terminals to facilitate the integration strategy along supply chains

(2) Theories of competitive advantage

Theoretical frameworks used to explain how the competitive advantage of firm(s) can be achieved also provide important theoretical bases because this research basically is interested in whether strategies adopted by seaport terminal operators improve competitive advantage and port performance. Two main theories of competitive advantage can be involved: Porter's competitive strategy framework (Porter 1980) and Resource-Based Theories (RBT) of competitive advantage (Barney 1991; 2001). Integration strategy of terminals can be considered using the Porter's framework which defines three strategies to create competitive advantage, i.e. cost leadership, differentiation and focus. In addition, the concept of 'value chain' which is used in the Porter's framework as a basic tool for diagnosing competitive advantage and finding ways to create and sustain it, emphasises the importance of vertical linkages between suppliers' value chain and a firm's value chain (Porter 1985). The vertical linkages provide opportunities for a firm to enhance its competitive advantage. Despite these advantages the Porter' framework has its limitations. It has been pointed out that it stresses the importance of heterogeneity within the same industry rather than industry membership in explaining the performance of a firm (Hoskisson *et al.* 1999), and is not able to explain the different levels of performance in the same industry as well as in the case of using the same strategy (Lynch *et al.* 2000).

RBT is also applied more importantly in identifying the organisational characteristics of terminal operators and their strategic attitudes to SCM as antecedents to the integration strategy. These can be viewed as resources of a particular terminal operator to be able to generate 'rents'. Examples can be organisational learning (Panayides

2007) and inter-organisational relationships which relate to the relational capability of an organisation such as trust and commitment (Bichou and Bell 2007; Panayides and So 2005). RBT is closely linked to the competence-based perspective of the theory of the firm which is represented by evolutionary economics (Barney 2001). RBT emphasises a firm's internal strengths and weaknesses rather than external opportunities and threats (Hoskisson *et al.* 1999). Strategies of a firm can be analysed with the view that a firm is considered an entity to make strategic decisions to optimally utilise its unique specialised resources (Menzter *et al.* 2004).

(3) SCM model

SCM model in this section refers to a particular research model developed and examined by Menzter *et al.* (2001), Min and Mentzer (2004) and Min *et al.* (2007) as shown in Figure 2.10. A conceptual model was structured in Menzter *et al.* (2001), which identifies antecedents and consequences of SCM and represents causal relationships among them. The validity and reliability of the model was examined in Min and Mentzer (2004) and the model was further extended associated with marketing function in Min *et al.* (2007).

This thesis adopted this SCM model in the process of research model development because this model was found to be useful to answer the research questions of this thesis. The SCM model encompasses concepts which represent not only inter-firm relationship and activities (SCM) but also intra-firm capabilities as antecedents to the inter-firm relationships (SCO). In addition, this model justifies the positive impact of these inter-firm and intra-firm relationships firm performance which is a core interest of this thesis.

Figure 2.10 SCM model

Source: Min and Mentzer (2004)

Although the structure of this model was fully adopted by this thesis, the concepts and the components of the concept were entirely re-constructed from the port industry's context. For example, the focus of this SCM model is on a focal company which co-ordinates its supply chain. However, even though the role of seaport terminals can be considered important, they are unlikely to control or co-ordinate a supply chain. Instead, they can make themselves more attractive to be chosen by supply chains. The integration strategy of seaport terminals in this thesis is viewed from this context. In addition, organisational resources and capabilities of seaport terminals need to be identified from the port industy's point of view. Therefore, this thesis endeavoured to undertake model development and analysis procedures, grounded in the port industry context rather than simply adopting and borrowing constructs and components from the existing literature of other research fields such as logistics and SCM research. More empirical type of research, thus, was inevitable in order to obtain more accurate view from reality. Semi-structured interview study was the contribution to develop research model, particularly in identifying antecedents to the integration strategy of seaport terminals which were not covered by the exiting port literature.

2.7 SUMMARY

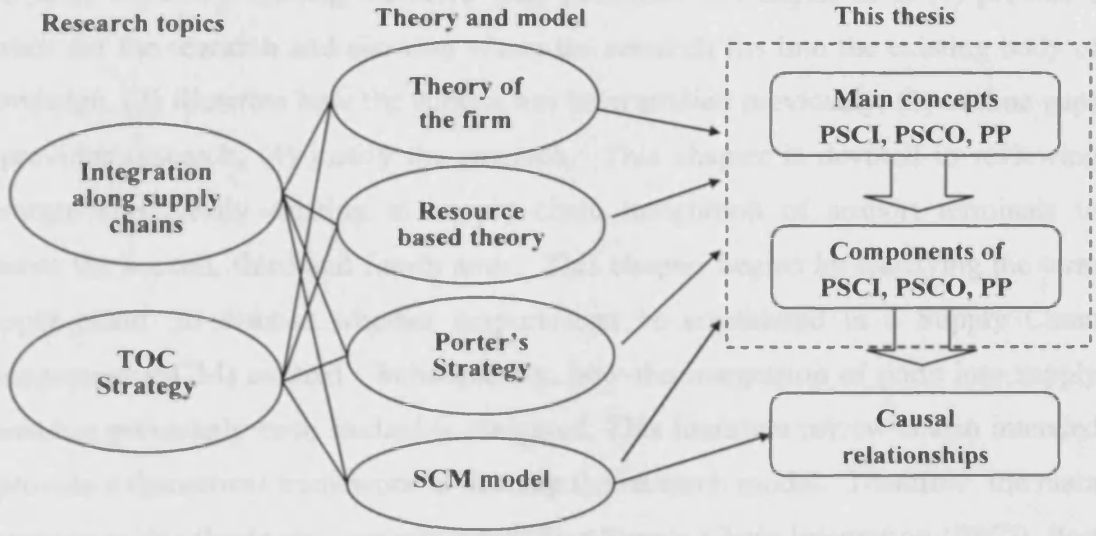
A structured literature review of port research in general was undertaken in this section to define the positioning of this thesis in port research. The literature was categorised in terms of research themes, theoretical and disciplinary bases, research methods, and data analysis techniques. This section showed the results for research themes and theoretical and disciplinary bases[2]. A structure of research theme in port research was constructed with eight main research themes: 'Port policy', 'Governance and reform', 'Management and strategy', 'Competition and performance', 'Ports in supply chains', 'Planning and development', 'Terminal operations' and 'Spatial analysis'. Research topics used in these themes were also presented. Focuses of port researchers in the 2000s were on research topics relating to port industry and market situation after port reform era (i.e. 1990s), port efficiency applying frontier approach to port performance,

[2] The investigation into research methods and analysis techniques are presented in Chapter 4.

and strategy of TOCs. As for the theoretical and disciplinary bases, theories and theoretical models used in economics, geography and operations research have primarily been involved in port research. In the 2000s, emerging involvement of management disciplines and research fields such as strategic management, marketing, information and communication, logistics and SCM, were outstanding.

Figure 2.11 shows the coherence among research topics, theories and the research model in this thesis. This thesis can be categorised within 'Ports in Supply Chains' studies, specifically 'integration along supply chains'. The integration of seaport terminals is considered as a strategy of TOCs.

Figure 2.11 Coherence of topics, theories and research model of this thesis



These research topics entailed the involvement of various theories and models. The SCM model developed by Min and Mentzer (2004) was used in reseach model development. This SCM model provided a theoretical framework which can relate inter-firm activities (PSCI), intra-firm capabilities and firm performance. In addition, the theory of the firm (TCT and competence-based perspective) and theories of competitive advantage (Porter's strategy framework and RBT) provides fundamental understanding about the integration strategy of seaport terminals.

CHAPTER 3

SUPPLY CHAIN INTEGRATION OF SEAPORTS

Four aims to review exising literature were presented in Chapter 2: to (1) provide a context for the research and showing where the research fits into the existing body of knowledge, (2) illustrate how the subject has been studied previously, (3) outline gaps in previous research, (4) justify the research. This chapter is devoted to reviewing literature specifically relating to supply chain integration of seaport terminals to achieve the second, third and fourth aims. This chapter begins by clarifying the term 'supply chain' to discuss whether seaports can be considered in a Supply Chain Management (SCM) context. Subsequently, how the integration of ports into supply chains has previously been studied is presented. This literature review is also intended to provide a theoretical framework to develop the research model. Therefore, the main constructs in this thesis are conceptualised: Port Supply Chain Integration (PSCI), Port Supply Chain Orientation (PSCO) and Port Performance (PP). Their components are identified from the literature and their causal relationships are justified in this part of this chapter. Finally research gaps are identified to justify this research.

3.1 SEAPORTS IN SUPPLY CHAINS

This section clarifies terminology in relation to supply chains and ports. This is useful because although the term 'supply chain' is frequently used in the port literature, it is

rarely defined or specified. In addition, several similar terms, such as logistics supply chain, service supply chain and port supply chain, appear in literature without clarification. This research also uses similar terms constantly from the first to the final chapter, so it is worthwhile to investigate, at an early stage of this thesis, what supply chain means in general and in this research; how a port can be involved with a supply chain; and whether a port can be considered as a member of a supply chain.

Stevens (1989) defines supply chain as 'a connected series of activities which are concerned with planning, coordinating and controlling materials, parts, and finished goods from supplier to customer'. A more common definition of a supply chain is a system of suppliers, manufacturers, distributors, retailers, and customers where materials flow downstream from suppliers to customers and information flows in both directions (e.g. Jones and Riley 1985; Lamming 1996). These definitions do not explicitly show whether transportation or transport companies such as port operators are included. Mentzer *et al.* (2001) defines supply chains as 'a set of three or more entities (organisations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer'. They also identified three degrees of supply chain complexity: a 'direct supply chain' which consists of a company, an immediate supplier, and an immediate customer; an 'extended supply chain' which includes suppliers of the immediate supplier and customers of the immediate customer; and an 'ultimate supply chain' which includes all the organisations involved in all the upstream and downstream flows from the ultimate supplier to the ultimate customer. Only an 'ultimate supply chain' includes third party logistics (3PL) providers whom transport companies can get involved with.

Some definitions explicitly include carriers and logistics service providers as a member of supply chains (e.g. Gentry 1996; Lalonde and Masters 1994). From the holistic view, all functions and organisations involved in the flow of materials and information are included as a member of a supply chain. It follows that ports also play certain roles somewhere between companies or organisations if the supply chains involve maritime transport. However, the term, 'supply chain' is defined variably according to the scope

and interests of studies as done by Mentzer *et al.* (2001). They used the 'ultimate supply chain' concept to consider the final customer and supplier in their study. If a study does not consider ports much in defining or specifying a supply chain, this may mean issues related to port operation and management are not addressed in the study.

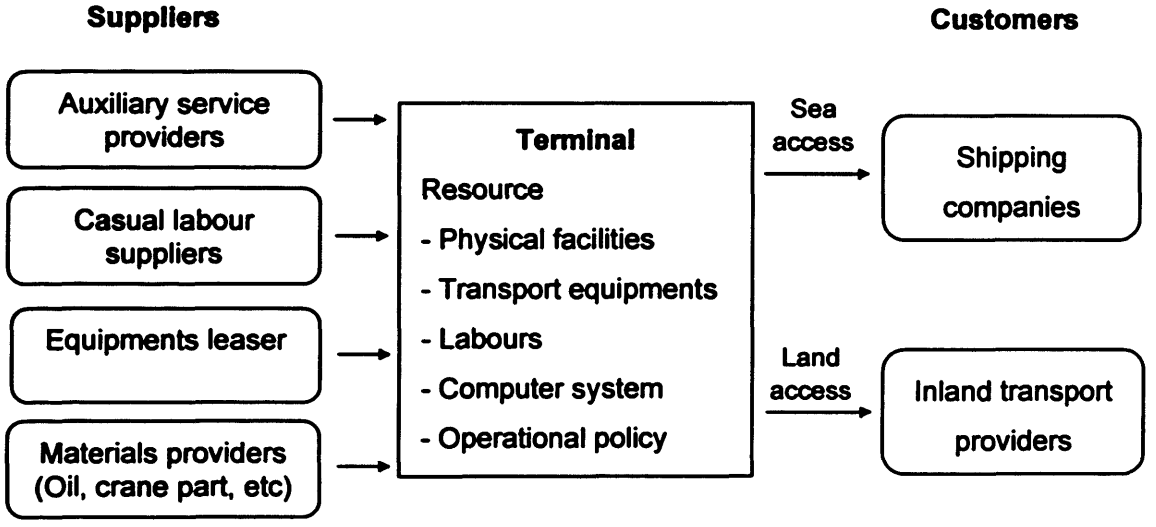
Some researchers distinguish 'service supply chain' from 'manufacturing supply chain' arguing that the majority of SCM research has focused on the manufacturing sector (Ellram *et al.* 2006; Sengupta *et al.* 2006). They use the same definition of supply chain and supply chain management but focus on supply chains in the private service sector. They highlight the different characteristics of the service supply chain: for example, human labour forms a significant component of the value delivery process in service supply chains. Sampson (2000), in service supply chains, identifies 'customer-supplier duality' which describes the feature that 'all services for a customer act on something (e.g. customer's belongings, information, bodies, etc) which is provided by the customer'. This implies that service businesses have customers as primary suppliers of inputs, in other words, customers are suppliers in all service businesses.

Maritime researchers propose more specific terms which concern seaports and shipping companies more significantly, or which seaports or shipping companies are centred in. Van Niekerk and Fourie (2002) define 'maritime supply chain' as management by shipping companies of the supply-side of supply chains to exercise control over the entire chain in pursuance of the lowest cost and efficiency gains. Lee *et al.* (2003) decompose supply chains with the concept of 'port supply chains' which focus on port operation of supply chain of products, materials and services. Lopez and Poole (1998) used the term 'maritime port logistics chain' which describes integrated and sequential physical and other transport activities confined to ports and the maritime-land transport interface. Robinson (2006) specifies 'port-oriented landside supply chain' to investigate integration of functions and activities of landside logistics.

All the above are cases where a whole supply chain of materials or products passing through ports is decomposed, focusing on, or confined to, maritime transportation and

port operation. Then, in contrast, it is also possible to think about the supply chain of services ports provide. In this case, Terminal Operating Companies (TOCs) are the focal company, and suppliers and customers for the services can be identified according to the service range ports provide. Figure 3.1 shows a simple case where a terminal provides a stevedoring service combining auxiliary services such as lashing and inspection. In this case, customers and suppliers would be relatively limited. Shipping companies for sea-access and inland transport providers for land-access would be considered as a 'customer'. If the terminal provides additional services, for example, services combining stevedoring (with auxiliary services), inland trucking and warehousing, forwarders, third-party logistics service providers and shippers would be considered as a customer of the port services, and more suppliers would be involved in this supply chain. It would be also interesting to investigate port operation and management within the scope of this supply chain concept.

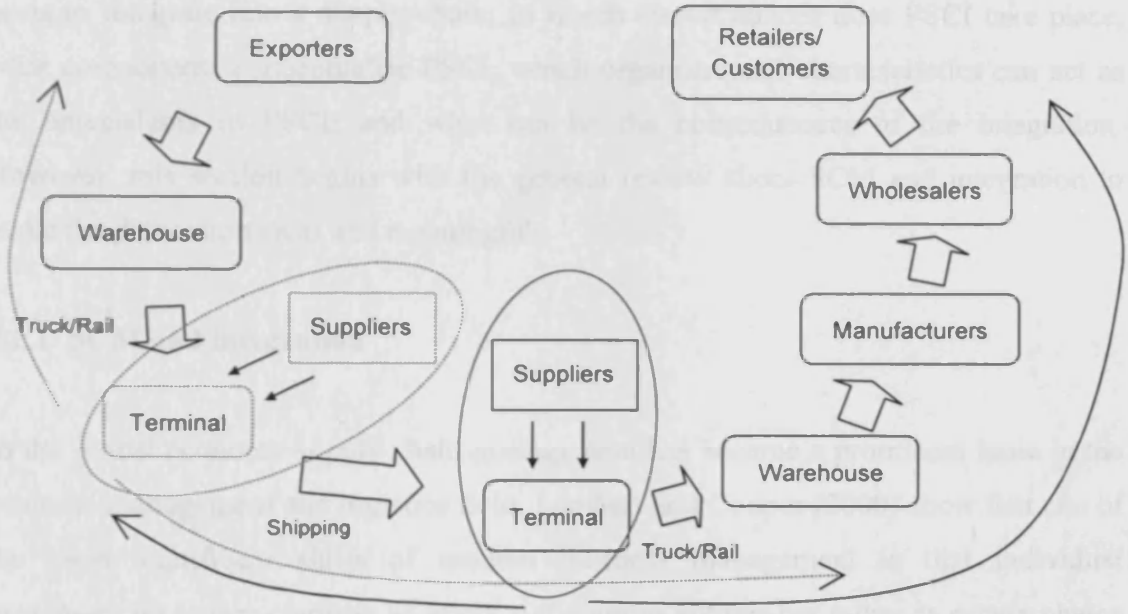
Figure 3.1 Supply chain of port services



A difference, in this case, can be made in that the suppliers of the port services can be considered while the customers of the port have primarily been involved in port research. Example cases are found in Lai *et al.* (2008) and Lai (2009). These studied channel relationships and buyer-supplier relationships in the context of a supply chain where a TOC is the focal company, and data were collected from the TOC's suppliers. However, in this thesis, 'supply chain' means 'supply chain of goods and materials' passing through ports rather than 'supply chain of services ports provide', and 'port' is

considered as one of the members of the wider (ultimate) supply chains. Figure 3.2 illustrates the supply chain of goods where maritime transport is involved.

Figure 3.2 Ports in a supply chain



Between the end-supplier who exports and the end-customer, there may exist a number of members and functions. Seaport terminals play a traditional role to link sea shipping and land transport. In Figure 3.2, suppliers of port services are encircled because they are not considered separately from seaport terminals. The arrows stand for the possible extension of the role and function of ports in the supply chain. In conclusion, (1) this thesis uses the term 'supply chain' as supply chain of goods; and (2) considers ports as a member of the supply chain and (3) as an actor who is able to proactively integrate functions along the supply chain.

3.2 INTEGRATION OF PORTS IN SUPPLY CHAINS

This section explores how supply chain integration of ports has been researched. From this section, the integration of seaport terminals in supply chains is termed as 'Port Supply Chain Integration (PSCI)' because the frequency of this term's usage increases

from this point. This exploration is expected to reveal research gaps to justify this research and establish a theoretical basis to develop the research model which is presented in Chapter 5. To meet this expectation, this section reviews relevant literature addressing a series of questions: what is the nature of PSCI, what motivates ports to integrate into a supply chain; in which circumstances does PSCI take place, what components conceptualise PSCI; which organisational characteristics can act as the antecedents to PSCI; and what can be the consequences of the integration. However, this section begins with the general review about SCM and integration to make the discussion clear and meaningful.

3.2.1 SCM and integration

In the global economy supply chain management has became a prominent issue in the business management and logistics field. Lambert and Cooper (2000) show that one of the most significant shifts of modern business management is that individual businesses no longer compete as solely autonomous entities but rather as supply chains. Cooper *et al.* (1997) state the term 'SCM' has risen to prominence over the past ten years. It is generally stated that SCM and other similar terms such as network sourcing, supply pipeline management, value chain management, and value stream management have become subjects of increasing interest in recent years, to academics, consultants and business management (Croom *et al.* 2000). It is also increasingly accepted that effective management of a supply chain is a key factor in differentiating product and service offerings and gaining competitive advantage for firms (Christopher 1998).

(1) Background and definition of SCM

The background reason that SCM has become so popular and recognised as a crucial firm strategy is that companies have become more dependent on supply chains and find it necessary to manage supply chains more effectively in order to meet complicated customer requirements in a global economy. Lai *et al.* (2002) state that the emergence of the global economy and intensified competition have led firms to recognise the importance of managing their supply chain for fast product introduction

and service innovations to the markets. Thus, firms have embraced SCM to increase organisational effectiveness and to achieve such organisational goals as improved customer value, better utilisation of resources, and increased profitability. Mentzer *et al.* (2001) also state that specific drivers to supply chain management may be traced to the trends in global sourcing, an emphasis on time and quality-based competition and their respective contributions to greater environmental uncertainty.

Researchers have made efforts to define the term supply chain management which is relatively new and somewhat ambiguous (Cooper and Ellram 1993; Croom *et al.* 2000; Mentzer *et al.* 2001). Croom *et al.* (2000) state that supply chain management has received attention since the early 1980s, yet conceptually the management of supply chains is not particularly well-understood, and many authors have highlighted the necessity of clear definitional constructs and conceptual frameworks on supply chain management (Burgess *et al.* 2006). Tyndall *et al.* (1998) point out that despite the popularity of the term, both in academia and practice there remains considerable confusion as to its meaning. Cooper and Ellram (1993) define SCM as "an integrative philosophy to manage the total flow of a distribution channel from the supplier to their ultimate user". SCM is also defined as the integration of key business processes to end users through original suppliers that provide products, services and information that add value for customers and other stakeholders (Lambert *et al.* 1998).

More useful distinctions are given by Mentzer *et al.* (2001). They at first distinguish "supply chains as phenomena that exist in business and the management of those supply chains" which is SCM. Also the definition of SCM is classified into three categories: a management philosophy, the implementation of a management philosophy, and a set of management processes. In addition, the activities necessary to successfully implement an SCM philosophy are presented: integrated behaviour, mutually sharing information, mutually sharing risks and rewards, cooperation, the same goal and the same focus on serving customers, integration of processes and partners to build and maintain long-term relationships. These activities are frequently adopted as constructs for conceptualising SCM (e.g. Min *et al.* 2007). On the other hand, they present a distinction between Supply Chain Orientation (SCO) and SCM:

"SCO is a management philosophy and SCM is the sum total of management actions undertaken to realise that philosophy". SCO can be expressed as the degree of recognition and willingness to address the strategic activities involved in managing a supply chain, and they highlight that "companies implementing SCM must first have a SCO". Thus SCO is used as one of the antecedents to SCM.

With regard to its relation with logistics, it is accepted that SCM has a broader scope from the definition by the Council of SCM stating that "Logistics management is that part of SCM that plans, implements and controls the efficient forward and reverse flow and storage of goods, services, and related information between the point of origin and point of consumption in order to meet customer requirements". Ballou (2007) points out that SCM is viewed as managing product flows across multiple enterprises whereas logistics is seen as managing the product flow activities just within the firm.

(2) Supply chain integration

Despite the various dimensions of understanding about SCM, the main concept that penetrates into the understandings of SCM is 'integration'. Bowersox and Closs (1996) argue that to be fully effective in today's competitive environment, firms must expand their integrated behaviour to incorporate customers and suppliers. They refer to this extension of integrated behaviours, through external integration, as SCM. According to Cooper and Ellram (1993), SCM is viewed as lying between fully vertically integrated systems and those where each channel member operated completely independently. Chow *et al.* (1995) state the concept of integration is central to logistics. According to them, integration is the degree to which logistics tasks and activities within the firms and across the supply chains are managed in a coordinated fashion.

Several terminologies are given to express the types and degrees of integration. Kahn and Mentzer (1996) identify two interdepartmental integration characteristics, namely, interaction and collaboration. In their view, interaction is information flow via communication and tends to be mandatory, formal, and somewhat tangible, thus it can

be easily tracked, whereas collaboration refers to working together in a team environment under shared goals and cannot be mandated, programmed or formalised thus is more difficult to monitor. Spekman *et al.* (1998) explain the transition from open market negotiation to collaboration through cooperation and coordination among market players. Cooperation is a starting point for SCM in itself but not a sufficient condition. Coordination is the next level, linking trading parties through exchanging workflow and information. The final stage is collaboration which requires high levels of trust, commitment, and information sharing among supply chain partners. The types of supply chain integration have been categorised in various ways; internal integration and external integration (Daugherty *et al.* 1996; Gustin *et al.* 1995; Stank *et al.* 2001; Stock *et al.* 2000), intra-organisational integration and inter-organisational integration (Morash and Clinton 1998), customer integration, internal integration, material and service supplier integration, technology and planning integration, measurement integration, relationship integration (Bowersox *et al.* 1999).

3.2.2 Nature of Port Supply Chain Integration (PSCI)

The phenomenon, 'integration of ports in supply chains', has been recently studied by maritime researchers (e.g. Carbone and De Martino 2003; Notteboom and Rodrigue 2005; Panayides and Song 2008) as discussed in the previous section. Panayides and Song (2008) termed the integration of seaport/terminals in supply chains as 'Seaport Terminal Supply Chain Integration (TESCI)', and defined the term as "the extent to which the terminal establishes systems and processes and undertakes functions relevant to becoming an integral part of the supply chain as opposed to being an isolated node that provides basic ship-shore operation". This thesis uses the term 'Port Supply Chain Integration (PSCI)' for the phenomenon. PSCI can be expressed, adapting Panayides and Song (2008)'s definition, as 'a strategy undertaken by a seaport terminal to integrate various functions and organisations in a supply chain to become an integral part of the supply chain'. Thus, the entity to implement the strategy is a company operating seaport terminals which are termed as Terminal Operating Companies (TOCs).

Most of the studies on PSCI demonstrate that PSCI is implemented through (1) providing integrated logistics services and (2) organisational integration (e.g. Beresford *et al.* 2004; Carbone and De Martino 2003; De Souza *et al.* 2003; Notteboom and Winkelmans 2001; Paixao and Marlow 2003; Robinson 2002). De Martino and Morvillo (2008) suggested that 'the concept of integration in the port context has essentially concerned intermodality and organisational integration undertaken by global carriers aimed at responding to the changing requirements of industrial and commercial enterprises and at the same time improving their own internal efficiency.' Beresford *et al.* (2004) pointed out that modern ports diversified into the emerging field of logistics and began to offer integrated logistics services as they became increasingly integrated into transport and supply chains.

(1) Integrated logistics services

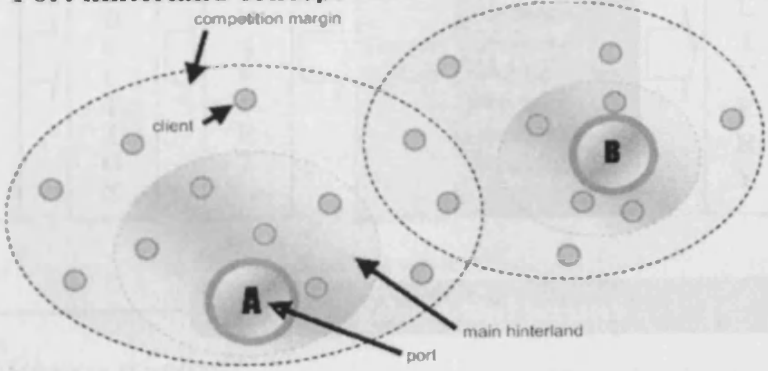
The integrated logistics services are primarily concerned with intermodal services and value-added logistics (VAL) services. Traditionally, TOCs have provided cargo handling services and simple storage. On top of these, they have also provided inland intermodal operation and transportation. Since ports are both involved in the sea and land side of logistics operations and they have importance in the land-sea cargo supply chains, they are granted the main role in the creation of intermodal transport systems (Mistzal 2007). Intermodal transport has emerged as a new transport concept in order to integrate transport modes and to provide coordinated transport activities under a single transport document in the logistics chain. Accordingly, ports' role in this logistics chain apart from their traditional activities and functions is expected to change and become intermodal transport-oriented in order to be competitive in the transport industry.

With the developments taking place in container transport and intermodal transport, land connections of ports and their hinterland have become a differentiation factor. Ports are important elements in the logistics chain and their level of integration with intermodal transport and their hinterland is very important, and this can be suggested as a new area of research (Denktas *et al.* 2009). The main reasons for this need is that

costs for inland transport are generally higher than maritime transport costs and many delays can occur on the inland side of the chain such as congestion, limited infrastructure, etc. Although more economical ships and alliance co-operation have lowered ship system costs, intermodal costs still share an increasing part of the total cost. In a typical intermodal transport system, inland transport now accounts for a much larger component of the cost than running the vessel. The portion of inland costs in the total costs of container shipping would range from 40% to 80% (Notteboom 2004). Improving the infrastructure and using cost-effective solutions for inland distribution of cargoes may help ports to achieve supply chain integration and to be intermodal transport-capable. The introduction of intermodal transport and its relation with ports have had the following consequences in the transport and port environment and these can be classified in terms of (a) hinterland connections of ports (b) the roles of the actors in the logistics chain (c) connectivity and integration of ports with different transport modes and (d) evolution of dry ports.

Port hinterlands are composed of two kinds of hinterlands as the main hinterland and competition margin hinterland (see Figure 3.3). The main hinterland can be mentioned as an exclusive area where a port has a monopolistic position in drawing cargo and the outer area is a competition area where more than two ports compete for cargo. It has been argued that recent developments in intermodality makes the exclusive port into a common hinterland where different ports share facilities so that the border of a hinterland between different ports will depend not on the exclusive market area of each port but on the development of intermodal transport corridors (UNESCAP 2005).

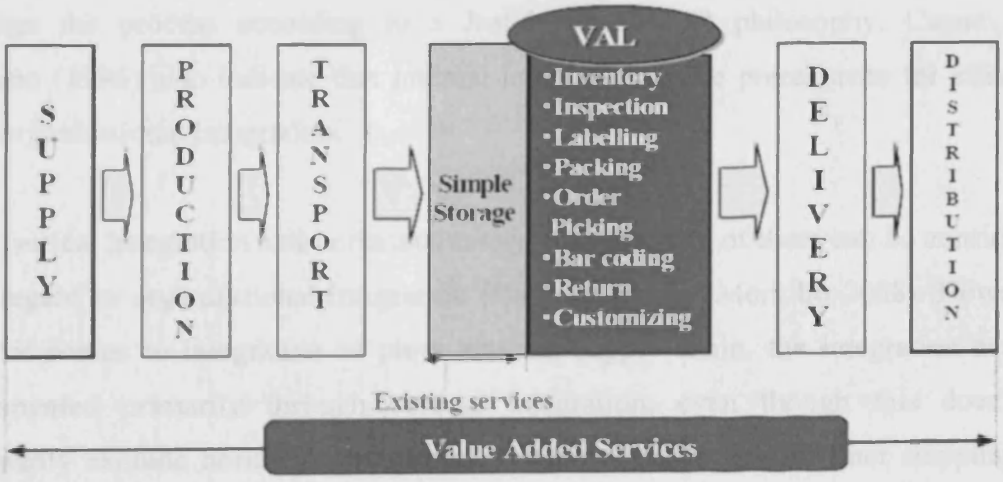
Figure 3.3 Port hinterland concept



(Source: Rodrigue 2005)

While ports aim to provide full door-to-door intermodal services, it is not easy to compete with Shipping Companies (SCs) in terms of door-to-door services involving sea operations. Therefore, they also provide VAL services in which the relationship with SCs may be less conflicting, and TOCs can gain comparative advantage. As customers' demands regarding a greater variety of services increase, providing VAL services has become a powerful way for ports to build a sustainable competitive advantage (UNESCAP 2002). In order to provide differentiated services to their customers, VAL services such as inventory management, inspection, labelling, packing, bar coding, receiving goods, breaking and consolidation of shipments, preparing for shipment, returning empty packaging, quality control, assembly, repair and reverse logistics have been offered to their customers by ports. As VAL services have been provided to customers, ports became more involved in the supply chains of their customers and customers have started to select ports which provide these services depending on their performance. The ports have started to operate as logistics hubs. Ports' role as a logistics hub is considered as an important contribution to the overall performance of the supply chain system (Estrada 2007). The range of VAL services varies from simple processes such as packing, labelling and bar-coding to more complicated processes such as inventory management and quality control, and overlaps or includes Third-Party Logistics (TPL) services (UNESCAP 2002). Figure 3.4 shows the range of VAL services which can be, or are being provided in the port area.

Figure 3.4 VAL services of logistics centres in port area



(Source: UNESCAP 2002)

(2) Organisational integration

The integrated logistics services provision necessarily involves organisational integration. The level of the organisational integration also varies in accordance with the companies' strategy. Cases of being fully vertically integrated or full outsourcing are rare. Most cases are somewhere between the two extremes. Further investigation into corporate governance relating to PSCI would be an interesting research issue but is not the focus of this research. However some more fundamental questions regarding organisational integration need to be addressed.

Supply chain integration has been traditionally categorised into two dimensions: internal integration and external integration (Daugherty *et al.* 1996; Stock *et al.* 2000; Stank *et al.* 2001). The former refers to the logistics integration across functional boundaries within a firm and the latter, the integration of logistics activities across firm boundaries (Stock *et al.* 2000). From the whole supply chain's view, the integration of a port into a supply chain appears to be the activities undertaken by ports, as a service provider, to cooperate with other members in the supply chain beyond their boundary, which is external integration. However, from the ports' view, PSCI involves or should involve both internal and external integration. Paixao and Marlow (2003) propose that implementation of an agile port should cover both the external integration which implements vertical and horizontal integration along logistics chains and the internal integration which identifies and breaks down the whole process of the port, and redesign the process according to a Just-In-Time (JIT) philosophy. Caputo and Mininno (1996) also indicate that internal integration is the prerequisite for effective inter-organisational integration.

Both vertical integration and horizontal integration or either of them can be considered with regard to organisational integration (De Martino and Morvillo 2008). However, when it comes to integration of ports into the supply chain, the integration can be implemented primarily through vertical integration, even though this does not necessarily exclude horizontal integration concepts. In the case of liner shipping, its integration along the supply chain is indirectly supported by horizontal integration

which leads to the creation of bigger organisations with more bargaining power, and therefore facilitates entry into inland markets (Panayides 2001). Also, in the manufacturing industry context, horizontal integration is considered as a requirement for vertical integration to produce synergies (Caputo and Mininno 1996). In contrast, it is less likely that horizontal integration brings about synergy effects on vertical integration of ports either directly or indirectly. Developing port operating networks globally would build up bargaining power against global shipping liners, mitigating the liners' footloose practices, but it hardly facilitates ports' entry into other transport or logistics markets.

Four types of integration are presented by Fawcett and Magnan (2002): internal integration, backward integration with first-tier suppliers, forward integration with first tier customers, and complete forward and backward integration which is expressed as integration from the suppliers' supplier to the customers' customer. The suppliers and customers can be differently identified according to the focal company of a supply chain. In this thesis 'supply chain' means the supply chain for goods or cargoes passing through the port, so PSCI can take place in either direction or both directions. However, as far as a supply chain for port services which was presented in the previous section (see Section 3.1, Figure 3.2) is concerned, PSCI can be identified as forward integration. PSCI is less concerned with the relationship with suppliers for producing port services, and more concerned with the relationship with customers such as shippers, freight forwarders, shipping companies, and inland transport providers including inland clearance depots/dryports/distriparks.

3.2.3 Motives and circumstances of PSCI

SCM is implemented primarily for the purpose of improving organisational and supply chain performance. Specific objectives other than the ultimate goals are suggested to be cost reduction and the customer service improvement through providing differentiated services (Mentzer *et al.* 2001). The question therefore arises: what can be the motives for ports to integrate into supply chains? Similarly to SCM, port operators adopting this strategy may expect to achieve competitive advantage to some

extent and eventually improve organisational performance, e.g. profitability. However the objectives and motives at the more specific level are rarely presented in the relevant literature. Notteboom and Winkelmans (2001) suggest that service differentiation is a more sustainable source of competitive advantage than cost leadership and this would be the basic motivation. However, some other reasons and motivations were expected to be revealed because PSCI may represent the diversification of the strategic direction of ports from shipping companies to shippers.

On the other hand, some researchers attempt to identify and outline the reasons and circumstances that logistics activities develop better in particular ports. Ferrari *et al.* (2006), investigating the development of Distribution Centres (DCs) in Southern European countries, present the reasons that the number of DCs in Western Mediterranean ports increases faster than that in Eastern Mediterranean ports. According to their analysis, the former has already achieved a considerable level of growth in terms of cargo throughput, and the annual growth rate is consistently 5-6%. Therefore they aim at gaining port activities' added value. Thus, ports' strategies seek to achieve two consecutive goals; firstly acquiring a considerable amount of traffic, and then developing facilities for value-added services and logistics services. Theys *et al.* (2008), firstly, citing UNESCAP (2005), suggest that ports nearby to major markets in the hinterland would feel easier with developing into a logistics centre port. Subsequently, they analyse the port characteristics that make the port attractive as a logistics centre and the characteristics of firm and cargo which a port region is considered as more appropriate for than a hinterland region. Their analysis, based on the surveys conducted on the Port of Busan, South Korea, presents as attractive port characteristics for logistics centre, geographical location near main shipping routes; good availability of modern port infra- and superstructure; well-skilled port labour; proximity to major consumption area; and port reputation and image.

3.2.4 Causal relationships

As explained in Chapter 1, this research aims at investigating causal relationships between PSCI, antecedents to PSCI and its consequences. More specifically, this

research concerns (1) how organisational characteristics and attitude of TOCs towards SCM practices impact on PSCI, and (2) how PSCI influences port performance. Following the traditional logistics research framework in Figure 3.5, these sorts of research objectives are achieved through, first, developing a research model (or theory) and hypotheses assuming causal relationships, and, subsequently, examining the model and hypotheses by empirical analysis (Mentzer and Kahn 1995). This section provides theoretical justification for developing the research model presented in Chapter 5, and the next section (Section 3.2.5, p.72) identifies the components representing the constructs adopted in the research model. This literature review encompasses both the relevant literature in SCM research and port research because, even though PSCI is a phenomenon grounded in the port industry, the ideas and concepts applied in the model are, to a considerable extent, involved with theories used in SCM research.

Figure 3.5 Logistics research framework

(Source: Adapted from Mentzer and Kahn 1995)

(1) Causal relationships in SCM research

The relationship between Supply Chain Management (SCM) and firm performance have been examined by a number of researchers (e.g. Li *et al.* 2006; Shin *et al.* 2000) as shown in Table 3.1, since SCM is expected to increase the performance and competitive advantage of supply chains as well as a firm in the supply chain. Mentzer *et al.* (2001) demonstrate that the improvement of competitive advantage within the supply chain is the motive for, and the consequence of, SCM. They propose that competitive advantage can be achieved through enhancing customer value and satisfaction by implementing SCM. Li *et al.* (2006) present empirical evidence that SCM practices have a direct impact on the financial and marketing performance of an organisation. Researchers also identified the relationship between supply chain integration and firm performance because integration is the main concept that

penetrates into the understanding of SCM, and strategic integration is also expected to have an impact on firm performance. The results of most research indicate that the higher the level integration occurs at, the better firm performance is (Johnson 1999; Lin *et al.* 2005).

Table 3.1 Causal relationships in SCM literature

Literature	Causal relationships		
Shin *et al.* (2000)		SMO	→ Supplier / Buyer Performance
Li *et al.* (2006)		SCM Practices	→ Organisational Performance / Competitive Advantage
Chow *et al.* (1995)	Strategy / Structure →	Integration	→ Performance
Stank and Traichal (1998)	Organisation Design →	Integration	→ Performance
Johnson (1999)	Dependence, Age, etc →	Integration	→ Performance
Mentzer *et al.* (2001)	SCO →	SCM	→ Competitive Advantage
Vickery *et al.* (2003)	Integrative IT →	Integration	→ Customer service → Performance
Min *et al.* (2007)	MO → SCO →	SCM	→ Firm Performance

Notes: SMO: Supply Management Orientation, SCM: Supply Chain Management, SCO: Supply Chain Orientation, MO: Market Orientation, IT: Information Technology

A body of literature exists which has developed more complicated models incorporating moderators between supply chain integration and firm performance, or antecedents of supply chain management and integration. The literature assesses direct and indirect relationships between them. Vickery *et al.* (2003) concluded that supply chain integration has an indirect impact on a firm's financial performance and that the performance can be improved through enhanced customer service which mediates the relationship between supply chain integration and firm performance. Johnson (1999) identified five antecedents of strategic integration which are dependence, age, continuity expectation, flexibility and relationship quality, and showed that dependence, continuity expectation and flexibility positively affect strategic integration, and, in turn, strategic integration enhances performance. Mentzer *et al.* (2001) differentiate Supply Chain Orientation (SCO) from SCM, defining SCO as 'the recognition by an organisation of the systemic, strategic implications of the tactical activities involved in managing the various flows in a supply chain' and calling 'the actual implementation of SCO across various companies in the supply chain' SCM. Their conceptual model, accordingly, identifies SCO as an antecedent of SCM, and

SCM as an enhancer of firm performance. Min *et al.* (2007) associated their SCM concepts with Market Orientation (MO). In their model, Supply Chain Orientation (SCO) and SCM act as mediators of the relationship between market orientation and performance, in other words, MO and SCO were the antecedents of SCM.

(2) PSCI and Port Performance (PP)

In port research, empirical work on the interrelationships between the integration of ports into supply chains and port performance has been very limited. Song and Panayides (2008) identified seven parameters for evaluating the extent of the integration and selected variables for port performance. They analysed the interrelationships between the parameters and the variables using multiple regression analysis. Their results showed that (1) information and communication technology positively influences the service quality of ports, (2) the relationship of ports with shipping companies has beneficial effects on the reliability and responsiveness of ports, and (3) value-added service is positively related to both port service customisation and port service price. However, they tested the relationships between the parameters for evaluating the degree of integration and the variables for performance rather than the higher level concepts, i.e. the integration of ports in supply chains and port performance.

Carbone and De Martino (2003), from their fieldwork interviewing the French car company (Renault), logistics providers and port operators, found that Renault outsources some significant parts of the outbound logistics to logistics providers and port operators so as to benefit from the higher reliability and minimised total logistics costs, while the inbound logistics is vertically integrated into Renault. This implies that the services integrating some logistics functions, e.g. inventory management, with physical transportation including inland transport and port cargo handling may produce a higher level of certain aspects of port performance. Many conceptual and descriptive works also associate the integration of ports with competitiveness or performance issues. De Martino and Morvillo (2008) assert that the integration of a port is concerned with intermodality and organisational integration and aims at responding to

the changing requirements of industrial and commercial enterprises and, at the same time, improving its own internal efficiency.

Notteboom and Winkelmans (2001) assert that in order to gain sustainable competitive advantage, ports should provide value-added logistics and intermodal transport services and develop advanced information systems. Paixao and Marlow (2003) also demonstrate that the internal and external integration of a port based on the agility concept can increase competitive advantage of the port, enabling the port to provide additional value-added and intermodal services, to decrease the transit and lead-times of cargoes and to reduce the total cost derived from port services. Morash and Clinton (1997) emphasise that the internal and external integrations focusing on transportation capabilities improve reliability and just-in-time delivery, which in turn, can reduce total costs and increase value to customers.

(3) PSCI and its antecedents

TOCs may have different attitudes to SCM practices and characteristics which facilitate or impede the implementation of the integration strategy. It would be very useful to terminal operators to investigate which organisational characteristics and attributes contribute to facilitating the implementation of integration strategies. TOCs' organisational characteristics and attitudes towards PSCI are adopted as antecedents to PSCI in this research, and are termed as Port Supply Chain Orientation (PSCO). This term was adapted from Supply Chain Orientation (SCO) which is used as an antecedent to SCM. It can be argued that the circumstances where logistics activities develop in particular ports, such as the growth rate of cargo throughput, proximity to major hinterlands, etc. discussed in Section 2.3.3, should be considered as an antecedent to PSCI. However, these are external factors relating to the logistics activities of a port as a whole, rather than internal and organisational aspects which can provide TOCs with the managerial implications on implementing PSCI.

Studies on the factors or organisational characteristics facilitating the integration strategies of ports are more limited. The features this research attempts to identify can

be interpreted as the 'resources' or 'capabilities' of a firm from the resource-based view. This view considers the tangible and intangible aspects of a firm's resources enabling it to implement strategies that improve its efficiency and effectiveness (Barney 1991). Such resources can encompass physical capital resources, human resources such as knowledge, and organisational resources such as inter-organisational relationships. De Martino and Morvillo (2008) demonstrate that the intangible resources of terminal operators such as human capital and relationships with supply chain members have become a source of competitive advantage, since these determine competences which are hard to imitate. They also emphasise that collaborative spirit and mutual trust entail a higher level of involvement of ports in supply chains. Bichou and Gray (2004) also indicate that the ability of ports to interact with the channel members improves the level of integration and hence performance of ports.

Apart from the literature, the causal relationship between PSCO and PSCI can be logically explained. When a TOC has to make strategic decisions, the results of the decision would be substantially affected by the organisations' attitude and willingness to SCM and logistics issues. For example, senior management of TOCs may have different positions on how to respond to current competitive market situations; 'cost leadership' and 'differentiation'. If a TOC's senior management has a strategic preference for the latter, the TOC is more likely to undertake a proactive involvement in supply chains. If the TOC has human resources having experience and knowledge about SCM and logistics issues, or has trained staff regularly on these issues, the strategic decision would be more confidently and easily made. When implementing the strategies, the organisational characteristics have more important contributions. The ability of the TOC to manage relationships with direct- and end-customers formally or informally may positively influence the development of mutual trust which can facilitate information sharing among them and eventually result in long-term relationships. The capability to meet customers' demands by designing the existing intermodal route would make the TOC's services more attractive to customers. In other words, the more oriented a TOC is to SCM issues, the more effectively the TOC will be able to implement an integration strategy into supply chains.

3.2.5 Components and constructs

To conceptualise a concept or phenomenon by identifying components of the concept or phenomenon is crucial when they are, in nature, abstract, or hard to define, or in lack of definition (De Vellis 1991). When research aims at measuring the concepts or the phenomena, identifying their components are of particular importance. In this case the constructs should be developed to measure them, because they are usually not measured directly due to the nature of being abstract, and the constructs are validated based on the identified components. The validated constructs provide a more rounded definition of the concepts and phenomena (Burgess *et al.* 2006). Table 3.2 shows several examples of the components and constructs used for SCM and supply chain integration. Reviewing 100 sampled articles, Burgess *et al.* (2006) found seven constructs used for conceptualizing SCM concepts with reasonable commonalities.

Table 3.2 Components and constructs of SCM and supply chain integration

Literature	Concept	Components/constructs
Mentzer *et al.* (2001) Min and Mentzer (2004) Min *et al.* (2007)	SCM	Agree on supply chain vision and focus Agree on supply chain leadership Share information Share risk and rewards Build and maintain long-term relationship Process Integration Cooperation
Lin *et al.* (2005) Li *et al.* (2006)	SCM practices	Strategic supplier partnership Customer relationship Information sharing Information quality Internal lean practices Postponement Delivery dependability Time to target
Vickery *et al.* (2003)	Supply chain integration	Supplier partnering Closer customer relationships Cross-functional teams
Burgess *et al.* (2006)	SCM	Leadership Intra-organisational relationships Inter-organisational relationships Logistics Process improvement orientation Information system Business results and outcomes

(1) Components of PSCI

Considering the intensive efforts to conceptualize SCM and supply chain integration concepts, it is fair to say the components of PSCI have rarely been identified. Fortunately, the components and constructs for PSCI are presented and validated in a few recent works as shown in Table 3.3. Carbone and De Martino (2003) identify four SCM components: mutual relationships, supplied services, information and communication technologies and performance measurement.

Based on their discussion, Panayides and Song (2008) conceptualize PSCI with four components: Information and communication systems (ICS); Value-added service (VAS); Multimodal systems and operations (MSO); Supply chain integration practices (SCIP). They also validate the instruments for the components using Confirmatory Factor Analysis (CFA), and show they are the constructs for PSCI with the second order model. In addition, Song and Panayides (2008) use seven constructs to examine the relationships between PSCI and port performance with multiple regression analysis, but the seven constructs have not been tested with the second order model. Therefore, the constructs empirically validated for PSCI are only those of Panayides and Song (2008).

Table 3.3 Components and constructs of PSCI

Literature	Components/constructs
Carbone and De Martino (2003)	Relationships between port operators and firm Supplied services that add value Information and communication technologies Performance measurement indicators common to supply chain partners
Panayides and Song (2008)	Information and communication systems (ICS) Value-added service (VAS) Multimodal systems and operations (MSO) Supply chain integration practices (SCIP)
Song and Panayides (2008)	Use of information and communication technology Relationship with shipping line Value added service Integration of transport modes Relationship with inland transport operators Channel integration practices and performance

Therefore Panayides and Song (2008) would be the basis for discussing the components of PSCI. They define ICS as 'the establishment and use of seamless communication systems that facilitate efficient servicing of supply chain operations and achievement of supply chain goals'. The role of the establishment of ICS has been emphasised in facilitating integration among supply chain members by most SCM researchers, and has been undoubtedly considered as core components for SCM and supply chain integration (Mentzer *et al.* 2001; Tyndall *et al.* 1998; Ellram and Cooper 1990). In addition, the port literature highlights the importance of ICS for higher degrees of PSCI (Bichou and Gray 2004; Kia *et al.* 2000; Paixao and Marlow 2003; Panayides and Song 2008).

Heaver (2001) also suggests that the quality of an IT system to a supply chain is critical to its performance since IT enables supply chains to reduce order cycle times, cut inventories and make the systems more flexible. However, it can be argued that the establishment of ICS would not be enough on its own. The definition of supply chain integration of seaport terminals (TESCI) presented in Panayides and Song (2008) implies that integration is not limited to setting up systems and processes, but includes the functional activities to be an integral part of a supply chain. Thus, the activity undertaken through ICS, i.e. 'information sharing' needs considering to be included as a component, as such in the SCM literature (e.g. Li *et al.* 2006; Lin *et al.* 2005; Mentzer *et al.* 2001; Min and Mentzer 2004; Min *et al.* 2007).

Panayides and Song (2008) defined VAS as 'the ability of the port to add value to the services that it provides in the context of facilitating further the objectives of the supply chain system' and MSO as 'the existence of systems to facilitate efficient and effective multimodal operations'. Beresford *et al.* (2004) suggest that since the 1980s ports have diversified into the emerging field of logistics and have offered value-addition services as they became increasingly integrated into the transport chain to varying degrees depending on cargo and customer requirements. Notteboom and Winkelmans (2001) also emphasise that since the maritime container battle will be won on land, the role of port authorities in the 21st century includes the promotion of an efficient intermodal system.

VAS and MSO are undoubtedly core components of PSCI since the PSCI concept itself means the activities undertaken by terminals to expand their service range from the fragmented physical transport to integrated logistics which includes multimodal transport and adding value activities. However, it should also be explored to accurately understand how ports can add value to the service and facilitate the objectives of the supply chain system and multimodal operations beyond the emphasis on importance. This would help develop more realistic and meaningful instruments for VAS and MSO.

Another argument is that Panayides and Song's (2008) constructs do not consider 'relationships' with other members in supply chains, even though the core concept of SCM and integration is to manage the relationship with suppliers and customers in an integrated fashion. A number of researchers suggest that the development of long-term relationships are an important feature of SCM and a well-developed long-term relationship can have a positive effect on the competitiveness of supply chains (e.g. Mentzer *et al.* 2001; Shin *et al.* 2000). It is also seen that Song and Panayides (2008) and Carbone and De Martino (2003) include relationships with other members as components and constructs for PSCI. There may have been problems with data collection or analysis. Inclusion of the feature deserves to be considered.

(2) Components of PSCO

The problem arising at this stage is that PSCO is a new concept so it is not possible to identify the components for PSCO from the existing port literature as shown in Table 3.4. What this research relies on is the components and constructs of SCO. However, content validity could not be confirmed because the port operators view of SCM is unlikely to be exactly the same as that of a focal company in a supply chain. Therefore this thesis attempted to identify the components of PSCO from interviews with practitioners and academics. During the interviews the components of SCO listed in Table 3.4 were used as potential components for PSCO to better communicate with the interviewees. Other relevant literature can also provide some ideas in that they deal with similar issues such as inter-organisational relationships (Bichou and Bell 2007; Lai *et al.* 2008) and organisational learning (Panayides 2007). Accordingly, the complete research model for this study is presented after the findings from the interviews are analysed in Chapter 5.

Table 3.4 Components in SCM and port literature

Literature	SCO	SCM	Firm Performance
Mentzer *et al.* (2001)	Trust Commitment Interdependence Organisational compatibility Vision Leader Top management support	Information sharing Sharing risk and rewards Cooperation Same goal and same focus on serving customers Integration process Build and maintaining long-term relationship	Cost reduction Customer satisfaction Competitive advantage
Min *et al.* (2007)	Credibility Benevolence Commitment Cooperative norms Top management support Organisational compatibility	Agree on SC vision and focus Share information Share risk and rewards Agree on SC leadership Build and maintaining long-term relationship Integrate processes Cooperation	Availability Product and service offerings Growth Profitability Timeliness

Literature	PSCO	PSCI	Port Performance
Carbone and De Martino (2003)	-	Relationships between port operators and firm Supplied services that add value Information and communication technologies Performance measurement indicators common to supply chain partners	-
Panayides and Song (2008)	-	Information and communication systems Value-added service Multimodal systems and operations Supply chain integration practices	-
Song and Panayides (2008)	-	Use of information and communication technology Relationship with shipping line Value added service Integration of transport modes Relationship with inland transport operators Channel integration practices and performance	Price Quality Reliability Customization Responsiveness

(3) Port Performance (PP)

Measures for port performance also should be developed appropriately for the objectives and contexts of this thesis. Port performance has traditionally focused on the internal aspects of port operations primarily as shown in Table 3.5 because the role of ports has been recognized as merely being nodes between land transport and sea transport and the virtue of ports was understood to be cost- and time-efficient operation.

Table 3.5 Traditional port performance measures / indicators

Literature	Category	Indicators
Metrics and indicator approach		
UNCTAD (1982), De Monie (1987)	Output	Berth output, Ship output, Gang output
	Service	Ship waiting time, Ship's time
	Utilization	Berth occupancy, Berth working time
	Productivity	Cost per tonnes of cargo handled
Tongzon and Ganesalingam (1994)	Operational efficiency	Capital and labour productivity, Asset utilization rates
	Customer oriented measures	Direct charges, Ship's waiting time, Inland transport, Reliability
Talley (1994a)	Shadow price	Cargo handling rate, Average delay to ships waiting berths, average delay to ships whilst alongside berths, truck time and queuing
Frontier approach		
Roll and Hayuth (1993)	Output	Cargo throughput, Level of service, Users' satisfaction, Ship calls
	Input	Manpower, Capital, Cargo uniformity
Cullinane *et al.* (2002)	Output	Turnover from container terminal service
	Input	Terminal quay length, Terminal area, Number of equipment
Cullinane *et al.* (2006)	Output	Cargo throughput
	Input	Terminal length, Terminal area, Number of quayside gantry, yard gantry and straddle Carrier
Wang and Cullinane (2006)	Output	Cargo throughput
	Input	Capital (terminal length), Labour (equipment cost), Land (terminal area)

Brooks (2007) indicates that port literature has focused on measuring efficiency while other transport modes such as air, road and rail put a greater emphasis on external perspectives such as customer orientation, reliability and service. Bichou (2007) also demonstrates that port performance measurement systems are hardly ever used to capture both efficiency and external effectiveness, and a single focus on either efficiency or effectiveness does not seem to be the only way to increase performance. In addition, Panayides (2006) suggests that ports in the supply chain era may have other measures of performance, apart from cargo throughput, such as leanness, agility, time compression as well as the performance of other parties in the supply chain.

Another criticism of traditional port performance measures is that the traditional measures are fragmented and biased towards sea access. Most port performance literature focuses solely on sea access and overlooks other processes of the port operating system and ignores the interests of other members of the port's supply chain network. In this regard, some researchers propose new port performance measurement concepts and frameworks based on different recognition about the environments ports are embedded in and the functions of ports in the supply chain (e.g. Marlow and Paixao-Casaca 2003; Bichou and Gray 2004).

Woo *et al.* (2008) also develop a port performance framework which reflects the aspects of port evolution currently taking place in changing logistics environments. Their suggestion is that the effectiveness which relates to the customers' perspectives on port operation should be reflected in performance measurement. The measures for the external effectiveness encompass service quality, customer-oriented practices and service price.

Table 3.6 Potential port performance measures

Category		Measures
External effectiveness	Service Quality	Reliability, Timeliness, Lead time, Information provision
	Customer Orientation	Responsiveness, Flexibility
	Service Price	Total price, Cargo handling charge
Internal operation efficiency	Sea operation	Ship waiting time, Ship turnaround time, Cargo handling time
	Land operation	Cargo waiting time, Cargo handling time, Truck waiting time
	Cargo operation	Cargo throughput, Cargo processing time

Denktas *et al.* (2009) also suggest, in an intermodal transport context, that when designing or measuring port performance, 1) ports should be recognized as a member of an intermodal transport system and furthermore a logistics centre combining various transport modes and actors; 2) port operation should be concerned with the whole process of cargo flow through the port from entry to exit in either direction from sea to land or *vice versa*; and 3) effectiveness, which concerns customers' perspectives should be incorporated into performance measurements and other members in the intermodal transport channel than shipping companies should also be regarded as customers of ports. Based on the discussions and the relevant literature, potential performance measures for this research are presented in Table 3.6.

3.3 SUMMARY AND CONCLUSION

In the beginning, the four objectives of evaluating and reviewing existing literature were presented. The first objective of providing a context for the research and showing where the research fits into the existing body of knowledge was achieved in Chapter 2 by positioning this thesis in port research. The remaining three objectives; illustrating how the subject has been studied previously, outlining gaps in previous research and justifying the research, were dealt with in this chapter.

Section 3.1 clarified the main terms used in this thesis; supply chain and port. Supply chain in this thesis means a supply chain of goods passing through ports, and the supply chain includes ports as a member of the supply chain, and ports are viewed as an actor who can proactively integrate the functions in the supply chain. In Section 3.2, most literature relevant to PSCI was reviewed on the various terms: the definition of SCM, the nature of PSCI, the motives and circumstances of PSCI, the components and constructs of PSCI, and the causal relationships involving PSCI. Some important research gaps which can justify this research were found from this literature review.

(1) One of the primary objectives of this research is how organisational characteristics of port operators, which are termed as PSCO in this research, influence PSCI and eventually performance. However, this sort of discussion was not found in the port literature, and accordingly the components of PSCO could not be identified. This is the most significant gap which this research has to overcome.

(2) As PSCI was found to have been better researched than the PSCO concept, so the nature and the components of PSCI could be intensively reviewed. However, the components identified by the existing literature were found to be missing some variables which have been considered as significant in the SCM literature, such as information sharing and building up long-term relationships.

(3) When investigating the strategies of an organisation, the organisation's motives to adopt the strategies can provide meaningful insights. Although it can be assumed that there is a complicated and different situation where ports have to adopt the strategy of PSCI from that of shipping liners and other organisations, the specific motives of ports to adopt the PSCI strategy have not been clearly presented.

(4) An argument about traditional port performance measures was also raised; port performance has traditionally focused on the internal aspects of port operations and has

been biased to sea-access. Thus, potential performance measures were presented based on the discussion that port performance should reflect effectiveness aspects of ports to concern customers' perspectives in the global supply chain era in which port services are required to meet customers' complicated demands.

(5) Very few studies which examine the causal relationship between PSCI, PSCO and performance were found in the port literature. To theoretically support the relationship and provide theoretical and managerial implications, more empirical studies are required. This is a main motivation of this research.

(6) The research strategy and research design which are eventually suggested and expected when testing theory are comparing different groups and cases. The empirical research on PSCI has reflected port operators' perspectives rather than port users' perspectives. Different perspectives can produce an entirely different result of an investigation. Therefore, this research attempts to investigate the causal relationships from both port operator's and port users' perspectives, and to compare them. In addition, the causal relationship has not been applied to comparing ports with different operational characteristics such as type of cargoes handled. This issue is also addressed in this research.

Based on this chapter's intensive discussion on PSCI, an interim research model and hypotheses are proposed, and they are completed as the result of interview study in Chapter 5. Chapter 4 addresses the methodological issues of this research.

CHAPTER 4

RESEARCH METHODOLOGY

Chapter 3 was devoted to exploring research gaps to justify this research, and to providing a theoretical basis for developing the research model through critically reviewing the existing literature. This chapter provides a bridge between the previous two chapters and the following four chapters which develop the research model and hypotheses (Chapter 5) and present the whole analytical processes and findings of this research (Chapter 6, 7, 8). This chapter broadly consists of three main parts. In the first part, a general discussion on research paradigm, approach and strategy is presented. The second section discusses methodological states of port research with the result of the structured literature review which categorised the journal papers published for the last three decades into research paradigm, strategy, methods and data analysis techniques. The third part presents the methodological positioning of this thesis and discusses data collection methods, and the data analysis techniques of this thesis.

4.1 RESEARCH APPROACH AND STRATEGY

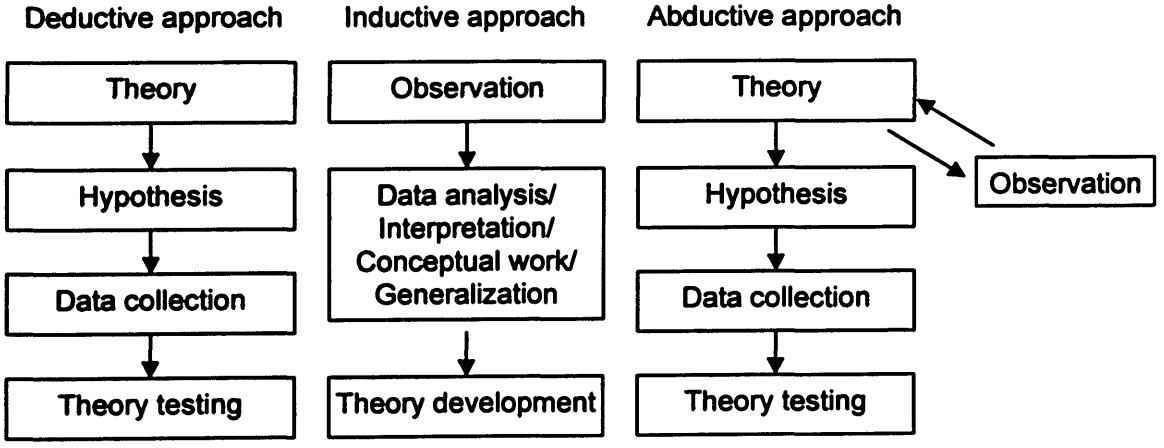
This section presents the philosophical and methodological background which influences selecting appropriate research methods prior to describing which methods are selected and how the methods are conducted for this thesis.

4.1.1. Research approach

The research approach is concerned with the nature of relationship between theory and research (Bryman and Bell 2007): deductive, inductive and abductive. The deductive approach is a theory testing process, which commences with an established theory or generalization and seeks to see if the theory applies to specific instances, while the inductive approach is a theory development process that starts with observations of specific instances and seeks to establish generalizations about the phenomenon under investigation (Spens and Kovacs 2005). The research process used in the inductive approach shows a mirror image of the deductive research process in Figure 4.1.

However, all research cannot follow the process of either pure deduction or pure induction. In reality most research involves both methods at the same time, which is the abductive research approach. Spens and Kovacs (2005) suggest that this approach can be adopted in two different situations; (1) facing a puzzling observation or an anomaly that cannot be explained by established theory and (2) applying an alternative theory deliberately for explaining a phenomenon. The difference between the abductive approach and the deductive approach is that the former involves a 'theory matching' process which is a creative iterative process to find a possible matching framework (Dubios and Gadde 2002). The difference from the inductive approach is that the abductive approach aims to suggest theory in the form of new hypothesis through a theory testing process (Spens and Kovacs 2005).

Figure 4.1 Deductive, inductive and abductive approaches



(Source: Based on Bryman and Bell 2007; Spens and Kovacs 2005)

4.1.2 Research strategy and design

A research strategy means a general plan of how to answer the research questions set up by the researcher (Saunders *et al.* 2003). A variety of strategies are presented as shown in Table 4.1. Researchers commonly consider several strategies; experiment, survey, case study, ethnography and action research. However, Bryman and Bell (2007) distinguish research strategy from research design which is described as a framework for the collection and analysis of data. While what they mean by a research strategy (a general orientation to the conduct of research) is not so different from other researchers, they employ a distinction between quantitative and qualitative research for research strategy and limit research design to data collection and analysis.

Table 4.1 Research strategy, design and data collection method

Literature	Research strategy	Research design	Data collection method
Bryman and Bell (2007)	Quantitative	Experimental Cross-sectional Longitudinal Case Study Comparative	Structured interviewing Self-completion questionnaire Structured Observation
	Qualitative		Ethnography Participant observation Interviewing Focus group
Thomas (2004)	Experiment Survey Case study Ethnography Action research		Questioning Observation Documentation Recording
Saunders *et al.* (2003)	Experiment Survey Case study Grounded Theory Ethnography Action research Cross sectional and longitudinal studies Exploratory, descriptive and explanatory studies		Observation Interviewing Questionnaire survey Secondary data
Yin (2003)	Experiment Survey Case study Archival analysis Historical analysis		Documentation Archival records Interviews Direct observations Participant observation Physical artifacts

Quantitative and qualitative research form two distinctive clusters of research strategy, and they are a helpful umbrella for a range of issues concerned with the practice of research. The distinction goes beyond the fact that quantitative researchers employ measurement and qualitative researchers do not (Bryman and Bell 2007). Quantitative research that emphasises quantification in the data collection and analysis entails a deductive approach. Qualitative research that emphasises words rather than quantification in data collection and analysis entails an inductive approach. Five different types of research design were also presented by Bryman and Bell (2007): experimental, cross-sectional, longitudinal, case study and comparative design. Bringing together research strategy and research design presented by Bryman and Bell (2007), typical forms of research methods can be specified associated with each combination of research strategy and design as shown in Table 4.2.

Table 4.2 Typical form of research method by research strategy and design

	Quantitative	Qualitative
Experimental	Quantitative comparison between experimental and control group	-
Cross-sectional	Survey; structured observation at a single point in time	Interviewing; focus group at a single point in time
Longitudinal	Survey; structured observation at more than one occasion	Ethnographic research over a long period; Interviewing on more than one occasion
Case study	Survey research on a single case	Ethnography or interviewing of a single case
Comparative	Survey research on two or more cases	Ethnography or interviewing on two or more case

(Source: Adapted from Bryman and Bell 2007)

4.2 METHODOLOGICAL STATUS OF PORT RESEARCH

A structured literature review of port research was undertaken in order to investigate how port research has been conducted. Port literature published from academic journals for the period between 1980 and 2009 were selected (840 papers from 125 journals). They were categorised in terms of research themes, theoretical and disciplinary bases, and methodological issues such as research paradigm, strategy,

methods and analysis technique. The results of categorisation of research themes and theoretical bases were presented in Chapter 2 to position this thesis in port research from a theoretical perspective. The results of methodological categorisation are discussed in this section. The categoristion was based on the classification framework shown in Table 4.3.

Table 4.3. Classification framework

Classification	Categories	References
Research paradigm	Functionalist / Interpretivist / Radical structuralist / Radical humanist	Burrell and Morgan (1979), Chua (1986), Goles and Hirshheim (2000)
Research strategy	Analytical: conceptual / mathematical / statistical Empirical: experimental / statistical / case study	Wacker (1998), Burgess *et al.* (2006)
Research methods	Survey, Interview, Math modelling, Economic Modelling, Simulation, Case studies, etc	Mentzer and Kahn (1995), Sachan and Datta (2005), Min and Zhou (2002)
Data analysis techniques	Data analysis techniques used in paper where discernable	Mentzer and Kahn (1995), Sachan and Datta (2005)

As for the categorisation of research paradigm, the paradigm matrix developed by Burrell and Morgan (1979) was used, which has been developed for the field of sociology and which has also been applied to other fields (Burgess *et al.* 2006; Chua 1986; Goles and Hirshheim 2000). Research strategy is a further categorisation from a philosophical standpoint, focusing more on the epistemological dimension, and Wacker's classification scheme (1998) was used for this categorisation. Research methods and analysis techniques which have been used in the selected papers were identified referring to the literature review studies in other disciplines (Menzter and Kahn 1995; Sachan and Datta 2005).

4.2.1 Research paradigm of port research

The framework of Burrell and Morgan (1979) is composed of four paradigms: functionalism, interpretivism, radical structuralism and radical humanism. The functionalist paradigm is concerned with 'providing explanations of the status quo, social order, social integration, consensus, and rational choice' (Goles and Hirshheim

2000), which can be aligned with positivism (Burgess *et al.* 2006). This paradigm has taken dominance in port research for the three decades as shown in Table 4.4. Some papers were based on the interpretivist paradigm which seeks 'explanation within realm of individual consciousness and subjectivity (Goles and Hirshheim 2000)'. The radical structuralist paradigm, 'focusing primarily on the structure and analysis of economic power relationships,' was used in four papers. These papers were primarily studies on industrial relations in port industry (Carter *et al.* 2003; Herod 1998; Saundry and Turnbull 1996; Turnbull 2006).

Table 4.4 Research paradigms in port research

Paradigm	1980s	1990s	2000s	Total
Functionalist	112	208	510	830
Interpretivist	2	2	2	6
Radical humanist	-	-	-	-
Radical structuralist	-	3	1	4
Total	114	213	513	840

4.2.2 Research strategy of port research

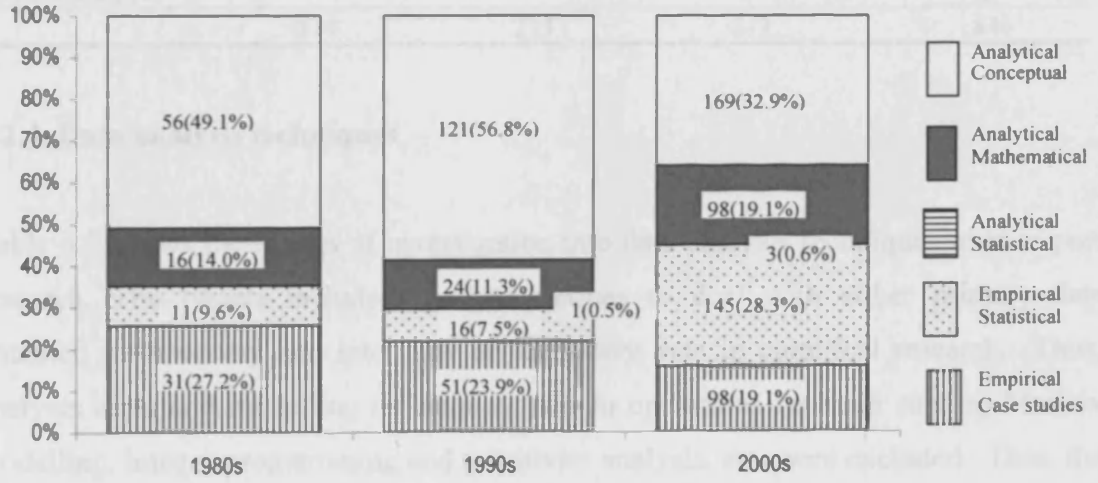
Research strategy, in this section, discusses both the research approach concerned with the nature of relationships between theory and research which are deductive and inductive, and research design which is a general plan of how to answer research questions. Specific categorisation for this issue is provided by Wacker (1998) who used a typology of theory-building research comprising broadly analytical research, which applies a deductive approach, and empirical research, which applies an inductive approach. The framework was used to categorise SCM research in terms of research methods by Burgess *et al.* (2006). As shown in Table 4.5, analytical research has three sub-categories: conceptual, mathematical and statistical, and empirical research is sub-divided into three: experimental, statistical and case studies. Analytical strategies were more extensively used (58.1%) than empirical strategies (41.9%). Analytical-conceptual research which aims to add new insights into traditional problems by using the researcher's experience (Wacker 1998) has been undertaken the most (41.2%), and empirical case studies was the second most (21.4%) used approach. Empirical experimental research strategies, which implements 'field experiments', have not been used.

Table 4.5 Research strategy in port research

Strategy	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Analytical							
Conceptual	26	30	46	75	79	90	346 (41.2%)
Mathematical	6	10	9	15	48	50	138 (16.4%)
Statistical	0	0	1	0	0	3	4 (0.5%)
Empirical							
Experimental	0	0	0	0	0	0	0 (0%)
Statistical	2	9	6	10	58	87	172 (20.5%)
Case studies	15	16	19	32	30	68	180 (21.4%)
Total	**49**	**65**	**81**	**132**	**215**	**298**	**840 (100%)**

Decadal trends are provided in Figure 4.2. For the 1980s and 1990s, analytical research strategy was dominantly used (63.1% and 68.1% respectively). In the 2000s, the proportion was relatively balanced between analytical (52.6%) and empirical strategies (47.4%) with empirical strategies increasingly used. The increasing involvement of research methods, which attempt to gather real world data from for example, surveys and interviews, in this period may have contributed to this change.

Figure 4.2 Proportion of research strategies in port research



4.2.3 Research methods used in port research

Researchers have various options on how to answer their research questions and the options for this study were chosen based on a review of existing literature (Mentzer and Kahn 1995; Meredith *et al.* 1989; Sachan and Datta 2005). The only key difference identified from the literature is economic modelling which is a modelling of objective reality applying economic theories. Pure modelling using mathematics to

capture objective reality was categorised as mathematical modelling. The conceptual work category is rather extensive, encompassing conceptual modelling and descriptive studies. The results are presented in Table 4.6. Case study and conceptual work accounted for 55.1% of port research in this study. Economic modelling and Mathematical modelling accounted for 16.4% and 11.3% respectively. Survey and interview methods which are normally used to capture people's perceptions have not been extensively used in port research, accounting for 8.9% and 3.3% of papers respectively. Results in other research fields such as logistics and SCM show a much higher proportion of papers in the latter two categories[3].

Table 4.6 Research methods used in port research

Methods	1980s		1990s		2000s		Total	
	No.	%	No.	%	No.	%	No.	%
Survey	4	3.5	11	5.2	60	11.7	75	8.9
Interview	3	2.6	9	4.2	16	3.1	28	3.3
Economic modelling	15	13.2	17	8.0	106	20.7	138	16.4
Math modelling	9	7.9	18	8.5	68	13.3	95	11.3
Simulation	3	2.6	4	1.9	27	5.3	34	4.0
Case study	38	33.3	74	34.7	105	20.5	217	25.8
Conceptual work	42	36.8	80	37.6	124	24.2	246	29.3
Archival analysis	-	-	-	-	2	0.4	2	0.2
Content analysis	-	-	-	-	5	1.0	5	0.6
	114		213		513		840	

4.2.4 Data analysis techniques

Table 4.7 shows the results of investigation into data analysis techniques used in port research. The papers included used techniques to deal with either primary data obtained from survey and interview or secondary data in empirical research. Thus, analysis tools and modelling techniques used in operations research such as Markov modelling, integer programming and sensitivity analysis, etc. were excluded. Thus, the total number of relevant papers was 310, which accounted for 37.3% of all the selected papers. The proportions of papers for each technique used was calculated against the total number of papers (=310). Techniques primarily used in port research were descriptive statistics (35.5%), regression analysis (16.9%), DEA (10.2%), Logit model (5.1%) and SFA (4.8%).

[3] Survey and interview accounted 54.3% and 13.8% respectively in Mentzer and Kahn (1995) and 34.6% and 6.8% respectively in Sachan and Datta (2005).

Table 4.7 Data analysis techniques in port research

	1980s		1990s		2000s		Total	
	No.	%	No.	%	No.	%	No.	%
Descriptive statistics	18	51.4	25	49.0	68	30.0	111	35.5
Descriptive	*12*	*34.3*	*21*	*41.2*	*50*	*22.0*	*83*	*26.5*
Descriptive with index	*6*	*17.1*	*4*	*7.8*	*18*	*7.9*	*28*	*8.9*
Regression	6	17.1	10	19.6	37	16.3	53	16.9
Data Envelopment Analysis	-	-	2	3.9	30	13.2	32	10.2
Logit model	-	-	-	-	16	7.0	16	5.1
Stochastic Frontier Analysis	-	-	1	2.0	14	6.2	15	4.8
Input-output analysis	6	17.1	5	9.8	3	1.3	14	4.5
Multi-Criteria Decision Making	-	-	-	-	14	6.2	14	4.5
Factor analysis	-	-	1	2.0	11	4.8	12	3.8
ANOVA	1	2.9	3	5.9	3	1.3	7	2.2
Shift-share analysis	2	5.7	3	5.9	1	0.4	6	1.9
Error Correction Model	-	-	-	-	5	2.2	5	1.6
Structural Equation Modelling	-	-	-	-	5	2.2	5	1.6
Total Factor Productivity	1	2.9	-	-	2	0.9	3	1.0
Cluster analysis	1	2.9	-	-	2	0.9	3	1.0
t-test	-	-	-	-	3	1.3	3	1.0
Correlation	-	-	1	2.0	1	0.4	2	0.6
Time series analysis	-	-	-	-	1	0.4	1	0.3
Others	-	-	-	-	8	3.5	8	2.6
Sub-total	35	30.7	51	23.9	224	44.2	310	37.3
NA	79		162		289		530	
Total	114		213		513		840	

As for decadal trends, the first observation of note was that data analysis techniques were used more extensively in the 2000s (=25, including techniques recorded in 'others'), compared to the 1980s (=7) and the 1990s (=9). It thus follows that the percentage of papers using data analysis techniques was higher in the 2000s (=44.2%) than those of the 1980s (=30.7%) and the 1990s (=23.9%). It was also shown that the extent of reliance on descriptive statistics has reduced with the involvement of new techniques in the 2000s. While Mentzer and Kahn (1995) interpreted the high percentage of descriptive statistics usage in logistics research as the lack of hypothesis testing research, there could be a variety of explanations and interpretations.

A plausible explanation from these observations is that some particular types of research have gained more attention from port researchers because some techniques such as DEA, SFA, Logit model, Multi-Criteria Decision Making (MCDM), Error Correction Model (ECM) and Structural Equation Modelling (SEM) have more

specific purposes and usages than descriptive statistics do. However, it should also be noted that, although they were categorised into descriptive statistics, analyses employing particular indices, such as connectivity, concentration and accessibility, showed strengths to reflect and explain complicated phenomena.

When it comes to the usage of the data analysis techniques in association with research topics in port research, several have been used across an extensive range of research themes. **DEA** and **SFA** are analytical tools for assessing the relative efficiency of port operations, and they were, therefore, applied primarily to port efficiency studies in 'Competition and performance'. These techniques were also used to evaluate the consequence of port reform in 'Governance and reform' studies (Cullinane *et al.* 2005), and the impact of regulation on port efficiency in 'Regulation and market' studies (Barros 2003; Ferrari and Basta 2009).

The logit model has also been used in various categories. Logit modelling has traditionally been used to determine or predict demand for freight and passengers in transport economics, using a discrete choice approach (Winston 1985). Therefore, this model was frequently used in 'Demand analysis' and 'Planning and development' (Anderson *et al.* 2009; Veldman *et al.* 2005). However, due to the nature of this model being discrete choice, this model has been used more frequently in port selection studies in 'Competition and performance' (Garcia-Alonso and Sanches-Soriano 2009; Magala and Sammons 2008; Malchow and Kanafani 2001; 2004; Tongzon and Sawant 2007), 'Port strategy' (Magala 2008) and 'Competitiveness' assessment (Low *et al.* 2009).

A variety of **MCDM** methods were employed in 'Competitiveness and management' studies: Analytical Hierarchical Process (AHP) (Lirn *et al.* 2003; 2004; Ugboma *et al.* 2006), PROMETHEE (Castillo-Manzano *et al.* 2009; Guy and Urli 2006), Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) (Celik *et al.* 2009), Gray Relation Analysis (GRA) (Huang *et al.* 2003; Teng *et al.* 2004), and Hierarchical Fuzzy Process (HFP) (Yeo and Song 2006).

ECM is a dynamic model which is concerned with movement of dependent variables in any period, related to the previous period's difference from long-run equilibrium. The strength of ECM is that it allows an analyst to estimate both short term and long run effects of explanatory time series variables (De Boef 2001). In this context, ECM is used both for forecasting by predicting short-run adjustments of the dependent variable (Fung 2001; Hui *et al.* 2004) and determining relationships between the variables, such as inter-port dynamics (Yap and Lam 2006).

SEM is a statistical methodology that takes a confirmatory approach to the analysis of a structural theory (Byrne 2001). Although SEM does not refer to a single statistical technique and has a variety of functions, this primarily enables a researcher to examine a complex model that comprises multiple causal relationships incorporating both unobserved and observed variables. In addition, this analytical tool stemmed from psychometrics and expanded to other disciplines such as marketing and education. In port research, SEM was employed to examine the channel relationship (Bichou and Bell 2007; Lai *et al.* 2008), the impact of people's perception on performance (Shang and Lu 2009) and the Technology Acceptance Model (TAM) (Norzaid *et al.* 2009).

4.2.5 Methodological status of port research

The investigation into the paradigmatic stance of port research (Table 4.4) revealed a strong dependence on the positivistic paradigm. Although Mangan *et al.* (2004) claimed that social sciences have been migrating from the positivistic paradigm towards the phenomenological paradigm, port research has not shown such decadal trends. This tendency is similar to that of other disciplines such as management information system (MIS) research (Alavi and Carlson 1992) and SCM (Burgess *et al.* 2006). Although there have been discipline-debates on the relative merits of paradigmatic unity and plurality (Kuhn 1970; Poole and Van de Ven 1989), it is suggested by a number of researchers that greater plurality of the research paradigm may lead to faster and more effective theory development (Mears-Young and Jackson 1997; Naslund 2002). This is in line with the lack of theories and theoretical models developed specifically for seaports. A multi-paradigmatic stance is more likely to lead to theoretical and methodological triangulation and may result in better theoretical bases of port research.

The increase of empirical research in the 2000s shown in Table 4.5 and Figure 4.2 should be understood in line with this discussion. Empirical research has more impact on its research field when theories developed specifically for the research field are examined and tested in an empirical situation. The increase of empirical research in the last decade led to a greater understanding of issues in ports, attributable to both the introduction of advanced analysis techniques, such as DEA and SFA, and the greater availability of data, making these analyses possible (Heaver 2006) rather than applying developed or borrowed theories to seaports.

Figure 4.3 explains methodological states of port research using a framework developed by Meredith *et al.* (1989). The horizontal dimension concerns the source and kind of information used in the research and the vertical dimension concerns the nature of truth. According to the investigation into research methods used in port research (see Table 4.6), port research showed a distribution skewed to 'artificial' types of research in the 1980s and a movement towards 'people's perceptions' types of research in the 2000s as shown in Figure 4.3.

Figure 4.3 A framework for research methods

Nature of truth	Kind of information used: Natural		Artificial
	Direct observation of object reality	People's perceptions of object reality	Artificial reconstruction of object reality
Rational – Axiomatic			▪ Reason/Logic theorems ▪ Normative modelling ▪ Descriptive modelling
Logical positivist	▪ Field studies ▪ Field experiments	▪ Structured interviewing ▪ Survey	▪ Physical modelling ▪ Simulation
Interpretive	▪ Action research ▪ Case studies	▪ Historical analysis ▪ Delphi ▪ Intensive interviewing ▪ Expert panel	▪ Conceptual modelling ▪ Hermeneutics
Critical theory		▪ Introspective reflection	
Existential			

1980s

2000s

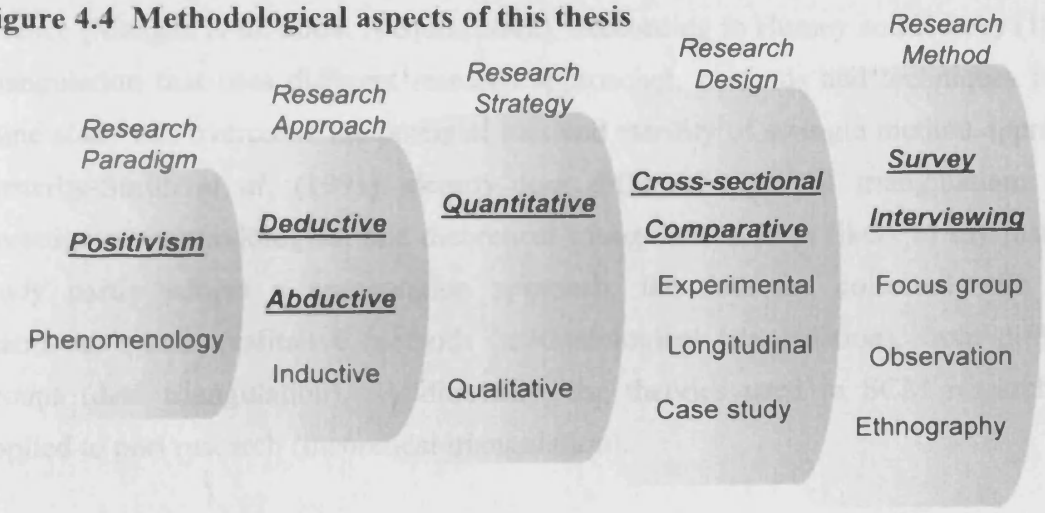
(Source: Adapted from Meredith *et al.* 1989)

Given that conceptual work in the categorisation includes both conceptual modelling and descriptive studies and case studies in port research rely on descriptive statistics rather than action research or field experiments, a considerable number of papers (economic and mathematical modelling) fall in the area of 'artificial-axiomatic' and 'artificial-positivist'. Methods to reflect peoples' perceptions such as survey and interview have been increasingly used, increasing from 6.1% of papers in the 1980s to 14.8% in the 2000s with a high proportion of 'artificial' type of research maintained. Port research has shown an outstanding advancement in terms of data analysis techniques in the 2000s (see Table 4.7, p.89). However, the techniques which were used more extensively, such as DEA, SFA, Logit model and ECM, are more useful in dealing with secondary data in association with economic or mathematical modelling than primary data obtained from survey or interview. For example, analytical tools which have strengths in testing hypotheses and, accordingly, lead to theory development, such as SEM, have rarely been used compared to popularity in other disciplines in marketing and SCM research.

4.2.6 Methodological positioning of this thesis

It is possible to identify this research in terms of a variety of methodological considerations. Figure 4.4 illustrates the position of this study on five different methodological concerns. The terms which are highlighted, italicised and underlined are applied to this research.

Figure 4.4 Methodological aspects of this thesis



This research primarily aims at examining the causal relationships between PSCO, PSCI and PP, and the causal relationships are hypothesised based on established theory and the findings from semi-structured interviews. In addition, the hypotheses are tested with a particular analytical tool, SEM, using the data collected through the questionnaire survey. Considering the brief descriptions about this research, it can be inferred that this research is based on positivist paradigm. This study recognises the port industry as an objective and external entity, and the integration of ports into supply chains takes place independently of the researcher.

Accordingly, it follows that this research applies a deductive research approach considering its philosophical background. However, in attempting to apply a research model used in SCM research to the port industry, this research faces the situation where the research model is not completed by the established theory. Thus, this study is bound to complete the research model by means of interacting with the port industry through interviews, which implies this research partly applies an abductive approach. With regard to the research strategy, this study adopts a quantitative strategy to test the hypotheses using the quantifiable data and statistical analytical tool. The research design of this study is both cross-sectional and comparative. Data was collected from interviewing and a questionnaire survey at a particular point in time, but the methods were conducted on different sample groups and in different ports to ensure that the research findings could be applied to different groups and environments.

A multi-strategy research is increasingly suggested by researchers with the argument against the positivist paradigm and approach which has been predominant in social science (Mangan *et al.* 2004; Naslund 2002). According to Hussey and Hussey (1997), triangulation that uses different research approaches, methods and techniques in the same study can overcome the potential bias and sterility of a single method approach. Easterby-Smith *et al.* (1991) identify four different types of triangulation; data, investigator, methodological and theoretical triangulation. It is likely to say that this study partly adopts a triangulation approach; the data are collected with both quantitative and qualitative methods (methodological triangulation), from different groups (data triangulation). Additionally, the theories used in SCM research are applied to port research (theoretical triangulation).

4.3 DATA COLLECTION METHODS

This research conducted two forms of data collection process. The first used semi-structured interviews and the second a questionnaire survey. The former was undertaken in order to acquire a more accurate view of the main concepts of this thesis, i.e. Port Supply Chain Integration (PSCI) and Port Supply Chain Orientation (PSCO), which resulted in the development of a more sensible and plausible research model. The latter was to obtain the primary data which were analysed to test the research hypotheses. This section delineates the rationale of the method of sample selection and survey design.

4.3.1 Semi-structured interview

The literature review in Chapter 3 (see Section 3.3) showed the components representing PSCI and PSCO and the research gaps identifiable from the existing port literature, but which were not enough to develop a research model to answer the research questions of this thesis. These gaps could be covered simply by adopting the components or concepts used in the SCM literature and adjusting them to the situation of this research. For example, the components used to conceptualise Supply Chain Orientation (SCO) in Min and Mentzer (2004) could be applied to this thesis. However, considering the argument that maritime transportation does not match well with SCM characteristics (Kuiper 2005), a cautionary approach was required when adapting the theories and concepts used in SCM research to maritime transport research, and empirical evidence or an exploration which justifies the adaptation is suggested.

(1) Selection of semi-structured interview

This research, therefore, attempted to explore what is taking place in the port industry focusing on PSCI and PSCO. Qualitative interviews are generally suggested to be an appropriate method for an exploratory study to find out what is happening and to seek new insights (Robson 2002; Saunders *et al.* 2003). Semi-structured interviews and unstructured interviews are categorised as qualitative interviews. While in the

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unstructured interviews there is no predetermined list of questions to work through, in the semi-structured interviews, the researcher has a list of questions and themes to be covered although these may vary from interview to interview. This means the researcher can omit some questions in particular interviews and may change the order of questions depending on the flow of the conversation. This research employed a semi-structured interview approach because the situations which the interviews aimed to explore were relatively constrained. In other words, the exploration had to be made within the research questions and research model this research intended to develop. However, the number of questions was minimised in order to make the interviews more flexible and less directive, and to obtain a deeper understanding about interviewee perceptions.

(2) Sampling for the interview

For the sampling design, various techniques can be considered such as probability sampling (simple random, systemic, stratified random and multi-stage samplings) and non-probability sampling (convenience, purposive, snowball and quota sampling) (Bryman and Bell 2007). In qualitative research, all these techniques can be applied. However, issues regarding the representativeness of the samples are considered less important in qualitative research than in quantitative research, because qualitative research aims to generate an in-depth analysis (Bryman and Bell 2007).

PSCI is basically an activity undertaken by terminal operators who are termed in this research as Terminal Operating Companies (TOCs). Therefore, this research targeted the port industry as the population. The semi-structured interviews were carried out in Korea because this was chosen to be the focus of the main research (questionnaire survey) for the reasons explained in the following section (see Section 4.3.2. p.101). The interviews were conducted over two months in December 2008 and January 2009. The sampling process was similar to that of snowball sampling where a researcher makes initial contact with a small group and then uses these to establish contacts with others (Saunders *et al.* 2003). This process was useful because access to sufficient sample was not easily obtained at the initial stage of the interview study.

In Korea, there are more than 250 TOCs. As of 2008, the number of TOCs registered with the Korea Port Logistics Association was 274 (KOPLA 2009). However, there

were six companies leading the industry in terms of market share (KOPLA 2009). Thus, the senior managers of the six companies were asked to participate in the interview by e-mail. They were generally in charge of the international logistics business for these companies. All of them accepted. During the interviews other potential interviewees were suggested by the initial participants. A total of 21 participated in the interviews: 10 Senior Managers and 2 CEOs from TOCs, 4 middle managers from port authorities and government and 5 academics from universities and research institutes. Most of the companies included in the research operate container terminals in Korea and run logistics businesses in the East Asia region including China and Japan. Two companies are representative of Global Terminal Operators (GTOs).

(3) Administration of the interviews

The semi-structured interview scheme allowed for the addition of more questions and asking these questions differently depending on the responses from interviewees. The interviews were recorded by note-taking and tape-recording and then transcribed for analysis. Each interview lasted 1-2 hours. At the initial stage of each interview, general issues in port industry such as current situation of Korean port industry and competitive status of Korean ports in the Asian region were discussed to get to the more specific topics these interviews intended to address. During the initial stage of each interview, the following questions were used as a stepping stone to reach a common understanding about the main concepts that this research is interested in (i.e. PSCI and PSCO).

To explore the range of services offered by the terminal for which the interviewee was representing:

"How many various kinds of services does your terminal provide?"

To explore the motives which drive the terminals to provide integrated services:

"Why does your terminal provide integrated services rather than only stevedoring service?"

Depending on the answers given by the interviewees, more specific questions were used in the interviews.

The main questions in the interviews were used to identify components which can represent PSCO, and they were:

"Could you tell me what organisational characteristics facilitate the integration of your terminal along supply chains?", and,

to explore both internal and external obstacles to implementing PSCI,

"Have there been (Are there) obstacles or conflicts internally or externally when implementing these integration strategies?"

While ethical issues, such as anonymity and confidentiality occur when collecting primary data rather than secondary data, these issues are generally considered more significant when conducting qualitative research as this involves direct interaction with persons than quantitative research. Confidentiality and anonymity were the main issues rather than privacy and deception because this research deals with organisational level strategies rather than personal perception. The contents of questions asked in the interviews and the method of interviewing were considered by the Research Ethics Committee of Cardiff Business School in advance (see Appendix G), and Cardiff Business School Research Ethics Guidelines were strictly applied throughout the interviews.

4.3.2 Questionnaire survey

Basically this research adopts a quantitative research strategy. This strategy, in nature, involves hypothesizing relationships between concepts of researcher's interest and testing the relationships using appropriate statistical tools. What is essential for implementing this strategy is the measurement of the concepts. Measurement in quantitative research entails addressing several issues to address: (1) single-dimensional or multiple-dimensional concepts: (2) single indicators or multiple indicators, (3) how to devise the indicator(s), (4) hard (objective) or soft (subjective or perceptual) measures, (5) validity and reliability of measurement. Validity and reliability issues will be dealt with in the following section (see Section 4.3.3, p.108). This section justifies why a questionnaire survey was selected addressing the first four

issues of measurement, and subsequently explains in which specific way the survey was conducted.

(1) Selecting questionnaire survey

The first issue for measurement is to consider whether the concepts this research is interested in comprise a single dimension or multiple dimensions. Depending on this, the measures and indicators would be organised differently. As revealed in the literature review the concepts, PSCI and PP, are conceptualized with multiple components, and PSCO also is expected to have a complicated conceptualization considering the multiple components of SCO. As for the second issue about whether to measure the dimensions with single indicators or multiple indicators, it is suggested that a single indicator is not desirable when measuring a complicated concept (Bryman and Bell 2007). The components of PSCI and PP are complicated concepts and they are therefore unlikely to be captured by a single indicator. In addition, the relevant literature has used a number of indicators (observed variables and indicators) to measure the components (Min and Mentzer 2004; Panayides and Song 2008).

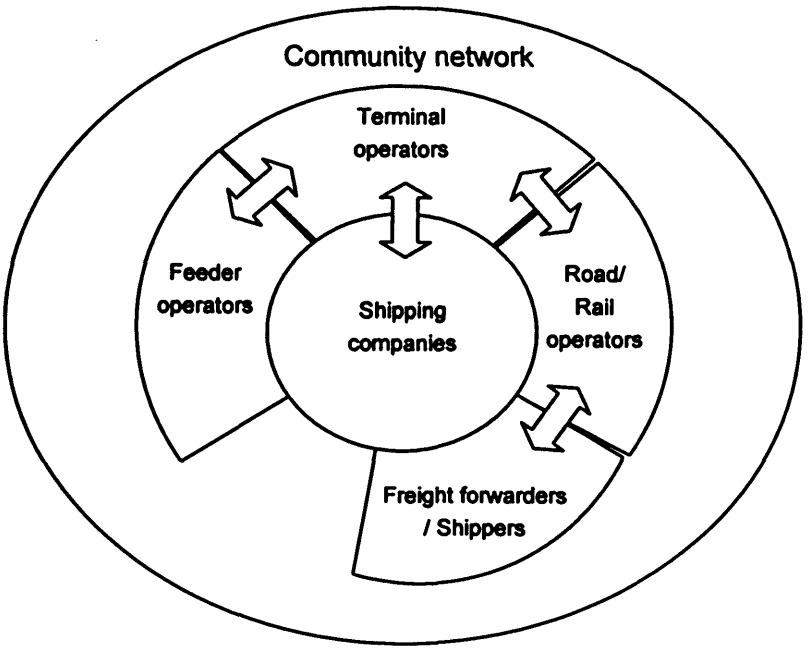
Bryman and Bell (2007) present four ways of devising indicators for measurement in quantitative research: (1) asking questions in a self-completion questionnaire or a structured interview, (2) recording individual's behaviour using a structured observation schedule, (3) official statistics, and (4) examination of mass media context through content analysis. This research investigates phenomena that take place at the organisational level and they cannot be observed at one instance. Therefore, it would take too much time and effort to capture all the aspects of the variables this research is interested in through observing organisations' strategic behaviour. In addition, it is not easy to obtain the reasonable sample size which the hypotheses are testable with from structured observation. The third and fourth options are also not appropriate for this research model because it is almost impossible to obtain official statistics or archives which stand for the variables in the research hypotheses. Thus a questionnaire survey is the most appropriate device which can be designed that is fit for testing the research hypotheses to provide an adequate sample size.

Another concern is whether to measure the concepts in an objective or subjective way. In business and operations research, ideally objective measures and data rather than soft measures which, can be called constructs, are preferred for analysis and benchmarking reasons (Fawcett *et al.* 1997). However, phenomena which cannot be measured directly clearly exist, for example, the level of integration, cooperation, orientation and collaboration including PSCO and PSCI. Also, there are some concepts which are difficult to measure accurately and objectively, such as customer satisfaction, responsiveness, and reliability. In addition, access to some data such as sales, price and profitability information is strictly limited (Chow *et al.* 1994). Soft measures may be called for when research faces at least one of the above problems. This research may suffer all these problems, so the variables used in this research are measured in a subjective way. This means that items in a questionnaire attempt to measure perception or attitudes of respondents towards the items. This is another important reason the questionnaire survey was selected for collecting data. It is fortunate that Fawcett *et al.* (1996) remarked that "while objective measures are preferable, perceptual measures have been found to correlate closely with objective measures and are therefore acceptable and useful substitutes when objective measures are unavailable".

(2) Sampling design for the questionnaire survey

Port industry is the population that this research had to consider because PSCI an activity undertaken by TOCs. However, the port community is complex in nature as a number of members interact as shown in Figure 4.5. It is therefore necessary to seek insights and perceptions from other members of the port community to get comprehensive views on PSCI and PSCO. In addition, the research questions of this research require comparative analysis between groups or ports. Thus, all the members in the port community are incorporated into the population in this research. Among the members, terminal operators and feeder operators are categorised into terminal operators group, i.e. TOCs group, and Shipping Companies (SCs), Freight Forwarders (FWDs), shipper, road/rail operator are categorised into the Port Users (PUs) group. As regards to which level the data are collected and analysed, individual organisations rather than individual persons are the primary unit of measurement and analysis.

Figure 4.5 Port community network (Container terminal model)



(Source: Martin and Thomas 2001)

In this research, samples for data collection were selected from the industries in the TOCs group and the PUs group in South Korea. The reason for this selection is partly due to accessibility as the Author of this thesis has work experience in South Korea, and a higher response rate was expected than from other countries.

Apart from this advantage, the research sought to highlight strategically and theoretically important issues relating to the role of ports in the supply chain in Korea. Korea has accounted for around 5.5% of world seaborne trade and around 3.5% of world container port traffic (UNCTAD 2009, also see Chapter 6, Section 6.1.1, Table 6.2 and 6.3 for details). It has ranked 4th in terms of container cargo traffic among 63 developing economies in 2006 to 2008, and 5th in terms of UNCTAD's Liner Shipping Connectivity Index (aiming at capturing a country's level of integration into global liner shipping networks) in recent years (UNCTAD 2009). Major ports such as Busan and Kwangyang have been regarded as global hub ports (Notteboom 2009; Low *et al.* 2009). However, despite its competitiveness and importance in maritime transport and port traffic, the Korean port industry has faced significant challenges derived from

fierce competition with other Asian ports, and has endeavoured to find sustainable ways to cope with these challenges. The industry still appears not to be sure which strategy between, broadly saying, vertical integration and horizontal integration is more effective at generating competitive advantage. This analysis is also important for policy makers and port authorities in Korea. They are adopting strategies related to both horizontal integration (e.g. preference to container lines and GTOs in concession policy) and vertical integration (e.g. development of distri-park and designation of free trade zones to support logistics activities in seaports area) (MLTM 2009). This analysis provides a rationale for investment in port infrastructure to support integrated logistics services.

There were some technical reasons, which were generalisability and comparability of analysis. If a survey is conducted in some countries in a particular region (e.g. China, Japan and South Korea in East Asia) or some countries selected from various regions (e.g. U.K from Europe, U.S from Northern America and South Korea from Asia), the sample sizes from each country are expected to be reasonably balanced so as to generalise the findings to the countries or to make comparative analysis between the countries and these chances seem to be very slim. Findings from the analysis of the data sampled from only South Korea can be generalized at least in South Korea as long as the samples are representative and the findings are reliable and valid. Also, the findings can be applied to other countries of which port management circumstances e.g. port ownership, are similar to those of South Korea. Additionally, various types of comparative analysis can be designed even only in South Korea because both port and shipping industries are well established and there are international ports which show comparable differences, for example, type of cargoes handled.

Sampling techniques comprise two types: probability sampling and non-probability sampling. The former concerns statistical inferences about the population from the responses of the sample, but the latter does not (Robson 2002). The former includes simple random, systemic, stratified random and multi-stage samplings and the latter includes convenience, purposive, snowball and quota sampling (Bryman and Bell 2007). For this research, convenience sampling was applied when deciding to sample

the industries in South Korea because convenience sampling was available to the researcher by virtue of its accessibility (Bryman and Bell 2007). Bryman and Bell (2007) indicate that convenience sampling is very common and indeed more prominent than are samples based on probability sampling. In addition, a purposive sampling technique was also used, which uses the knowledge and experience of a researcher, in order to make samples appropriate for the comparative analysis between different ports and different groups. For example, when this research selected sample ports (explained below), the knowledge and experience obtained from the semi-structured interviews were used. In addition, the numbers of samples in the PU group were decided based on the grouping practices used by relevant associations for SCs and FWDs in Korea.

It is unlikely that all ports are capable of providing integrated logistics services. According to the literature exploring the circumstances that logistics activities develop better in particular ports (e.g. Ferrari *et al.* 2006; Theys *et al.* 2008), the level of cargo throughput, proximity to the hinterland and geographical location near main shipping routes are suggested to be the characteristics of ports for logistics centres. Therefore, two representative ports in South Korea were chosen for the sampling based on the interviews in South Korea. This research found that the TOCs of these two ports have provided a varied range of integrated services and showed proactive attitudes towards the integration strategies. In this thesis, the two ports are termed as Port A and Port B because of confidentiality reasons. Another advantage from focusing on the two ports is that they have some common and distinguishing characteristics. The common characteristics are that; (1) both ports handle both containerised and non-containerised cargoes and, (2) they are ranked within the World Top 50 in terms of annual container cargo throughput (MLTM 2009). The distinguishing characteristics are that (1) Port A is included in most of the main shipping routes and Port B is basically a feeder port, (2) the ratio of containerised to non-containerised cargoes of Port A is higher than that of Port B. Thus Port A can be considered as a container hub-port whereas Port B is considered as a feeder port in terms of container hub-and-spoke network and handles primarily dry-bulk and general cargoes. The detailed characteristics of Port A and B are presented in Chapter 6 (see Section 6.1).

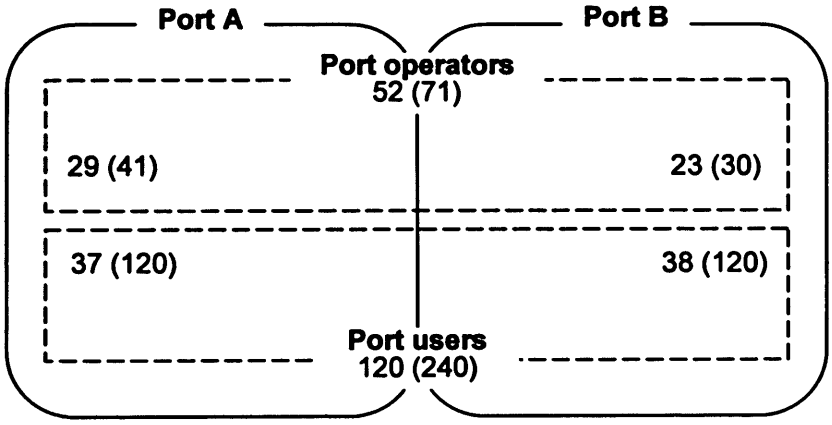
(3) Sampling for each group

As for the TOCs group, the TOCs of Port A and B were selected as the sample for the questionnaire survey. The number of the TOCs is 71 in total, with 41 and 30 from Port A and B respectively in terms of the registered TOCs with Korean Port Logistics Association (KOPLA). Therefore, the TOCs are representative of Ports A and B and it is likely that they are representative of all the Korean ports, considering their significant contribution to seaborne cargo trade and container traffic in Korea (see Section 6.1.1, Table 6.14 for details). The questionnaire was designed for the TOCs to evaluate their levels of PSCI, PSCO and PP using a variety of items (see Appendix A). This research distributed the questionnaire to all the TOCs in Ports A and B (i.e. 71 companies) and received 29 responses from Port A and 23 from Port B. The details of the questionnaire responses are presented in Chapter 6 (see Section 6.1, Table 6.1).

As for the SCs, the top 20 companies in terms of capacity were selected out of 164 companies registered with the Korea Shipowners' Association. The association has grouped the 20 companies as a leading group because their capacity in DWT (Dead Weight Tonnage) has accounted for around 85% of the capacity of the Korean SCs registered with the association, while the proportion can vary year by year. The reason for using the top 20 companies group suggested by the association was that this research needed to ensure that the companies were representative of the SCs in Korea as well as the fact that they have used both Ports A and B. The association suggested that companies not in this group are more likely to focus on a specified business area and are less likely to use both Ports A and B. The questionnaire for the PU group was designed for the companies in the group to evaluate terminals in both Ports A and B (see Appendix A) and differently worded from that for the TOC group. In the respondent profile section in the questionnaire, the respondents were asked to specify Korean ports which their companies primarily use, with some example ports given, including Port A and B. One respondent did not use Port A, so the respondent did not answer. The rest of them selected both Ports A and B. From the 20 companies, this research received 17 responses for Port A and 18 for Port B (see Section 6.1, Table 6.1 for details).

For FWDs, 100 companies were selected out of 744 companies registered with the Korea International Freight Forwarders Association. The help of the Association was enlisted to ensure that their business primarily involved maritime transportation rather than air transportation and that they had been in business for more than 10 years. The list of the 100 companies has been managed by the association for the similar reason. This was more important because a freight forwarding business is relatively small-sized business and its operation is less sustainable than other businesses such as manufacturing and physical transportation industries. In relation to the question of which ports the companies primarily use, one company did not select Port B. However the respondent answered all the items in the questionnaire for Port B. This research assumed that although Port B is not the main port the companies have used, the company may have used Port B for the period of its business and the respondent was confident enough to evaluate the terminals in Port B. Therefore the response from the company was included in the analysis. The number of respondents was 20 and, thus, 20 responses were obtained for each port respectively.

Figure 4.6 Possible sample sizes and the number of responses



Note: The numbers in the brackets represent the maximum number of possible responses

The contacts of road/rail operators and shippers were not approachable because the relevant association refused. In particular, a manager in Korea International Trade Association which is considered as the representative association of shippers in Korea, mentioned that the export and import companies have an interest in logistics but are unlikely to be able to assess port operation and management on particular issues. It should be again noted that the companies in the PUs group were asked to answer the questionnaires for both Port A and B with a reworded questionnaire set (see Appendix

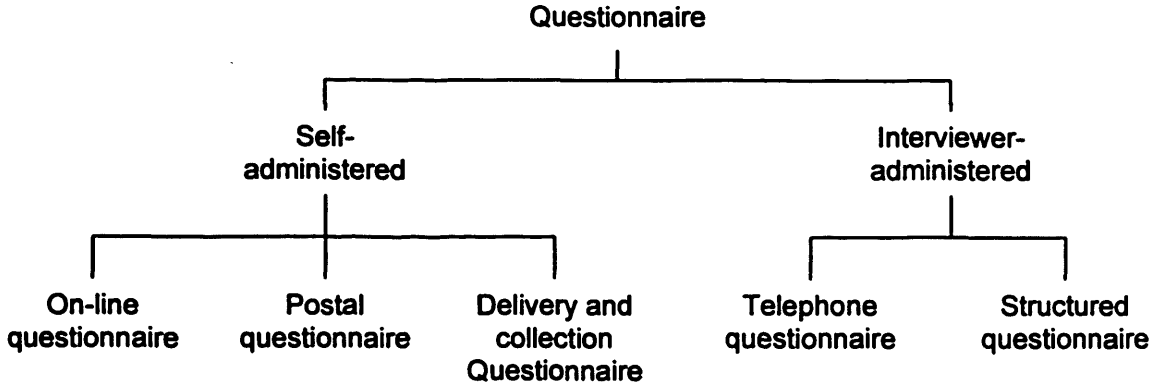
A and B for the details of the questionnaire set). In addition, although anonymity was applied to Ports A and B in this thesis, their own names were presented in the actual questionnaires for the PUs group. In summary, the number of the selected sample was 191 in total, but this research could generate a maximum 311 responses from the sample as shown in Figure 4.6. This research eventually obtained 127 responses.

It is also arguable that the PUs group was unlikely to be able to answer all the question items in the questionnaire due to the possibility that they had limited knowledge about terminal operations and management, in particular, PSCO which represents the internal organisational characteristics of TOCs. However, the constructs, PSCI and PSCO, are basically related to activities which take place across firms in supply chains. In addition, considering the fact that the PUs group have used Ports A and B for a considerable period, it is reasonable to assume that the TOCs and the PUs (the SCs and FWDs) have established a community in each port and have communicated with each other either formally or informally. In particular, the SCs and FWDs are considered as direct customers of TOCs, which have closer relationships than shippers. Thus, this research assumed that perceptions and understandings about each other have developed and they can evaluate each other appropriately.

(4) Administration of the survey

A questionnaire survey was selected as a main data collection method for this research. However, it was also necessary to decide how to administer the questionnaire survey because there are various kinds of survey methods as shown in Figure 4.7 and there are advantages and disadvantages among them. At first, comparing a self-administered questionnaire with an interviewer-administered questionnaire, the former was preferred by this research primarily due to efficiency in time and cost. Interviewing can take time and cost much in case research requires a large sample and especially if the sample is geographically widely dispersed. The former has more advantage over the latter: for example, the former is more convenient for respondents and respondents are less likely to be influenced by the characteristics of the interviewers (Bryman and Bell 2007). However, self-completion questionnaires also have several disadvantages: respondents cannot ask questions, and researchers cannot collect additional data, etc. The most significant limitation this research had to overcome was a low response rate.

Figure 4.7 Types of questionnaire



(Source: Saunders *et al.* 2003)

Among the three ways of using self-administered questionnaire, this research adopted an on-line questionnaire, specifically an e-mail questionnaire, in which researchers send questionnaires and respondents receive, complete, and return the questionnaires through an e-mail system. On-line questionnaires have been employed less frequently than traditional methods like postal and face-to-face interview due to the lack of accessibility to computer networks at work (Jones and Pitt 1999). However, the number of surveys being administered on-line has recently grown considerably (Bryman and Bell 2007). One of the reasons for the growth is that most workplaces are connected to the internet network.

This method has several advantages. Firstly, questionnaires can be sent quickly to even a huge number of potential respondents that immediately receive the questionnaire regardless of their location, as long as internet access is available at their locations (Kiesler and Sproull 1986). In addition, this method is convenient for both researchers and respondents. Researchers only need to send e-mails once questionnaires are designed and e-mail addresses are acquired, while a postal survey requires photocopying questionnaires, stuffing envelops and addressing outgoing mail. Another convenience is that researchers can identify whether the questionnaires have arrived and been opened. This technique also gives the researcher the opportunity to communicate with respondents repeatedly and easily. Respondents can also answer the questionnaire easily on the received e-mail or the attached questionnaire on widely used software like Microsoft Word, and only need to reply to the questionnaire on-line.

However, e-mail questionnaires also have disadvantages. This method may involve concerns for anonymity and confidentiality because respondents' names and affiliations can be automatically conveyed to the surveyor (Simsek and Veiga 2000). Respondents can perceive the e-mail as junk mail and they may be reluctant to open the e-mail because of concerns about virus infection. These concerns may cause a low response rate which can be overcome through effective and careful sampling (Jones and Pitt 1999; Simsek and Veiga 2000). As for the design of the questionnaire items, this research follows Churchill and Iacobucci (2002)'s nine step guidelines to questionnaire design. However, it could be designed after all the latent variables and observed variables are identified. Thus the detailed process of designing the questionnaire and the completed questionnaire are presented in Chapter 5 where the research model is developed based on the findings from the interview.

4.3.3 Validity and reliability of measurement

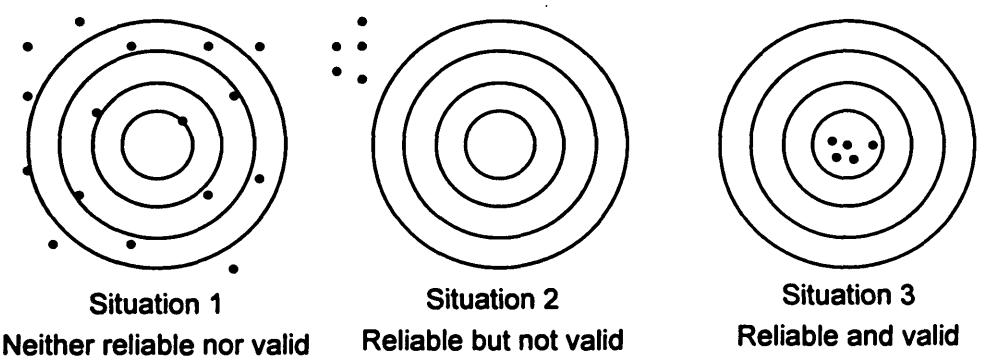
Confirming validity and reliability of measurement is essential in quantitative research because the concepts used are represented by numbers through measurement. Invalid and unreliable measurement may lead analysis and interpretation to different outcomes from the real world. The validity and reliability relate to the whole process of model development and data collection from building up the concepts via identifying components of the concepts from the literature review to designing questionnaire. They are generally supposed to be confirmed in the analysis phase. Some statistical techniques cover all the dimensions of validity and reliability and some cannot. In the latter case, multiple techniques can be used to do so.

The analysis procedure of SEM examines the validity and reliability incorporating some statistics into the procedure while SEM primarily provides statistics for the overall model fit and the individual structural paths. This section focuses on what measurement validity and reliability mean and how they can be examined. It is worth noting that the measurement validity and reliability do not represent validity and reliability which are used as criteria to assess research quality in quantitative research. Measurement validity is a part of validity which generally comprises internal, external, measurement and ecology validity (Bryman and Bell 2007).

(1) Basic concepts of measurement validity and reliability

Validity is defined as the extent to which differences in scores of a measure reflect true differences among individuals on the characteristic we seek to measure, rather than constant or random errors (Selltiz *et al.* 1976). In other words, this refers to 'whether what we tried to measure was actually measured' (McDaniels and Gates 1999). Reliability refers to the consistency, stability over time, and reproducibility of a measurement instrument (Garver and Mentzer 1999; Panayides and Song 2008). According to Kline (2005), 'tests that are relatively free of random measurement error are called reliable' and 'measures that are relatively free from both random and systemic error may be called valid'. Some books provide illustrations that describe validity and reliability altogether as shown in Figure 4.8 (McDaniel and Gates 1999). Situation 1 shows the holes scattered over the entire target, indicating there is neither validity nor reliability because of the lack of consistency and huge errors. Situation 2 shows a very tight pattern of holes, but that they are out of the target, implying that the measurement has consistency but does not measure what the researcher wants to measure. Situation 3 shows the pattern converges on the centre of the target, indicating the measurement is both reliable and valid.

Figure 4.8 Illustrations of possible relationships between reliability and validity



(Source: McDaniels and Gates 1999)

(2) Dimensions of measurement validity

Various dimensions are considered for measurement validity. Measurement validity is alternatively called construct validity comprising numerous sub-dimensions including

content validity, unidimensionality, reliability, convergent validity, discriminant validity and nomological validity.

Content validity refers to the degree that the construct is represented by items that cover the domain of meaning for the construct (Garver and Mentzer 1999). Content validity exists when the domain of the characteristics is adequately reflected by the scale items (Churchill 1979). However, since there is no formal statistical test for assessing the content validity, research judgement and insight must be applied. Nevertheless, if constructs used in studies are derived from a comprehensive analysis of the relevant literature, content validity can be certified (Ahire *et al.* 1996).

Unidimensionality is defined as the existence of one construct underlying a set of items (Steemkamp and Trijp 1991) and the degree to which items represent an underlying latent variable. Some traditional techniques such as Cronbach's Alpha, item-to-total correlations and Exploratory Factor Analysis (EFA) have been adopted to evaluate unidimensionality (e.g. Narashiman and Jayaram 1998; Swafford *et al.* 2006). However, many authors have argued that these techniques can measure reliability but cannot truly assess unidimensionality (Anderson and Gerbing 1988). A better way to assess unidimensionality is to perform CFA and assess overall model fit using goodness-of-fit indices along with diagnostic tools such as standardised residuals and modification indices. Many researchers suggest that there is no single index to satisfy all statistical tests and, thus, multiple combined indexes be adopted (Kline 2005).

Scale reliability can be assessed by various methods such as split-half technique and Cronbach's alpha which is the most commonly used technique. For the technique using Cronbach's alpha, generally scales achieving an alpha score over 0.7 are considered reliable (Gerbing and Anderson 1988). However, it is argued that Cronbach's alpha has several disadvantages: Cronbach's alpha is inflated on a measuring scale that has a large number of items and assumes that all the measured items have equal reliabilities (Fornell and Larker 1981; Gerbing and Anderson 1988). Therefore, alternative methods have been suggested by researchers: the composite

reliability of construct and variance extracted measure (Hair *et al.* 2010). The composite reliability is calculated as:

$$\text{Composite reliability} = \frac{(\Sigma \lambda_i)^2}{(\Sigma \lambda_i)^2 + \Sigma \varepsilon_j},$$

where λ_i is the component loading to an indicator and ε_j is the measurement error ($1-\lambda_i^2$). With the minimum level of 0.50, the recommended level of composite reliability is 0.70 (Hair *et al.* 2010).

Average variance extracted represents the overall amount of variance in the indicators accounted for by the latent construct (Hair *et al.* 2010). It is calculated as:

$$\text{AVE} = \frac{\Sigma \lambda_i^2}{\Sigma \lambda_i^2 + \Sigma \varepsilon_j}$$

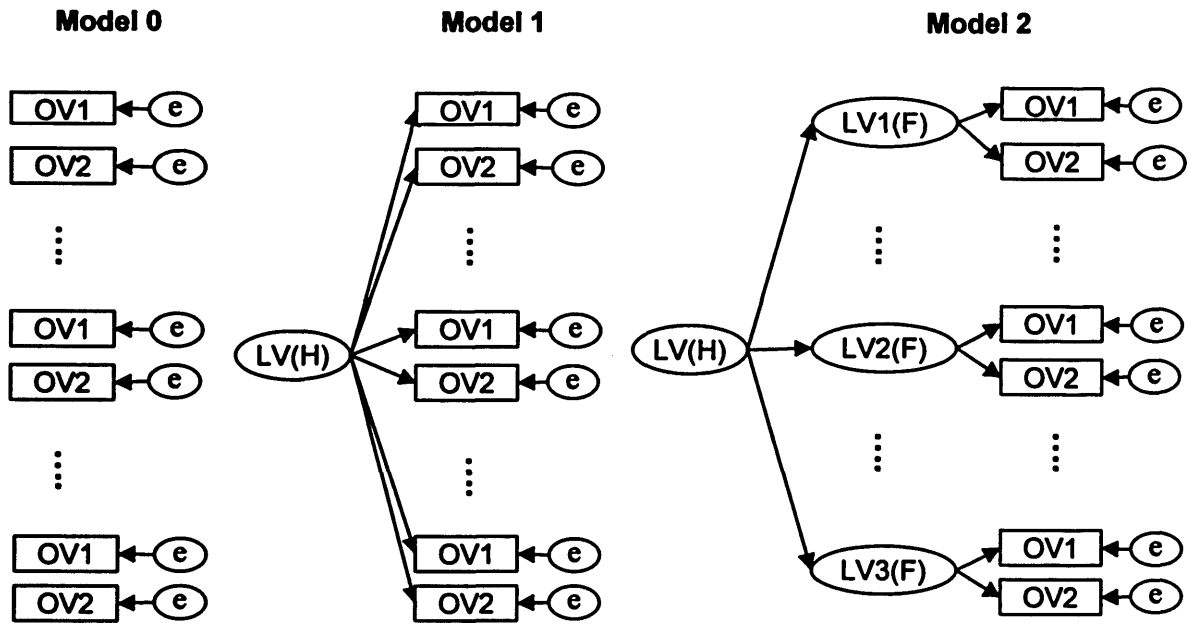
where λ_i is the component loading to an indicator and ε_j is the measurement error ($1-\lambda_i^2$). The acceptable value for the AVE is 0.5 (Garver and Mentzer 1999).

Convergent validity is the extent to which the latent variable correlates to items designed to measure that same latent variable (Garver and Mentzer 1999). The convergent validity is assessed by determining whether each parameter estimate (standardised factor loading) on its posited underlying construct is statistically significant (Anderson *et al.* 1987). In addition, the factor loadings are required to be greater than at least 0.5 and preferably 0.7.

Discriminant validity is the extent to which the items representing a latent variable discriminate that construct from other items representing other latent variables (Garver and Mentzer 1999). Discriminant validity can be assessed in various ways: (1) examining the inter-correlations among the latent constructs (e.g. Lee *et al.* 2008; Chang *et al.* 2008); (2) examining the Average Variance Extracted (AVE), (3) comparing the squared rooted AVE with inter-correlations between the latent constructs (e.g. Lai *et al.* 2008; Bichou and Bell 2007), (4) conducting a χ^2 difference test (e.g. Panayides and Song 2008; Mentzer *et al.* 1999; Lai *et al.* 2004; Chen and Paulraj 2004; Rosenzweig and Roth 2007; Shang and Lu 2009; Swafford *et al.* 2006; Shang and Marlow 2005), and (5) conducting a correlation confidence interval between the latent variables (e.g. Panayides 2007; Panayides and So 2005).

Convergent validity and discriminant validity can also be assessed by Widaman (1985)'s three comparison models. The three comparison models include Model 0 with individual measurement items as unique factors in a construct, Model 1 with individual items loaded on one unique first order factor, and Model 2 with individual items loaded on any one of the appropriate first order factors that in turn are loaded on the second order factor as shown in Figure 4.9. A significant improvement in fit of Model 1 over Model 0 provides evidence of convergent validity and that of Model 2 over Model 1 provides evidence of discriminant validity (Min and Mentzer 2004; Min *et al.* 2007; Widaman 1985).

Figure 4.9 Widaman's three comparison models



(Source: Adapted from Min and Mentzer 2004)

Nomological validity is the extent to which measures of different but related constructs correlate to each other in theoretically predicted ways (Min and Mentzer 2004). Therefore, the test of nomological validity examines whether the correlations among the constructs in a measurement theory make sense. Nomological validity can be tested in the measurement model if the measurement model contains the construct of interest and a construct that it should predict. In this case, the correlations between the two constructs should be substantial in magnitude and statistically significant. This validity can also be supported by demonstrating that the constructs are related to other

constructs not included in the model in a manner that supports the theoretical framework (Hair *et al.* 2010). Thus, researchers can examine whether the correlations are consistent with the theoretical expectations.

4.4 DATA ANALYSIS METHODS

This research collected two sets of data. One is a set of qualitative data from the semi-structure interviews, and the other is a set of quantitative data from the questionnaire survey. Structure Equation Modelling (SEM) was adopted to analyse the data collected from the questionnaire survey and the results of the empirical analysis are provided in Chapters 7 and 8. This section mainly focuses on SEM analysis. However it is necessary to discusss how the qualitative data were analysed for a better understanding of the relationship between the two sets of data.

Analysing the qualitative data requires a different approach from analysing quantitative data. Bryman and Bell (2007) indicate that 'clear-cut rules about how qualitative data analysis should be carried out have not been developed' because qualitative data take the form of 'a large corpus of unstructured textual material'. However, the basic concept for qualitative data analysis is categorisation and characterisation (Saunders *et al.* 2003). The various aspects that the interviewees describe in the interviews can be sorted into various categories. For this research, the answers from each question could form a possible categorisation system. More specifically, the contents relating to the organisational characteristics facilitating PSCI, which is PSCO, needed to be categorised. The categorisation can be supported by existing literature. However, some categories can emerge from the data without being supported by a predetermined theoretical framework. Subsequently, the categories need to be characterised. The categories supported by existing theories are more easily characterised than the new categories because newly emerging categories are suggested to be justified in terms of why they can be differentiated from the existing categories (Robson 2002). Components of PSCO emerged from the categorisation and the details of the components were worded in the questionnaire as measurement items. The data collected from the questionnaire were analysed using SEM analysis techniques.

4.4.1 Overview of SEM

SEM is a statistical methodology that takes a confirmatory approach to the analysis of a structural theory (Byrne 2001). Although SEM does not refer to a single statistical technique and has a variety of functions, this primarily enables a researcher to examine a complex model that comprises multiple causal relationships incorporating both unobserved and observed variables. Hair *et al.* (2010) demonstrate that the main characteristics of SEM are that it is able (1) to estimate the multiple and interrelated dependence relationships and (2) to represent unobserved concepts which are termed as constructs, latent variables and factors, in these relationships, and (3) to account for measurement error in the estimation process.

SEM generally combines the measurement model (confirmatory factor analysis) and the structural model (regression or path analysis) into a simultaneous statistical test (Garver and Mentzer 1999; Hair *et al.* 2010). The measurement model specifies the relationships between the observed variables and the unobserved variables. Latent variables represent theoretical constructs which cannot be observed directly, and observed variables represent the measured score from the instruments (Byrne 2001). Specifically CFA is concerned with the extent to which the observed variables are generated by the underlying latent constructs, and thus the strengths of the regression paths from the latent variables to the observed variables are of primary interest. The structural model specifies the hypothesised causal relationships among the latent variables and thus this model is most interested in the regression coefficient between the latent variables.

Accounts of the statistical theory that underlies SEM as currently practiced appeared in the 1970s (Hoyle 1995). However the origin of SEM can be traced back to Spearman (1904) with the development of what is now called Confirmatory Factor Analysis (CFA). It was some years later when Wright (1921) developed and applied path analysis to the study of causal effect in genetics (Gimenez *et al.* 2005). Not until the early 1970s was it that path analysis and confirmatory factor analysis were integrated into a unique framework, i.e. SEM (Gimenez *et al.* 2005). Subsequently, these SEM techniques have expanded rapidly to more diverse area such as education, marketing and management (Hoyle 1995) due to these advantages over other multivariate

techniques. However, Hoyle (1995) pointed out that the underlying reason that the techniques have acquired such popularity would be the fact that research questions in the social sciences and behavioural sciences have become increasingly complex and specific.

In logistics and SCM research, a number of studies have applied these techniques. This is not surprising considering the fact that SCM involves abstract concepts such as integration, collaboration, coordination, and competitive advantage. In contrast, it was not easy to identify studies applying SEM techniques in port research. Table 4.7 (p.89) showed that only five studies published in the 2000s used SEM in port research. Woo and Pettit (2010) inferred the reasons for the scarcity of SEM application in port research. Firstly abstract concepts are rarely involved because internal operational aspects of ports rather than external relationships with customers and stakeholders have been focused on. However, with changes in the logistics environment such as the introduction of SCM and intermodal service concepts and logistics outsourcing, some abstract concepts such as vertical and horizontal integration, strategic alliance, value-addition and competitive advantage have begun to appear in the port research (e.g. Bichou and Gray 2004; Notteboom and Winkelmans 2001; Robinson 2002; Notteboom 2004). Secondly, however, these abstract concepts have not been analysed by empirical methods or processes. The concepts were employed largely in conceptual works, and even where they have been adopted in empirical studies using DEA, Analytical Hierarchy Process (AHP) and Multivariate Analysis of Variance (MANOVA), they have been selected subjectively and arbitrarily.

4.4.2 Comparing SEM, PLS and regression analysis

This research aims at examining the research model incorporating the interrelated causal relationships between PSCO, PSCI and PP which are latent variables. SEM is a strongly recommended research methodology for this sort of research interest (Byrne 2001; Hair *et al.* 2010; Tabachnick and Fidell 2001). In addition, it is not surprising that SEM has become a highly popular analytical option considering its strengths over other multivariate procedures: (1) SEM takes a confirmatory approach (i.e. hypothesis testing) while most other multivariate procedures are descriptive (Byrne 2001; Hair *et al.* 2010); (2) SEM provides explicit estimates of measurement error, while other

methods are not capable of assessing measurement errors assuming the errors of independent variables vanish (Byrne 2001; Rigdon 1998); (3) SEM can incorporate both observed and latent variables while others are based on observed measurement only (Byrne 2001); (4) SEM can deal with interrelated multiple relationships between dependent and independent variables while others permit only a single relationship (Hair *et al.* 2010).

Despite the explicit advantages over other methods, researchers also need to be considerate when selecting this method because SEM also has several strict assumptions and limitations (Tomarken and Waller 2005). Therefore, this section is devoted to not only delineating the difference and similarity of SEM with other similar statistical tools, but also justifying the reason for applying SEM to this research by means of comparing SEM with Partial Least Squares (PLS) and linear regression analysis which are generally used to examine causal relationships. Linear regression is one of the first generation regression models such as ANOVA and MANOVA, which analyse a layer of linkage between independent and dependent variables. There are two approaches or techniques widely applied to SEM: partial least squares and covariance structure analysis (Gefen *et al.* 2000). SEM with the former is called PLS-based SEM, in short, PLS, and SEM with the latter is called covariance-based SEM, in short, SEM in this study. The comparisons are made in terms of: (1) basic characteristics including objectives of analysis, analysis approaches, basic assumptions and sample size and (2) analytical capabilities such as ranges of provided statistics, interaction effect examinations, curable data problems, and observed variables that can be incorporated as detailed in Table 4.8 and 4.9.

(1) Objective of analysis and analytical techniques

SEM aims to show that the null hypotheses based on the assumed research model with all its paths is insignificant, which means the complete set of paths specified in the model is plausible. In contrast, the objective of PLS and regression analysis to reject the null hypotheses by showing high R^2 and significant t-value as indicated in Table 4.8. More critical differences between them are due to the varying algorithms for the analytical technique. SEM uses model fitting to compare the covariance structure fit of

the research model to a best possible fit covariance structure. Model fit indices and residuals provided tell how closely the proposed model fits the data as opposed to a best-fitting covariance structure. In other words, SEM techniques emphasise the overall fit of the entire observed covariance matrix with the hypothesised covariance model, which requires the research model to have a sound theoretical base. Therefore, SEM is considered best suited for confirmatory research (Byrne 2001; Gefen *et al.* 2000). PLS and regression are designed to explain variance, i.e. to examine the significance of the relationships and their resulting R^2. Therefore researchers suggest that they are more suited for predictive applications and theory building, when the researcher is not certain about the model and measures (Chin 1998). PLS, using Ordinary Least Squares (OLS) as the estimation technique, performs an iterative set of factor analyses combined with path analyses until the difference in the average R^2 of the constructs becomes insignificant. Subsequently, PLS estimates the significance of the structural paths applying either a jacknife or a bootstrapping approach (Stan and Saporta 2009).

Table 4.8 Comparison of basic characteristics between the three techniques

Issues	SEM	PLS	Regression
Objective of overall analysis	To show the entire model is plausible	To reject a set of path specific to null hypotheses	To reject a set of path specific to null hypotheses
Objective of variance analysis	Overall model fit	Variance explanation	Variance explanation
Approach of analysis	Covariance based	Variance based	Variance based
Theoretical requirement	Sound theory base required to support confirmatory research	Sound theory base is not required and it supports both exploratory and confirmatory research	Sound theory base is not required and it supports both exploratory and confirmatory research
Sample size	At least 100-150 cases	At least 30-100 cases	At least 30 cases
Assumed distribution	Multivariate normality is required when estimation is through Maximum Likelihood. Deviations from multivariate normality are support with other estimation technique	Robust to deviations from multivariate normal	Normal distribution required, but handles non-normal data with established methods

(Source: Adapted from Gefen *et al.* 2000; Stan and Saporta 2009)

(2) Assumptions and sample size

The estimation techniques applied in PLS do not require parametric assumptions, thus multivariate normality of the sample data is not assumed. These techniques also offer PLS with an advantage that even small data sampling can be analysable by PLS. Stan and Saporta (2009) depict that a minimum requirement is from 30 to 100 while a guideline for the required sample size is that the sample should have at least ten times more data points than the number of items in the most complex construct in the model (Gefen *et al.* 2000). Regression also requires the data to be normally distributed, but some methods which can remedy the non-normality to considerable extent have been established, such as data transformation. In addition, once the normality of data is obtained, regression depends less on sample size, and when a data set has more than 30 cases, the result of regression analysis is infuenced less by the normality assumption.

In contrast, multivariate normality is relatively strictly applied to SEM when using Maximum Likelihood (ML) functions which is set as a default estimation technique in SEM and General Least Squares (GLS) (Byrne 2001). West *et al.* (1995) suggest that non-normality in SEM research yields some interesting results, such as inflating the Chi-square value, underestimating some fit indices such as the Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI), and underestimating standard error, rendering the regression paths statistically significant. However, the deviation from multivariate normality can be partly coped with using other estimation techniques such as Weighted Least Squares (WLS), Asymptotic Distribution-Free estimation (ADF) and Unweighted Least Squares (ULS). Another remedy suggested by Byrne (2001) is the bootstrapping approach where new sub-samples are generated based on the original sample, and the research model is then estimated for each new sub-sample deriving the final parameter estimates directly from multiple model estimation across the new sub-samples. In SEM, sample size is concerned with whether it is likely to be sufficient to execute the model with the given number of parameters to be estimated. However, the Chi-square value tends to inflate when the data has small size. At least 100 or 150 cases are required depending on the complexity of the research model.

(3) Analytical capabilities

As shown in Table 4.9, both SEM and PLS are capable of analysing all the paths in the measurement model and structural model simultaneously unlike regression analysis. All three techniques provide statistics for overall model fit and individual paths. Analysis of item loadings is not applicable to regression because it cannot estimate latent variables from observed items. More importantly, the residual non-common error is not analysed by either PLS or regression. Interaction effects can be analysed in regression relatively simply by adding interaction variables into the regression model as an independent variable. However, regression analysis has the limitation that the interaction effect cannot be applied to other analysis such as item loading and non-common error as in other issues. SEM analyses the interaction effect applying a multi-sample or multi-group approach which analyses whether the research model is applied differently in accordance with sample groups. In addition, the approach allows the researcher to examine the interaction effect on all the paths in measurement and structural models. However, there are concerns that the SEM technique is fragile and subject to violations of the major distribution such as influential outliers, heteroscedasticity and multicollinearity unlike regression because it does not have explicit remedial tools to identify and handle these problems (Byrne 2001; Gefen *et al.* 2000; Hair *et al.* 2010).

Table 4.9 Comparison of analytical capabilities between the three techniques

Issues	SEM	PLS	Regression
Analyses all the paths in both measurement and structural model in a analysis	Supported	Supported	Not supported
Provides statistics for following analyses:			
overall model fit	Supported	Supported	Supported
individual paths	Supported	Supported	Supported
individual item loadings	Supported	Supported	Not supported
residual non-common error	Supported	Not supported	Not supported
Examines interaction effect on:			
cause-effect path	Supported	Supported	Supported
item loadings	Supported	Not readily supported	Not supported
non-common variance	Supported	Not readily supported	Not supported
the entire model	Supported	Not readily supported	Not supported
Dealing with			
possible over-fitting	Problematic	Problematic	Less problematic
suspected influential outliers	Problematic	Problematic	Less problematic
suspected heteroscedasticy	Problematic	Problematic	Less problematic
Reflective observed variables	Support	Supported	Supported
Formative observed variables	Not supported	Supported	Not supported

(Source: Adapted from Gefen *et al.* 2000)

(4) Applying the criteria to this research

In summary, SEM is suitable for a confirmatory research approach which examines a complicated model with interrelated relationships between multiple observed and latent variables and has a reasonable sample which has a sufficient size and of which data conforms to the assumed distribution. A particular reason that SEM should be used for confirmatory purposes and be based on a strong theoretical justification is that SEM has concern for over-fitting that implies the fact that the same data can support many equivalent models. Therefore, while PLS shares some advantages with SEM, this technique can be an alternative to SEM when the research is more exploratory than confirmatory and the sample size is small. However, one limitation of PLS which is important when applying the above criteria to this study is that the interaction effect is not analysed by PLS, which means multi-group or multi-sample analysis is not available in this technique. While regression has attractive capabilities coping with problems derived from the violation of distribution assumptions, this technique's analytical capabilities are limited by its primitive characteristics that it can neither incorporate unobserved variables into the model nor test a set of causal relationships simultaneously, and ignore measurement error.

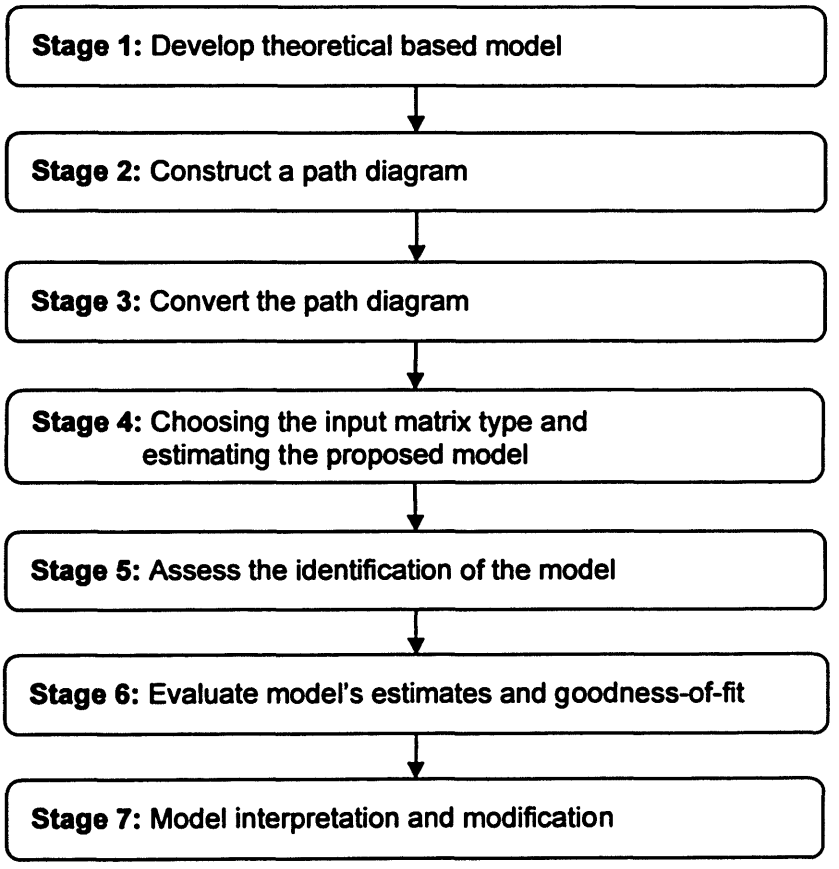
This research develops a complicated research model incorporating interrelated causal relationships between PSCO, PSCI and PP, and both latent and observed variables are included in the model. Thus, regression analysis cannot be a suitable analytical method for this research. There are a few explicit reasons that SEM is more suitable for this research than PLS. The objective of this research is to confirm the research model rather than to explore the possible relationships among PSCO, PSCI and PP. Research hypotheses are proposed before an empirical analysis based on reseach questions and a theoretical justification from existing theory or observation. Once the hypotheses are examined in the empirical analysis, the research objectives of this research will be accomplished regardless of the results. Adding more hypotheses and examining competing models require other theoretical justifications. In this regard this research follows a confirmatory approach. Another reason is that this research is also concerned with testing model invariance among groups and ports. This analysis should be implemented by the multi-group approach (Koufteros and Marcoulides 2006) which is not available in PLS (Gefen *et al.* 2000). Some challenges such as

multivariate non-normality and outliers may appear in analysing the data using SEM. To cope with these problems some statistical techniques need to be adopted in such cases. For example this research can consider applying the bootstrapping approach to deal with possible non-normality of the collected data.

4.4.3 SEM analysis procedure

A seven stage approach proposed by Hair *et al.* (2010) is applied to the data analysis of this research as shown in Figure 4.10, while other researchers have proposed five-stage (Bollen and Long 1993) or six-step procedures (Kline 2005).

Figure 4.10 A seven-stage process for SEM



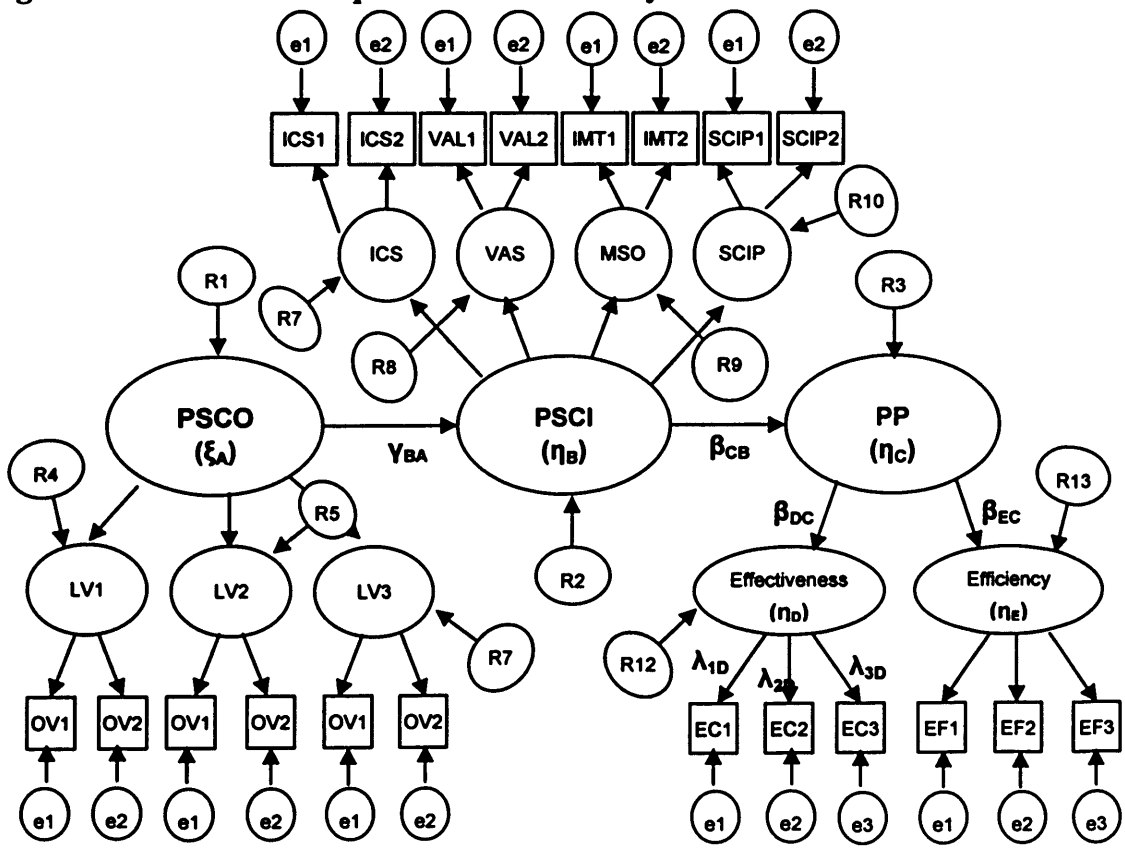
(Source: Adapted from Hair *et al.* 2010)

The first step involves developing a theoretical model. As previously discussed, the model examined by SEM should be strictly grounded in theoretical rationale (Byrne 2001; Hair *et al.* 2010; Tabachnick and Fidell 2001). Therefore, most studies using

SEM conduct an extensive literature review for item generation and relationship specification. However, when the theory is relatively undeveloped in the area of interest the item generation and relationship specification can be supported by in-depth interview or focus groups (Hensley 1999; Woo and Pettit 2010). This research also relies on both the existing theories and the findings from the qualitative interview to build up the research model. **The second step** is to construct a path diagram of the theoretical model. The assumptions underlying a path diagram are: (1) all causal relationships represent the theory and the theory is the basis for inclusion or omission of any relationship and (2) the causal relationships are assumed to be linear.

The third step is to specify the model in more formal terms, which means that the causal relationships must be expressed in the form of a series of equations. These equations define the model's parameters, which correspond to the relationships among observed or latent variables. SEM models are generally decomposed into two sub-models which are a measurement model and a structural model. In Figure 4.11, PP has two latent variables, Effectiveness and Efficiency, and each latent variable has three observed variables.

Figure 4.11 Structural equation model with syntax of this thesis



Relationships between Effectiveness and its three observed variables are depicted by a measurement model, and Effectiveness has first-order structure. PP has second-order structure which comprises two first-order factor models. In addition a structure model depicts the causal relationships between three second-order factors which are PSCO, PSCI and PP. In SEM the special diagrammatic syntax is used to represent the equations. Figure 4.11 presents a sample of the syntax on some part of the model. Ksi (ξ) stands for exogenous latent variables, Eta (η) for endogenous latent variables and Gamma (γ) for the path connecting Ksi (ξ) and Eta (η). Thus, for example, the equation for the path from PSCO to PSCI can be expressed as $\eta_B = \gamma_{BA}\xi_A + \zeta_A$. Similarly, the equation for Effectiveness measurement model can be expressed as $\eta_D = \Lambda_D EC + \Theta_D$, where Lambda ($\lambda$) represents the path between an observed variable and its latent variable and Theta (θ) is the error variance associated with the observed variable

The fourth step is to choose the input matrix type between the covariance matrix and correlation matrix. In this step, the estimation technique and the computer program also need to be selected. Among various estimation technique such as ML, GLS, WLS, ULS and ADF, the suitable technique should be chosen depending on the distribution and sample size of the collected data. The analysis process basically relies on computer software. Hoyle (1995) indicates that with the appearance of flexible, user-friendly computer software, SEM has drawn interest as a standard approach to testing research hypotheses. A number of programs exist: Linear Structural Relations (LISREL), structural Equation modelling Software (EQS), Analysis of Moment Structures (AMOS), and Latent Variable Partial Least Square (LVPLS). Hair *et al.* (2010) describe LISREL is the most widely used program that has become almost synonymous with SEM. Narasimhan and Jayaram (1998) mention LISREL and EQS are the most popular SEM software package used by researchers. LISREL is very flexible model and has found applications across all fields of study, and EQS is less strict about the assumptions on multivariate normality. However, AMOS has gained popularity recently due to its simple interface to users. This research uses AMOS 6.

The fifth step is to assess the identification of the structural model, which concentrates on whether or not there is a unique set of parameters consistent with the data (Byrne 2001). Identification refers to idea that there is at least one unique solution for each parameter estimate in an SEM model (Kline 2005). A number of rules can be used to

assess the identification level of a model, but these rules are not perfect and they are very difficult to evaluate by hand. SEM software such as AMOS performs identification checks and they usually provide reasonable warning about under-identification conditions (Hoyle 1995).

Once the model is identified, the model fit is evaluated in **the sixth step**. The SEM has three categories of goodness-of-fit: absolute fit measures, incremental fit measures and parsimonious fit measures as seen in Table 4.10. An absolute fit index directly assesses how adequately a model reproduces the sample data (Hu and Bentler 1995). For chi-square statistics, insignificant values show good model fit. However, the criterion is rarely satisfied because this is very sensitive to sample size. Therefore, the ratio of the chi-square statistics to degrees of freedom is frequently examined with a recommendation of being between 1 and 2. Standardised Root Mean Square Residual (SRMR) and Root mean Square Error of Approximation (RMSEA) are also frequently applied with their large values indicating high residual variance that reflects a poorly fitting model. Thresholds for these two indices are below 0.05. GFI measures the absolute fit of the combined measurement and structural model to the collected data with recommended threshold of being higher than 0.9. An incremental fit measure mainly measures the extent of fit improved by comparing the proposed model to some more restricted nested baseline model which are often referred to as the null or independence model (Kelloway 1998). The Adjusted Goodness-of-Fit Index (AGFI) is the index that adjusts the Goodness-of-Fit Index (GFI) value to the degrees of freedom in the proposed model. It is suggested to be greater than 0.9 but values between 0.8 – 0.9 also means acceptable fit. Other indices in this category such as the Normed Fit Index (NFI), the Tucker-Lewis Index (TLI) and the Comparative Fit Index (CFI) are also very frequently used and the thresholds for these should be above 0.9. The parsimonious fit measure aims to identify whether model fit has been achieved by over-fitting the data with too many coefficients (Hair *et al.* 2010). The closer the values of the Akaike Information Criterion (AIC), the Parsimony Normed Fit Index (PNFI) and the Parsimony Comparative Fit Index (PCFI), the better fit the proposed model has. Once the model is deemed acceptable, the researcher may wish to examine possible model modifications to improve theoretical explanations or the goodness-of-fit. However, it has been indicated that model changes should not be based on only modification indices but should be justified by theory (Hair *et al.* 2010).

Table 4.10 Summary of alternative goodness-of-fit indices

Fit Index	Description	Acceptable Fit
1. Measure of Absolute Fit		
Chi-square (χ^2)	Test of null hypothesis that the estimated variance-covariance matrix deviates from the sample. Greatly effected by sample size. The larger the sample, the more likely it is that the p value will imply a significant difference between model and data	Non significant (χ^2) at least p value >.05
Standardised Root Mean Square Residual (SRMR)	Representing a standardised summary of the average covariance residuals. Covariance residuals are the differences between observed and model-implied covariance.	Value <.05 good fit 0.1-0.05 adequate fit
Root mean Square Error of Approximation (RMSEA)	Representing how well the fitted model approximates per degree of freedom	Value 0.05-0.08 is adequate fit
Goodness-of-Fit Index (GFI)	Representing a comparison of the square residuals for the degree of freedom	Value > .95 good fit 0.90-0.95 adequate fit
2. Incremental Fit Measure		
Adjusted Goodness-of-Fit Index (AGFI)	Goodness-of-fit adjusted for the degree of freedom. Less often used due to not performing well in some applications. Value can fall outside 0-1 range	Value > .95 good fit 0.90-0.95 adequate fit 0.80-0.90 acceptable
Buntler-Bonnet Normed Fit Index (NFI)	Representing a comparative index between the proposed and more restricted nested baseline model not adjusted for degree of freedom, thus the effects of sample size are strong	Value > .95 good fit 0.90-0.95 adequate fit
Tucker-Lewis Index (TLI)	Comparative index between proposed and null models adjusted for degrees of freedom. Can avoid extreme underestimation and overestimation and robust against sample size. Highly recommended fit index of choice	Value > .95 good fit 0.90-0.95 adequate fit
Comparative Fit Index (CFI)	Comparative index between proposed and null models adjusted for degrees of freedom. Interpreted similarly as NFI but may be less affected by sample size. Highly recommended as the index of choice	Close to 1 very good fit Value > .95 good fit 0.90-0.95 adequate fit
Bollen's Incremental Fit Index (IFI)	Comparative index between proposed and null models adjusted for degrees of freedom	Value > .95 good fit 0.90-0.95 adequate fit
3. Parsimonious Fit Measures		
Akaike Information Criterion (AIC)	Comparative index between alternative models	Values closer to 0 better fit and greater parsimony
Normed Fit Chi-square (χ^2/df)	Chi-square statistics are only meaningful taking into account the degrees of freedom. Also regarded as a measure of absolute fit and parsimony. Value close to 1 indicates good fit but less than 1 imply over fit	Value smaller than 2 and as high as 5 is a reasonable fit
Parsimony Normed Fit Index (PNFI)	This index takes into account both model being evaluated and the baseline model	Higher value indicates better fit, comparison between alternative model
Parsimony Comparative Fit Index (PCNFI)	This index takes into account both model being evaluated and the baseline model	

(Source: Adapted from Hair *et al.* 2010)

4.4.4 Important issues related to SEM analysis

There are some important issues which are necessary to consider particularly for the empirical analysis in this research: (1) choice of one-step or two-step approach, (2) whether to specify a first-order or higher order factor model, and (3) multiple groups analysis.

(1) One-step or two-step approach to testing structural theory

Under a two-step approach, the first step assesses model fit and construct validity of a proposed measurement model, and, once a satisfactory measurement model is obtained, the second step tests the structural theory. In contrast, the one-step approach estimates both measurement and structural models simultaneously. The one-step approach is suggested by some researchers arguing that the overall model fit of a model is tested without regard to a separate measurement model and structural model, especially when the model possesses a strong theoretical rationale and the measures used in the study are highly reliable (Fornell and Larker 1981). However, the two-step approach is preferred by SEM researchers because a valid structural theory test cannot be conducted with bad measures (Anderson and Gerbing 1992). The six-stage process described in the previous sub-section is also consistent with the two-step approach.

(2) Higher-order factor model

Another issue is whether to use a higher-order factor analysis or only first-order factor analysis. A first-order factor model means that the covariances between measured items are explained with a single latent factor layer and a second-order factor model means the structure contains two layers of latent constructs. Theoretically this structure can be extended to more than two layers, which thus is termed higher-order factor model. When a researcher decides to specify a first-order or a higher order model, it is suggested that both theoretical and statistical considerations should be taken into account (Garver and Menter 1999; Hair *et al.* 2010). Theoretically, it should be questioned: whether a first-order or higher-order factor model can better answer the research questions and whether there is a theoretical reason to expect that multiple conceptual layers of a construct exist. Statistically, if correlations between the first-

order factors are relatively high (e.g. above 0.7), then the higher-order factor model can be specified. In addition, both first-order and higher-order factor models should be tested for model fit and construct validity. It should be evaluated whether the higher-order factor model exhibits adequate fit and whether the higher-order factor model predicts other conceptually related constructs adequately and as expected, which means nomological validity. The interim structural model of this study (see Figure 4.11) consists of three higher-order measurement models: PSCO, PSCI and PP. In order to justify specifying the higher-order measurement models, this study adopts Widaman (1985)'s comparison models by comparing model fits between first-order measurement model and higher-order measurement model.

(3) Multi-group analysis

Multi-group analysis is expressed as 'an SEM framework for testing any number or type of differences between similar models estimated for different groups of respondents' (Hair *et al.* 2010). The main objective is to examine whether a proposed measurement or structural model applies across different groups or environments. Specifically possible research questions would be as follows: for the measurement model, "Is the measurement model validated across different groups?"; "Are means of the constructs invariant across different groups?" and, for the structural model, "Does the structural model have an adequate model fit in a same way across different groups?"; "Are the regression coefficients significant and invariant across different groups?" For the fifth research question in this research (see Chapter 1, Section 1.2, p.3), this multi-group analysis needs to be applied. The detailed process and specific methods are presented in Chapter 8. (see Section 8.1.1, p.226)

4.5 SUMMARY

This chapter was devoted to methodological issues of this thesis. Firstly, a general discussion on research paradigm, approach and strategy was presented. Subsequently the methodological states of port research were presented with the result of the structured literature review. This showed a biased tendency towards positisivsm and

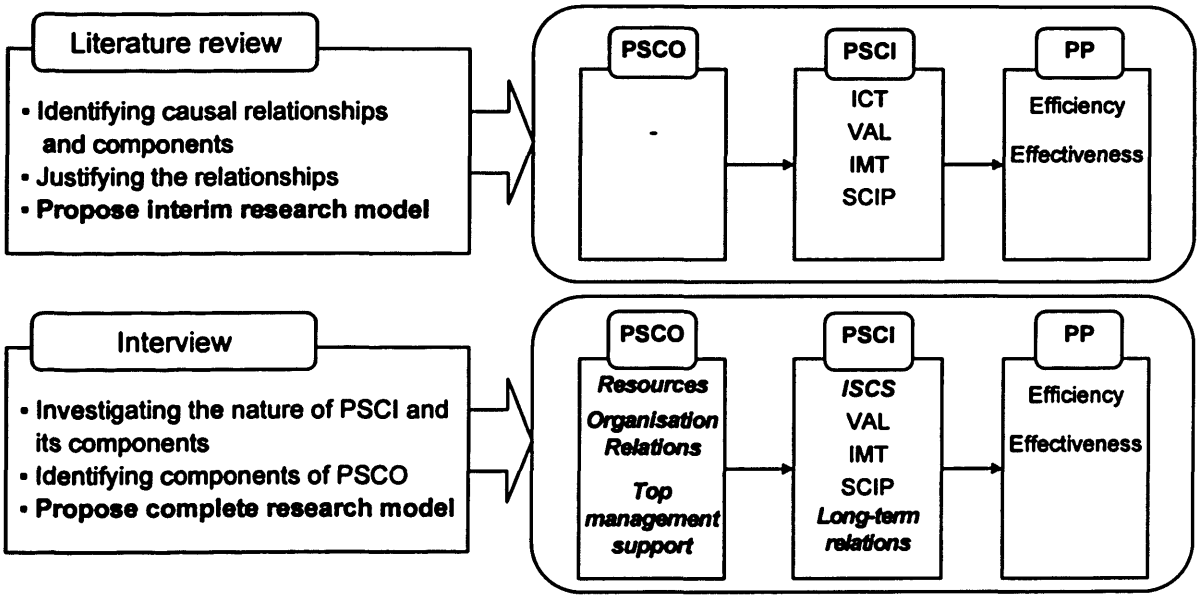
analytical type of studies, but a recent trend towards a balance between analytical and empirical studies was also observed. Next, this thesis was positioned in the positivist paradigm applying deductive approach and quantitative strategy. However, a triangulation approach can be partly incorporated since a qualitative method, which is a qualitative interview is adopted to complete the research model. Fourthly a qualitative interview and questionnaire survey were presented as data collection methods. The rationale for selecting the methods, the process of conducting the methods, sampling design and measurement validity and reliability were also delineated. Finally, the SEM data analysis method was presented. Adopting this analytical method was justified by comparing SEM with similar analytical techniques, PLS and regression in various terms. In addition, the analytical procedure was illustrated following Hair *et al.* (2010)'s seven step process with some important issues regarding SEM analysis briefly discussed.

CHAPTER 5

RESEARCH MODEL DEVELOPMENT: INTERVIEW STUDY

This chapter is primarily devoted to developing a research model for this thesis. In this research a reseach model is developed through both a literature review and interview study as shown in Figure 5.1.

Figure 5.1 Developing research model



The literature review was undertaken in Chapter 3 on the literature relating to the main concepts which are Port Supply Chain Integration (PSCI), Port Supply Chain

Orientation (PSCO) and Port Performance (PP), and their relationships. Some research gaps were revealed that the components representing PSCO were not identified and the components for PSCI need to be supplemented. Semi-structured interviews were conducted to fill these gaps.

This chapter, therefore, is composed of mainly two parts. The first part proposes a research model developed on the basis of the literature review and the research hypotheses. A structural model which is specified in Structural Equation Modelling (SEM) analysis is also presented. The research model is an interim model and forms a basis on which the interview study intends to obtain insights from the port industry. The second part presents the findings from the qualitative interviews, primarily aimed at identifing the components of PSCO, which may lead to the completion of the research model and hypotheses for this research.

However, the interview process focused on a broader range of issues than just PSCO in order to make the most of the opportunity of accessing practitioners and academics in the port industry. Thus, the interview process was designed to: (1) obtain an accurate view of Port Supply Chain Integration (PSCI) as it is currently practiced, based on the experience and insight of practitioners and academics, delineating the nature of PSCI and the motives for adopting PSCI, (2) determine whether specific strategies are employed depending on the situation of Terminal Operating Companies (TOCs), and (3) to assess whether the existing components of PSCI are considered appropriate or need modification. The interviews were conducted over two months in December 2008 and January 2009. A total of 21 interviewees, practitioners and academics in South Korea, were invited to join and actually participated in the interview process: 10 Senior Managers and 2 CEOs from TOCs, 4 middle managers from port authorities and government and 5 academics from universities and research institutes. Most of the companies included in the research operate container terminals in South Korea and run logistics businesses in the East Asia region including China and Japan. Two companies are representative of Global Terminal Operators (GTOs). Based on the findings from the interviews, the complete research model and the more detailed hypotheses are presented.

5.1 RESEARCH MODEL

This section proposes a research model which is developed to address the research questions and the research model proposed at this stage is based on the literature review. Figure 5.2 illustrates the conceptual research model which is an interim model because a complete model is presented at the end of the exploratory study.

Figure 5.2 Interim conceptual research model

5.1.1 Research hypotheses

PSCI can be expressed as 'a strategy undertaken by a seaport terminal to integrate various functions and organisations in a supply chain to become an integral part of the supply chain' as opposed to being an isolated node that provides basic ship-shore operation. Thus, the entity to implement the strategy is a company operating seaport terminals which are termed as TOCs. TOCs may have different attitudes to SCM practices and characteristics which facilitate or impede the implementation of the integration strategy. The organisational characteristics adopted in this model as antecedents to PSCI are termed as PSCO. The interim conceptual model in Figure 5.2 assumes PSCO has a positive impact on PSCI. Considering the TOCs' traditional practices of being fragmented and isolated physical transport providers focusing on ship-shore operations, a high level of PSCI is unlikely to be achieved without organisational willingness and proactive attitudes towards SCM philosophy and practices. Accordingly, the following hypothesis can be proposed.

H1: PSCO has a positive impact on PSCI

Benefits TOCs may pursue from PSCI would be primarily the achievement of a competitive advantage through providing differentiated services and eventually improving organisational performance. Therefore, adopting a PSCI strategy is

expected to improve TOCs' performance, i.e. PP in the research model. In addition, researchers increasingly suggest that integration across supply chains positively influences a firm's performance (e.g. Johnson 1999; Vickery *et al.* 2003). Thus, H2a can be proposed. From the examination of H1 and H2a, the impact of PSCO on PP also can be assessed. However, only indirect impacts through PSCI can be assessed because PSCO is positioned in the research model as antecedents to PSCI rather than PP. It is strongly suggested that the SEM be used only for confirmatory purposes rather than exploratory purposes due to its statistical nature (Gefen *et al.*, 2000). Thus, all the possible relationships among the constructs in this model cannot be hypothesised in SEM analysis. As such, a direct impact of PSCO on PP is unlikely to be hypothesised due to a lack of theoretical justification.

H2a: PSCI has a positive impact on PP
H2b: PSCO has an indirect and positive impact on PP through PSCI

These hypotheses concern only the causal relationships between high level concepts which are PSCO, PSCI and PP. This study also attempts to examine the causal relationships between the components of the three concepts as suggested by Min *et al.* (2007). The hypotheses for these relationships are proposed after the research model is completed through the interview study.

For a comparative analysis to answer the fifth research question in this study (see Chapter 1, Section 1.2, p.3), it is necessary to propose one more hypothesis. The research question was 'Can these relationships be equally applied to different environments?' The sample of the questionnaire survey was designed to address this research question (see Chapter 4, Section 4.3.2, Figure 4.6, p.105). The sample included two ports with different operational characteristics, and the data were collected from two groups which were port operators (i.e. TOCs) and port users (SCs and FWDs). Therefore H3 was proposed as below.

H3: The research model and causal relationships in the model are applied in the same way across ports with different operational characteristics and different groups which are port operators and port users.

5.1.2 Latent variables and observed variables

For examining the hypotheses statistically, the three theoretical constructs need to be measured. However, they are not easily observed and measured directly due to their abstract nature. Thus, they can be conceptualized or defined in terms of activities or behaviour believed to represent them, and linked to the variables which can be observed directly. In the SEM context, the unobservable variables are termed as latent variables and the observable variables, observed variables. The observed variables can be represented in various forms; for example, "self report responses to an attitudinal scale, scores on an achievement test, in vivo observation scores representing some physical task or activity, and coded responses to interview questions" (Byrne 2001). Identifying the observed variables relating to underlying latent variables is a crucial part of developing the research model.

(1) Port Supply Chain Orientation (PSCO)

When it comes to PSCO, the theoretical components which represent PSCO have not been identified from the port research. Thus, the research model could not be completed at this stage. Identifying the latent variables and observed variables for PSCO would take place during the qualitative interviews. Instead, at this stage, it was useful to explore which variables could potentially be the latent and observed variables for PSCO. The latent variables and observed variables of SCO (Supply Chain Orientation) was the initial starting point. Min and Mentzer (2004) and Min *et al.* (2007) propose six latent variables for SCO.

Some relevant studies (e.g. Panayides 2007) would also provide other potential variables. Table 5.1 presents the potential latent variables and observed variables for PSCO. In the literature, primarily the measured scores from responses to attitudinal scales are used for the observed variables. In Table 5.1, the scale items are presented in abstracted form in the 'Observed variable' column. Some of these variables would be used to conceptualise PSCO, and also some new latent variables were identified from the interview study.

Table 5.1 Potential latent and observed variables for PSCO

Latent variable	Observed variable	Sources
Credibility	Being reliable; being knowledgeable; openness; not making false claims	Min and Mentzer (2004) Min *et al.* (2007)
Benevolence	Being concerned about welfare; mutual understanding; being dependent on supply chain members' support	Min and Mentzer (2004) Min *et al.* (2007)
Commitment	Being patient with supply chain members; being protective to outsiders	Min and Mentzer (2004) Min *et al.* (2007)
Cooperative norms	Willingness to make cooperative changes; working together for success	Min and Mentzer (2004) Min *et al.* (2007)
Organisational compatibility	Objectives consistent with supply chain members; sharing similar philosophy with supply chain members	Min and Mentzer (2004) Min *et al.* (2007) Panayides (2007)
Trust	Being trustworthy on important things; trusting each other	Panayides (2007)
Top management support	Top management attitudes to adaptation to SCM; long-term relationship with supply chain members; sharing information, risks and rewards with supply chain members; offering education opportunities about SCM	Min and Mentzer (2004) Min *et al.* (2007)

(2) Port Supply Chain Integration (PSCI)

As for PSCI, Panayides and Song (2008) proposed four latent variables and validated them as the parameters to capture and represent PSCI (see Table 5.2). The interim research model adopts the latent variables and the scale items for the latent variables. However, some other variables can be added to the interim model and the scale items can be supplemented through investigation in the fieldwork interviews. Thus both the variables by Panayides and Song (2008) and the potential variables are presented.

Table 5.2 Latent and observed variables for PSCI

Latent	Observed	Sources
Information and communication systems	Using EDI; using integrated information systems; adopting computerized port service system; using the latest IT	Panayides and Song (2008)
Value-added logistics services	Having adequate facilities for VAS; meeting customers' specifications; launching tailored services	Panayides and Song (2008)
Inter-modal transport services	Having adequate connectivity; reliable multimodal services; cost-effective and efficient multimodal services	Panayides and Song (2008)
Supply chain integration practices	Evaluating alternative routes; collaborating with supply chain members; evaluating performance of transport modes	Panayides and Song (2008)

As indicated in the literature review in Chapter 3, the parameters of Panayides and Song (2008) did not account for some variables which have been used to conceptualise SCM and supply chain integration. The variables in Table 5.3 were adopted to represent SCM in several studies (e.g. Mentzer *et al.* 2001; Min and Mentzer 2004; Min *et al.* 2007). It was also found that information sharing leads to a high level of supply chain integration by enabling organisations to improve reliability, dependability and speed (Jarrell 1998). In addition, Mentzer *et al.* (2001) suggest that effective SCM is made up of a series of partnerships and SCM requires partners to build up long-term relationships. Shin *et al.* (2000) state that a close relationship means that channel participants share the risks and rewards and have willingness to maintain the relationship in the long-term.

Table 5.3 Potential latent and observed variables for PSCI

Latent	Observed	Sources
Information sharing	Practicing EDI; exchanging supply and demand forecast; exchanging demand change information	Min and Mentzer (2004) Min *et al.* (2007) Vickery *et al.* (2003)
Long-term relationship	Reducing channel complexity with supply chain members; having guidelines for long-term relationships; facilitating long-term relationship	Shin *et al.* (2002) Min and Mentzer (2004) Min *et al.* (2007)

(3) Port Performance (PP)

How port performance has to be measured has been well discussed and the potential measurement framework was proposed in the literature review chapter (see Chapter 3, Section 3.2.5). This measurement framework is adopted for the research model of this study as shown in Table 5.4. Performance measurement concerns both the external effectiveness and the internal efficiency as suggested by many studies (e.g. Bichou and Gray 2004; Brooks 2007; Woo *et al.* 2008). Effectiveness is concerned with the extent to which goals are accomplished and efficiency measures how well the resources are utilized. In this study, the external effectiveness is related to the extent which customers' requirements are met. In the competitive logistics environment, customers want to pay less for higher quality logistics services. Customers expect services to be

reliable and on-time. Also, they require the service to be flexible and quickly adaptable to their complicated demands and emergent situations. Internal efficiency is concerned with how efficiently a port is operated. This latent variable measures both sea and land access, and concerns movement of cargoes from entry to a port to exit from the port.

Table 5.4 Latent and observed variables for PP

Latent	Observed	Sources
External effectiveness		
Service Quality	Reliability; timeliness; lead time; shipment information provision	Marlow and Paixao-Casaca (2003) Tongzon and Ganesalingam(1994) Tongzon (1995)
Customer Orientation	Responsiveness; flexibility	
Service Price	Total price;handling charge	
Internal efficiency		
Sea operation	Ship waiting time; ship turnaround time; cargo handling time	UNCTAD (1976) UNCTAD (1982) De Monie (1987) Tongzon (1995) Marlow and Paixao-Casaca (2003)
Land operation	Cargo waiting time; cargo handling time; truck waiting time	
Cargo operation	Cargo throughput; cargo processing time	

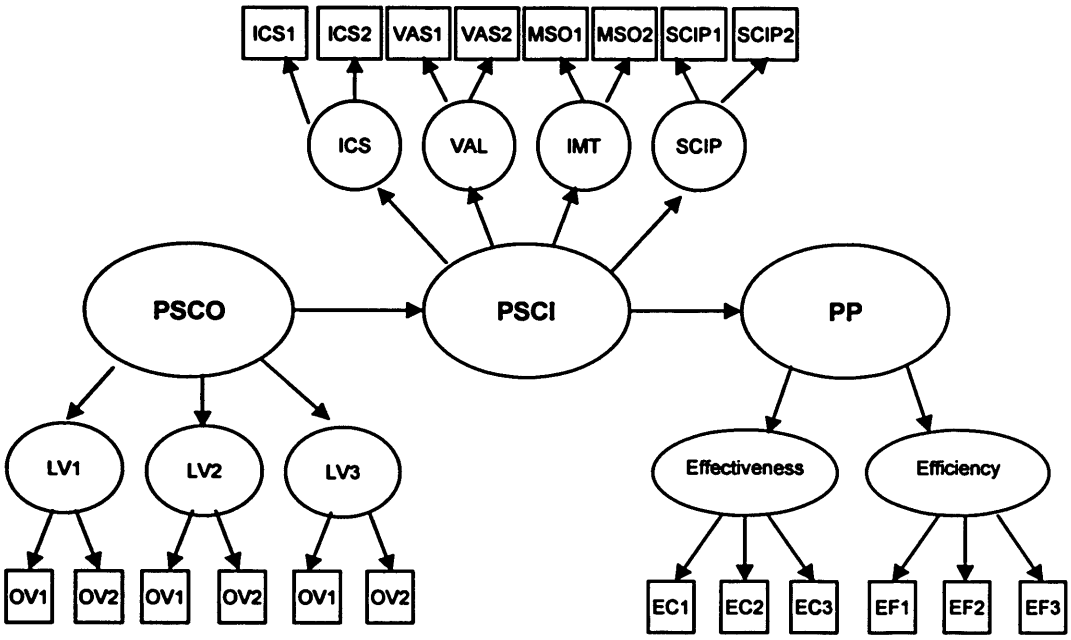
5.1.3 Structural model for the interim model

Given that the interim research model and hypotheses are proposed, and the latent variables are presented, it is possible to illustrate the research model in the form used in SEM as shown in Figure 5.3. Detailed methodological issues on SEM were addressed in Chapter 4 (see Section 4.4.3, p.121). This section provides a simple explanation of the interim research model using a form of SEM. The interim research model consists of three constructs and the causal relationships among them. In addition the three constructs are represented by the latent variables and the observed variables which were detailed in the previous section. The structural model consists of the three constructs, their latent and observed variables and the causal relationships in one diagram at the same time as shown in Figure 5.3.

Conventionally, circles in the model represent latent variables, squares represent observed variables and single-headed arrows represent the impact of one variable to another variable. PSCO, PSCI and PP are in circles indicating that they are latent

variables. Each construct has components which conceptualise the constructs respectively. These components are also in circles, which mean they are also latent variables.

Figure 5.3 Simplified structural model for the interim research model



PSCO, PSCI and PP are called higher-order factors, while their components are called first-order factors. The first-order factors are measured by their observed variables which are represented as squares. It should be noted that PSCO's first-order factors and observed variables are represented by the abbreviation of latent variable (LV) and observed variable (OV) because they are not specified yet. Also, the number of first-order factors and observed variables of the three second-order factors is not precise because the structural equation model is drawn based on the interim research model. Error terms associated with the observed variables and residual terms are temporarily omitted from the diagram to simplify the description of the structural model. Each first-order factor and second-order factor is confirmed statistically in measurement model. Subsequently, causal relationships between confirmed factors are examined in the structural model. The causal relationships hypothesised in this study are illustrated with single-headed arrows in Figure 5.3: PSCO→PSCI (H1); PSCI→PP (H2a); PSCO→PSCI→PP (H2b).

5.2 FINDINGS FROM THE INTERVIEW STUDY

This section presents the findings from the interview study in the order of: (1) the nature of PSCI; (2) actors of PSCI and their strategies; (3) components of PSCI; and (4) components of PSCO.

5.2.1. Nature of PSCI: Revisited

This section revisits the issue of 'the nature of PSCI' discussed in Chapter 3 (see Section 3.2.2, p.60) because this issue was re-discussed during the semi-structured interview. Some interesting points were revealed about: whether PSCI is critical or not; how the interviewees perceive PSCI; and what the motives of implementing PSCI are.

(1) Critical strategy or not

Published literature suggests that integration into supply chains is undoubtedly a critical strategy which seaports must adopt to cope with challenges in the global supply chain era (Bichou and Gray 2004; 2005; Notteboom and Winkelmans 2001; Robinson 2002). However some interviewees, during the initial exploration, expressed doubt about the validity and feasibility of the strategy noting that,

"*we are sceptical about the view that 'logistics business based on terminals' or 'terminal oriented logistics business' have advantages in the global logistics business, since the status of the port is at the lowest level in the supply chain and even in the transport channel, and ports are the least powerful among members in supply chain*".

As the interviews went along with other respondents, a range of attitudes to the strategy emerged. Most interviewees mainly agreed with the importance and urgent necessity of introducing the strategy. One CEO of a TOC mentioned that,

"*I do not think there is a CEO who believes he or she can keep up the business by providing customers with only stevedoring service or service combining stevedoring*

with trucking and storage in current market circumstances. If there is one, we may not see him or her very soon in this market."

Some companies showed confidence stemming from several successful contracts with manufacturing companies, and some companies were struggling with implementing the strategy due to a lack of understanding and agreement about the strategy between functional departments in the companies. This implies that TOCs have different views on PSCI, depending on the situation the TOCs are embedded within: for example, relationships with other channel members, capabilities of human and financial resources, etc. and may involve different levels of PSCI.

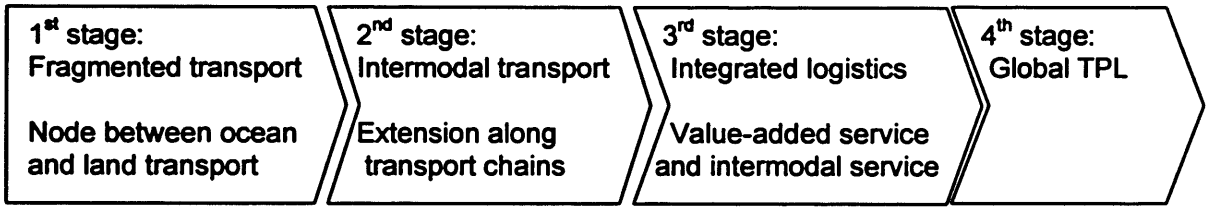
(2) Perceptions on PSCI

Supply chain integration is traditionally defined as 'the degree to which logistics tasks and activities within the firms and across the supply chains are managed in a coordinated fashion' (Chow *et al.* 1995). Literally speaking, PSCI can be understood as an active participation of ports in supply chain integration. Then what does the participation mean specifically and in reality? The interviewees did not show a clear theoretical understanding about the integration of ports into supply chains and, in the initial stage of interview they used various expressions such as '*vertical integration*', '*integrated logistics service provision*', '*Third Party Logistics (TPL)*', '*tailored logistics service for particular shipper or industry*', '*differentiated services*', etc. However, it is clear that they grasp the concept as '*being closer to or approaching the end-customers functionally*' and most interviewees considered shippers as the ultimate end-customers. Their basic understanding is that the era when ports mainly catered for Shipping Companies (SCs) providing the same packaged services and competing merely based on price, has passed. They believe that the industry has moved and is still moving towards a new era when ports concern both direct customers and end-customers and compete based on differentiated services.

The interviewees also agreed that '*being closer to end-customers functionally*' can be primarily achieved by means of (1) the provision of integrated logistics services and (2)

organisational integration, as discussed in Chapter 3 (see Section 3.2.2, p.60). The range of integrated logistics services the interviewed TOCs provide was different depending on the capabilities of the TOCs and the characteristics of the industry the TOCs serve with these services. Figure 5.4 shows an evolutionary change of terminal operators to global logistics providers, which emerged from the inteviews. It was also revealed that the TOCs aim for a position where ports provide supply chain solutions to shippers with high quality value-added and intermodal logistics services (the third and fourth stages), going beyond the stage of providing fragmented transport services as a physical transport operator which links shipping and inland transport (the first stage), through the stage that ports provide simple intermodal transport service combining two or more transport modes (the second stage).

Figure 5.4 Evolution of port operators to global logistics providers



Regarding organisational integration, 'internal and external integration' and 'vertical and horizontal integration' were highlighted in the literature review (see Section 3.2.2). The interviewees from the TOCs pointed out that, for a successful integration along supply chains, it is essential to make all the departments in the companies, such as terminal operation units, logistics business units, inland transport units, etc. '*identify themselves as a member of the supply chain rather than a fragmented physical transport provider, and motivate them with the same philosophy and aim*'. The companies, therefore, emphasise the importance of strengthening training and education, and allocating more time and budget to develop the capabilities of human resources. In addition, the TOCs that participated in this research did not see it as a significant and effective strategy to associate horizontal integration with vertical integration. They asserted that integrated logistics does not necessarily require geographically global port operating networks only because the service is provided globally, indicating that the case of implementing vertical integration processes associated with global port networking would be limited. Recently

researchers have shown the evidence that GTOs such as PSA and HPH have begun to provide logistics service (De Souza *et al.* 2003). Their global presence may look attractive to supply chains, but there has been little theoretical or practical evidence that it facilitates vertical integration practices and processes.

(3) Motives for implementing PSCI

The fact that profitability has worsened due to structural changes in the port industry has driven ports to seek PSCI. The bargaining power of direct customers, Shipping Companies (SCs), has become stronger through horizontal integration and competition has become more intense due to new entrants including SCs. Therefore, the objective of integration of ports into the supply chain will be improved organisational performance, in particular profitability. Then, the question arising here was 'what are the specific level of objectives for ports to integrate into supply chains?'

The first motive is demand complementarity meaning that demand for one business increases demand for other related businesses. Working with shippers by means of dealing with inland logistics or value-added logistics services may bring out demand for cargo handling in the terminal. This relates closely to the second motive which is increasing the bargaining power against SCs. Relationships with a particular shipper, which is a main customer of a SC, has a huge impact on relationships with the SC. The SC is bound to account for the TOC dealing with the cargoes of its customer. The interviewees said that,

'even informal relationships, let alone formal service contracts with main shippers, can strengthen the TOCs' position in negotiating a contract with shipping liners'.

De Martino and Morvillo (2008) also demonstrate that activities within a port (e.g. warehousing and value-added logistics) and hinterland (e.g. road and rail transportation) may create customer loyalty.

However, these two motives are not likely to justify a higher level of integration into a supply chain because the TOCs' principal will be still the shipping liners. The third is to enhance service quality. An important benefit from integrated logistics service is to provide enhanced visibility to customers. The wider the range of integrated services, the higher the visibility of the supply chain would be. The rapid and accurate availability of transportation and logistics information would benefit most members in the supply chain and create chances to facilitate a higher level of integration of the supply chain itself. In addition, the service quality can be improved by seeking reliability, flexibility and responsiveness.

In the era of the global supply chain, the manufacturing industry is exposed to uncertainty and under pressure to meet the complicated demand of consumers at the same time. Therefore, the logistics service providers are in turn required to be reliable and flexible to offset is this uncertainty and to be responsive to the industry's efforts to meet consumer demands. Tailored logistics services for a specific product line in a company or for a particular company can be designed by a TOC integrating intermodal transportation and value-added logistics services. Furthermore, shared resources and expertise through integrated logistics services may reduce total logistics cost, which is the fourth motive and another source achieving one of the objectives of SCM.

It can be argued that these motives can be applied to SCs' integration strategy into supply chains in the same way. Some interviewed TOCs assert that,

'*TOCs are much less competent than SCs in every aspect and therefore there would be no logistics service market for TOCs to enter if they compete with shipping liners rather than cooperate with them*'.

Some researchers and interviewees have a different position; that TOCs have a different potential from those shipping liners and are more competent in some parts of logistics services. This argument is dealt with in the following section.

5.2.2 Actors of PSCI and their strategies

This study considers PSCI as a strategy undertaken by a seaport terminal to integrate various functions and organisations in a supply chain to become an integral part of the supply chain. Therefore, the actors of this strategy are the entities that operate seaport terminals. With the trend of port privatization and deregulation, understanding players in the port industry is not simple. However, in this paper, SCs operating dedicated terminals and TOCs are considered as actors of PSCI, whereas terminal operators can be typed into four according to their origins; terminal-operating shippers, terminal-operating shipping lines, terminal-operating port authorities and terminal-operating companies (Bichou and Bell 2007).

Port authorities also have a major role in achieving the high degree of PSCI since facilities for value-added logistics and intermodal transport are mainly provided by port authorities in the context of landlord port ownership. Carbone and De Martino (2003) propose factors which contribute to satisfying specific customer requirements: (1) the availability of efficient infrastructures and inland connections, as part of a global transport system, (2) the ability of logistics and transport operators to contribute to value creation and to accomplish also the qualitative attributes of demand. Even though they are not mutually exclusive, the first factor, generally, can be achieved by a port authority in the context of landlord port ownership. In the same regard, however port authorities are unlikely to be considered as actors in PSCI.

Although both SCs and TOCs have been striving to transform themselves into large logistical organisations to increase power in logistics and supply chains, SCs have been taking the initiative (Heaver *et al.* 2001). Either vertical integration or horizontal integration, or both were the options SCs could choose to meet the customers' needs to widen geographical range and expand the service range. The selection or combination of the options was dependent upon the ability of the SCs to implement strategies and their perception of customer preferences (Heaver 2001). One of the key elements of vertical integration by SCs was the establishment of exclusive berthing space at a terminal i.e. dedicated terminal. SCs also have increased market power through

horizontal integration and cooperation strategies, together with the development of hub-and-spoke networks and their footloose transhipment practices, pushing port authorities to open the port operation market in their countries. Based on dedicated terminals, SCs have expanded the service range more easily and have completed their logistics service, which entails not only reducing costs, but which also significantly affects flexibility in providing transport services (Evangelista and Morvillo 1999). However, SCs' evolution challenged and threatened other service providers, in particular TOCs, and they were forced to respond to the challenges quickly. The strategic options for TOCs were the same as those of SCs.

As a result of this exploration, four types of strategy to cope with the challenge have been identified. The first type is a strategy aiming at enhancing bargaining power against SCs through developing global terminal operation networks, so-called horizontal integration. Thus this type of strategy is unlikely to be categorised into a type of PSCI. However, Type 1 (horizontal integration) is discussed together with Type 2 (passive PSCI), Type 3 (active PSCI with cooperation from SCs) and Type 4 (active PSCI without cooperation from SCs) for a better and clearer comparison.

(1) Horizontal integration: Type 1

A Type 1 TOC response is to expand the port operating business globally to obtain counterbalancing power against SCs. Expansion has been achieved by means of mergers and acquisitions and strategic partnerships. These require financial strength to cope with the capital expenditure required for container terminal development and management expertise to ensure the fulfilment of the increased specialisation and operational sophistication demanded by shipping lines (De Souza *et al.* 2003). The competitive advantage companies expect to achieve from this strategy stems from economies of scale and cost leadership (Notteboom and Winkelmans 2001). For example, companies may negotiate with SCs offering lower cargo handling charge for package services combining several terminals in a different range of ports. These companies which have successfully adopted this strategy have become dominant market players in the port industry over the last 15 years. They are normally called

Global Terminal Operators (GTOs). In addition, their objective to neutralize SCs' increased bargaining power has been achieved to some extent.

However, the increasingly footloose practices of SCs have not been mitigated, and transport and logistics channels are rarely controlled by TOCs. Therefore, researchers suggest that they should pursue another source of competitive advantage, i.e. differentiation which may involve economies of scope; specifically to integrate vertically along the supply chain (De Souza *et al.* 2003; Notteboom and Winkelmans 2001). The interesting point is that there exists a sceptical view on the likelihood for GTOs whose origin is pure TOCs to successfully adopt and implement the strategy of coordinating vertically, despite their increasing involvement in the provision of logistics services. The scepticism comes from the doubt about their business interest (Bichou and Gray 2004), which was also revealed from the interviews. Some interviewees considered the GTOs as '*asset investment companies rather than logistics companies*'. They supposed, therefore, those GTOs would be satisfied with the current situation of managing pure stevedoring businesses in a worldwide context, and be reluctant to expand their business range vertically along a supply chain which particularly requires more complicated knowledge and experience.

(2) Passive PSCI: Type 2

This is a strategy used by Type 2 TOCs to increase bargaining power against SCs by means of direct or indirect relations with shippers or shippers' agents. The main business of the companies belonging to this category is still to provide SCs with cargo handling services or cargo handling services combined with inland transportation and storage. They also provide shippers who are the customers of SCs with integrated transport services. However the basic motivation is to retain current customers and attract new SCs through the building up of a relationship with shippers. Some companies mentioned that this strategy sometimes works out to sustain long-term service contracts without lowering cargo handling charges. The portion of business with shippers, therefore, is not a major part of their whole business, and the range of service is normally limited to transport and simple intermodal services.

The potential reason for the limitation may be the unclear strategic setting and the lack of financial capabilities. The companies also expect the current limited service range to be expanded to integrated total logistics services encompassing intermodal services and value-added services. However, senior management teams in such companies perceive that,

'TOCs are not able to compete with SCs to accommodate big shippers or the agents of shippers in terms of marketing capability and financial capability'.

The perception appears to be more convincing due to port authorities' preference to SCs as cargo generators rather than TOCs, particularly where terminal concessions are concerned. In addition, differing views on their current strategic positioning was revealed among functional departments in companies, specifically the port operation business units and logistics business units. The former preferred the current position, but the latter asserted that more active involvement in logistics and supply chains is necessary where the profitability of stevedoring businesses has dramatically worsened. As a consequence, the companies may not concentrate their full capabilities on either strategy, and would not realize their evolution to large logistics organisations or even maintain current market share.

(3) Active PSCI with cooperation from SCs: Type 3

Type 3 TOCs expand their service and business range along the supply chain through strategic cooperation with SCs. The companies expressed their view on the future picture of the port operating and logistics industry noting that,

'SCs based TPL will gradually get more competitive than any other business model in the long run and the business model will take ports as a forward base. SCs will make their terminals cluster for integrated logistics service, putting together all relevant functions and facilities in the terminals and distriparks. Therefore TOCs who do not cooperate with them will not survive in the future'.

Their strategy is to implement a part or a considerable part of SCs' integrated services based on cooperative relationships on terminal operation with SCs.

Major SCs have set up a network of port operations all over the world, but they do not, or cannot, operate the terminals for themselves. According to very recent research (Soppe *et al.* 2009), only 13% of total containerized transport capacity of SCs sampled in the research is handled by their terminal handling subsidiaries (i.e. self-handling) whereas the rest is handled by GTOs (43%) and local TOCs (44%). In addition they presented four ways of operating sampled SCs' dedicated terminals: contract, joint venture, partially owned subsidiary and wholly owned subsidiary, and the result was that the contracts with an independent third party terminal operator were the most favoured option (76%, average of the option percentage the option was chosen by SCs). This implies all options except for the last one can offer TOCs chances to operate SCs' terminal even if the TOCs are not GTOs. Furthermore, SCs would presumably make the most use of the well-established local transport and logistics networks associated with terminal operation. Theoretically, the TOCs can undertake all routes and range of service SCs provided except for ocean transportation. Regarding the service range, the interviewees pointed out that,

'We can contract with shippers or the agents of shippers for full logistics service on behalf of SCs. However, they do not want to lose initiative, so we undertake all range of logistics service between terminals and shippers or consignees'.

(4) Active PSCI without cooperation from SCs: Type 4

Type 4 TOCs aim at providing shippers with TPL service and furthermore FPL (Fourth Party Logistics) service. They deal with the total range of logistics services in either separated or integrated fashion. Generally, their basic and original business is physical transportation including terminal operation, inland transport, warehouse logistics and forwarding. Their aim is to create higher value from integrated services more importantly based on physical transportation and logistics. Thus, they still have contracts with SCs on cargo handling, inland transportation, warehousing, and so on,

but, in contrast to Type 3, they do not entirely or necessarily rely on the cooperative relationship with SCs and rather endeavour to market shippers or agents of the shippers directly. An interviewee emphasised that,

"*The number of cases that the TOCs conclude the TPL service contract with shippers, and subsequently sub-contract with SCs is increasing in a certain industry. Thus we are shaping services tailored to a particular product line, for example, half-finished cars which still require assembly processes, or used cars which are freighted internationally but still need repairing or manipulating*".

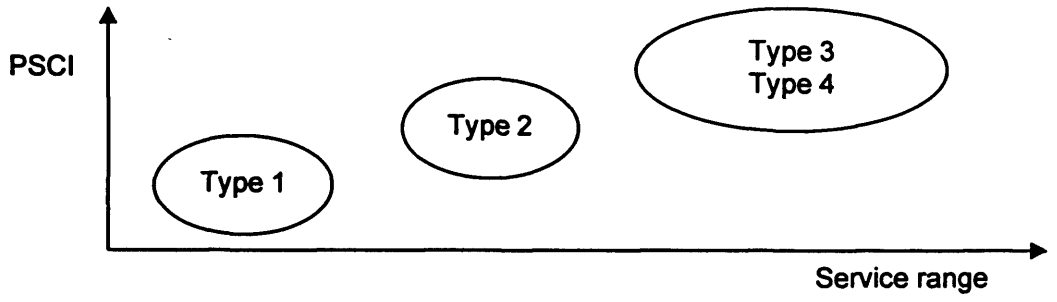
In addition they have different views on SCs' capabilities for logistics business from that of Type 3. They think that SCs have the strength and advantage in intermodal service rather than logistics and value-added service:

'*We think of SCs' service as transport service combining simply more than one transport mode, and their motivation is limited to securing cargos for ocean shipping rather than total logistics service delivering values to shippers*" and "*SCs are also one of physical transport providers who are at the same level as TOCs, and cannot control shippers either as we cannot. Additionally value-added services which SCM requires are different from simple door-to-door service which SCs have had advantages on*'.

This point is in line with Heaver (2001)'s observation that shippers suspect that SCs' logistics business is for 'feeding cargo to their lines', and some SCs will likely continue to concentrate on shipping and follow a door-to-door only service strategy 'as full logistics service is a different business'.

Figure 5.5 shows conceptually the level of PSCI for the four types according to the service range they normally provide. Type 1 primarily focuses on cargo handling service and PSCI of Type 1 can be the lowest. Service range of Type 3 and 4 is the widest and their PSCI would be the highest among the four types. However the service range of Type 3 would likely be limited to that of the shipping companies which Type 3 has a cooperative relationship with.

Figure 5.5 Service range and PSCI of the four types



5.2.3 Components of PSCI

The components of PSCI presented in Chapter 3 (see Section 3.2.5, p.72) were discussed by the interviewees. They considered the existing components appropriate, but suggested that some of them need to be carefully interpreted and it is necessary to add additional components. For example, the establishment of Information and Communication System (ICS) is necessary but not enough for the higher level of integration. The level and quality of information shared matters. In addition, the evolution of the relationship with supply chain members from the contractual to the long-term and strategic cooperative relationship is the essence of PSCI.

(1) Information Sharing and Communication Systems (ISCS)

The literature relevant to the integration of ports highlights the importance of Information and Communication Systems (ICS) for the higher level of PSCI (Bichou and Gray 2004; Kia *et al.* 2000; Paixao and Marlow 2003; Panayides and Song 2008). Panayides and Song (2008) empirically showed that ICS is a valid and reliable instrument representing PSCI, and additionally Song and Panayides (2008) proved the positive impact of use of ICS on the quality of port service. Heaver (2001) also posits that the quality of an IT system to a supply chain is critical to its performance since IT enables supply chains to reduce order cycle times, cut inventories and make the systems more flexible.

However, the interviewees pointed out that the level of PSCI can be evaluated by the quality and level of information that a TOC shares with supply chain members.

Information expected to be shared by supply chain members is, generally, inventory levels, forecasts, sales production strategies, lead-time and marketing strategies (Mentzer *et al.* 2001) and the information moves in the opposite direction to the physical flow. Most advanced container terminals have already introduced EDI (Electronic Data Interchange) to share relevant information among transport providers, i.e. shipping liners, trucking companies and rail service providers. When they are serviced in an integrated fashion, shippers can acquire information about shipment tracking more easily, which offers 'visibility' of shipment to shippers.

Is it enough for the full implementation of PSCI? Carbone and De Martino (2003) break down the supply chain process of a car manufacturing company and investigate the information generated and ICS used in each process. According to their empirical study, from the physical distribution process, tracing and tracking information is provided through EDI, and from inventory management, inventory levels of components, parts and finished cars can be generated through the inventory management system. A higher level of integration must involve sharing a higher level of information. The information shared in the transportation channel flows in the same direction as the physical flow (Paixao and Marlow 2003), as the tracing and tracking information flows to shippers. Information sharing in the fully implemented PSCI encompasses information flows, not only along the transportation channel, but also along the supply chain, which involves the flow of information, such as customer demand patterns, forecasting, and the marketing strategy from shippers to service providers.

The companies in Type 3 and 4 among the interviewed companies were found to share the higher level of information with shippers or TPL providers to the shippers. In particular, one of the companies in Type 4 is provided with information including marketing strategy by shippers. The interviewee mentioned that "*information sharing is the essence of TPL since it should necessarily be based on trust and credibility, and eventually leads to a long-term relationship*", as Lalonde (1998) suggested that the sharing of information among supply chain members is viewed as a building block that characterizes a solid supply chain relationship.

(2) Long-term relationships (LTR)

The evidence in this thesis indicates that 'building up long-term relationships' is one of the benefits and consequences of PSCI. The physical transport market is currently in the situation that supply exceeds demand and players compete based on merely price, which fuels the mobility and foot-loose practice of SCs. Building up long-term relationships through an integration strategy is the solution that TOCs have found to overcome difficulties derived from short-term contractual relationships. However, all the TOCs participating in this research did not agree with this. Some companies did not think that long-term relationships can be developed in the current logistics market situation, particularly not with SCs. These companies, generally, belong to Type 1 and 2. However, the other companies pointed out that

"*the relationship initially begins with the contractual terms and is easily affected by price, but time and effort transform the relationship into partnership and further long-term relationship.*"

In addition, they demonstrate that shippers and shipping companies' attitudes are also changing from price-focused to quality-focused. Carbone and De Martino (2003) also show the evidence in their empirical analysis that some processes have been outsourced to port operators and logistics providers with long-term contracts.

(3) Value-Added Logistics (VAL) and InterModal Transport (IMT) services

VAL and IMT are undoubtedly considered as core components of PSCI since the integrated logistics services TOCs provide would be produced combining these two services. These two features are primarily affected by both physical facilities and infrastructure of terminals and the capabilities of TOCs. The former is generally provided by port authorities in the landlord ownership context. Infrastructure and facilities facilitating VAL and IMT are well considered and developed in terminals which are newly developed, but it is a challenge for terminals which were developed a long time ago and are adjacent to cities, to expand distri-parks and to equip rail and

road connections. The interviewees recognized that this factor is less controllable at the TOC level and, therefore, may act as a barrier and create disadvantages for some terminals. The interviewed TOCs put an emphasis on the latter. They indicated that the integrated logistics services should not be understood as simply combining VAL and IMT services, and creating and delivering more value to end-customers is the fundamental concept.

A finding from the investigation is that TOCs should find solutions to make the outsourced logistics service and value-addition process more valuable through re-designing the existing routes and processes or creating new routes and processes, rather than implement the outsourced services as they have been. In addition, for developing long-term contracts or relationships, there should be a ceaseless effort and ability to create new services to keep on delivering more value to the shippers even after concluding TPL contracts. One interviewee stated that,

"*we have created new services tailored for several particular shippers, which was successful. However, we have to continuously launch such services for securing the existing customers and attracting new customers like mobile phone or car industry in which new models are launched nearly every month*".

(4) Supply Chain Integration Practices (SCIP)

The findings from the study indicate that SCIP is a very important dimension of PSCI and the basic principles penetrating other components of PSCI. The interviewees perceive this feature as the change of their business practices from being reactive, fragmented and intra-organisational to being proactive, integrated and inter-organisational. Specifying SCIP based on the findings from the interview and the relevant literature (e.g. Bichou and Gray 2004; Panayides and Song 2008), SCIP of a TOC comprises activities (1) planning and organizing processes and procedures beyond its boundaries, (2) comparing and benchmarking the performance of services, (3) scrutinizing more efficient routes and processes, (4) producing new service packages and marketing them to customers.

5.2.4 Components of PSCO

Finally, the interviewees were asked to explain the strengths and weaknesses in their companies in implementation of PSCI, focusing on intra-organisational characteristics and attributes. The objective of this question was to identify the organisational resources which have a positive impact on PSCI. Three different views were revealed highlighting three firm resources to facilitate the implementation of PSCI respectively: (1) financial and human resources, (2) organisational relationships, (3) willingness and support of the TMT (Top Management Team).

(1) Financial Resources (FR) and Human Resources (HR)

The first view relates to the capability of TOCs to implement PSCI. This is specifically related to the existing financial resources available to provide for organisational integration, and to establish the relevant system including ICT; and the human resources which embrace knowledge and experience to develop the concept, to set up appropriate strategies depending on their capabilities, and to create new services tailored for particular shippers' sophisticated demands. One interviewee stated that "*TOCs 'cannot' rather than 'do not'. Financial and human resources are important factors. Our company has been enhancing human resources capabilities by both recruiting logistics experts who also have experience in physical transportation and training the existing human resources.*"

Financial resources have been associated with pricing strategies that aim to drive out new entrants, employing aggressive pricing with sufficient financial resources by economists (Lerner 1995). The interviewees showed different perspectives. Establishing systems necessary for providing integrated logistics services, such as ICT and operational systems and organisational integration may require a substantial investment. They argued that it is more important '*whether a TOC is willing to make investment for implementing PSCI and how high priority it has on investment for PSCI than whether it has sufficient financial resources*'. They also indicated that this organisational characteristic exists to varying degrees and does not easily change, although they did not assert that the characteristic is imperfectly imitatable or rare.

This view also finds it especially important to make human resources see beyond the traditional practices implemented in the fragmented physical transport era to integrated logistics in the global supply chain era. From this view, the workforce's 'understanding of rapidly changing logistics environments' and the workforce's '*capabilities to develop integrated logistics services tailored to a particular industry or company*' are emphasised. Thus, it may entail a high level of training and organisational learning which are organisation-wide activities of creating and using knowledge to enhance competitive advantage. These activities would positively affect the degree of PSCI in that these include obtaining and sharing information about customer needs and market changes which are essential for creating new value-added services and intermodal services.

(2) Organisational Relationships (OR)

The second view is that organisational relationships facilitate the implementation of PSCI. As previously examined, information sharing and long-term relationships are based on the relationships among members in a supply chain. Without shippers' trust of service providers, they would be reluctant to share internally important information with the service providers. Sharing the same corporate philosophy is also considered important, since this can lead from short-term and price-focused relationships to long-term relationships. In addition, a TOC's cooperative attitudes towards supply chain members including SCs, FWDs (Freight Forwarders) and shippers may make a difference in building long-term relationships with supply chain members. The cooperative approach and attitudes may enable the TOC to make efforts to respond better to the supply chain members' specific requirements, and, in turn, involve simplifying and facilitating work processes with the supply chain members. This may bring out reduction in the complexity of the supply chain and logistics channels and, ultimately, result in long-term relationships with members in the supply chain.

(3) Top Management Support (TMS)

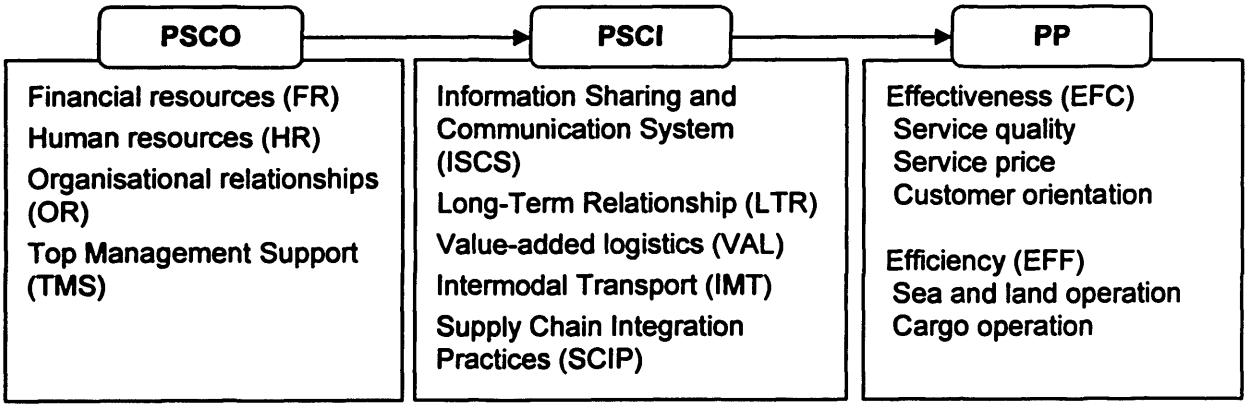
The third view is that the Top Management Team (TMT) has a critical role in transforming an organisation towards the new approach in that the TMT shapes an

organisation's values, orientation and direction. It is based on the recognition that it is the TMT that instigates all the practices in PSCI. In addition, the resources the first (FR/HR) and second (OR) views emphasise are also considerably affected by TMT's willingness and support, since organisational learning and building inter-organisational relationships are up to TMT's commitment towards learning, sharing vision with other supply chain members, open-mindedness towards change and intra-organisational sharing of knowledge (Panayides 2007). This view concerns TMT's emphasis on 'developing and maintaining long-term relationships', 'sharing valuable information', and 'sharing objectives and philosophy with supply chain members', and education opportunities offered by TMT about SCM and PSCI. A notion was given by an interviewee that "*If anyone should initiate and drive the innovation and changes for implementing PSCI, it should be the TMT*".

5.3 COMPLETE RESEARCH MODEL

Based on the findings from this intensive exploration, the conceptual model of this paper can be developed as shown in Figure 5.6.

Figure 5.6 Complete research model



Differences from the interim research model proposed in Section 5.1 are that: (1) the components of PSCO are presented, which are Financial Resources (FR), Human Resources (HR), Organisational Relationships (OR) and Top Management Support (TMS), (2) the components of PSCI are restructured, adding Information Sharing to Information and Communication System (ICS) which becomes Information Sharing

and Communication Systems (ISCS), and Long-Term Relationship (LTR), and (3) measurement instruments for three constructs, i.e. items in the survey questionnaire, can reflect more accurate views of practitioners and academics on PSCO and PSCI.

5.3.1 Research hypotheses

It is not necessary to modify the hypotheses previously proposed based on the interim research model in Section 5.1, because the hypotheses concern the relationships among PSCO, PSCI and PP rather than among their components as follows;

H1: PSCO has a positive impact on PSCI

H2a: PSCI has a positive impact on PP

H2b: PSCO has an indirect and positive impact on PP through PSCI

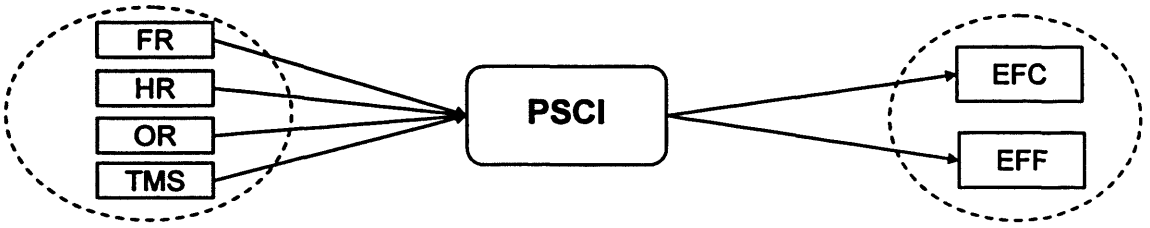
H3: The research model and causal relationships in the model are applied in the same way across ports with different operational characteristics and different groups which are port operators and port users.

However, since the research model has been finally developed with all the components, it is worthwhile to consider proposing more hypotheses at a specific level. Caveats to be considered here are that this should also be theoretically justified and be technically accepted by analytical method, i.e. SEM. Therefore, if specific level hypotheses are to be proposed, they should be sub-hypotheses of the higher-level hypotheses, staying within their theoretical boundaries. This study conceptually situates PSCI in the centre of the research model and attempts to examine its relationship to its antecedents and consequences. Therefore, PSCI cannot be disaggregated to test relationships with individual components of PSCO and PP.

Instead, the impact of the individual components of PSCO on PSCI can be examined under H1 because they have been identified as an antecedent to PSCI. Similarly, the impact of PSCI on the sub-dimensions of PP, which are Effectiveness and Efficiency, can be assessed under H2a. Again, the indirect impacts of PSCO's components on PP's sub-dimensions through PSCI also can be examined under H2b as shown in

Figure 4.4. Regarding empirical concerns, researchers tend to give up the ability to test for relationships between the first-order factors (i.e. components) and other constructs when they are used as indicators of a higher-order factor (e.g. PSCO) (Hair *et al.* 2010). However, there is no reason for the examinations to be limited to the higher-order construct level.

Figure 5.7 Complete research model (Lower order construct level)



The hypotheses at the specific level are proposed as follows;

Under H1,

H1-1: FR has a positive impact on PSCI

H1-2: HR has a positive impact on PSCI

H1-3: OR has a positive impact on PSCI

H1-4: TMS has a positive impact on PSCI

Under H2a,

H2a-1: PSCI has a positive impact on EFC

H2a-2: PSCI has a positive impact on EFF

Under H2b,

H2b-1: FR has an indirect and positive impact on EFC through PSCI

H2b-2: FR has an indirect and positive impact on EFF through PSCI

H2b-3: HR has an indirect and positive impact on EFC through PSCI

H2b-4: HR has an indirect and positive impact on EFF through PSCI

H2b-5: OR has an indirect and positive impact on EFC through PSCI

H2b-6: OR has an indirect and positive impact on EFF through PSCI

H2b-7: TMS has an indirect and positive impact on EFC through PSCI

H2b-8: TMS has an indirect and positive impact on EFF through PSCI

5.3.2 Latent and observed variables: measurement instruments

The latent and observed variables of PSCO, PSCI and PP were presented in developing the interim research model (see Section 5.1.2, p.133). However, some of them were only potential variables which can be accounted for when selecting the actual variables, and some were not made sure whether they can reflect what the variables intend to measure because they were adopted from relevant studies of which contexts are a bit different, for example SCM research. Now it is possible to present latent and observed variables which are actually used in the complete research model. The observed variables are used as measurement items in an actual questionnaire for this research. This research made efforts to find usable instruments from the existing literature for better validity and reliability. Yet the variables from the existing literature still needed refinement to better reflect reality. In addition, in the case where usable instruments were not found from the existing literature, the instruments were worded based on the findings of the qualitative interviews.

(1) PSCO

Table 5.5 provides the latent and observed variables representing the PSCO construct. When developing the interim model, only potential variables were presented from the relevant SCM literature (e.g. Min and Mentzer 2004; Min *et al.* 2007). Some of the potential variables were adopted for measuring PSCO. For a latent variable, 'OR' (Organisational Relationships), some observed variables for measuring 'Trust', 'Organisational compatibility' and 'Cooperative norms' were incorporated. However, the observed variables (i.e. measurement items) for measuring FR (Financial Resources) and HR (Human Resources) could not be provided by the existing literature. Thus, they were newly developed based on the findings from the qualitative interviews.

Table 5.5 Latent and observed variables for PSCO (complete)

Measurement items	Source
FR (Financial Resources)	
Having the financial resources to invest for supply chain integration when necessary (FR1) Being willing to invest for supply chain integration when necessary (FR2) Playing a high priority on investment for supply chain integration (FR3)	Interview findings
HR (Human Resources)	
Workforce has a good understanding of new logistics environments (HR1) Workforce has the capabilities to develop new logistics services (e.g. integrated logistics services) (HR2) Offering constantly education opportunities about supply chain integration to enhance the workforce' capabilities (HR3)	Interview findings
OR (Organisational Relationships)	
Goals and objectives are consistent with those of our supply chain members (OR1) CEO and the CEOs of our supply chain members have similar operating philosophies (OR2) Being willing to make cooperative changes with our supply chain members (OR3) Believing our supply chain members must work together to be successful (OR4) Our supply chain members trust each other (OR5) Keeping promises with our supply chain members (OR6) Dealing with supply chain members with honesty (OR7)	Min and Mentzer (2004) Min *et al.* (2007) Panayides (2007) Interview findings
TMS (Top Management Support)	
Top management repeatedly tell employees that our continued success depends on its adapting to new logistics environment such as supply chain integration (TMS1) Top managers repeatedly tell employees that building, maintaining, and enhancing long-term relationships with supply chain members are critical to our business's success (TMS2) Top managers repeatedly tell employees that sharing valuable strategic/tactical information with supply chain members is critical to business's success (TMS3) Top managers repeatedly tell employees that sharing objectives and philosophy is critical to our business's success (TMS4) Top management offers various education opportunities about supply chain management and integration (TMS5)	Min and Mentzer (2004) Min *et al.* (2007) Interview findings

* References in the 'Source' column represent sources for all the items in each block where they belong.

(2) PSCI

From the qualitative study, it was suggested that 'Information sharing' and 'Long-term relationships' be included as a component of PSCI. 'Information sharing' was aggregated with 'Information and communication system' and the items were adopted from the relevant SCM research (e.g. Vickery *et al.* 2003; Min and Mentzer 2004) and Panayides and Song (2008). The sources of the items for 'Long-term relationship' are also presented in Table 5.6.

Table 5.6 Latent and observed variables for PSCI (complete)

Measurement items	Source
ISCS (Information Sharing and Communication System)	
Providing information concerning shipment and cargo tracking (ISCS1) Sharing information concerning inventory management with supply chain members (ISCS2) Exchanging information concerning supply and demand forecasts with supply chain members (ISCS3) Exchanging information concerning marketing strategy with supply chain members (ISCS4) Using integrated EDI (Electronic Data Interchange) to communicate with partners in the supply chain (ISCS5) Using integrated information systems to share data/information with partners in the supply chain (ISCS6) Adopting computerized service systems for supply chain operations (ISCS7) Using the latest IT technology to support supply chain goals (ISCS8)	Vickey *et al.* (2003) Min and Mentzer (2004) Min *et al.* (2007) Panayides and Song (2008) Interview findings
LTR (Long-Term Relationships)	
Reducing channel complexity to closely work with a selected set of supply chain members (LTR1) We have facilitated a strong and long-term supply chain relationship fostering cooperation with each other (LTR2) Relationships with supply chain members are based on trust rather than contractual obligations (LTR3) Having guidelines for developing and maintaining long term relationships with supply chain members (LTR4)	Shin *et al.* (2002) Min and Mentzer (2004) Min *et al.* (2007) Interview findings
VAL (Value-Added Logistics)	
Having adequate facilities for adding value to cargoes (VAL1) Capable of adapting a service to meet the customers' specifications (VAL2) Capable of launching new tailored services should the need arise (VAL3) Capable of delivering services tailored to different market segments (VAL4) Capable of handling different types of cargo (VAL5)	Panayides and Song (2008) Interview findings
IMT (Inter-Modal Transport)	
Having the capacity to convey cargo through the most diversified routes/modes at the least possible time (IMT1) Having a variety of services to handle the transferring of cargo from one mode to another (IMT2) Having adequate connectivity for the multimodal interface (IMT3) Having reliable service operations for the multimodal interface (IMT4) Providing cost-effective multimodal operations (IMT5) Evaluating alternative routes for the more efficient multimodal transport of containers via our Terminal (IMT6)	Panayides and Song (2008) Interview findings
SCIP (Supply Chain Integration Practices	
Collaborating with other supply chain partners to plan for greater supply chain optimization (SCIP1) Seeking to identify other competing supply chains for containers that might flow through our terminal (SCIP2) Comparing the cost and time of cargoes flowing through our port and those of the cargoes flowing other competitive ports (SCIP3) Benchmarking the logistics/supply chain options available for cargoes that will flow through our port vis-a -vis alternative routes via competing ports (SCIP4) Seeking to identify least cost options for the transport of cargoes to hinterland destinations (SCIP5) Constantly evaluating the performance of the transport modes available for linking our port/terminal to its hinterland destinations (SCIP6)	Panayides and Song (2008) Interview findings

* References in the 'Source' column represent sources for all the items in each block where they belong.

(3) PP

The items for 'Effectiveness' and 'Efficiency' were obtained from previous research (Woo *et al.* 2008) and port performance studies (e.g. Marlow and Paixao-Casaca 2003; Tongzon 1995) as shown in Table 5.7.

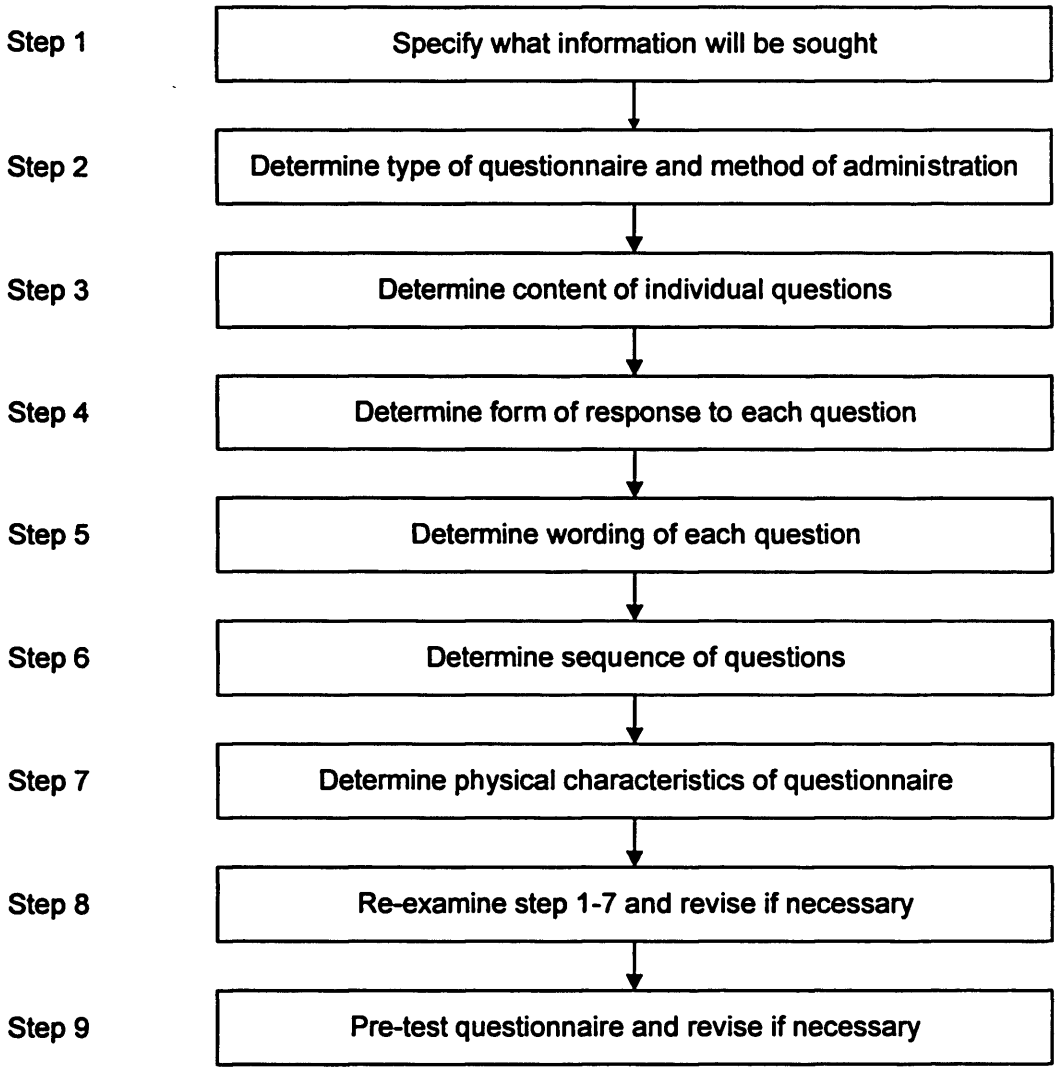
Table 5.7 Latent and observed variables for PP (complete)

Measurement items	Source
EFC1: Service Quality	
We provide a consistent reliable service (EFC1-1)	
We handle cargoes on quoted or anticipated time (EFC1-2)	Marlow and Casaca (2003) Woo *et al.* (2008)
Annual number of complaints from customers (EFC1-3)	
We handle cargoes on customers' time requirements (EFC1-4)	
Our service lead-time is appropriate (EFC1-5)	
We provide shipment information accurately (EFC1-6)	
EFC2: Customer Orientation	
We respond promptly to the need of customers (EFC2-1)	Lai *et al.* (2002) Woo *et al.* (2008)
We have quick decision making process (EFC2-2)	
We are flexible in terms of volume and type of cargo handling (EFC2-3)	
We deal with unexpected events or situations well (EFC2-4)	
EFC3: Service Price	
Comparing with competitors, our total service price is (EFC3-1)	Tongzon (1995) Woo *et al.* (2008)
Comparing with competitors, our cargo handling charge is (EFC3-2)	
Comparing with competitors, our charge for auxiliary services is (EFC3-3)	
EFF1: Sea and Land Operations	
Our cargo throughput per crane is (EFF1-1)	
Our cargo throughput per acre is (EFF1-2)	Tongzon (1995) Marlow and Casaca (2003)
Our ship waiting time is (EFF1-3)	
Our ship turnaround time is (EFF1-4)	
Our time for loading/unloading cargo is (EFF1-5)	
EFF2: Cargo Operation	
Our time for mode transit is (EFF2-1)	Marlow and Casaca (2003)
Our time for truck entry is (EFF2-2)	
Our time from cargo's entry to its exit is (EFF2-3)	

* References in the 'Source' column represent sources for all the items in each block where they belong.

These items for PSCO, PSCI and PP were used in the survey questionnaire in the same order. The process of designing the questionnaire followed Churchill and Iacobucci (2002)'s nine step guidelines as shown in Figure 5.8. Through the literature review and the qualitative interview study, steps 1-4 have been covered, and steps 5-7 were implemented through identifying the observed variables and items for the latent variables. For steps 8-9, the initial version of the questionnaire was reviewed to make the questions more clearly understandable. Subsequently, the English version of questionnaire was translated into Korean and both versions were pre-tested by one researcher and one practitioner in South Korea.

Figure 5.8 Questionnaire development process

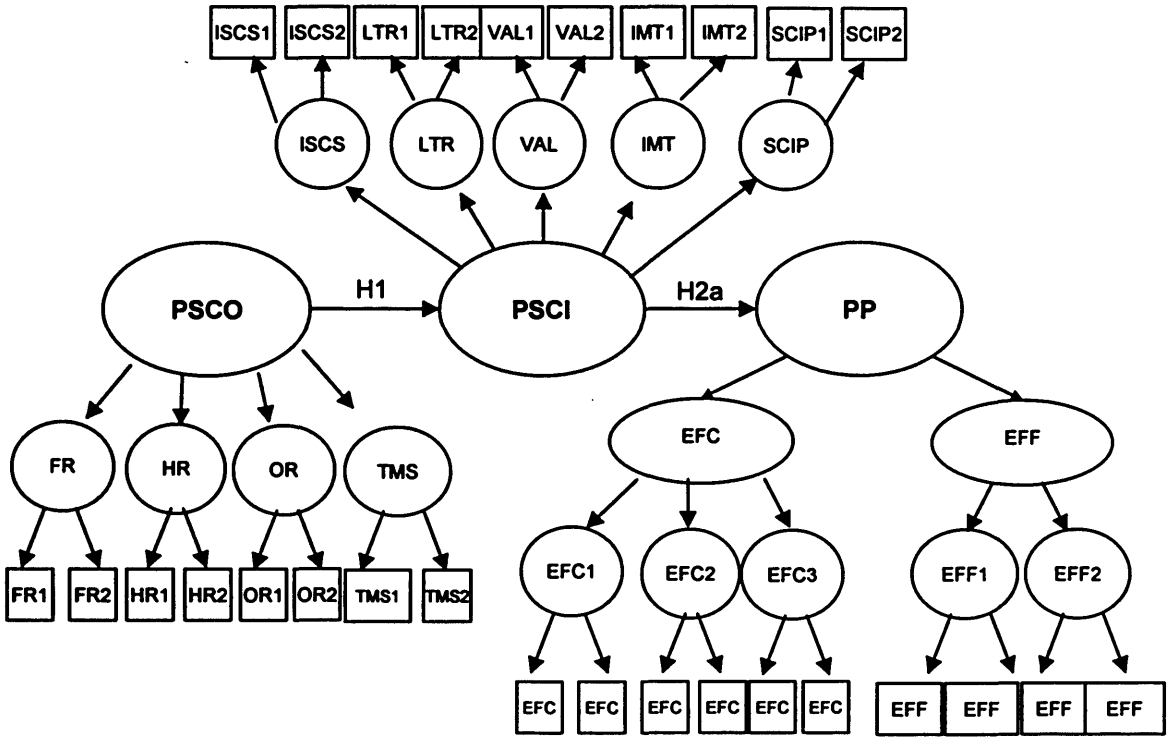


(Source: Adapted from Churchill and Iacobucci 2002)

5.3.3 Structural models

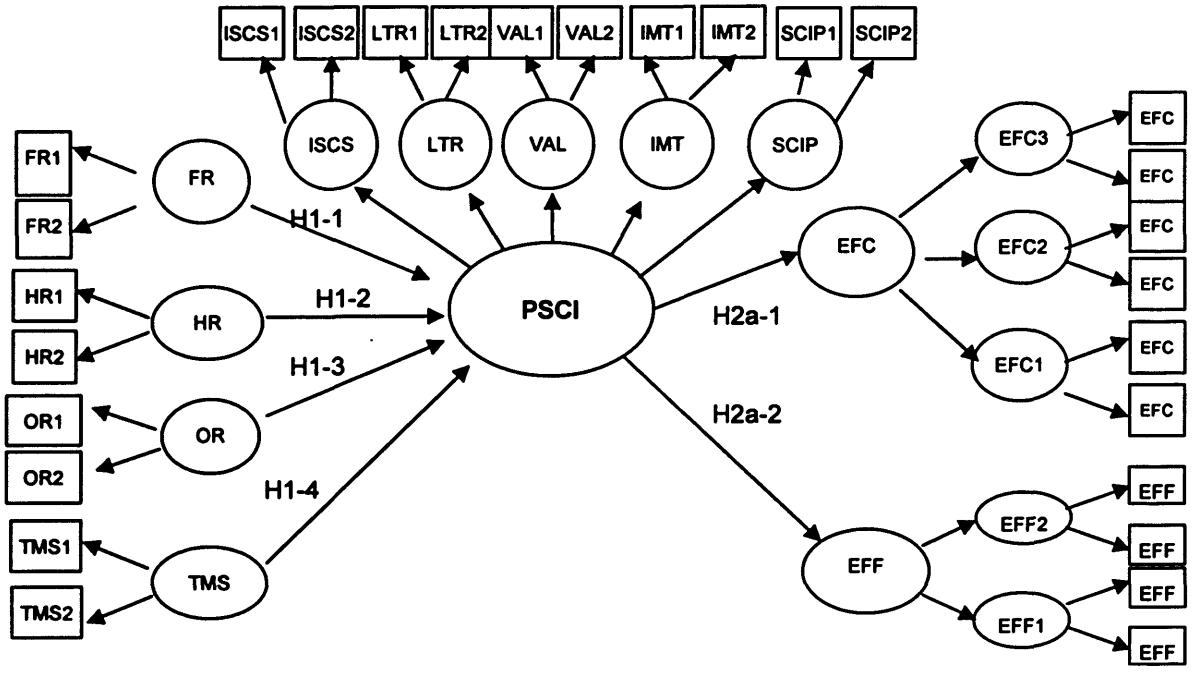
The complete form of structural model can be illustrated as shown in Figure 5.9 and 5.10. These models are a simplified illustration where error and residual terms are not described and all the observed variables are not detailed. The model in Figure 5.9 is for examination of the causal relationships among PSCO, PSCI and PP (i.e. H1, H2a and H2b). The arrow from the oval with PSCO to the oval with PSCI represents HI and the arrow from PSCI to PP represents H2a. It should be also noted that PP higher order factor which explains 'Effectiveness' and 'Efficiency' which are also second-order constructs explaining their corresponding first order constructs. This may imply the structural model has a number of latent and observed variables and is very complicated.

Figure 5.9 Structural model with higher-order constructs



The model in Figure 5.10 is for examining the causal relationships among the first order constructs of PSCO and PSCI (H1-1~H1-4), and PSCI and the second order measurement model 'Effectiveness' and 'Efficiency' (H2a-1 and H2a-2).

Figure 5.10 Structural model with lower-order constructs



5.4 SUMMARY

This chapter was devoted to describing the findings from the qualitative interview study. The study, firstly, investigated the nature of PSCI comprising (1) the integrated logistics services combining value-added logistics and intermodal transportation and (2) the organisational integration, and the motives why TOCs adopt the integration strategy: gaining bargaining power against SCs, demand complementary, improving service quality and reducing total logistics costs. Investigation of the actors in PSCI and their strategies indicate that PSCI can be implemented to varying degrees and in different ways depending on the circumstances and the views TOCs have. Thirdly, the components of PSCI were intensively investigated. The implication from this investigation is that information sharing and building up of long-term relationships are essential dimensions representing the level of PSCI. In addition, value-added logistics and intermodal transportation services can be completed through efforts to ceaselessly create new services to cater for customers' sophisticated demand. Finally, three firm resources facilitating PSCI were revealed as the components of PSCO: financial and human resources, organisational relationship, and willingness and support of TMT. Based on the findings from the intensive exploration, the conceptual model of this thesis could be completed and all the measurement items were presented in this Chapter.

CHAPTER 6

DESCRIPTIVE STATISTICS:

QUESTIONNAIRE SURVEY

A questionnaire survey was conducted to obtain data which can be used for empirical analysis using Structural Equation Modelling (SEM). Prior to the empirical analysis, this chapter conducts an initial data analysis and presents the descriptive statistics of the data. This is useful because the initial data analysis provides not only a general picture of the data through exploring and summarizing the data, but also meaningful implications for the empirical analysis. The first section presents an overview of the survey respondent profile including overall sample profile and profile by port and group. The second section provides descriptive statistics for PSCO (Port Supply Chain Orientation), PSCI (Port Supply Chain Integration) and PP (Port Performance) respectively. The statistics are primarily percentage frequency, mean and standard deviation of each item in the questionnaire survey relating to the three constructs. This initial data analysis also includes a simple comparison of data between different ports and groups. Information about the sample ports and groups is also briefly provided for better understanding about them.

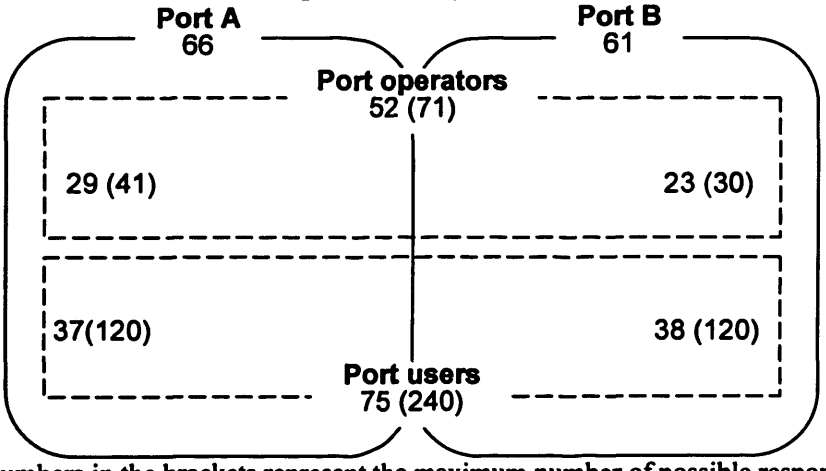
6.1 SURVEY RESPONSE PROFILE

The questionnaire survey was conducted over two months from March to April 2009 on companies in South Korea. As previously presented, two representative ports in

South Korea, which are called Port A and B, were selected in terms of the level of cargo throughput, proximity to the hinterland and geographical location near main shipping routes because researchers suggest that not all the ports are capable of providing integrated logistics services (e.g. Ferrari *et al.* 2006; Theys *et al.* 2008). The port industry is a target population because PSCI is an activity undertaken by Terminal Operating Companies (TOCs). However, considering the complexity of the port community and the concept of PSCI, Shipping Companies (SCs) and Freight Forwarders (FWDs) were also invited to participate in a questionnaire survey aimed at a Port Users (PUs) group to get a comprehensive and balanced view on PSCI.

Therefore, TOCs in Ports A and B are the first sample group in this questionnaire survey, and the number of TOCs in the two ports is 71 in total (41 and 30 respectively) in terms of the registered TOCs with the Korean Port Logistics Association. As for the PU group, 20 SCs and 100 FWDs were selected out of 164 companies registered with the Korea Shipowners' Association and 744 companies registered in the Korea International Freight Forwarders Association respectively. The selection process was presented in Chapter 4 (see Section 4.3.2). Thus, the number of companies participating in the survey was 191. However, the PU group companies were asked to evaluate the terminals they frequently use in both Ports A and B (see Appendix A and B for the details of the questionnaire). Accordingly, the number of maximum possible responses this research could obtain was 311 (71 from TOCs and 240 from SCs and FDWs) as shown in Figure 6.1.

Figure 6.1 The number of responses by port and group



Note: The numbers in the brackets represent the maximum number of possible responses

The questionnaire was developed following Churchill and Iacobucci (2002)'s guidelines and distributed to all the potential respondents. Consequently, 127 responses were received, yielding a response rate of 40.8% as shown in Table 6.1.

Table 6.1 Questionnaire response

Port	Group	Sent	Not opened	Opened but not responded	Responded Frequency	Responded %*	Response rate (%)
Port A	TOC	41	5	7	29	44	
	SC	20	1	2	17	26	
	FWD	100	33	47	20	30	
	Subtotal	161	39	56	66	100	40.9
Port B	TOC	30	3	4	23	38	
	SC	20	1	1	18	30	
	FWD	100	33	47	20	32	
	Subtotal	150	37	52	61	100	40.6
	Total	311	76	108	127		40.8

* % in 'Responded' column stands for proportion of response of each group in subtotal responses

It was possible to identify whether the questionnaires were safely sent to the potential respondents and they were checked because the questionnaires were distributed via email. The email containing the questionnaire was not opened by 8 TOCs, 1 SC and 33 FWDs because the email would have been either automatically filtered as spam mail or deleted by the potential respondents with the suspicion of it being spam mail. Among the companies which checked the emails, 11 TOCs did not respond. 47 FWDs and 1 SC did not respond to the questionnaire of both Port A and B. Interestingly 1 SC sent back the response on only Port B. In summary, the number of responses from Port A is 5 questionnaires more than that of Port B: specifically 6 more from TOCs, 1 less from a SC and the same from FWDs.

6.1.1 Characteristics of respondents by port

This section describes the characteristics of respondents from the sample ports, while the following section does so by the sample groups (Section 6.1.2). The latter primarily provides the employment period and position of the respondents to make sure that the respondents have sufficient knowledge and experience for providing accurate and reliable answers to the questionnaires. However, this section provides the basic information on the sample ports, for example, cargo throughputs, contribution to international seaborne trade, berthing facilities and connectivity to shipping lines, to obtain a basis for understanding the companies participating in this survey.

Table 6.2 presents total annual seaborne trade for the world and South Korea. The amount is the sum of cargoes loaded and discharged. South Korean cargo has accounted for around 5.5% of world seaborne trade from 2006 to 2008. Table 6.3 also presents annual container port traffic for the world and South Korea. About 3.5% of World container port traffic was handled in South Korean ports for the same three years, which is slightly lower that the South Korean proportion of seaborne trade.

Table 6.2 World and South Korean seaborne trade (in million ton)

	2008	2007	2006
World	16,348	15,943	15,265
South Korea	895	863	810
Percentage	5.5	5.4	5.3

(Source: UNCTAD 2009; MLTM 2009)

Table 6.3 World and South Korean container port traffic (in 1,000 TEU)

	2008	2007	2006
World	506,921	487,132	434,360
South Korea	17,297	16,986	15,522
Percentage	3.4	3.5	3.6

(Source: UNCTAD 2009; MLTM 2009)

Ports A and B have very high proportions of both total seaborne trade cargo and container cargo throughput of South Korea as shown in Table 6.4 and 6.5. The former is around 45% and the latter is around 85%, which means that the two ports make a greater contribution to container cargo handling than to total amount of seaborne cargo.

Table 6.4 Seaborne cargo trade in South Korea (in million ton)

	2008	2007	2006
South Korea	895	863	810
Port A	241	243	229
Port B	142	138	129
Subtotal	383	381	35
Percentage	42.8	44.1	44.2

(Source: UNCTAD 2009; MLTM 2009)

Table 6.5 Container cargo throughput in South Korea (in 1,000 TEU)

	2008	2007	2006
South Korea	17,297	16986	15,522
Port A	13,453	13,261	12,039
Port B	1,703	1,664	1,377
Subtotal	15,156	14,925	13,416
Percentage	87.6	85.1	84.1

(Source: UNCTAD 2009; MLTM 2009)

(1) Port A

According to Table 6.6, 26.9% of international seaborne cargo and 77.8% of container cargo in South Korea were handled in Port A in 2008. It can be inferred that the type of cargo handled in Port A is largely containerised cargo, although the percentage of cargo handled in the form of container out of the total amount of cargo is not easy to get. This can be deduced from Table 6.7. Out of 46 berths in total, 28 are berths in container terminals and 18 in general piers dealing with both general and containerised cargoe.

Table 6.6 Cargo throughput of Port A

		2008	2007	2006
Total seaborne cargo (in million tons)	South Korea	895	863	810
	Port A	241	243	229
	Percentage	26.9	28.1	28.3
Container cargo throughput (1000 TEU)	South Korea	17,297	16986	15,522
	Port A	13,453	13,261	12,039
	Percentage	77.8	75.6	75.4

(Source: MLTM 2009)

Table 6.7 Berthing facilities of Port A

	No. Berth	Length (m)	Draft (m)	Capacity (1000 TEU)
Container terminals	28	8,473	7.5-16	9,940
General piers	18	3,367	8-11	1,180
Total	46	11,840		11,120

(Source: MLTM 2009)

In addition, Table 6.8 presents the number of regular container lines connected to Port A. It can be shown that Port A is located on the main trunk shipping routes which connect East Asian countries with North America (43) and Europe (18). This port is also connected to South America (29), Australia (16), Russia (16) and the Middle East (3) by a number of shipping lines. Thus it, in turn, also has good connectivity to adjacent regions such as South Asia (55), Japan (61) and China (53) in order to connect them with the main trunk lines.

Table 6.8 Regular container lines in Port A

	Number of lines
Southeast Asia	55
Japan	61
China	53
North America	43
South America	29
Europe	18
Australia	16
Russia	16
Middle East	3
Other	7
Total	301

(Source: MLTM 2009)

Among the 29 TOCs which responded in Port A, 86.2% of the companies (25) operate terminals in more than 2 ports in Korea, and 6.9% of them (2) are operating terminals world-wide, which can be called GTOs (Global Terminal Operators) as shown in Table 6.9. Additionally, 86.2% of the companies operate both container terminal and general cargo terminal or handle both types of cargo in terminals.

Table 6.9 Characteristics of the sample TOCs in Port A

	Category	Frequency	Percentage
Business area	Single port in Korea	2	6.89
	Multi ports in Korea	25	86.20
	Multi ports world wide	2	6.89
Type of terminal	Container terminal only	4	13.79
	General cargo terminal only	0	0
	Both	25	86.20

(2) Port B

Table 6.10 shows that Port B has a lower proportion in both total seaborne cargo trade and container cargo throughput than Port A. 15.8% of seaborne cargo and 9.8% of container cargo in South Korea were handled in Port B in 2008. While Port B deals with both containerised and non-containerised cargoes (dry bulk and general cargoes) and the proportion of container cargo has been increasing, the cargoes Port B handles are primarily dry bulk and general cargoes rather than containerised cargoes. Table 6.11 shows that the physical facilities of Port B are generally for handling non-containerised cargoes. Out of 86 berths in total, 10 are berths in container terminals and 76 in general piers dealing with both containerised and non-containerised cargoes.

Table 6.10 Cargo throughput of Port B

		2008	2007	2006
Total seaborne cargo (in million tons)	South Korea	895	863	810
	Port B	142	138	129
	Percentage	15.8	15.9	15.9
Container cargo throughput (1000 TEU)	South Korea	17,297	16,986	15,522
	Port B	1,703	1,664	1,377
	Percentage	9.8	9.8	8.9

(Source: MLTM 2009)

Table 6.11 Berthing facilities of Port B

	Berth	Length (m)	Draft (m)	Capacity
Container terminals	10	2,092	7.5-14	1,210 (1000 TEU)
General piers	76	14,479	7.5-14	54,504 (1000 Tons)
Total	86	16,571		

(Source: MLTM 2009)

Considering the connectivity of Port B to shipping lines in Table 6.12, it can be shown that Port B is a feeder port rather than a hub port. Port B is not directly connected to North America and Europe, but primarily connected to Southeast Asia (64), China (18) and Japan (5).

Table 6.12 Regular container lines in Port B

	Port B
Southeast Asia	64
Japan	5
China	18 (10)
North America	-
South America	-
Europe	-
Australia	6
Russia	-
Middle East	1
Other	2
Total	96 (10)

Note: The number in brackets stands for the number of ferry lines

(Source: MLTM 2009)

20 TOCs (87%) out of 23 TOCs from Port B operate terminals in more than 2 ports in South Korea. One terminal among the sample TOCs in Port B was operated by a GTO (Global Terminal Operator). In addition, 87% of the sample TOCs operate both container terminals and non-containerised cargo terminals or handle both types of cargo in terminals as shown in Table 6.13.

Table 6.13 Characteristics of the sample TOCs in Port B

	Category	Frequency	Percentage
Business area	Single port in Korea	2	8.7
	Multi port in Korea	20	87.0
	Multi port world wide	1	4.3
Type of terminal	Container terminal only	2	8.7
	Non-containerised cargo terminal only	1	4.3
	Both	20	87.0

(3) Characterising Port A and B

In summary, it is possible to characterise the sample ports based on the discussion above. It is clearly seen from Table 6.14 that Port A has greater contribution to cargo handling in South Korea in terms of both total seaborne cargoes and containerized cargoes than Port B has. However, the proportion of container cargo handling in Port A is much higher than that of Port B. It was also found that the berthing facilities of Port A are primarily handling container cargoes, while those of Port B mostly were for general cargoes with some berths dedicated to container cargoes. In addition, considering the shipping routes connected to the sample ports, Port A can be categorised as a hub port and Port B as a feeder port.

Table 6.14 Characteristics of the sample ports (as of 2008)

	Port A	Port B
Proportion of cargo handling		
- Total seaborne cargo	26.9%	15.8%
- Containerized cargo	77.8%	9.8%
Container throughput (1,000 TEU)	13,453	1,703
Facilities	Container cargo focused	Non-containerised cargo focused
Connectivity	Both main and regional routes	Mostly regional routes
Classification	Hub port	Feeder port

Depending on some existing studies (e.g. Ferrari *et al.* 2006; Theys *et al.* 2008), it can be presumed that logistics activities take place in Port A more than Port B. According to Ferrari *et al.* (2006), ports that have achieved a considerable amount of cargo traffic seek developing facilities for value added and logistics services. Theys *et al.* (2008) also presents as attractive port characteristics for logistics centre, geographical location near main shipping routes; availability of modern port infra- and superstructure, and the like. Thus, presumably the levels of PSCO and PSCI of Port A would be higher than those of Port B.

6.1.2. Characteristics of respondents by group

This section provides the information on the respondents' working period in this area, position in companies or organisations, and the companies' business area to make sure the respondents are capable of providing reliable responses to the questions.

(1) Terminal Operating Companies (TOCs)

As of March 2009, the number of TOCs registered in the Korea Port Logistics Association was 274 (KOPLA 2009), and 71 TOCs among them (26%) were registered in Port A and B. As 52 TOCs responded to the questionnaire, around 20% of Korean TOCs joined this research according to Table 6.15. Among the 52 respondents in the TOC group, 78% of respondents (41) have worked for longer than 11 years in the port industry, and 89% of respondents were working at the position of Middle Manager, Senior Manager and CEO when the survey was conducted as shown in Table 6.16.

Table 6.15 The number of TOCs in South Korea

	Number of TOCs	Percentage
Total	274	100
Port A	41	15
Port B	30	11
Subtotal	71	26
Responded	52	18.9

(Source: Based on KOPLA 2009)

Table 6.16 Respondents profile for TOCs

		Category	Frequency	Percentage
TOC	Working Period (years)	1-5	5	11
		6-10	6	11
		11-20	26	50
		21-	15	28
	subtotal		52	
	Position	Staff	6	11
		Middle Manager	37	71
		Senior Manager	7	14
		CEO	2	4
	subtotal		52	

(2) Port Users (PUs)

PU (Port User) group comprises SCs (Shipping Companies) and FWDs (Freight Forwarders) as explained previously. Table 6.17 shows that the Korean shipping

industry controls 3.3% of the world fleet and stands at the 7th position. When the survey was conducted, 164 SCs were registered in the Korea Shipowners' Association whose members are ocean-going shipping companies, and the top 20 SCs among them were selected for the survey. These SCs were controlling 42% of the fleets the Korean SCs were controlling, and the DWT (Dead Weight Tonnage) of the fleets of the selected SCs was 85% of that of all the fleets of the Korean SCs (see Table 6.18).

Table 6.17 Top 10 countries by controlled fleets (as of December 2008)

Country	Number of fleet	DWT (1,000)	Percentage
Japan	3,674	176,377	15.4
Greece	3,094	175,485	15.3
Germany	3,476	104,875	9.2
China	3,148	91,192	8.0
UK	988	50,839	4.4
Norway	1,468	43,650	3.8
South Korea	**1,083**	**38,015**	**3.3**
USA	967	34,692	3.0
Hong Kong	614	32,635	2.9
Taiwan	622	30,014	2.6
Subtotal	19,134	777,774	67.9
World total	36,542	1,144,375	100.00

(Source: KSA 2009)

Table 6.18 Shipping companies in South Korea (as of December 2008)

	Number of SCs	Number of fleet	DWT (1,000)
Total	164	786	32,819
Sample SCs	20	332	27,789
Percentage	12	42	85

(Source: KSA 2009)

28% of the respondents of SCs have worked for longer than 11 years in the shipping industry, and 44% of them have worked for between 6 and 10 years at the point of time this survey was conducted. 68% of the respondents were working at the position of Middle Manager or CEO at that time as shown in Table 6.19.

Table 6.19 Respondents profile for SCs

	Category	Frequency	Percentage
Working Period (years)	1-5	5	27.8
	6-10	8	44.4
	11-20	4	22.2
	21-	1	5.6
subtotal		18	100.0
Position	Staff	6	33.3
	Middle Manager	11	61.1
	Senior Manager	0	0.0
	CEO	1	5.6
subtotal		18	100.0

50% of the respondents of FWDs have worked for longer than 11 years in the freight forwarding industry and 40% have worked for between 6 and 10 years when the survey took place. 90% of the respondents were working at the position of Middle Manager, Senior Manager or CEO at that time as shown in Table 6.20.

Table 6.20 Respondents profile for FWDs

	Category	Frequency	Percentage
Working Period (years)	1-5	2	10.0
	6-10	8	40.0
	11-20	8	40.0
	21-	2	10.0
subtotal		20	100.0
Position	Staff	2	10.0
	Middle Manager	12	60.0
	Senior Manager	5	25.0
	CEO	1	5.0
subtotal		20	100.0

6.2 DESCRIPTIVE STATISTICS

This section describes the result of responses to the items in the questionnaire survey. Each item is designed to measure the components representing the three constructs which are PSCO, PSCI and PP. Respondents were asked to indicate the degree of agreement on the items for PSCO and PSCI from 1 (Strongly Disagree) to 5 (Strongly Agree). The response scale for PP varied depending on the type of question as shown in Table 6.21.

Table 6.21 Response scale in the questionnaire survey

Items		Response scale					
		1	2	3	4	5	N/A
PSCO	All items	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Not applicable
PSCI	All items	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Not applicable
PP	EFC1-EFC2	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Not applicable
	EFC3	Much less competitive	Less competitive	Neutral	Competitive	Much more competitive	Not applicable
	EFF1-1,2	Much worse	Worse	No difference	Better	Much better	Not applicable
	EFF2	Much Longer	Longer	No difference	Shorter	Much shorter	Not applicable

In addition, the measurement scales included a N/A (Not Applicable) option, but no respondents marked N/A. Apparently, respondents did not respond to the whole questionnaire rather than to certain questions even if they were not interested in a part

of questionnaire. Some respondents sent back responses which did not contain answers on the whole questionnaire or on some pages by mistake. In those cases, they were asked to send responses again with the full answers. Eventually there were no missing data including N/A marking found from the responses.

6.2.1 Port Supply Chain Orientation (PSCO)

The components of PSCO were identified from the qualitative interview study and the instrument items for the components were also presented in Section 5.3.2. Each item is not fully described, but presented in the shortened form as shown in Table 6.22.

(1) Overall statistics

Table 6.22 Descriptive statistics for PSCO

Items	1	2	3	4	5	Mean	SD
(FR1) Having the financial resources to invest for supply chain integration when necessary	0.8	13.4	40.9	32.3	12.6	3.42	0.90
(FR2) Being willing to invest for supply chain integration when necessary	3.9	13.4	40.9	26.8	15.0	3.35	1.01
(FR3) Playing a high priority on investment for supply chain integration	2.4	22.0	37.8	22.0	15.7	3.26	1.04
(HR1) Workforce has a good understanding of new logistics environments	7.1	12.6	36.2	32.3	11.8	3.29	1.06
(HR2) Workforce has the capabilities to develop new logistics services	4.7	15.0	29.1	39.4	11.8	3.38	1.03
(HR3) Offering constantly education opportunities about supply chain integration	3.1	15.0	44.1	28.3	9.4	3.25	0.93
(OR1) Goals and objectives are consistent with those of our supply chain members	2.4	17.3	32.3	40.2	7.9	3.33	0.93
(OR2) CEO and the CEOs of our supply chain members have similar operating philosophies	4.7	12.6	27.6	45.7	9.4	3.42	0.98
(OR3) Being willing to make cooperative changes with our supply chain members	3.1	14.2	26.0	35.4	21.3	3.57	1.07
(OR4) Believing our supply chain members must work together to be successful	4.7	8.7	22.8	33.1	30.7	3.76	1.12
(OR5) Our supply chain members trust each other	3.1	13.4	37.0	29.9	16.5	3.43	1.02
(OR6) Keeping promises with our supply chain members	0.0	7.9	39.4	32.3	20.5	3.65	0.89
(OR7) Dealing with supply chain members with honesty	1.6	15.7	29.1	34.6	18.9	3.53	1.02
(TMS1) Top managers emphasizing the importance of adapting to new logistics environments	1.6	13.4	28.3	30.7	26.0	3.66	1.05
(TMS2) Top managers emphasizing the importance of long-term relationships with supply chain members	0.8	7.1	26.8	37.8	27.6	3.84	0.93
(TMS3) Top managers emphasizing the importance of sharing valuable information with supply chain members	0.8	11.8	26.8	37.0	23.6	3.70	0.98
(TMS4) Top managers emphasizing the importance of sharing objectives and philosophy	0.0	14.2	33.1	29.9	22.8	3.61	0.99
(TMS5) Top management offering education opportunities about supply chain management	3.1	19.7	35.4	32.3	9.4	3.25	0.98

Table 6.22 shows that the average scores for the items of PSCO are all between 3 and 4 points. In general, the items for FR (Financial Resources) and HR (Human Resources) were rated closer to 3 and the items for OR (Organisational Relationships) and TMS (Top Management Support) were close to 4 points. The highest is TMS2 (mean = 3.84) which is 'Top management repeatedly tell employees that building, maintaining and enhancing long-term relationships with supply chain members are critical to our business success', and the lowest is HR3 (mean = 3.25) which is 'Offering constant education opportunities about supply chain integration to enhance workforce' capabilities'. It can be presumed for this stage that the level of PSCO would be not so high while it is above the medium level.

(2) Comparisons between ports and groups

Table 6.23 compares the average scores for the items of PSCO between Port A and B and TOC and SC group. Figure 6.2 and 6.3 also provide a clear illustration about the comparisons.

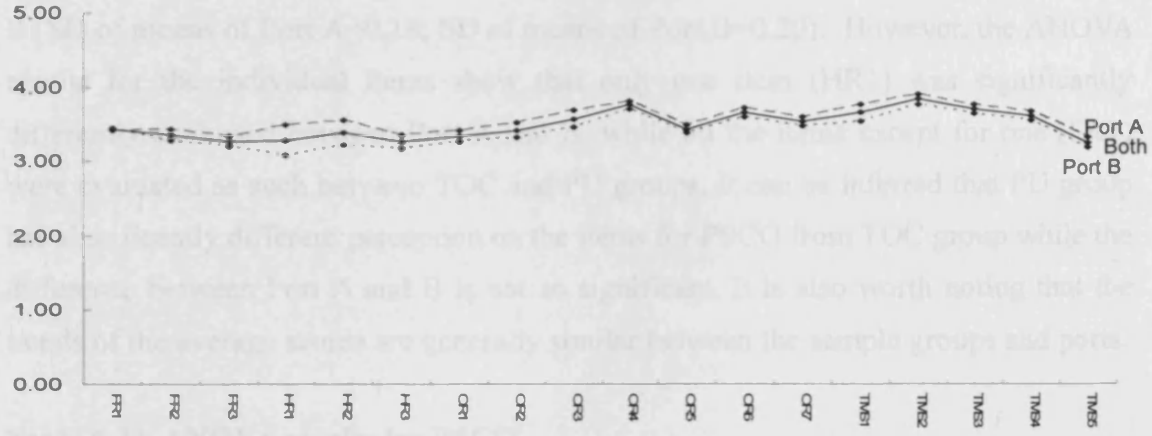
Table 6.23 Mean values of items for PSCO by port and group

Items		Ports		Groups	
		Port A	Port B	TOC	PU
Financial Resources	FR1	3.41	3.44	3.56	3.33
	FR2	3.42	3.28	3.96	2.93
	FR3	3.33	3.20	3.88	2.84
Human Resources	HR1	3.48	3.08	3.98	2.81
	HR2	3.55	3.21	3.98	2.97
	HR3	3.35	3.16	3.67	2.97
Organisational Relationships	OR1	3.41	3.26	3.96	2.91
	OR2	3.52	3.33	4.02	3.01
	OR3	3.68	3.46	4.37	3.03
	OR4	3.82	3.70	4.56	3.21
	OR5	3.48	3.38	4.13	2.95
	OR6	3.71	3.59	4.29	3.21
	OR7	3.59	3.48	4.23	3.05
Top Management Support	TMS1	3.77	3.54	4.37	3.17
	TMS2	3.91	3.77	4.46	3.41
	TMS3	3.77	3.64	4.25	3.33
	TMS4	3.67	3.56	4.21	3.20
	TMS5	3.32	3.18	3.85	2.84

Figure 6.2 shows that Port A was rated slightly higher than Port B. This may imply that the respondents perceive the terminals in Port A are more oriented to supply chain

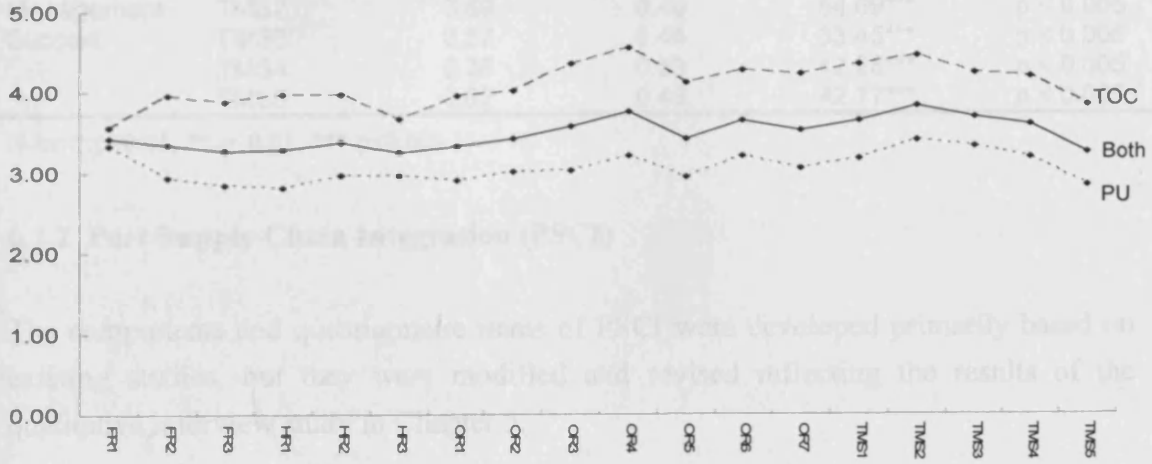
integration strategies and practices than those in Port B. However the level of PSCO is not determined directly from the scores of the items while it is measured and represented using the scores of the items. In addition the difference is necessary to examine whether it is significant statistically.

Figure 6.2 Comparison between Port A and B



When it comes to comparison between TOC and PU groups, all the items were rated much higher by TOC group than by PU group as shown in Figure 6.3. The average scores of all the items rated by TOC group were above 3.5 points, and 10 out of 18 items achieved higher than 4.0 points from the TOC group. In contrast, 8 items out of 18 were rated below 3.0 points by PU group, and the scores of the remaining items also close to 3.0. This implies the TOCs evaluated their terminals rather positively on the given items, while the respondents in PU group evaluated the terminals neutrally or rather negatively.

Figure 6.3 Comparison between TOC and PU groups



One way ANOVA (Analysis of Variance) was carried out to examine the differences emerging from comparing the sample ports and groups. The ANOVA results for the average scores show that both differences between the sample ports and the sample groups were statistically significant as shown in Table 6.24 while the difference between the Port A and B appeared to be very small in Figure 6.2. The result is reasonable considering the low standard deviations of the average scores of Port A and B (SD of means of Port A=0.18; SD of means of Port B=0.20). However, the ANOVA results for the individual items show that only one item (HR1) was significantly differently evaluated between Port A and B, while all the items except for one (FR1) were evaluated as such between TOC and PU groups. It can be inferred that PU group has significantly different perception on the items for PSCO from TOC group while the difference between Port A and B is not so significant. It is also worth noting that the trends of the average scores are generally similar between the sample groups and ports.

Table 6.24 ANOVA results for PSCO

Items		Ports		Groups	
		F-statistics	p-value	F-statistics	p-value
Mean values		6.42*	0.02	179.538***	p < 0.005
Financial Resources	FR1	0.04	0.83	1.90	0.17
	FR2	0.64	0.42	41.16***	p < 0.005
	FR3	0.53	0.46	39.74***	p < 0.005
Human Resources	HR1	4.69*	0.03	52.12***	p < 0.005
	HR2	3.35	0.07	37.85***	p < 0.005
	HR3	1.23	0.27	19.70***	p < 0.005
Organisational Relationships	OR1	0.77	0.37	56.00***	p < 0.005
	OR2	1.14	0.28	42.23***	p < 0.005
	OR3	1.37	0.24	76.43***	p < 0.005
	OR4	0.32	0.57	67.08***	p < 0.005
	OR5	0.35	0.55	61.66***	p < 0.005
	OR6	0.58	0.44	67.99***	p < 0.005
	OR7	0.40	0.52	59.78***	p < 0.005
Top Management Support	TMS1	1.53	0.22	56.34****	p < 0.005
	TMS2	0.69	0.40	54.69***	p < 0.005
	TMS3	0.57	0.44	33.45***	p < 0.005
	TMS4	0.38	0.53	42.28***	p < 0.005
	TMS5	0.62	0.43	42.77***	p < 0.005

Note: *:p<0.05; ** p<0.01; *** p<0.001

6.2.2 Port Supply Chain Integration (PSCI)

The components and questionnaire items of PSCI were developed primarily based on existing studies, but they were modified and revised reflecting the results of the qualitative interview study in Chapter 5.

(1) Overall statistics

Table 6.25 provides the descriptive statistics of PSCI. The items of PSCI were rated between 3 and 4 points except for two items which were ISCS3 (mean=2.94) and ISCS4 (mean=2.77). The highest was ISCS 7 (mean=3.90) which is 'Adopting computerized operational system for supply chain operation', and the lowest was ISCS 4 (mean=2.77) which is 'Exchanging information concerning marketing strategy with supply chain members'. 20 out of 29 items were rated between 3 and 3.5 points, while 7 were between 3.5 and 4 and 2 were between 2.5 and 3. This implies that the respondents generally showed neutral positions for the items of PSCI, and did not show either strong agreements or strong disagreements. Specifically, LTR (Long-Term Relationships), IMT (Intermodal Transport) and SCIP (Supply Chain Integration Practices) obtained lower scores than ISCS (Information Sharing and Communication System) and VAL (Value-Added Logistics) did.

Table 6.25 Descriptive statistics for PSCI

Items	1	2	3	4	5	Mean	SD
(ISCS1) Providing information concerning shipment and cargo tracking	3.9	7.9	17.3	44.9	26.0	3.81	1.03
(ISCS2) Sharing information concerning inventory management with supply chain members	7.1	15.7	30.7	29.1	17.3	3.33	1.14
(ISCS3) Exchanging information concerning supply and demand forecasts with supply chain members	15.0	22.8	24.4	28.3	9.4	2.94	1.22
(ISCS4) Exchanging information concerning marketing strategy with supply chain members	18.9	24.4	25.2	23.6	7.9	2.77	1.22
(ISCS5) Using integrated EDI to communicate with partners in the supply chain	3.1	15.0	21.3	26.0	34.6	3.74	1.17
(ISCS6) Using integrated information systems to share information with the supply chain members	6.3	19.7	25.2	27.6	21.3	3.37	1.20
(ISCS7) Adopting computerized service systems for supply chain operations	3.1	9.4	16.5	35.4	35.4	3.90	1.08
(ISCS8) Using the latest IT technology to support supply chain goals	3.9	12.6	21.3	38.6	23.6	3.65	1.09
(LTR1) Reducing channel complexity to closely work with a selected set of supply chain members	7.9	14.2	25.2	36.2	16.5	3.39	1.15
(LTR2) Having facilitated a strong and long-term supply chain relationship fostering cooperation with each other	4.7	12.6	33.1	30.7	18.9	3.46	1.08
(LTR3) Relationships with supply chain members are based on trust rather than contractual obligations	6.3	15.0	37.8	33.1	7.9	3.21	1.00
(LTR4) Having guidelines for developing and maintaining long term relationships with supply chain members	6.3	15.0	33.9	33.9	11.0	3.28	1.05

(VAL1) Having adequate facilities for adding value to cargoes	5.5	22.8	31.5	29.1	11.0	3.17	1.07
(VAL2) Capable of adapting a service to meet the customers' specifications	7.9	8.7	29.1	35.4	18.9	3.48	1.13
(VAL3) Capable of launching new tailored services should the need arise	3.9	13.4	27.6	36.2	18.9	3.52	1.06
(VAL4) Capable of delivering services tailored to different market segments	4.7	15.0	33.9	32.3	14.2	3.36	1.05
(VAL5) Capable of handling different types of cargo	3.9	7.1	29.9	38.6	20.5	3.64	1.01
(IMT1) Having the capacity to convey cargo through the most diversified routes/modes at the least possible time	3.9	12.6	36.2	33.9	13.4	3.40	1.00
(IMT2) Having a variety of services to handle the transferring of cargo from one mode to another	6.3	12.6	43.3	26.8	11.0	3.23	1.01
(IMT3) Having adequate connectivity for the multimodal interface	6.3	14.2	37.8	32.3	9.4	3.24	1.02
(IMT4) Having reliable service operations for the multimodal interface	7.1	13.4	34.6	36.2	8.7	3.25	1.03
(IMT5) Providing cost-effective multimodal operations	8.7	11.0	46.5	23.6	10.2	3.15	1.04
(IMT6) Evaluating alternative routes for the more efficient multimodal transport of containers via our Terminal	7.9	15.0	30.7	33.9	12.6	3.28	1.11
(SCIP1) Collaborating with other supply chain partners to plan for greater supply chain optimization	6.3	11.0	25.2	44.1	13.4	3.47	1.06
(SCIP2) Seeking to identify other competing supply chains for containers that might flow through our terminal	4.7	18.9	29.1	35.4	11.8	3.30	1.05
(SCIP3) Comparing the cost and time between cases using our terminal with cases using other competitive terminals	7.1	9.4	26.0	38.6	18.9	3.52	1.11
(SCIP4) Benchmarking the logistics options available for cargoes flowing through our terminal	7.1	10.2	31.5	37.8	13.4	3.40	1.07
(SCIP5) Seeking to identify least cost options for the transport of cargoes to hinterland destinations	7.9	19.7	25.2	31.5	15.7	3.27	1.17
(SCIP6) evaluating the performance of the transport modes available for linking our terminal to hinterland destinations	12.6	15.0	37.0	26.0	9.4	3.04	1.13

In addition it is worthwhile discussing the items regarding information sharing. The four items were ordered according to how likely supply chain members may share the information with terminal operators. Cargo tracking information is regarded as the basic information terminal operators are able to and make effort to provide. The extent to which other information, such as inventory, forecasting, marketing strategy is shared, would be depending on the extent to which the terminal operators are functionally involved with other supply chain members. The first item, ISCS1 which is 'Providing information concerning shipment and cargo tracking' obtained relatively high score

(mean=3.81). The second item, ISCS2, which is 'Sharing information concerning inventory management with supply chain members' obtained lower score (mean=3.3) than ISCS1. ISCS3 and ISCS4 were rated below 3, which may mean the respondents do not think that information concerning inventory management and marketing strategy is shared between terminal operators and other supply chain members.

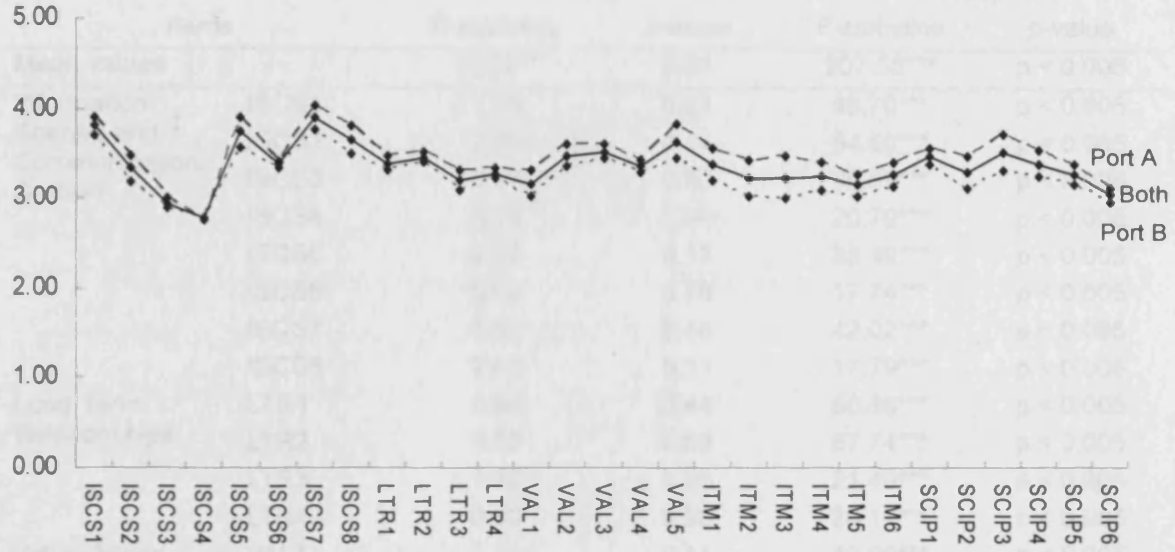
(2) Comparisons between ports and groups

The comparisons were made in the same way for the items for PSCI as they were for those of PSCO, and the results also were almost the same as those of PSCO. Port A was evaluated slightly better than Port B for all the items of PSCI, and the patterns of the responses were similar to each other as shown in Table 6.26 and Figure 6.4.

Table 6.26 Mean values of items for PSCI by port and group

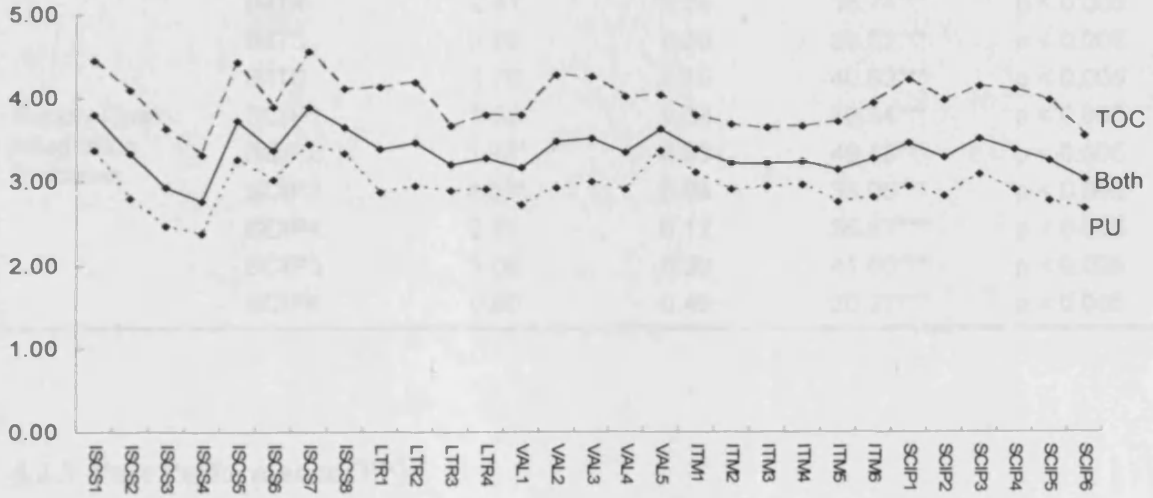
Items		Ports		Groups	
		Port A	Port B	TOC	PU
Information Sharing and Communication System	ISCS1	3.91	3.70	4.44	3.37
	ISCS2	3.48	3.18	4.10	2.81
	ISCS3	3.00	2.89	3.63	2.47
	ISCS4	2.76	2.79	3.33	2.39
	ISCS5	3.89	3.57	4.42	3.27
	ISCS6	3.41	3.34	3.88	3.03
	ISCS7	4.03	3.77	4.56	3.45
	ISCS8	3.80	3.49	4.12	3.33
Long-Term Relationships	LTR1	3.47	3.31	4.13	2.88
	LTR2	3.52	3.41	4.19	2.96
	LTR3	3.32	3.10	3.67	2.89
	LTR4	3.33	3.23	3.81	2.92
Value-Added Logistics	VAL1	3.32	3.02	3.81	2.73
	VAL2	3.61	3.36	4.29	2.93
	VAL3	3.61	3.44	4.27	3.01
	VAL4	3.42	3.30	4.02	2.91
	VAL5	3.83	3.44	4.04	3.37
Inter-Modal Transport	IMT1	3.58	3.21	3.81	3.12
	IMT2	3.42	3.03	3.69	2.92
	IMT3	3.47	3.00	3.65	2.96
	IMT4	3.41	3.10	3.67	2.97
	IMT5	3.27	3.03	3.73	2.76
	IMT6	3.41	3.15	3.94	2.83
Supply Chain Integration Practices	SCIP1	3.56	3.38	4.23	2.95
	SCIP2	3.48	3.11	3.98	2.84
	SCIP3	3.73	3.31	4.15	3.09
	SCIP4	3.55	3.25	4.12	2.91
	SCIP5	3.38	3.16	3.98	2.79
	SCIP6	3.12	2.97	3.56	2.69

Figure 6.4 Comparison between Port A and B



The TOC group evaluated their terminals far more positively than PU group did. All the items except for ISCS4 (mean=3.3) were rated above 3.5 points by TOC group while all the items were below 3.5 points by PU group as shown in Figure 6.5.

Figure 6.5 Comparison between TOC and PU groups



The ANOVA results for PSCI in Table 6.27 show that both differences of mean values between the sample ports and the sample groups were statistically significant. However, when it comes to the differences in terms of the individual items, most of the items turned out not to be evaluated significantly differently between Port A and B, while all the items showed significant differences between TOC and PU groups.

Table 6.27 ANOVA results for PSCI

Items		Ports		Groups	
		F-statistics	p-value	F-statistics	p-value
Mean values		13.32**	0.01	207.55***	p < 0.005
Information Sharing and Communication System	ISCS1	1.23	0.27	43.70***	p < 0.005
	ISCS2	2.25	0.14	54.50***	p < 0.005
	ISCS3	0.27	0.60	35.69***	p < 0.005
	ISCS4	0.02	0.90	20.79***	p < 0.005
	ISCS5	2.37	0.13	38.49***	p < 0.005
	ISCS6	0.09	0.76	17.74***	p < 0.005
	ISCS7	1.82	0.18	42.02***	p < 0.005
	ISCS8	2.60	0.11	17.79***	p < 0.005
Long-Term Relationships	LTR1	0.60	0.44	50.36***	p < 0.005
	LTR2	0.30	0.59	57.74***	p < 0.005
	LTR3	1.52	0.22	21.49***	p < 0.005
	LTR4	0.30	0.58	26.17***	p < 0.005
Value-Added Logistics	VAL1	2.52	0.11	40.00***	p < 0.005
	VAL2	1.50	0.22	66.91***	p < 0.005
	VAL3	0.74	0.40	63.58***	p < 0.005
	VAL4	0.48	0.50	46.89***	p < 0.005
	VAL5	4.90*	0.03	14.70***	p < 0.005
Inter-Modal Transport	IMT1	4.26*	0.04	16.21***	p < 0.005
	IMT2	4.82*	0.03	20.33***	p < 0.005
	IMT3	7.02**	0.01	15.84***	p < 0.005
	IMT4	2.91	0.09	15.74***	p < 0.005
	IMT5	1.69	0.20	33.52***	p < 0.005
	IMT6	1.76	0.19	40.63***	p < 0.005
Supply Chain Integration Practices	SCIP1	0.95	0.33	69.54***	p < 0.005
	SCIP2	3.97*	0.05	49.43***	p < 0.005
	SCIP3	4.50*	0.04	35.06***	p < 0.005
	SCIP4	2.51	0.12	56.27***	p < 0.005
	SCIP5	1.05	0.30	41.60***	p < 0.005
	SCIP6	0.60	0.45	20.37***	p < 0.005

6.2.3 Port Performance (PP)

Performance of the sample ports were also evaluated, with the items developed from existing studies and previous research. As previously discussed, the measures used to evaluate performance in this research are perceptual and soft measures rather than objective and hard measures because some aspects of performance are not possible to be measured objectively and some are very difficult information to obtain.

(1) Overall statistics

Similar to PSCO and PSCI, the mean values of the items for PP ranged from 3.44 (EFC3-3; EFF2-2; EFF2-3) to 3.92 (EFC1-2) as shown in Table 6.28. However, PP turned out to be rated a bit higher than PSCI and PSCO. 15 out of 21 items obtained greater than 3.5 points and 6 items were below 3.5 but very close to 3.5. In addition, EFC1 (Effectiveness-Service Quality) and EFF1 (Efficiency-Sea and land operation) were evaluated relatively better than EFC3 (Effectiveness-Service price) and EFF2 (Efficiency-Cargo operation). However, the relative differences were so large as to have significant implications.

Table 6.28 Descriptive statistics for PP

Items	1	2	3	4	5	Mean	SD
(EFC1-1) We provide a consistent reliable service	0.0	5.5	29.9	44.1	20.5	3.79	0.82
(EFC1-2) We handle cargoes on quoted or anticipated time	0.0	6.3	19.7	49.6	24.4	3.92	0.83
(EFC1-3) Annual number of complaints from customers	4.7	6.3	27.6	40.9	20.5	3.66	1.02
(EFC1-4) We handle cargoes on customers' time requirements	0.0	7.1	24.4	44.9	23.6	3.85	0.86
(EFC1-5) Our service lead-time is appropriate	1.6	6.3	38.6	34.6	18.9	3.62	0.91
(EFC1-6) We provide shipment information accurately	1.6	10.2	31.5	39.4	17.3	3.60	0.94
(EFC2-1) We respond promptly to the need of customers	2.4	17.3	29.9	31.5	18.9	3.47	1.06
(EFC2-2) We have quick decision making process	3.1	11.0	34.6	34.6	16.5	3.50	0.99
(EFC2-3) We are flexible in volume and type of cargo handling	2.4	15.7	29.1	30.7	22.0	3.54	1.07
(EFC2-4) We deal with unexpected events or situations well	0.8	12.6	32.3	38.6	15.7	3.55	0.93
(EFC3-1) Compared with competitors, our total service price is	2.4	15.7	33.1	24.4	24.4	3.52	1.09
(EFC3-2) Compared with competitors, our cargo handling charge is	3.9	15.0	33.1	26.0	22.0	3.47	1.11
(EFC3-3) Compared with competitors, our charge for auxiliary services is	3.9	14.2	35.4	26.0	20.5	3.44	1.08
(EFF1-1) Our cargo throughput per crane is	1.6	8.7	33.9	40.9	15.0	3.59	0.90
(EFF1-2) Our cargo throughput per acre is	1.6	7.9	36.2	44.1	10.2	3.53	0.84
(EFF1-3) Our ship waiting time is	0.8	7.1	38.6	36.2	17.3	3.62	0.88
(EFF1-4) Our ship turnaround time is	0.0	11.0	32.3	40.9	15.7	3.61	0.88
(EFF1-5) Our time for loading/unloading cargo is	0.8	8.7	33.9	40.9	15.7	3.62	0.88
(EFF2-1) Our time for mode transit is	0.0	9.4	46.5	33.1	11.0	3.45	0.81
(EFF2-2) Our time for truck entry is	0.0	18.1	33.1	35.4	13.4	3.44	0.93
(EFF2-3) Our time from cargo's entry to its exit is	0.0	12.6	44.1	29.9	13.4	3.44	0.87

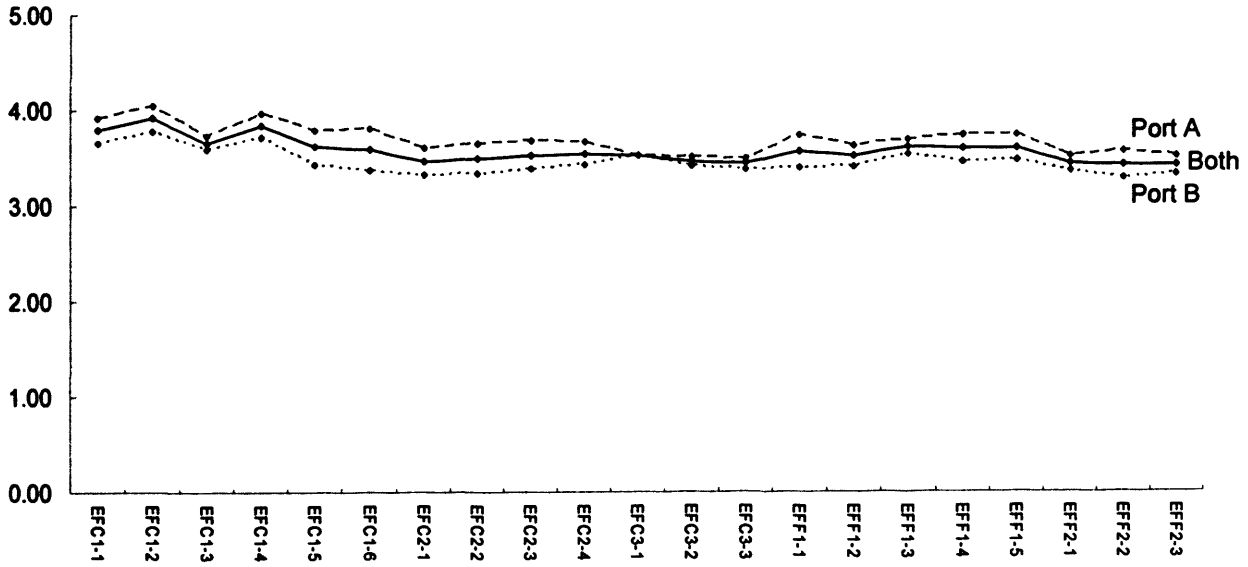
(2) Comparisons by port and group

Performance of terminals in Port A was evaluated slightly higher than those in Port B. However, according to the items in EFC3 which are 'the terminals' service prices (total service price; cargo handling charge; auxiliary service charge respectively) are competitive comparing competitors' competitiveness in terms of service price was almost same between Port A and B as shown in Table 6.29 and Figure 6.6.

Table 6.29 Mean values of items for PP by port and group

Items		Port		Group	
		Port A	Port B	TOCs	SCs
Service Quality	EFC1-1	3.92	3.66	4.29	3.45
	EFC1-2	4.05	3.79	4.42	3.57
	EFC1-3	3.73	3.59	4.31	3.21
	EFC1-4	3.97	3.72	4.44	3.44
	EFC1-5	3.80	3.44	4.12	3.29
	EFC1-6	3.82	3.38	4.15	3.23
Customer Orientation	EFC2-1	3.61	3.33	4.29	2.91
	EFC2-2	3.65	3.34	4.15	3.05
	EFC2-3	3.68	3.39	4.42	2.93
	EFC2-4	3.67	3.44	4.27	3.07
Service Price	EFC3-1	3.53	3.52	4.42	2.91
	EFC3-2	3.52	3.43	4.29	2.91
	EFC3-3	3.50	3.39	4.21	2.92
Sea and Land Operation	EFF1-1	3.76	3.41	3.87	3.40
	EFF1-2	3.64	3.43	3.83	3.33
	EFF1-3	3.70	3.54	4.10	3.29
	EFF1-4	3.74	3.48	4.10	3.28
	EFF1-5	3.74	3.49	4.04	3.33
Cargo Operation	EFF2-1	3.53	3.38	3.96	3.11
	EFF2-2	3.58	3.30	4.02	3.04
	EFF2-3	3.53	3.34	4.06	3.01

Figure 6.6 Comparison between Port A and B



The comparison by group also showed the same pattern as in PSCO and PSCI. The scores by PU group were considerably lower than those by TOC group and thus the average scores were pulled up by TOC group. However, Figure 6.7 shows the PU group also responded to the items in EFC1 (Service quality) and EFF1 (Sea and land operation) rather positively.

Figure 6.7 Comparison between TOC and PU groups

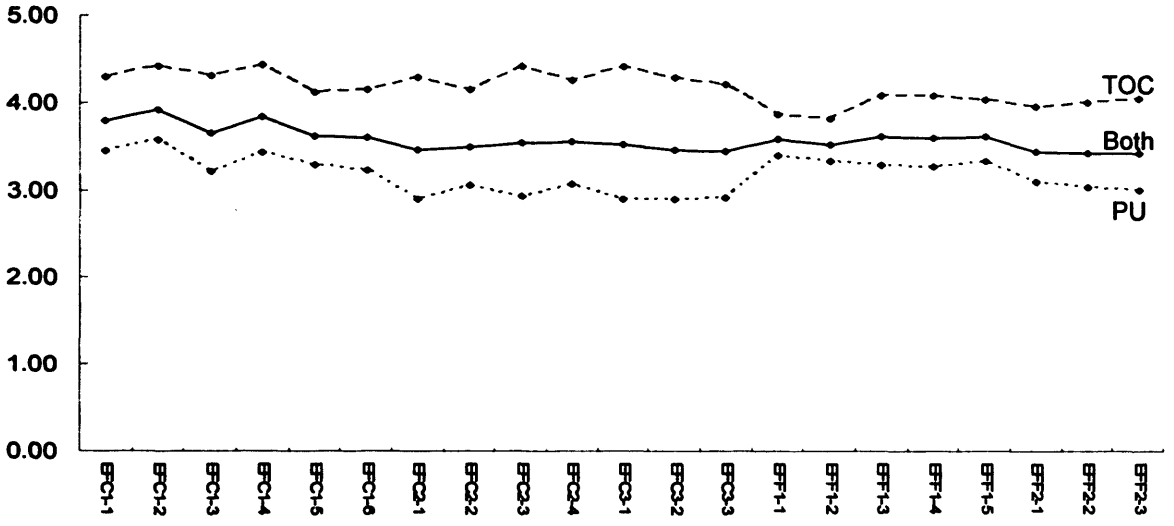


Table 6.30 ANOVA results for PP

Items		Port F-statistics	Port p-value	Group F-statistics	Group p-value
Mean values		28.08***	p < 0.005	281.82***	p < 0.005
Service Quality	EFC1-1	3.38	0.07	41.02***	p < 0.005
	EFC1-2	3.11	0.08	42.61***	p < 0.005
	EFC1-3	0.56	0.45	48.05***	p < 0.005
	EFC1-4	2.65	0.11	60.91***	p < 0.005
	EFC1-5	5.07	0.26	30.57***	p < 0.005
	EFC1-6	7.26	0.08	38.41***	p < 0.005
Customer Orientation	EFC2-1	2.20	0.14	88.28***	p < 0.005
	EFC2-2	3.05	0.83	52.50***	p < 0.005
	EFC2-3	2.30	0.13	110.12***	p < 0.005
	EFC2-4	1.85	0.18	85.54***	p < 0.005
Service Price	EFC3-1	0.001	0.98	108.92***	p < 0.005
	EFC3-2	0.20	0.65	75.54***	p < 0.005
	EFC3-3	0.30	0.58	65.21***	p < 0.005
Sea and Land Operation	EFF1-1	4.85*	0.03	8.66***	p < 0.005
	EFF1-2	1.98	0.16	11.40***	p < 0.005
	EFF1-3	0.99	0.32	31.69***	p < 0.005
	EFF1-4	2.95	0.09	32.93***	p < 0.005
	EFF1-5	2.60	0.11	23.11***	p < 0.005
Cargo Operation	EFF2-1	1.12	0.29	45.92***	p < 0.005
	EFF2-2	2.87	0.09	44.96***	p < 0.005
	EFF2-3	1.42	0.23	65.61***	p < 0.005

The ANOVA for PP also showed similar results to PSCO and PSCI as shown in Table 6.30. As for mean values, both differences between the sample ports and the sample groups were statistically significant. However, as for the differences in terms of the individual items, the performance of Port A and B was not significantly different, while TOC and PU groups evaluated the sample ports very significantly differently.

6.3 SUMMARY AND CONCLUSION

This chapter was devoted to providing descriptive statistics of the data collected from the questionnaire survey. First, the respondent profile was presented in Section 6.1. 127 usable responses were obtained and the overall response rate was 41%. Also, the characteristics of respondents, which presented employment period and position of the respondents, asserted that the respondents had sufficient knowledge and experience for providing accurate and reliable answers to the questionnaire. This included information about Korean ports and shipping industries to figure out how the sample ports and sample groups could be understood in the world and the South Korean context. It was shown that although both sample ports are a major port in South Korea, they have different characteristics and roles in logistics chains. Port A handles primarily container cargoes and is connected to main shipping routes, which means Port A can be considered as, so to speak, a hub port. In contrast, port B handles both general cargoes and container cargoes, showing strength in handling general cargoes, and generally connected to regional shipping routes, indicating Port B is a feeder port.

Subsequently, the average scores the respondents rated on the items representing PSCO, PSCI and PP in the questionnaire were described in Section 6.2. The average score of any item did not reach higher than 4 points, indicating that the respondents did not show strong agreement to the measurement items in evaluating the terminals in the sample ports. However, it did not go below 3 except for two items, implying the respondents generally evaluated the sample ports neutrally. The consistent pattern in comparing the sample ports and groups was that Port A was rated slightly higher than Port B, and the TOC group evaluated the sample ports more positively than the PU

group did. The ANOVA results showed that the difference between Port A and B is primarily statistically insignificant, but that between TOC and PU groups is statistically very significant.

The descriptive statistics provided a part of the whole picture of the collected data, and the comparisons showed how the respondents differently or similarly perceive about the phenomena this study is interested in. However, the ANOVA results are not likely to predict the results from the empirical analysis using SEM, because ANOVA concerns differences based on analysing variance, but SEM concerns causal relationships based on analysing covariance. What can be presumed for the multi-group analysis in SEM analysis at least is that it is likely that the sample groups show greater differences than the sample ports do.

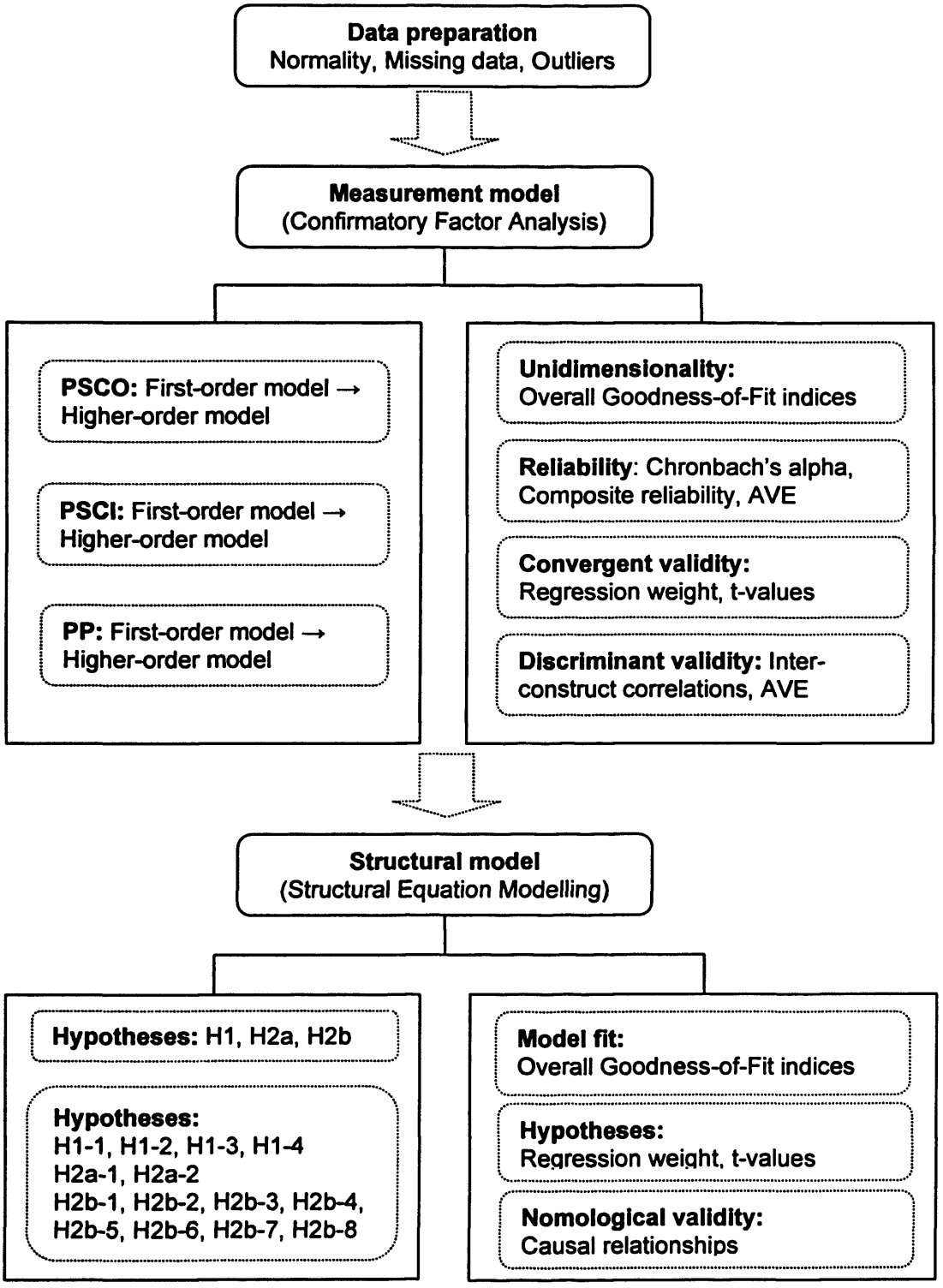
CHAPTER 7

EMPIRICAL ANALYSIS:

EXAMINING CAUSAL STRUCTURE

Chapter 6 focused on presenting the descriptive statistics of the data from the questionnaire survey. This chapter is dedicated to examining the research model and hypotheses developed and presented in Chapter 5. The research model and hypotheses primarily represent the causal relationships between Port Supply Chain Orientation (PSCO), Port Supply Chain Integration (PSCI) and Port Performance (PP). One of the hypotheses (H3) of this research concerns the applicability of the research model to different operational environments and interest groups. The examination of H3 is carried out in the following chapter, Chapter 8, titled a multi-group analysis. This research adopted a particular analytical tool which is Structural Equation Modelling (SEM) in order to test the hypotheses. The general process of SEM analysis was presented in Chapter 4 (see Section 4.4.3, Figure 4.10, p. 121). Figure 7.1 illustrates how this process is carried out specifically in this study. SEM analysis comprises primarily a measurement model and a structural model. The measurement model validates three measurement models which are PSCO, PSCI and PP. To this end, the measurement validity of these three measurement models is examined: unidimensionality, convergent validity, reliability and discriminant validity. First-order models of these measurement models which have only first-order factors are validated, and then higher-order models in which the higher order factors, PSCO, PSCI and PP, govern the first order factors are verified. In the structural model process, two waves of analysis are implemented.

Figure 7.1 Analysis process and flow



The first structural model tests the hypotheses proposing the causal relationships between the higher order factors which are PSCO, PSCI and PP (i.e. H1, H2a and H2b). The second structural model concerns the sub-hypotheses proposing the causal relationships between PSCI and the first order factors of PSCO and PP. Before

conducting the analysis, the collected data are screened preparing for the analysis by addressing issues of multivariate normality, missing data and outliers.

7.1 DATA PREPARATION

While SEM has enormous analytical power and advantages over other analytical techniques, it also has limitations and assumptions to be considered before conducting the analysis. General points on some issues, such as sample size and multivariate normality were discussed in Chapter 4 (see Section 4.4.2, p.115). Thus this section deals with the issues specifically regarding the collected data for this research.

7.1.1 Multivariate normality

SEM analysis in this research is carried out with the AMOS software package (version 6.0) using Maximum Likelihood (ML) functions as a default estimation technique. In this case, multivariate normality is relatively strictly applied because the violation of this assumption may cause some interesting results regarding model fit and factor loadings (West *et al.* 1995). Appendix E presents the assessment of multivariate normality of the collected data for PSCO, PSCI and PP, which is provided by the AMOS programme. The observed variables were largely negatively skewed with negative kurtosis. As for the variables of PSCO, 2 items are significantly negatively skewed and multivariate kurtosis (93.65 with critical ratio of 13.36) is also significant. 11 items of PSCI out of 27 have significant negative skewness and 1 item has significant negative kurtosis. In addition, multivariate kurtosis for PSCI items is relatively high and significant (93.65 with critical ratio of 13.34). PP has also 2 significantly negatively skewed items and 2 items with significant negative kurtosis. Multivariate kurtosis of PP is also significantly negative (64.13 with critical ratio of 11.63). These statistics imply that the data used in this research is non-normally distributed while the non-normality is not so serious. Among remedies suggested by researchers, this study applied the bootstrapping approach. This analysis performed a bootstrap on 200 samples using ML estimators. The bootstrapping was successfully performed for each analysis in this study.

7.1.2 Outliers

SEM analysis concerns multivariate outliers indicating an unusual combination of scores on two or more variables rather than univariate outliers which happen when cases have extreme values in a single variable (Hair *et al.* 2010). Multivariate outliers can be diagnosed with the Mahalanobis D^2 distance which is a measure of the distance in multidimensional space of each observation from the mean centre of the observations, providing a single value for each observation no matter how many variables are considered (Hair *et al.* 2010). This statistic is provided by the AMOS programme in the form of Appendix F. A large Mahalanobis distance score indicates observations farther removed from the general distribution of observations in this multidimensional space. Hair *et al.* (2010) suggested a conservative level of significance be used as the threshold value for designation as an outlier. According to this criterion, 2 responses for PSCI and 1 response for PP can be designated as outliers. However, researchers suggest outliers should be retained unless demonstrable proof indicates that they are truly aberrant and not representative of any observations in the population (Tabachnick and Fidell 2001). Thus, all the cases were retained.

7.1.3 Missing data

Missing data is one of the most pervasive problems in data analysis (Tabachnick and Fidell 2001) because the missing data may cause two main problems: (1) decreased statistical power and (2) biased parameter estimates (Hair *et al.* 2010). The presence of incomplete data can occur for a wide variety of reasons that are usually beyond the researcher's control: for example failure to answer certain items in the questionnaire, refusal to answer sensitive items, and so on. In general, there are three commonly applied strategies to treat the missing data problems: (1) listwise deletion, (2) pairwise deletion and (3) imputation (Byrne 2001). However none of these were necessary to consider because missing data were not found in the data set. No respondents marked on the N/A column. One respondent mistakenly marked a N/A column instead of on '5' column because they were adjacent in the questionnaire. This case was corrected with the agreement of the respondent. Some respondents sent back responses which did not contain answers to the whole questionnaire or some parts of the questionnaire by mistake. In these cases, they were asked to send responses again with full answers.

7.2 MEASUREMENT MODEL

The measurement model depicts the links between the latent variables and their observed measures. The measurement model is concerned with the extent to which the observed variables are generated by the underlying latent constructs, and thus strengths of the regression paths (i.e. factor loadings) from the latent variables to the observed variables are of primary interest. In addition, the validity of the measurement model is also a major concern. Focusing on these issues, the three measurement models which are PSCO, PSCI and PP are validated.

7.2.1 Criteria for assessing measurement model

In order to assess the measurement model, overall model fit and construct validity are the main concerns. The concept of construct validity and the method of assessing measurement validity were sufficiently discussed in Chapter 4 (see Section 4.3.3, p.108) in which six sub-dimensions of the construct validity were presented. Among them, content validity was not considered because it cannot be assessed in statistical ways. Instead the content validity of the research model in this study can be verified through a comprehensive literature review and qualitative interview study. In addition, nomological validity is tested in the following section (see Section 7.3). This section examines the remaining four dimensions of construct validity as suggested by researchers (e.g. Garver and Mentzer 1999; Min and Menzter 2004; Min *et al.* 2007). This study established the criteria to assess measurement models based on the suggestions and discussions given by researchers (e.g. Byrne 2001; Gefen *et al.* 2000; Hair *et al.* 2010; Tabachnick and Fidell 2001) as shown in Table 7.1.

Table 7.1 Criteria used for measurement model validity

Validity	Criteria
Overall model fit	χ^2/df <3, CFI>0.9, TLI>0.9, SRMR<0.08
Unidimensionality	
Reliability	Composite reliability>0.7 Average variance extracted (AVE) >0.5 Chronbach's alpha>0.7
Convergent validity	Widaman's comparison (Model0-Model1) Factor loadings are significant and greater than 0.5
Discriminant validity	Widaman's comparison (Model1-Model2) AVE >0.5 Inter-construct correlations<0.85 AVE>Squared inter-construct correlations

(Source: Tabulated by Author)

(1) Overall model fit and unidimensionality

While a number of fit indices are provided by the AMOS programme for overall model fit, all the indices do not need reporting. Researchers, instead, suggest that at least one incremental index and one absolute index, in addition to the chi-square value and the associated degrees of freedom (Kline 2005) are used. Frequently suggested and used sets of indices are the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) (which are incremental fit measures) and the Standardised Root Mean Squared Residual (SRMR) (which is an absolute fit measures), in addition to the chi-square value, degrees of freedom and the ratio between them (Hair *et al.* 2010). For CFI and TLI, values greater than 0.9 indicate an adequate fit, while some researchers propose more stringent criteria (e.g. Hu and Bentler 1999). SRMR represents badness of fit, so SRMR of 0.08 or less is evidence of good fit. The normed chi-square which is the ratio of the chi-square value to the associated degrees of freedom is suggested to be greater than 3. The same criteria are applied to unidimensionality because it has been suggested that unidimensionality be assessed by overall model fit rather than Chronbach's alpha or EFA (Anderson and Gerbing 1988).

(2) Scale reliability

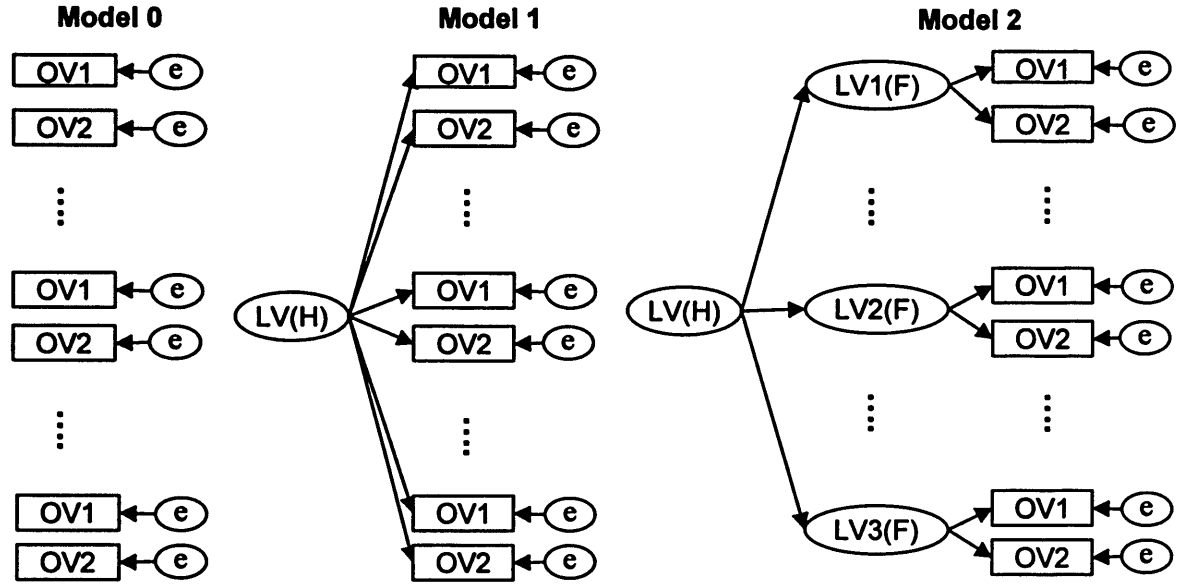
Composite Reliability (CR) and Average Variance Extracted (AVE) are reported together with Chronbach's alpha for measurement reliability. For either CR or Chronbach's alpha, 0.7 or higher is the rule of thumb. High CR value indicates that internal consistency exists, implying that the measures all consistently represent the same latent construct. Furthermore, AVE should equal or exceed 0.5 based on the logic that a higher AVE value occurs when indicator measurement errors are low (according to the formula of AVE; see Chapter 4, Section 4.3.3, p.108), which implies that the observed variables are truly representative of the latent construct.

(3) Convergent validity

Convergent validity can be tested by determining whether the items in a scale converge or load together on a single construct in the measurement model (Steenkamp and van Trijp 1991). For good evidence of convergent validity, the factor loadings in the measurement model should be substantial rather than statistically significant. This

means all the factor loadings need to be statistically significant and their estimates to be higher than at least 0.5 and preferably 0.7 (Garver and Mentzer 1999).

Figure 7.2 Widaman's three comparison models



(Source: Adapted from Min and Mentzer 2004)

As previously explained in Chapter 4 (see Section 4.3.3, p.112), convergent validity can also be tested by Widaman's comparison models as shown in Figure 7.2. Model 0 is a measurement model with individual measurement items as unique factors in a construct, Model 1 is a measurement model with individual items loaded on one unique first order factor, and Model 2 is a measurement model with individual items loaded on any one of the appropriate first order factors that, in turn, are loaded on the second order factor. A significant improvement in model fit of Model 1 over Model 0 suggests convergent validity (Min and Mentzer 2004).

(4) Discriminant validity

To assess discriminant validity, this study adopts two waves of tests: Widaman's comparison models and comparisons between AVE and squared inter-constructs correlations. In Widaman's comparison models, a significant improvement in model fit of Model 2 over Model 1 provides evidence of discriminant validity. The second wave is a more conservative approach which can provide good evidence of discriminant validity. This approach applies three criteria: (1) AVE of a construct exceeds 0.5

(Fornell and Larker 1981), (2) inter-correlation between constructs is less than 0.85 (Kline 2005), (3) AVEs are higher than the squared correlation estimates. The first criterion reflects the fact that higher AVE value occur when indicator measurement errors are low, which implies that the observed variables are truly representative of the latent construct. The second criterion is based on the logic that if the correlations are too high, the measure is not actually capturing distinctively. The third demonstrates the idea that a latent construct should explain more of the variance in its item measures than it shares with another construct (Hair *et al.* 2010).

7.2.2 Port Supply Chain Orientation (PSCO)

The PSCO measurement model was designed to test the multidimensional nature of PSCO. Specifically, this means the measurement model tests the hypothesis that PSCO is a multidimensional construct composed of four factors which are Financial Resources (FR), Human Resources (HR), Organisational Relationships (OR) and Top Management Support (TMS).

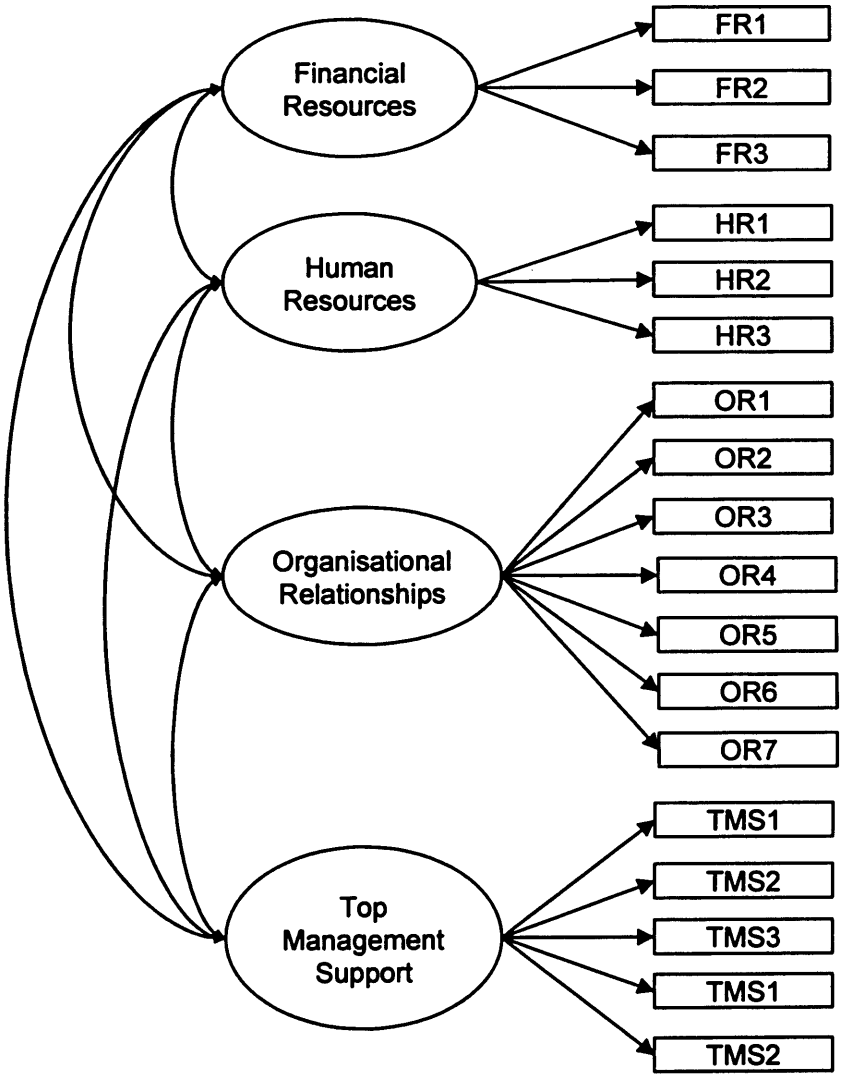
(1) First-order measurement model

Figure 7.3 illustrates the first-order PSCO measurement model. In this model, only first-order factors exist. The four constructs are inter-correlated as indicated by the two-headed arrows and there are 18 observed variables loading on the corresponding factors respectively as indicated by the one-headed arrows. The measurement model can be alternatively called Confirmatory Factor Analysis (CFA).

Table 7.2 shows the CFA results of the first-order PSCO measurement model. As for overall model fit, the chi-square value is 306.65 with 124 degrees of freedom and a probability of less than 0.001, suggesting that the hypothesised model is not entirely adequate. Literally interpreted, the hypothesised model should be rejected. However researchers have suggested that the chi-square statistic not be used as the sole model fit measure due to its limitation that it is very sensitive to sample size and model complexity. Therefore, other alternative indices were also reported. The normed chi-

square (χ^2/df=2.4) was lower than 3. CFI (=0.92) and TLI (=0.91) were slightly higher than 0.9. SRMR (=0.056) was also lower than 0.08. These results indicate that the hypothesised model has an acceptably good fit although it is not an excellent fit. Unidimensionality of this measurement model was also verified by these indices. The statistics for measurement reliability also met the criteria successfully: CR values of the four constructs are higher than 0.7, AVEs are higher than 0.5 and Chronbach's alpha values are higher than 0.7.

Figure 7.3 First-order PSCO measurement model



Convergent validity of this measurement model was assessed with factor loadings and t-values. All factor loadings on their corresponding constructs are high ranging from 0.67 to 0.91 and significant at the 0.001 significance level with their t-values higher than 3.29 (ranging from 3.5 to 14.7). The comparison between M0 and M1 in Table 6.3 also shows evidence of convergent validity. It is clearly seen that all the fit indices of

M1 were improved from M0. The difference in chi-square ($\Delta\chi^2$=1315.726) was statistically very significant with differences in degrees of freedom of 18. In addition M1 achieved a model fit almost close to good fit while M0 showed very poor fit.

Table 7.2 CFA result for PSCO: First-order measurement model

Construct		Regression Weight	t-value	R^2	Composite Reliability	AVE	Chronbach's Alpha
Financial Resources	FR1	0.67	-	0.44	0.86	0.68	0.87
	FR2	0.89	3.6***	0.79			
	FR3	0.90	3.5***	0.82			
Human Resources	HR1	0.84	4.2***	0.70	0.87	0.71	0.87
	HR2	0.89	5.3***	0.79			
	HR3	0.77	-	0.60			
Organisational Relationships	OR1	0.72	-	0.52	0.94	0.69	0.94
	OR2	0.77	12.9***	0.60			
	OR3	0.88	9.8***	0.77			
	OR4	0.89	10.0***	0.79			
	OR5	0.85	9.4***	0.71			
	OR6	0.87	9.7***	0.75			
	OR7	0.84	9.4***	0.71			
Top Management Support	TMS1	0.87	8.4***	0.76	0.93	0.73	0.93
	TMS2	0.91	-	0.82			
	TMS3	0.87	14.7***	0.75			
	TMS4	0.84	13.4***	0.75			
	TMS5	0.74	9.9***	0.55			
Overall Goodness-of-Fit Indices χ^2=306.65 (df=124, p<0.001); χ^2/df=2.4; CFI=0.92; TLI=0.91; SRMR=0.056							

Note: *** p<0.001

Table 7.3 and 7.4 provide information for assessing the discriminant validity of the PSCO measurement model. The significant difference in chi-square statistics and clear improvement in model fit of M2 in Table 7.3 shows evidence of discriminant validity.

Table 7.3 Widaman's comparison models for PSCO

	M0	M1	M2	M1-M0	M2-M1
χ^2	1828.947	513.221	311.33	1315.726	201.892
d.f	148	130	126	18	4
CFI	0.27	0.83	0.92	improved	improved
TLI	0.25	0.80	0.90	improved	improved
SRMR	0.55	0.073	0.057	improved	improved

Table 7.4 Comparing AVE and inter-construct correlations

	FR	HR	OR	TMS
FR	**0.68**	0.4	0.5	0.45
HR	0.66***	**0.71**	0.59	0.71
OR	0.71***	0.77***	**0.69**	0.79
TMS	0.67***	0.84***	0.89***	**0.73**

Note: *** p<0.001; ** p<0.01; * p<0.05

In Table 7.4, the numbers on the diagonal line are AVEs of four first-order constructs and they are all higher than 0.5. The numbers under the diagonal line represent correlation estimates between four constructs. They are lower than 0.85 and significant at the 0.001 significance level, except for the correlation between OR and TMS (=0.89). The shaded cells show the squared correlation estimates. The squared correlation between HR and FR (=0.4) is lower than both AVE of HR (=0.71) and of FR (=0.68). Similarly, the squared correlations between two constructs among the four constructs are lower than their individual AVE. However, the squared correlation between OR and TMS (=0.79) is higher than the AVE of both constructs (0.69 and 0.73 respectively). This was initially expected to some extent and is excusable because these four constructs are sub-dimensions of PSCO (higher order construct) and relatively high correlations are required to specify a higher-order factor model. Based on this assessment, discriminant validity was supported for the PSCO first-order measurement model.

(2) Higher-order measurement model

The higher-order measurement model of PSCO was specified as shown in Figure 7.4. Four first-order factors measured by their corresponding measurement items are explained by a second order factor, PSCO. Thus, now the first-order factors are used as measurement indicators for the second-order factor. Theoretically specifying this higher-order measurement model is justified because the first-order factors were identified as components of PSCO through the interviews with practitioners and academics in Chapter 5 (see Section 5.2.4, p.153). The four first-order factors capture different aspects of terminal management with regard to logistics and SCM issues, and they can be driven by the PSCO a Terminal Operating Company (TOC) has. Therefore, PSCO cannot be viewed as a construct with the same level of abstraction as the first-order constructs. In other words, the PSCO of a TOC is difficult to measure directly, but it can be more easily indicated by more tangible factors, i.e. the four first-order factors. For statistical justification, the higher-order measurement model also needs to be evaluated in terms of model fit and construct validity, while the first-order measurement model was validated successfully. The overall model fit is acceptably good. The normed chi-square (=2.47) is lower than 3 and both CFI and TLI are marginally higher than 0.90. SRMR (=0.057) also met its criteria (<0.08). The factor

loadings of the first-order factors on PSCO are statistically significant at a 0.001 significance level and higher than 0.7 (ranging from 0.74 to 0.96). Thus the higher-order PSCO measurement model was validated as shown in Table 7.5. The nomological validity of the PSCO also needs to be assessed. However it can be tested in a structural model because theoretically PSCO is expected to correlate positively to PSCI.

Figure 7.4 Higher-order PSCO measurement model

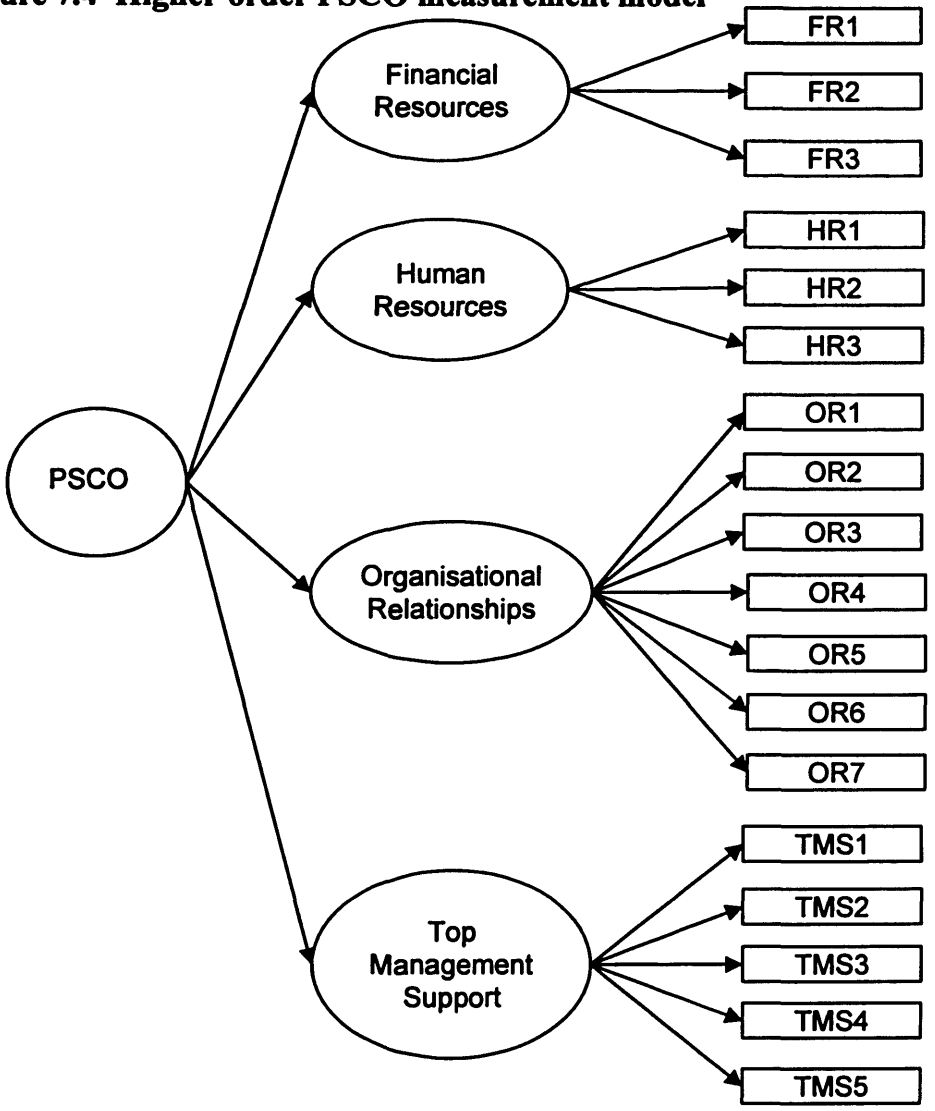


Table 7.5 CFA result for PSCO: Higher-order measurement model

Construct		Regression Weight	t-value	R^2
PSCO	FR	0.74	6.9***	0.54
	HR	0.87	-	0.76
	OR	0.92	8.0***	0.85
	TMS	0.96	8.6***	0.92

Overall Goodness-of-Fit Indices
χ^2=311.33(df=126, p<0.001); χ^2/df=2.47; CFI=0.92; TLI=0.90; SRMR=0.057

Note: *** p<0.001

The higher-order model was compared in model fit with the first-order factor model to consider efficacy of using the higher-order measurement model in a hypothesis test in Table 7.6. The first-order model is better in absolute terms with the chi square difference of 4.71 (df=2). However this is taken for granted because the first-order model uses more paths to capture the same amount of covariance. In contrast, the higher-order model (CAIC=574.321) shows superiority in terms of parsimony to the first-order model (CAIC-581.332) because it consumes fewer degrees of freedom. CAIC is one of the parsimonious fit indices representing a better fit with smaller values. The other fit indices did not show differences between the two models. In conclusion, the higher-order model can be specified because it is theoretically justified and no problem was found statistically.

Table 7.6 Comparison between first-order and higher-order model

	First-order	Higher-order	Comparison
χ^2	306.62	311.33	4.71
d.f	124	126	2
CFI	0.92	0.92	No difference
TLI	0.90	0.90	No difference
SRMR	0.056	0.057	No difference
CAIC	581.332	574.321	

7.2.3 Port Supply Chain Integration (PSCI)

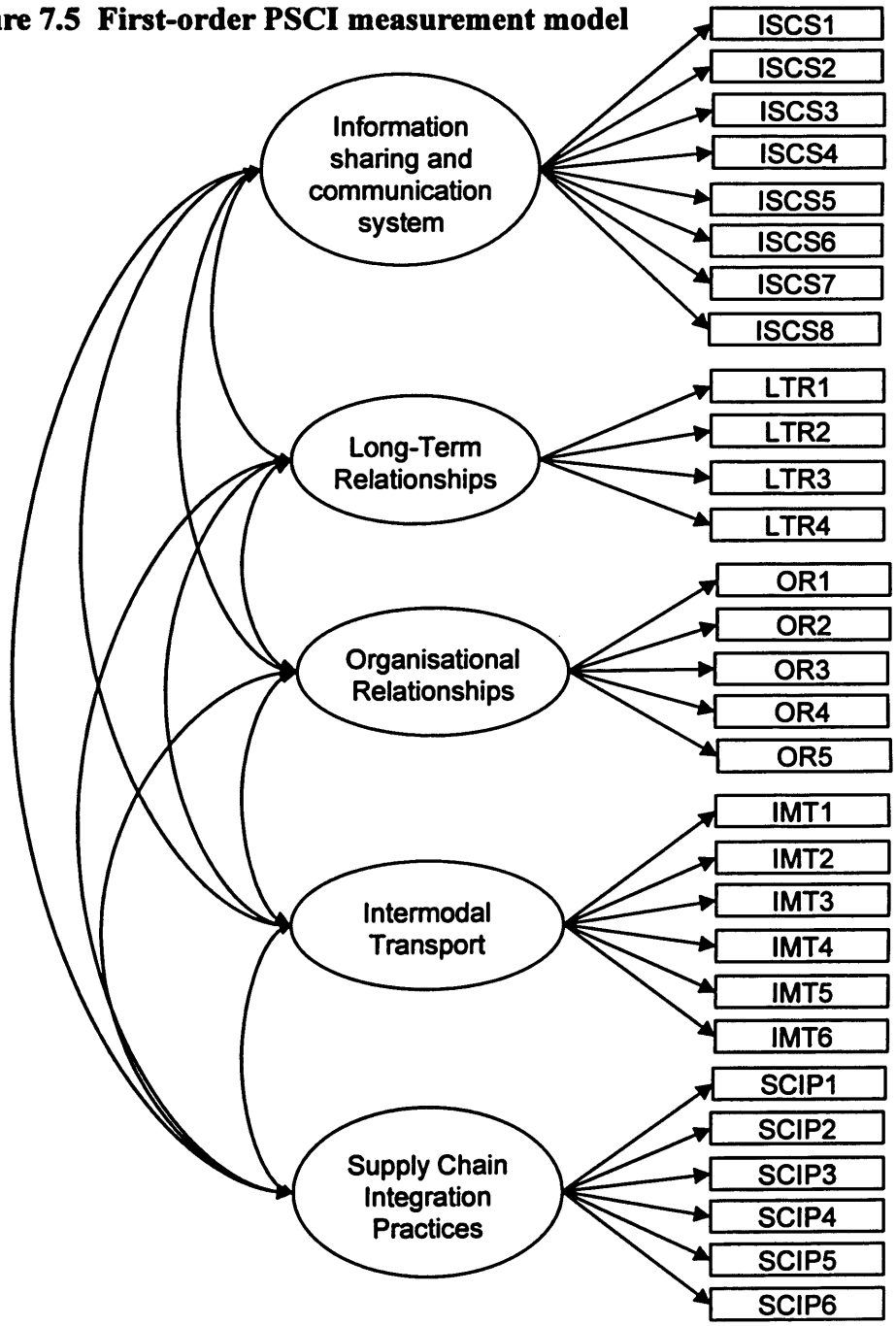
The PSCI measurement model was specified based on the theoretical investigation carried out in Chapter 3 (Literature review) and Chapter 5 (Interview study). The main findings of the investigation were that PSCI is a multidimensional construct composed of five constructs as shown in Figre 7.5: Information Sharing and Communication System (ISCS), Long-Term Relationships (LTR), Value-Added Logistics (VAL), Intermodal Transport (IMT) and Supply Chain Integration Practices (SCIP).

(1) First-order measurement model

Figure 7.5 shows the illustration of the first-order PSCI measurement model in which the 5 constructs are inter-correlated with two-headed arrows and 29 observed variables loaded on the corresponding constructs respectively. The result of an initial analysis including all the observed variables showed an unacceptable model fit: χ^2=800.380

(df=358, p<0.001); χ^2/df=2.23; CFI=0.87; TLI=0.85; SRMR=0.0642. Therefore, problems causing bad fit were diagnosed. All the standardised factor loadings were significant, but some factor loadings were less than 0.7 (ISCS3=0.637; ISCS4=0.584; ISCS8=0.640). Consequently standardised residuals were checked and there were none found greater than |4.0|, but the highest was close to 4.0, which was 3.3 between ISCS3 and ISCS4. It is suggested that standardised residuals between |2.5| and |4.0| require attention (Hair *et al.* 2010).

Figure 7.5 First-order PSCI measurement model



Regarding Modification Indices (MI), large MIs for both factor loadings and error terms were examined. For factor loadings, the MI values above 20.0 were found to be associated with ISCS3 and ISCS4: ISCS4→ISCS3=23.08, ISCS3→ISCS2=22.37, ISCS3→ISCS4=20.53. The two largest MI values for the error term were also involved with ISCS3 and ISCS4: ISCS3↔ISCS4=36.33; ISCS2↔ ISCS3=39.49.

According to this diagnostic process, the problematic items, ISCS3 and ISCS4, were spotted, and respecification needed to be considered. One possible option is to drop these two items. However, when making model modification, theory should be considered, and even problematic items, at times, can be retained for content validity and construct validity (Hair *et al.* 2010). The items, ISCS3, ISCS4 and ISCS2 were newly identified from the interview study in Chapter 5 (see Section 5.2.3, p.149). The items from ISCS1 to ISCS4 are all to measure the degree of 'information sharing': 'Providing information concerning shipment and cargo tracking (ISCS1)', 'Sharing information concerning inventory management (ISCS2), demand forecasting (ISCS3) and marketing strategy (ISCS4)'. The interviewees demonstrated that the quality and level of the information shared among supply chain members matter. As discussed, the provision of cargo shipment and cargo tracking information is considered as a 'must-do' for modern container terminals. Therefore, it is necessary to retain the items which make a difference between TOCs which have a high level of PSCI.

Another option is to retain the two problematic items and consider what MIs suggest. Both MIs for factor loadings and error terms suggest that two items, ISCS2 and ISCS3, and the other two items, ISCS3 and ISCS4, are closely related respectively. It can be argued that they appear to elicit responses reflective of the same phenomenon. Given that cargo tracking information is a basic requirement for PSCI, these three items may reflect a higher level of information sharing. Once one of these three kinds of information is shared between supply chain members in a supply chain, the other two kinds of information are likely to be shared in the supply chain. Another point, considering what the MIs suggest, is that ISCS3 may be correlated with ISCS2 and ISCS4 respectively, but ISCS2 and ISCS4 may not be. It is also logically reasonable. Inventory management is much affected by ordering policy and the ordering policy is

variable depending on demand forecasting. Thus, the inventory management related information is likely to be shared together with demand forecasting related information. In addition, the forecast demand pattern is supposed to be reflected when setting up a marketing strategy. On the basis of the substantiated rationales, the error terms of ISCS2 and ISCS3 and the error terms ISCS3 and ISCS4 were specified as a free parameter.

Table 7.7 CFA result for PSCI: First-order measurement model

Construct		Regression Weight	t-value	R^2	Composite Reliability	AVE	Chronbach's Alpha
Information Sharing & Communication System	ISCS1	0.78	10.4***	0.61	0.89	0.67	0.89
	ISCS2	0.70	8.9***	0.46			
	ISCS3	0.60	7.2***				
	ISCS4	0.54	6.4***				
	ISCS5	0.86	-	0.74			
	ISCS6	0.67	8.6***	0.45			
	ISCS7	0.80	11.0***	0.66			
	ISCS8	0.66	8.2***	0.45			
Long-Term Relationships	LTR1	0.90	-	0.81	0.90	0.67	0.89
	LTR2	0.92	15.7***	0.84			
	LTR3	0.66	8.6***	0.44			
	LTR4	0.77	15.7***	0.59			
Value-Added Logistics Services	VAL1	0.77	-	0.59	0.91	0.67	0.92
	VAL2	0.93	13.3***	0.86			
	VAL3	0.86	10.1***	0.74			
	VAL4	0.86	10.2***	0.74			
	VAL5	0.65	7.4***	0.42			
Intermodal Transport	IMT1	0.76	-	0.58	0.90	0.61	0.92
	IMT2	0.74	12.1***	0.55			
	IMT3	0.72	8.4***	0.53			
	IMT4	0.78	9.0***	0.60			
	IMT5	0.80	9.2***	0.64			
	IMT6	0.88	9.8***	0.77			
Supply Chain Integration Practices	SCIP1	0.89	-	0.79	0.94	0.71	0.93
	SCIP2	0.88	14.3***	0.77			
	SCIP3	0.87	14.1***	0.75			
	SCIP4	0.90	15.0***	0.81			
	SCIP5	0.79	11.5***	0.62			
	SCIP6	0.71	9.8***	0.50			
Overall Goodness-of-Fit Indices χ^2=721.773(df=356, p<0.001); χ^2/df=2.0; CFI=0.90; TLI=0.88; SRMR=0.061							

Note: *** p<0.001

Table 7.7 shows the CFA results of the modified first-order PSCI measurement model. The normed chi-square (=2.0) is lower than 3, but CFI (=0.90) and TLI (=0.88) marginally met the suggested level. SRMR (=0.061) is lower than 0.08. This suggests that the overall model fit is marginally acceptable and unidimensionality is also

marginally verified. CR values, AVEs and Chronbach's alpha also met the criteria establishing scale reliability. Factor loadings were all significant at the 0.001 significance level and mostly higher than 0.7 except for 6 items. However, among 6 items, 4 items' factor loadings were close to 0.7 (ISCS6=0.66; ISCS8=0.67; LTR=0.66; VAL=0.65) and the others (ISCS3=0.60; ISCS4= 0.54) were retained despite their low factor loadings for the reasons explained above. While convergent validity was verified by examining factor loadings, comparison between M0 and M1 also provided as such evidence as shown in Table 6.8. The difference in chi-square statistics ($\Delta\chi^2$=1807.589; Δdf=29) was significant and M1 achieved much better model fit than M0 did.

Table 7.8 Widaman's comparison models for PSCI

	M0	M1	M2	M1-M0	M2-M1
χ^2	2783.090	975.501	736.903	1807.589	238.589
d.f	395	366	361	29	5
CFI	0.32	0.83	0.90	improved	improved
TLI	0.31	0.81	0.88	improved	improved
SRMR	0.49	0.078	0.065	improved	improved

Comparison between M1 and M2 in Table 7.8 provides evidence of the discriminant validity of the PSCI measurement model. All the model fit indices were substantially improved by specifying the model with the 5 first-order constructs and 1 second-order model construct. Discriminant validity was assessed with the more conservative method in Table 7.9. All the AVE values of the five constructs on the diagonal line were higher than 0.5. The inter-construct correlations were 0.85 or less except for one between VAL and SCIP. Some correlations were higher than their individual AVE, which took place particularly in the correlations associating SCIP. However this result was expected considering that this method applied the very conservative criteria and the constructs were required to be highly correlated for specifying the higher-order measurement model.

Table 7.9 Comparing AVEs with inter-construct correlations

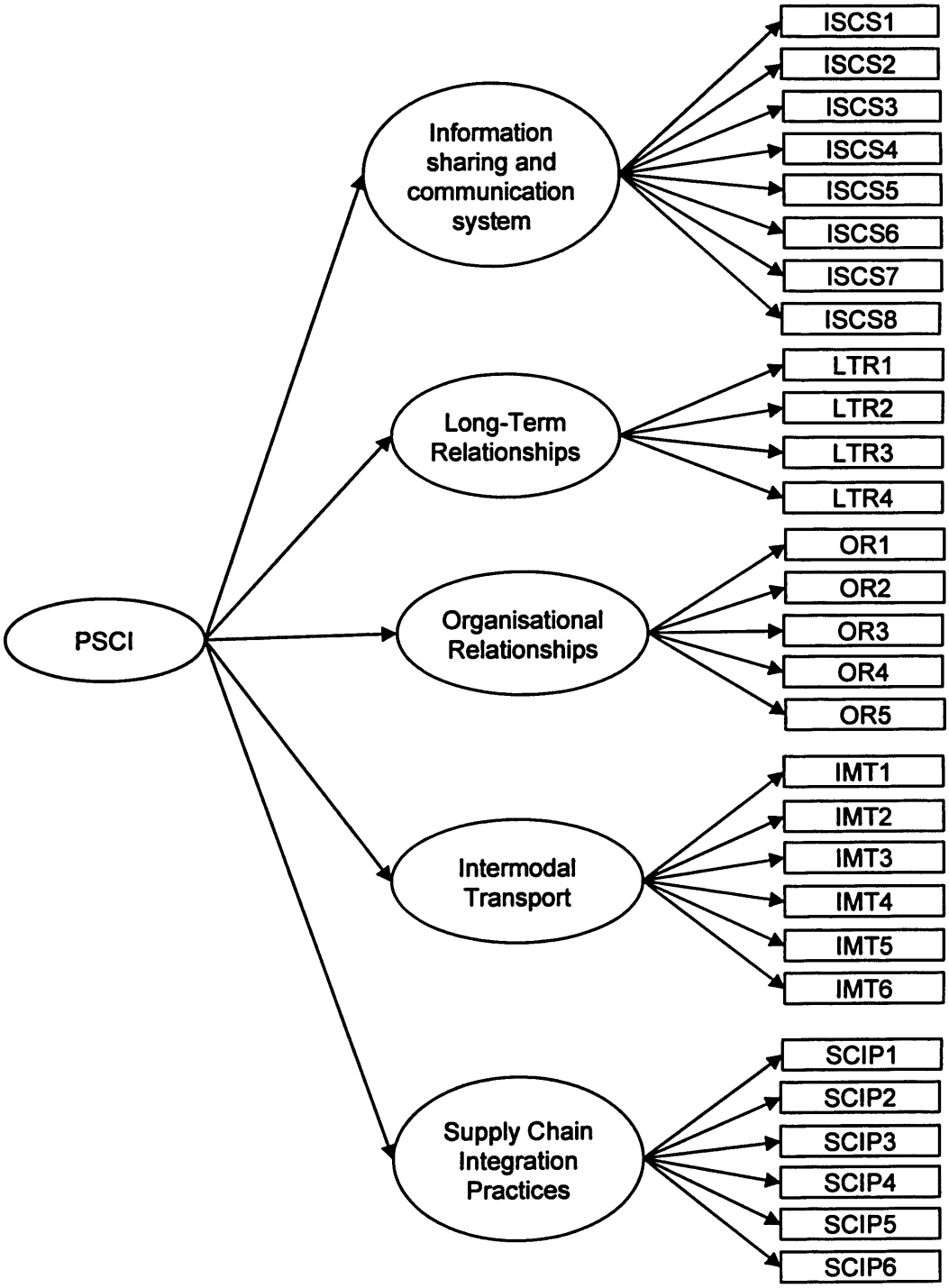
	ISCS	LTR	VAL	IMT	SCIP
ISCS	**0.67**	0.72	0.66	0.41	0.72
LTR	0.85***	**0.67**	0.66	0.48	0.70
VAL	0.82***	0.81***	**0.67**	0.58	0.75
IMT	0.64***	0.69***	0.76***	**0.61**	0.67
SCIP	0.85***	0.84***	0.87***	0.82***	**0.71**

Note: *** p<0.001; ** p<0.01; * p<0.05

(2) Higher-order measurement model

The higher-order PSCI measurement model was specified with a second-order construct, PSCI, and 5 first-order constructs, hypothesizing PSCI explains the five first-order constructs as illustrated in Figure 7.6.

Figure 7.6 Higher-order PSCI measurement model



Theoretically, the first constructs represent the integration strategies and activities of terminal operators along supply chains, and they can be driven by the higher level of inter-organisational strategies, i.e. PSCI. This means PSCI should be placed in a higher layer of constructs. Statistically, the overall model fit met the suggested criteria marginally and the factor loadings were also substantial: all the factor loadings were significant at the 0.001 significance level and greater than 0.7 ranging from 0.82 to 0.96 as shown in Table 7.10.

Table 7.10 CFA result for PSCI: Higher-order measurement model

Construct		Regression Weight	t-value	R^2
PSCI	ISCS	0.90	-	0.86
	LTR	0.89	10.0***	0.78
	VAL	0.91	8.7***	0.83
	IMT	0.82	7.8***	0.67
	SCIP	0.96	10.7***	0.93

Overall Goodness-of-Fit Indices
χ^2=736.90(df=361, p<0.001); χ^2/df=2.04; CFI=0.90; TLI=0.88; SRMR=0.065

Note: *** p<0.001

In terms of the efficacy of hypotheses testing, the higher-order model can also be supported. Although the higher-order model showed inferiority in absolute terms and superiority in terms of parsimony as shown in Table 7.11, it does not mean the higher-order model should not be used or not because the higher-order models have such statistical characteristics. If the research questions require a higher-order model and it is not significantly statistically inferior to the first-order model, a higher-order model can be justified. According to Table 7.11, the higher-order PSCI measurement model is supported.

Table 7.11 Comparison between first-order and higher-order models

	First-order	Higher-order	Comparison
χ^2	721.77	736.90	15.13
d.f	356	361	5
CFI	0.90	0.90	No difference
TLI	0.88	0.88	No difference
SRMR	0.061	0.065	No difference
CAIC	1183.463	1169.373	

7.2.4 Port Performance (PP)

The PP (Port performance) measurement model was hypothesised to have two sub-dimensions, which are Effectiveness (EFC) and Efficiency (EFF). However the theoretical investigation demonstrated that the two sub-dimensions, EFC and EFF, were very difficult to be measured directly and they were also multi-dimensional concepts. Therefore EFC and EFF need to be validated as a second-order measurement model and PP is examined as a third-order measurement model.

(1) First-order measurement models: EFC and EFF

The first-order EFC measurement model is composed of three constructs: service quality (EFC1), customer orientation (EFC2) and service price (EFC3) based on the existing literature and previous studies as illustrated in Figure 7.7. The first-order EFF measurement model also comprises two constructs: sea and land operation (EFF1) and cargo operation (EFF2) as shown in Figure 7.8

Figure 7.7 First-order EFC measurement model

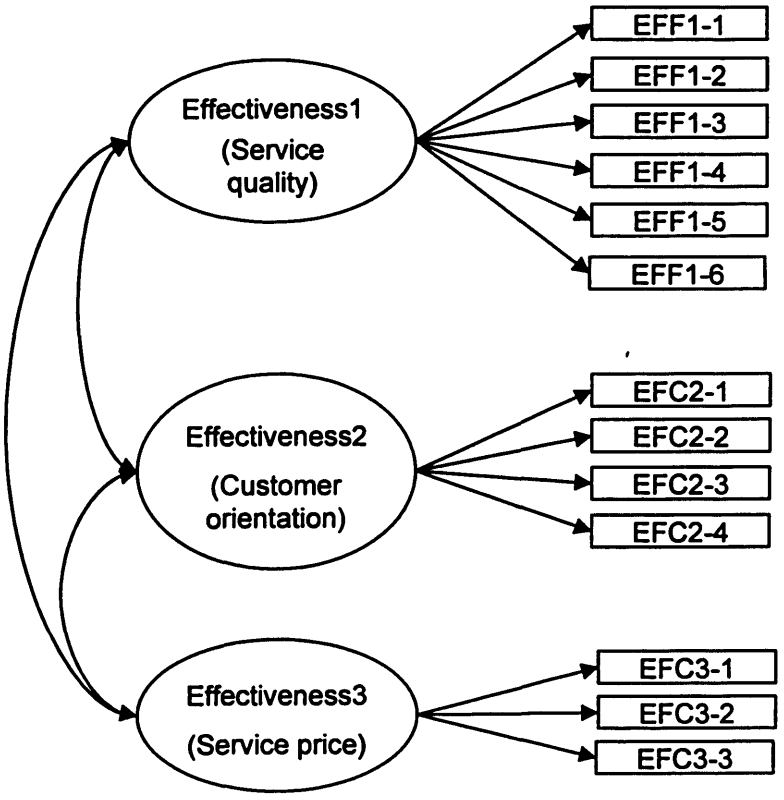


Figure 7.8 First-order EFF measurement model

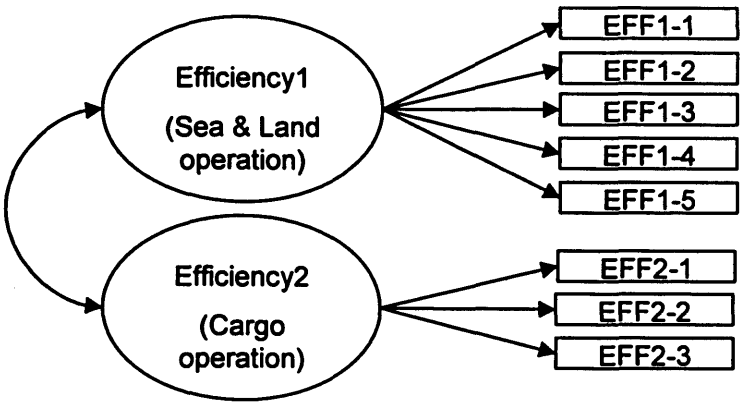


Table 7.12 shows the CFA results of EFC measurement models. The indices for overall model fit suggest good model fit: the normed chi-square was 2.6; CFI, 0.94; TLI, 0.93 and SRMR, 0.048. The standardised regression weights were all significant at the 0.001 significance level and greater than 0.7 ranging from 0.71 to 0.97. CR and Chronbach's alpha values were all higher than 0.7 and AVE values were also higher than 0.5, indicating scale reliability.

Table 7.12 CFA result for PP-Effectiveness: First-order measurement model

Construct		Regression Weight	t-value	R^2	Composite Reliability	AVE	Chronbach's Alpha
Effectiveness1	EFC1-1	0.83	-	0.69	0.93	0.70	0.93
(Service quality)	EFC1-2	0.86	12.1***	0.75			
	EFC1-3	0.71	9.2***	0.51			
	EFC1-4	0.90	13.0***	0.82			
	EFC1-5	0.89	12.7***	0.78			
	EFC1-6	0.81	10.9***	0.65			
Effectiveness2	EFC2-1	0.89	-	0.79	0.93	0.77	0.93
(Customer	EFC2-2	0.88	14.4***	0.77			
orientation)	EFC2-3	0.91	15.5***	0.82			
	EFC2-4	0.84	12.9***	0.71			
Effectiveness3	EFC3-1	0.93	-	0.87	0.95	0.88	0.95
(Service price)	EFC3-2	0.97	22.3***	0.93			
	EFC3-3	0.91	18.5***	0.83			
Overall Goodness-of-Fit Indices							
χ^2=160.01(df=61, p<0.001); χ^2/df=2.6; CFI=0.94; TLI=0.93; SRMR=0.048							

Note: *** p<0.001

The first-order EFF measurement model achieved good model fit according to Table 7.13. Factor loadings were significant at the 0.001 significance level. Although some

factor loadings were lower than 0.7 (EFF1-2=0.53; EFF1-3=0.59), they were retained because they are to reflect important aspects of operational efficiency and there were no problematic diagnostic information on the items. Scale reliability was also verified.

Table 7.13 CFA result for PP-Efficiency: First-order measurement model

Construct		Regression Weight	t-value	R^2	Composite Reliability	AVE	Chronbach's Alpha
Efficiency1	EFF1-1	0.67	-	0.45	0.93	0.70	0.93
	EFF1-2	0.53	9.0***	0.29			
	EFF1-3	0.59	6.2***	0.35			
	EFF1-4	0.94	9.2***	0.88			
	EFF1-5	0.93	9.2***	0.86			
Efficiency2	EFC2-1	0.76	-	0.58	0.93	0.77	0.93
	EFC2-2	0.95	11.3***	0.90			
	EFC2-3	0.92	11.3***	0.85			
Overall Goodness-of-Fit Indices							
χ^2=50.78(df=18, p<0.001); χ^2/df=2.8; CFI=0.96; TLI=0.93; SRMR=0.060							

Note: *** p<0.001

Convergent validity of the EFC and EFF measurement models were also confirmed by Table 7.14. Comparison between M0 with all measurement items in these measurement models as unique factor and M1 with the individual items load on one unique first order factor showed clear improvement in model fit.

Table 7.14 Widaman's comparison models for PP

	M0	M1	M2	M1-M0	M2-M1
χ^2	2639.490	1049.213	390.013	1590.277	201.892
d.f	208	187	181	21	6
CFI	0.062	0.69	0.93	improved	improved
TLI	0.053	0.65	0.91	improved	improved
SRMR	0.55	0.085	0.069	improved	Improved

Table 7.15 Discriminant validity: PP

	EFC1	EFC2	EFC3	EFF1	EFF2
EFC1	**0.70**	0.71	0.52	0.56	0.40
EFC2	0.84***	**0.77**	0.61	0.37	0.44
EFC3	0.72***	0.78***	**0.88**	0.32	0.38
EFF1	0.75***	0.61***	0.57***	**0.65**	0.40
EFF2	0.63***	0.66***	0.62***	0.63***	**0.81**

Note: *** p<0.001; ** p<0.01; * p<0.05

Comparison between M1 and M2 also demonstrated discriminant validity for these two measurement models showing a significant model fit improvement. The measurement models' discriminant validity was also assessed by Table 7.15. AVE values of the constructs on the diagonal line were higher than 0.5 and the inter-construct correlations were less than 0.85 and significant at the 0.001 significance level. The squared correlations estimates were less than the individual AVE value, while the squared correlation between EFC2 and EFC1 (=0.71) was almost the same as the AVE of EFC1 (=0.70).

(2) Higher-order measurement model

Both EFC and EFF measurement models were specified as second-order measurement models as shown in Figure 7.9 and 7.10. Once these second-order models are validated, the third-order measurement model, PP, is tested. Table 7.16 and 7.17 suggest both second-order models achieved as good a fit as their first-order models: for EFC, χ^2/df=2.6; CFI=0.94; TLI=0.93; SRMR=0.048 and, for EFF, χ^2/df=2.8; CFI=0.96; TLI=0.93; SRMR=0.060. All the factor loadings were significant at the 0.001 significance level and very high, ranging from 0.82 to 0.91. This suggests that these second-order measurement models can be used for hypotheses testing as they did not have statistical inferiority to their first-order models.

Figure 7.9 Second-order EFC measurement model

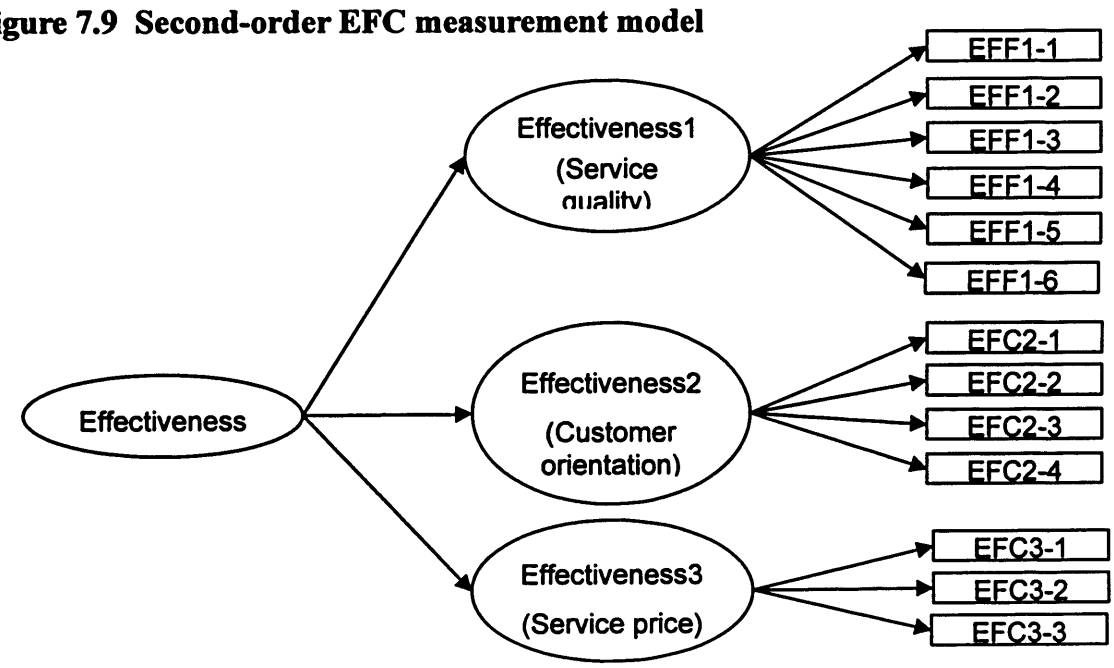


Table 7.16 CFA result for EFC: Higher-order measurement model

Construct		Regression Weight	t-value	R^2
Effectiveness	EFC1	0.88	-	0.78
	EFC2	0.95	9.2***	0.91
	EFC3	0.82	8.7***	0.67
Overall Goodness-of-Fit Indices				
χ^2=160.01(df=61, p<0.001); χ^2/df=2.6; CFI=0.94; TLI=0.93; SRMR=0.048				

Note: *** p<0.001

Figure 7.10 Second-order EFF measurement model

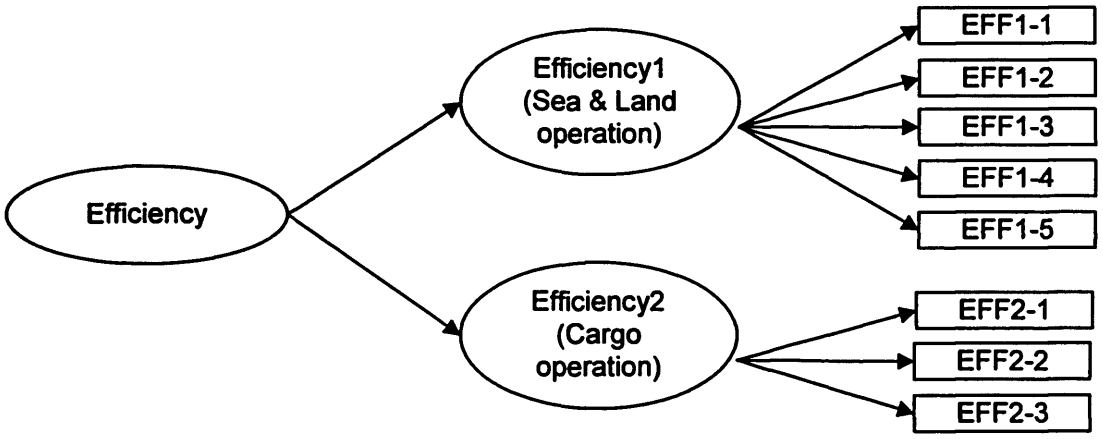


Table 7.17 CFA result for EFF: Higher-order measurement model

Construct		Regression Weight	t-value	R^2
Efficiency	EFF1	0.90	-	0.86
	EFF2	0.91	8.7***	0.83
Overall Goodness-of-Fit Indices				
χ^2=50.78(df=18, p<0.001); χ^2/df=2.8; CFI=0.96; TLI=0.93; SRMR=0.060				

Note: *** p<0.001

The PP measurement model was specified as a third-order measurement model with 2 second-order constructs, 5 first-order constructs and 21 measurement items as illustrated in Figure 7.11. The CFA results for this higher-order model suggest adequate model fit: χ^2/df=2.15; CFI=0.93; TLI=0.92; SRMR=0.070. All factor loadings were statistically significant and very high (EFC=0.97; EFF=0.94). In conclusion, the measurement model PP was validated and ready for the structural model.

Figure 7.11 Higher-order PP measurement model

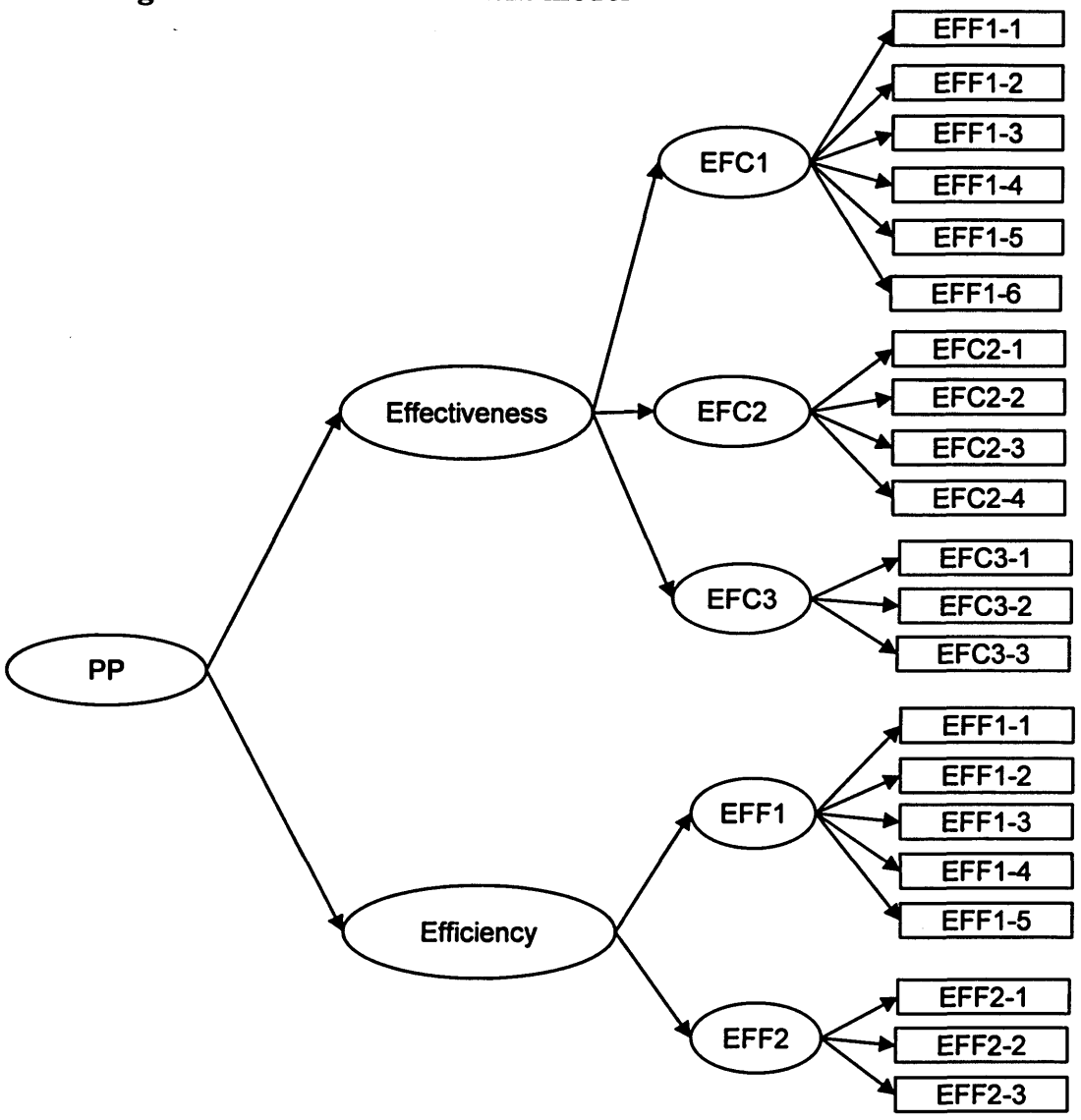


Table 7.18 CFA result for PP: Higher-order measurement model

	Construct	Regression Weight	t-value	R^2
PP	Effectiveness	0.97	-	0.94
	Efficiency	0.94	5.95***	0.89

Overall Goodness-of-Fit Indices
χ^2=390.013(df=181, p<0.001); χ^2/df=2.15; CFI=0.93; TLI=0.92; SRMR=0.070

Note: *** p<0.001

7.3 STRUCTURAL MODEL

A structural model represents a structural theory which is a representation of causal relationships between constructs with a set of structural equations (Hair *et al.* 2010).

The structural relationship between any two constructs is represented by the structural parameter estimate, and, thus the estimate is of primary interest. However, in order to test structural relationships, SEM analysis examines two issues in the structural model stage: (1) overall model fit as a measure of acceptance of the proposed model and (2) structural parameter estimates (Hair *et al.* 2010). The specific criteria to examine these two issues also need to be established as they were for the assessment of measurement model. The indices and their criteria for overall model fit are applied in the same way as when assessing the measurement model as shown in Table 7.19. In addition, the hypothesised paths are required to be statistically significant for supporting the proposed structural model. However, Hair *et al.* (2010) suggest that nomological validity needs to be tested because 'good fit does not mean that some alternative model might not fit better or be more accurate'.

Table 7.19 Criteria used for assessing the structural model

Validity	Criteria
Overall model fit	χ^2/df <3, CFI>0.9, TLI>0.9, SRMR<0.08
Structural parameter estimates	The estimates are significant
Nomological validity	Causal relationships make sense and are consistent with theoretical expectations

(Source: Tabulated by Author)

The structural relationships are specified by the hypotheses proposed by the research. The hypotheses which are to be tested in this section are presented in the sections in which the corresponding hypotheses are examined. However, it should be noted that because H3 (The research model and causal relationships in the model are applied in the same way across ports with different operational characteristics and different groups which are port operators and port users) concerns the applicability of this research model to different groups as below, this hypothesis is tested in Chapter 8. It should be noted that a partial disaggregation approach was applied in the structural model stage based on the successful measurement model assessment. This approach uses composites of more than 2 measurement items as observed variables for their corresponding constructs. In this study, for example, item FR1 and FR2 were summed up and used as a single measurement item with the name of cFR1 (composite FR). Table 7.20 shows how the original items were aggregated and used in structural model.

Table 7.20 Composite measurement items

	Constructs	Measurement model	Structural model
PSCO	Financial Resources	FR1-2	cFR1
		FR3	cFR2
	Human Resources	HR1-2	cHR1
		HR3	cHR2
	Organisational Relationships	OR1-3	cOR1
		OR4-5	cOR2
		OR6-7	cOR3
	Top Management Support	TMS1-3	cTMS1
		TMS4-5	cTMS2
PSCI	Information Sharing and	ISCS1-4	cISCS1
	Communication System	ISCS5-8	cISCS2
	Long-Term Relationships	LTR1-2	cLTR1
		LTR3-4	cLTR2
	Value-Added Logistics	VAL1-3	cVAL1
		VAL4-5	cVAL2
	Inter-Modal Transport	IMT1-2	cIMT1
		IMT3-4	cIMT2
		IMT5-6	cIMT3
	Supply Chain Integration	SCIP1-2	cSCIP1
	Practices	SCIP3-4	cSCIP2
		SCIP5-6	cSCIP3
PP	EFC	EFC1-1-6	cEFC1
		EFC2-1-4	cEFC2
		EFC3-1-3	cEFC3
	EFF	EFF1-1-5	cEFF1
		EFF2-1-3	cEFF2

There is a trade-off in using the partial disaggregation approach. Partial disaggregation reduces model complexity by reducing the number of observed variables and parameters, which permits modelling with a smaller sample size and reduces the likelihood of computational problems (Bagozzi and Heatherton 1994; Leone *et al.* 2001). The drawback would be that this approach may be less informative than a total disaggregation in which all individual items load on their respective factor aggregate models, where all items are averaged or summed. However, a total disaggregation

analysis requires larger samples, and single items are by definition more vulnerable to measurement error and sample specificity (Leone *et al.* 2001).

Leone *et al.* (2001), therefore, demonstrate that 'researchers generally rely on aggregation of several items when testing substantive hypotheses, ignoring the finer-grained (but error-infused) information given by the single-item level of analyses'. As for this study, given that the measurement models have been rigorously validated in the form of a total disaggregation model providing sufficient information relevant to individual items and factors, the partial disaggregation approach can be applied to the structural model stage so as to allow this stage to be dedicated to testing the hypothesised relationships.

7.3.1 Structural model with higher-order factors

Table 7.21 presents the hypotheses that are tested in this section. These hypotheses were initiated by the research questions, and proposed and justified by both the literature review in Chapter 3 and the interview study in Chapter 5. The reason for naming it a 'structural model with higher-order factors' is to distinguish this model from a structural model in the following section, and named a 'structural model with lower-order factors'. This section examines the hypotheses representing causal relationships among PSCO, PSCI and PP which are higher-order factors. The hypotheses tested in the following section represent the causal relationships between PSCI and the individual first-order factors of PSCO and PP.

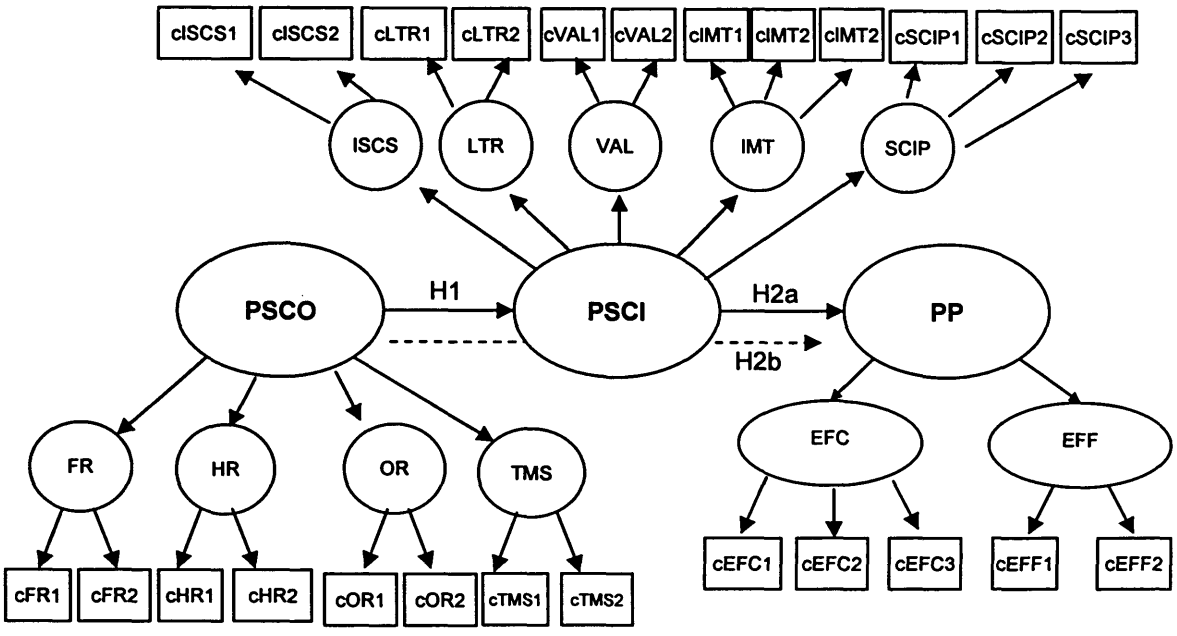
Table 7.21 Hypotheses with higher-order factors

	Hypotheses	Paths
H1	PSCO has a positive impact on PSCI	PSCO→PSCI
H2a	PSCI has a positive impact on PP	PSCI→PP
H2b	PSCO has an indirect and positive impact on PP through PSCI	PSCO→PSCI→PP

Figure 7.12 illustrates the structural model representing these hypotheses. H1 concerns the impact of PSCO on PSCI, as indicated by the one-headed arrow from PSCO to PSCI. H2a tests the impact of PSCI on PP as indicated by the one-headed arrow from

PSCI and PP. The dotted arrow from PSCO via PSCI to PP represents H2b examining the indirect impact on PP through PSCI.

Figure 7.12 Structural model with higher-order factors



The SEM results in Table 7.22 suggest that this proposed structural model has an acceptably good fit. The normed chi-square (=2.2) was lower than 3, and CFI (=0.90) and TLI (=0.89) marginally met the suggested criteria. SRMR (=0.057) was far below the suggested threshold (0.08).

Table 7.22 SEM results: structure model with higher-order factors

Path			Standardised Regression Weight	t-value
PSCO	→	PSCI	0.96	9.90***
PSCI	→	PP	0.95	10.39***
PSCO	→	FR	0.70	8.47***
PSCO	→	HR	0.89	10.02***
PSCO	→	OR	0.94	-
PSCO	→	TMS	0.94	11.23***
PSCI	→	ISCS	0.98	-
PSCI	→	LTR	0.92	10.56***
PSCI	→	VAL	0.87	11.28***
PSCI	→	IMT	0.72	7.39***
PSCI	→	SCIP	0.96	11.41***
PP	→	EFC	0.96	-
PP	→	EFF	0.93	10.7***
Overall Goodness-of-Fit Indices				
χ^2=616.835(df=282, p<0.001); χ^2/df=2.2; CFI=0.90; TLI=0.89; SRMR=0.057				

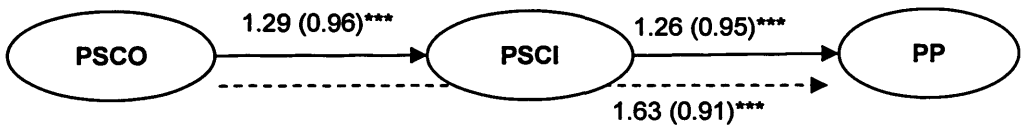
Note: *** p<0.001

The individual paths were also evaluated. Path PSCO-PSCI was statistically significant at the 0.001 significance level with the critical ratio of 9.90. The standardised regression weight was 0.96, indicating the impact of PSCO on PSCI is positive and very strong. Path PSCI-PP was also significant at the 0.001 significance level and the standardised regression weight was 0.95. This also indicates PSCI influences PP positively and very strongly. All the factor loadings of first-order factors on the corresponding higher-order factors were significant and high ranging from 0.7 to 0.96. In addition, the factor loadings did not show substantial differences from those in the measurement models demonstrating the measurement model's validity and stability (Hair *et al.* 2010). The SEM results also supported the nomological validity of the PSCO and PSCI measurement models because the PSCO-PSCI path is theoretically expected to have a positive contribution to PP.

Table 7.23 Hypotheses testing results

Hypotheses	Regression weight	Standardised weight	t-value	Accept/Reject
H1: PSCO→PSCI	1.29	0.96	9.90***	Accepted
H2a: PSCI→PP	1.26	0.95	10.39***	Accepted
H2b: PSCO→PSCI→PP	1.63(1.29x1.26)	0.91 (0.96x0.95)	-	Accepted

Figure 7.13 Hypotheses testing results



Based on the SEM results, the hypotheses were examined as shown in Table 7.23 and Figure 7.13. H1 and H2a were supported by testing the path PSCO-PSCI and PSCI-PP. Since these paths were significant and showed evidence of strong relationships, H1 and H2a were accepted. Accordingly H2b was also supported because there was not any unsupported path from PSCO via PSCI to PP. The indirect impact calculated by multiplying the standardised regression weight of PSCO-PSCI path (=0.95) and PSCI-PP path (=0.96) was found to be very strong (0.91).

7.3.2 Structural model with first-order factors

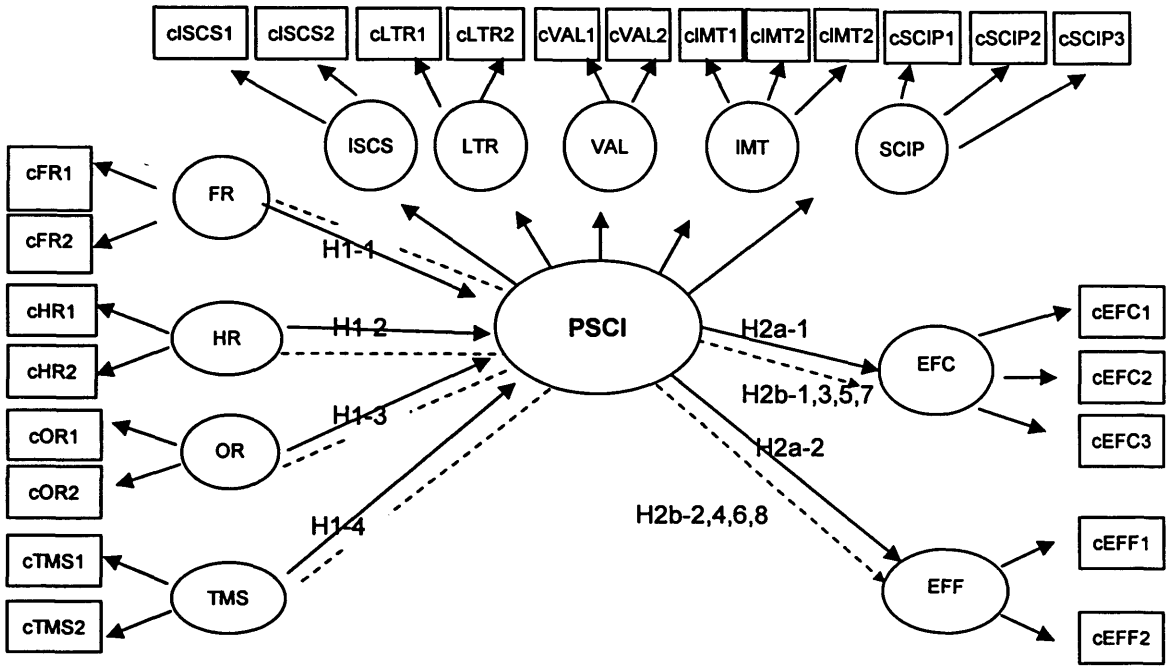
The hypotheses in Table 7.24 were proposed to test the causal relationships between PSCI and the first-order constructs of PSCO and PP. These hypotheses can be considered as sub-hypotheses of the hypotheses with higher-order factors, which were tested in the previous section, because they were proposed within the theoretical boundaries of H1, H2a and H2b (see Chapter 5, Section 5.3.1, p.156).

Table 7.24 Hypotheses with first-order factors

	Hypotheses	Paths
H1-1	FR has a positive impact on PSCI	FR→PSCI
H1-2	HR has a positive impact on PSCI	HR→PSCI
H1-3	OR has a positive impact on PSCI	OR→PSCI
H1-4	TMS has a positive impact on PSCI	TMS→PSCI
H2a-1	PSCI has a positive impact on EFC	PSCI→EFC
H2a-2	PSCI has a positive impact on EFF	PSCI→EFF
H2b-1	FR has an indirect and positive impact on EFC through PSCI	FR→PSCI→EFC
H2b-2	FR has an indirect and positive impact on EFF through PSCI	FR→PSCI→EFF
H2b-3	HR has an indirect and positive impact on EFC through PSCI	HR→PSCI→EFC
H2b-4	HR has an indirect and positive impact on EFF through PSCI	HR→PSCI→EFF
H2b-5	OR has an indirect and positive impact on EFC through PSCI	OR→PSCI→EFC
H2b-6	OR has an indirect and positive impact on EFF through PSCI	OR→PSCI→EFF
H2b-7	TMS has an indirect and positive impact on EFC through PSCI	TMS→PSCI→EFC
H2b-8	TMS has an indirect and positive impact on EFF through PSCI	TMS→PSCI→EFF

These hypotheses were expressed with the one-headed arrows in Figure 7.14. H1-1, H1-2, H1-3 and H1-4 represent the causal relationships between the first-order constructs of PSCO and PSCI. H2a-1 and H2a-2 examine the impact of PSCI on Effectiveness and Efficiency respectively, which are sub-dimensions of PP. The indirect impacts of the first-order factors of PSCO on the sub-dimension of PP through PSCI were also hypothesised. These indirect impacts were illustrated with the dotted one-headed arrows from each first-order factor of PSCO via PSCI to EFC and EFF respectively.

Figure 7.14 Structural model with first-order factors



The SEM results of the structural model with first-order factors are presented in Table 7.25. This structural model achieved acceptably good fit: χ^2/df=2.2; CFI=0.90; TLI=0.89; SRMR=0.057. Among paths from PSCO's first-order factors to PSCI, HR-PSCI and OR-PSCI were significant at the 0.05 and 0.001 significance level respectively, and the others were not statistically supported. The OR-PSCI path showed the strongest relationship among them with the regression weight of 0.53. Both paths from PSCI to EFC and EFF were strongly supported with the standardised regression weights of 0.93 and 0.90 respectively.

Table 7.25 SEM results: structure model with first-order factors

Path			Standardised Regression Weight	t-value
FR	→	PSCI	0.01	0.08
HR	→	PSCI	0.24	2.17*
OR	→	PSCI	0.53	4.46***
TMS	→	PSCI	0.23	1.78
PSCI	→	EFC	0.93	10.52***
PSCI	→	EFF	0.90	8.53***
PSCI	→	ISCS	0.98	-
PSCI	→	LTR	0.92	10.51***
PSCI	→	VAL	0.87	11.09***
PSCI	→	IMT	0.71	7.31***
PSCI	→	SCIP	0.96	11.36***
Overall Goodness-of-Fit Indices				
χ^2=615.348(df=279, p<0.001); χ^2/df=2.2; CFI=0.90; TLI=0.89; SRMR=0.057				

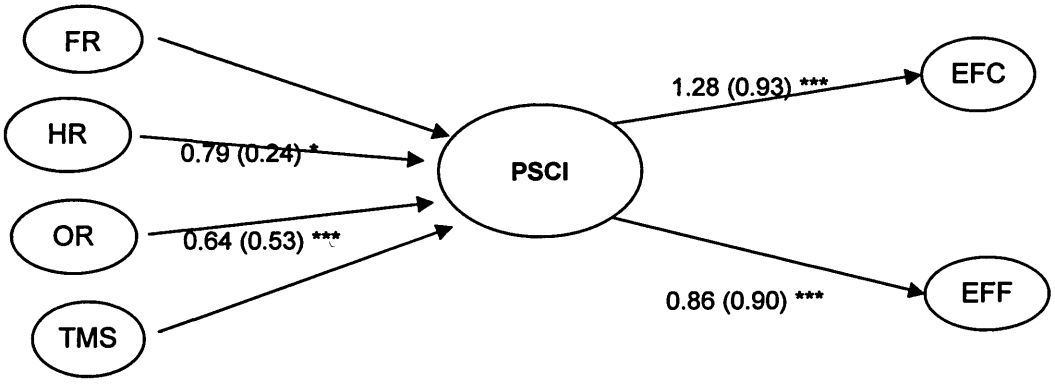
Note: *** p<0.001; ** p<0.01; * p<0.05

The hypotheses were tested with the SEM results as shown in Table 7.26 and Figure 7.15. H1-2 and H1-3 were supported by the significant paths, HR-PSCI and OR-PSCI. The paths PSCI-EFC and PSCI-EFF supported H2a-1 and H2a-2. Accordingly, the hypotheses associated with HR-PSCI and OR-PSCI were bound to be supported, which were H2b-3 (HR-PSCI-EFC), H2b-4 (HR-PSCI-EFF), H2b-5 (OR-PSCI-EFC) and H2b-6 (OR-PSCI-EFF).

Table 7.26 Hypotheses testing results

Hypotheses	Regression weight	Standardised regression weight	t-value	Accept/ Reject
H1-1: FR→PSCI	0.01	0.01	0.08	Rejected
H1-2: HR→PSCI	**0.79**	**0.24**	**2.17***	**Accepted**
H1-3: OR→PSCI	**0.67**	**0.53**	**4.46*****	**Accepted**
H1-4: TMS→PSCI	0.41	0.23	1.78	Rejected
H2a-1: PSCI→EFC	**1.28**	**0.93**	**10.52*****	**Accepted**
H2a-2: PSCI→EFF	**0.86**	**0.90**	**8.53*****	**Accepted**
H2b-1: FR→PSCI→EFC	0.013(0.01x1.28)	0.009(0.01x0.93)	-	Rejected
H2b-2: FR→PSCI→EFF	0.009(0.01x0.86)	0.009(0.01x0.90)	-	Rejected
H2b-3: HR→PSCI→EFC	**1.011(0.79×1.28)**	**0.223(0.24x0.93)**	-	**Accepted**
H2b-4: HR→PSCI→EFF	**0.679(0.79×0.86)**	**0.216(0.24x0.90)**	-	**Accepted**
H2b-5: OR→PSCI→EFC	**0.857(0.67×1.28)**	**0.493(0.53x0.93)**	-	**Accepted**
H2b-6: OR→PSCI→EFF	**0.576(0.67×0.86)**	**0.477(0.53x0.90)**	-	**Accepted**
H2b-7: TMS→PSCI→EFC	0.525(0.41×1.28)	0.214(0.23x0.93)	-	Rejected
H2b-8: TMS→PSCI→EFF	0.353(0.41×0.86)	0.207(0.23x0.90)	-	Rejected

Figure 7.15 Hypotheses testing results



When it comes to comparing the two structural models, they did not show a substantial difference in model fit as shown in Table 7.27. Most fit indices except the chi-square showed the same values between the two models. However, the difference in chi-

square statistics ($\Delta\chi^2$=1.438; Δdf=3) was not significant. Notably, the structural model with higher-order factors showed superiority in nomological validity to the structural model with first-order factors. The first-order factors of PSCO were theoretically expected to positively relate to PSCI in the same way as PSCO do. However, nomological validity was not verified in FR-PSCI path and TMS-PSCI path.

Table 7.27 Comparison between the two structural models

	First-order factor	Higher-order factors	Comparison
χ^2	615.348	616.385	1.438
d.f	279	282	3
CFI	0.90	0.90	No difference
TLI	0.89	0.89	No difference
SRMR	0.057	0.057	No difference
CAIC	1036.130	1020.084	

7.4 SUMMARY

This chapter conducted the empirical analysis and presented the results of the analysis. The empirical analysis was to examine the causal structure representing the research hypotheses of this study. The causal structure was examined with SEM (Structural Equation Modelling) which primarily comprises a measurement model and a structural model. Before conducting the measurement and structural models, the collected data were screened. As some extent of non-normality was diagnosed, a bootstrapping approach was applied throughout the analysis and the bootstrapping was successfully performed. In addition, some cases spotted as outliers were retained.

At the measurement model stage, the PSCO, PSCI and PP measurement models were successfully validated. In order to assess the models, the assessment criteria were established. The first-order measurement models of each measurement model were assessed with the criteria and, subsequently, their higher-order models were confirmed. Through comparing the first-order and higher-order models, specification of the higher-order measurement models was also justified.

At the structural model stage, two structural models were examined, which were the structural model with higher-order factors and with first-order factors. Both models achieved acceptably good model fit. With the former model, three main hypotheses were tested and found to be supported: the causal relationships between PSCO and PSCI (H1) and between PSCI and PP (H2a); the indirect impact of PSCO on PP (H2b). With the latter model, the sub-hypotheses were examined. Among 14 hypotheses, 6 were supported: HR-PSCI (H1-3), OR-PSCI (H1-4); PSCI-EFC (H2a-1), PSCI-EFF (H2a-2); HR-PSCI-EFC (H2b-3), HR-PSCI-EFF (H2b-4), OR-PSCI-EFC (H2b-5), OR-PSCI-EFF (H2b-6). While the two structural models showed almost the same level of model fit, the structural model with higher-order factors were found to have superiority in terms of nomological validity.

CHAPTER 8

MULTI-GROUP ANALYSIS:

INVARIANCE ACROSS PORTS AND GROUPS

Chapter 7 tested most of the hypotheses proposed by the research model of this research, which represented the causal relationships among Port Supply Chain Orientation (PSCO), Port Supply Chain Integration (PSCI) and Port Performance (PP). A hypothesis which has not been tested up to this point concerns whether the research model or the causal relationships are invariant across different environments or different groups (H3). Therefore, this hypothesis primarily aims to see if the validated measurement and structural models show differences in accordance with different groups by comparing the same model across different samples of respondents. This comparative approach is recommended by many researchers to ensure that the practices suggested based on a developed and validated model can contribute equally in different environments (e.g. Koufteros and Marcoulides 2006; Min *et al.* 2007). In order to compare different groups using a model, it is possible to run the model separately for different groups. This approach may provide some insight into potential differences between the groups (e.g. Lin *et al.* 2005). However, SEM offers a sophisticated statistical testing approach to investigate more specific similarities and discrepancies, which is referred to as a multi-group analysis or model invariance test. This study adopts this approach to examine the remaining hypothesis (H3) in this chapter. The first section presents analysis process and flow for this particular method. The second and third sections provide the results of this multi-group analysis following the analysis process and flow.

8.1 ANALYSIS PROCEDURE

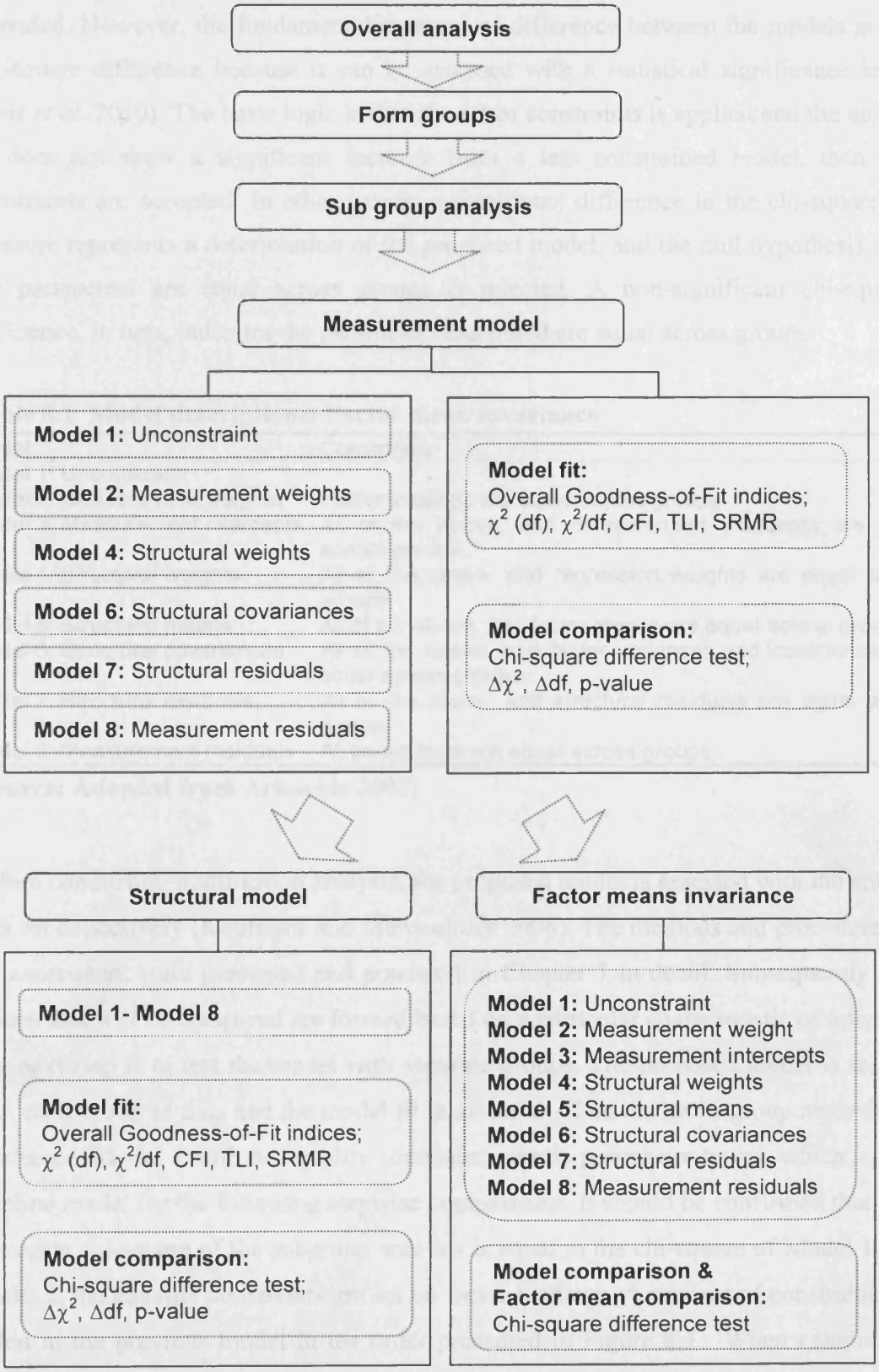
Although the specific process of the multi-group invariance test in SEM may vary depending on the type of research question being addressed, a general framework can be presented with the help of various sources in the following section. Based on the framework, the specific process and flow can be developed to test H3.

8.1.1 General analysis procedure

Researchers (e.g. Arbuckle 2007; Byrne 2001; Koufteros and Marcoulides 2006; Hair *et al.* 2010) have suggested a framework and guidelines for multi-group SEM analysis shown in Figure 8.1. The framework has three principal features: (1) a two-step approach comparing the measurement models, and subsequently structural models, across groups; (2) increasingly restrictive constraints which are placed on sets of parameters in a logical order; (3) a chi-square difference test which compares the less restrictive and more restrictive models. The first feature is consistent with the SEM procedure applied to this research (see Chapter 4, Section 4.4.4, p.126; Chapter 7, Figure 7.1, p.191), which assumes the measurement model to be a prerequisite for the structural model. Therefore, once the measurement model invariance is assessed, then structural model comparisons are made. Alternatively, depending on the research question, factor mean invariance is tested, or both structural model invariance and factor mean invariance are tested after the measurement model variance test. If measurement invariance is not achieved, it cannot be sure that the differences seen in a structural model parameter truly represent a differing structural relationship. In other words, any potential differences in the structural model parameter can be attributed to measurement non-equivalency.

Regarding the second feature, the sets of parameters of common interest in multi-group invariance tests are as follows: factor loadings, factor variances/covariances, structural regression paths, and errors and residual terms. In the case of the factor mean invariance test, factor means and intercepts are added. The test for the invariance of error variances/covariances and residual terms are of less interest than the rest of them (Byrne 2001). The normally used order of restriction is presented in Figure 8.1 for both model invariance test with six models and factor mean invariance test with eight models. The names of the models are exactly after the terms used in AMOS 6.0 and the description for the models is provided in Table 8.1.

Figure 8.1 A multi-group analysis approach



(Source: Adapted from Arbuckle 2007; Byrne 2001; Koufteros and Marcoulides 2006; Hair *et al.* 2010)

For comparing the models, the main model fit measures, such as CFI, TLI, SRMR, are provided. However, the fundamental measure of difference between the models is the chi-square difference because it can be assessed with a statistical significance level (Hair *et al.* 2010). The basic logic is that if a set of constraints is applied and the model fit does not show a significant increase from a less constrained model, then the constraints are accepted. In other words, a significant difference in the chi-square fit measure represents a deterioration of the proposed model, and the null hypothesis that the parameters are equal across groups is rejected. A non-significant chi-square difference, in turn, indicates the parameters examined are equal across groups.

Table 8.1 Model descriptions: Factor mean invariance

Model	Constraints
Model 1: Unconstraint	-
Model 2: Measurement weights	Factor loadings are equal across groups
Model 3: Measurement intercepts	All of the above, and measurement intercepts are equal across groups
Model 4: Structural weights	All of the above, and regression weights are equal across groups
Model 5: Structural means	All of the above, and factor means are equal across groups
Model 6: Structural covariances	All of the above, and factor variances and covariances are equal across groups
Model 7: Structural residuals	All of the above, and structural residuals are equal across groups
Model 8: Measurement residuals	All parameters are equal across groups

(Source: Adapted from Arbuckle 2007)

Before conducting multi-group analysis, the proposed model is assessed with the entire data set collectively (Koufteros and Marcoulides 2006). The methods and procedure of the assessment were presented and practiced in Chapter 7 in detail. Subsequently the groups that will be compared are formed based on a particular characteristic of interest. The next step is to test the model with separate groups. The proposed model is tested with each group of data and the model fit is assessed. Then the multi-group analysis is conducted. Model 1 with no equality constraints across groups are tested, which is the baseline model for the following stepwise comparisons. It should be confirmed that the aggregate chi-square of the subgroup analysis is equal to the chi-square of Model 1. In Model 2, the equality constraints are set on factor loadings. A new set of constraints is added in the previous model in the order presented in Figure 8.1. When examining model invariance, it is better to exclude the constraints on factor means (M3) and intercepts (M5) because they increase model complexity and may cause an

identification problem (Arbuckle 2007). As previously explained, the chi-square difference test is conducted between the less restrictive and more restrictive models, while the model fit measures are also assessed.

This is followed by either the structural model invariance test applying the same procedure or factor mean invariance test, or both. When it comes to structural model comparisons, the comparisons primarily aim to test the differences for causal relationships in the structural model between groups. These tests normally involve examining interaction or moderating effects which occur when a third variable changes the relationships between two related constructs. In the case of the factor mean invariance test, there is another notable point, apart from the fact that the additional constraints are set on factor means and intercepts. SEM programs including AMOS compare factor means only in a relative sense (Arbuckle 2007; Byrne 2001; Hair *et al.* 2010). Therefore, latent construct means in one group are fixed to zero to make comparisons with those in the other groups. Only the relative differences from the group are estimated for the other groups, and can be interpreted as to how much higher or lower they are than the factor means in the group.

Another important issue to discuss before conducting multi-group analysis is whether a full or partial invariance should be established. Full invariance means constraining all the parameters which are of interest in each model (M1-M8) to be equal across groups does not significantly worsen fit. Partial invariance is a less conservative standard involving at least multiple per construct to be equivalent across groups. Thus, the question arising here is whether it is necessary to achieve full invariance for all models in Table 8.1. Researchers have provided guidelines for the level of invariance needed for different types of research questions (Byrne 2001; Hair *et al.* 2010; Koufteros and Marcoulides 2006) as shown in Table 8.2. Full invariance of Model 1 which has no equality constraints and represents the same patterns need to be established for any research type. On top of this, partial invariance of factor loadings (Model 2 and, in the case of a higher-order model M4) in the measurement invariance stage are required to move onto the structural model invariance test or factor mean invariance test.

Table 8.2 Suggested minimum levels of invariance by type of test

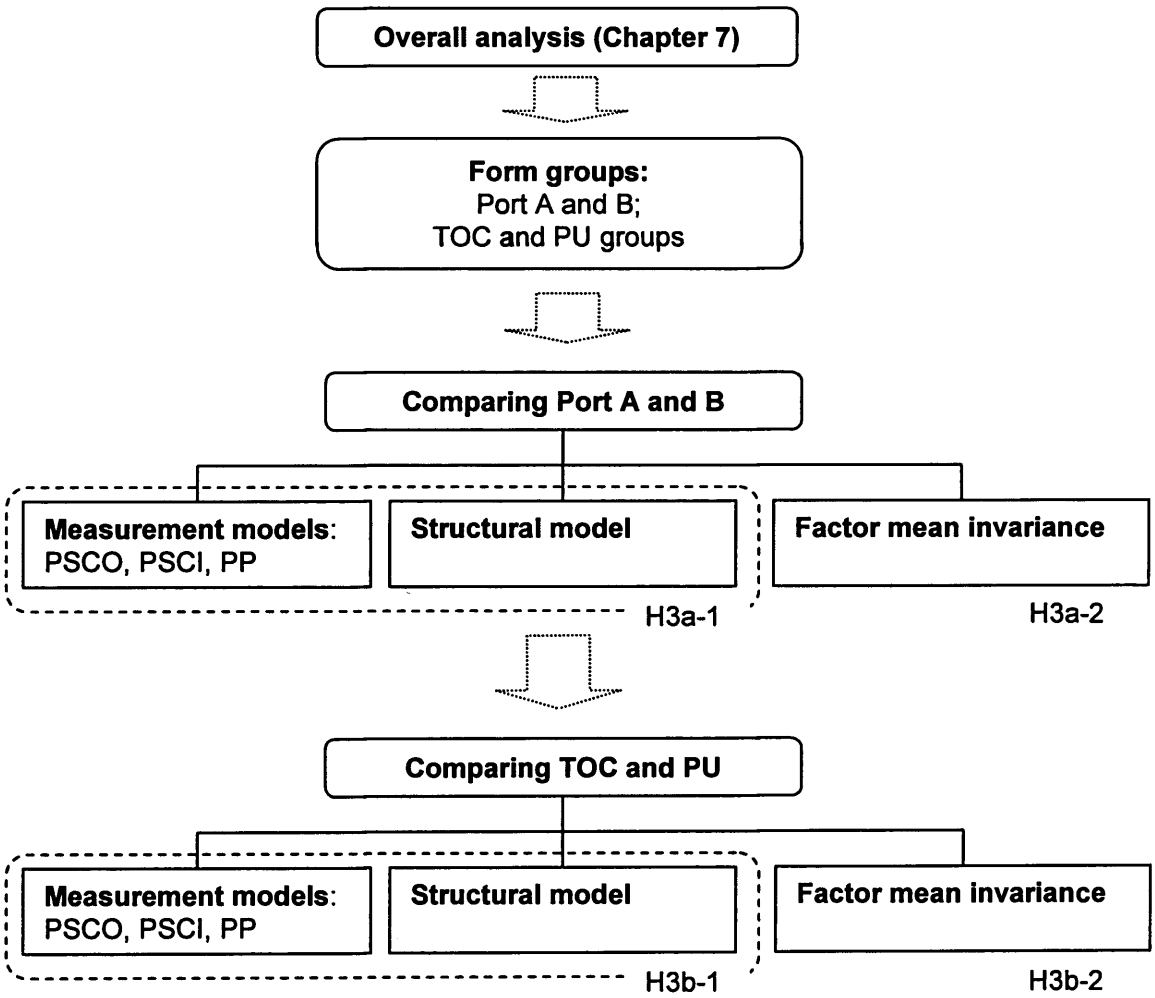
	Measurement model		Structural model	
	Basic structure	Mean levels	Relationships	Correlations
M1	Full	Full	Full	Full
M2	Partial	Partial	Partial	Partial
M3				Partial
M4				Partial
M5				Partial
M6				
M7				
M8				

(Source: Adapted from Hair *et al.* 2010)

8.1.2 Analysis process of this study

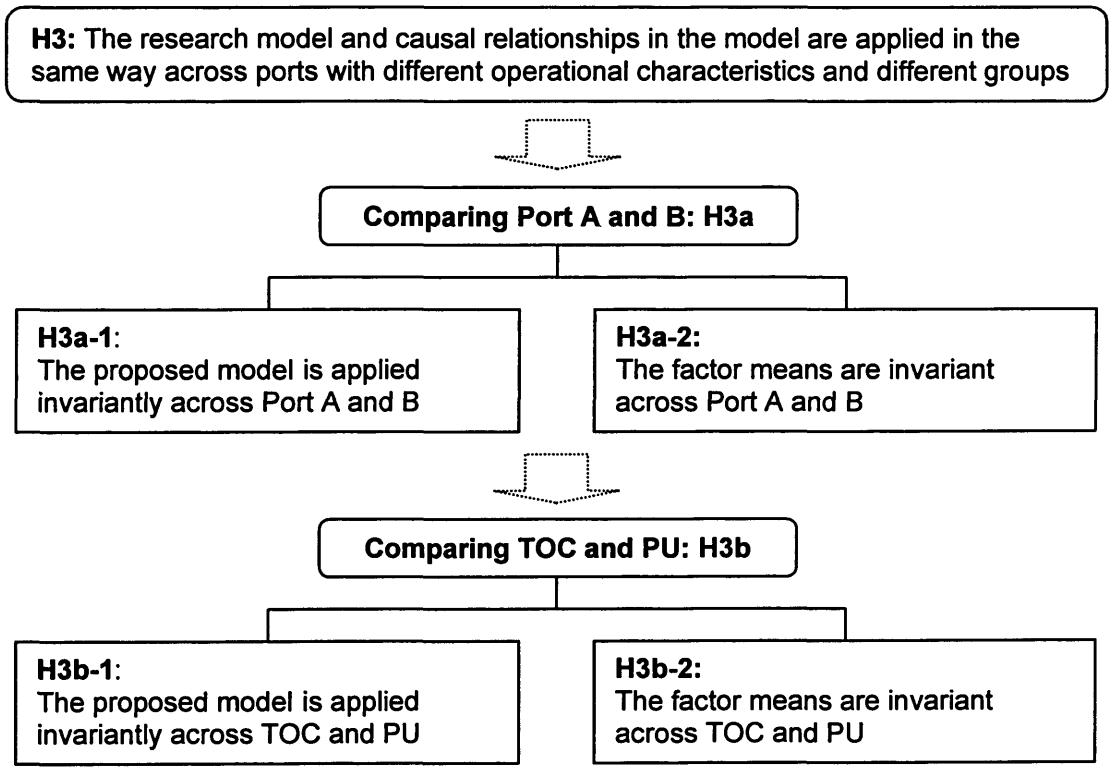
Multi-group analysis of this study is conducted in the process in Figure 8.2. The overall analysis which assesses a proposed model with the entire data set was carried out in Chapter 7.

Figure 8.2 Analysis process and flow of this chapter



All the measurement models were successfully validated and the proposed structural model and hypotheses were tested. The entire data set with 127 responses was composed of the data from Port A and B, and these two ports were evaluated by Terminal Operating Companies (TOCs) and Port Users (PUs) groups (see Chapter 6, Figure 6.1, p.166). Therefore, the groups of which model invariance are tested can be formed in two ways as such. The analysis, in turn, has two main parts: comparison between Port A and B and between TOC and PU groups. The characteristics for these groups are briefly described in the following sections. The details were presented in Chapter 6 (see Section 6.1.1; 6.1.2, pp.167-175). These two parts of analysis examine measurement model invariance first and then both structural model invariance and factor mean invariance. Each process tests hypotheses which were set according to the purpose of the analyses as described in Figure 8.3. The multi-group analysis of this study is supposed to examine H3. However, it is necessary to break down this hypothesis to secondary hypotheses in accordance with the analysis process as shown in Figure 8.3. H3a concerns invariance between Port A and B and H3b concerns invariance across TOC and PU groups. H3a-1 and H3b-1 are examined by the model invariance test, and H3a-2 and H3b-2 are by a factor mean invariance test.

Figure 8.3 Hypotheses tested in multi-group analysis



8.2 COMPARISON BETWEEN PORTS

Port A and B were selected as sample ports to collect data from because these ports are traditionally representative of seaports in South Korea. More importantly, while the interview study (Chapter 5) found that a various range of integrated logistics services have been provided in these two ports, these ports have shown some contrasting characteristics as described in Table 8.3. Port A and B commonly make a substantial contribution to seaborne cargo handling in South Korea. However the proportion of container cargo handling in Port A is much higher than that of Port B. Also, the berthing facilities of Port A are primarily for container cargoes while those of Port B mostly were for general cargoes. In addition, considering the shipping routes connected to both ports, Port A can be categorised as a hub port and Port B as a feeder port.

Table 8.3 Sample sizes and characteristics of Port A and B (as of 2008)

	Port A	Port B
No. of responses	66	61
Proportion of cargo handling		
- Total seaborne cargo	26.9%	15.8%
- Containerized cargo	77.8%	9.8%
Container throughput (1,000 TEU)	13,453	1,703
Facilities	Container cargo focused	Non-containerised cargo focused
Connectivity	Both main and regional routes	Mostly regional routes
Classification	Hub port	Feeder port

The invariance test across Port A and B is worth conducting because presumably the integration strategy and activities may be undertaken in ports connected to main shipping lines and focused on container cargoes (Ferrari *et al.* 2006; Theys *et al.* 2008). Accordingly, the mean values of primary constructs (i.e. PSCO, PSCI and PP) are expected to be higher in Port A than in Port B. The descriptive statistics in Chapter 6 showed that the scores of the individual items were slightly higher in Port A than in Port B, but the difference was statistically insignificant. However, these statistics cannot guarantee the invariance of factor means between Port A and B because the factor means are indirectly measured from the measurement items.

8.2.1 Model invariance

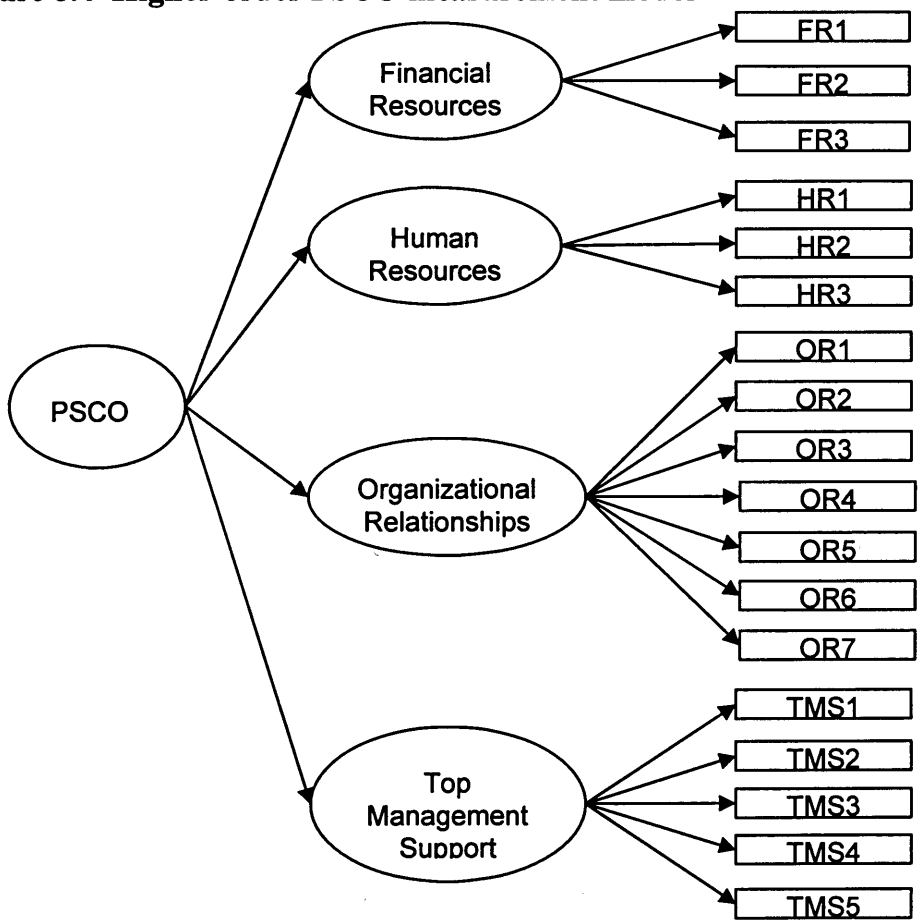
As explained in Figure 8.2, model invariance is tested and then factor means are compared. Also at the model invariance stage, the measurement model invariance is

firstly examined and the structural models are compared between Port A and B. In addition, the higher order factor models of PSCO, PSCI and PP are tested in the measurement model invariance test, while the factor mean invariance test uses both first-order factor and higher-order factor model to compare all the constructs on both levels. Diagrams of the measurement models and structural model are presented again for the sake of convenience, but only once in comparing Port A and B. It also should be noted that among the 8 invariance models, only 6 models (excluding M3 and M5) are tested in this model invariance test stage because estimating factor means and constraining the factor means increase model complexity and cause identification problems (Arbuckle 2007).

(1) Measurement models

Figure 8.4 illustrates the higher order PSCO measurement model which has four first order constructs.

Figure 8.4 Higher-order PSCO measurement model



This model was validated in the previous chapter with an adequate model fit: χ^2=311.33 (df=126, p<0.001); χ^2/df=2.47; CFI=0.92; TLI=0.90; SRMR= 0.057. Firstly this model was tested individually with the data from Port A and Port B as shown in Table 8.4. The overall model fit measures suggest that this model can be validated in both Port A and B individually; the normed chi-square values are lower than 2, and CFI and TLI values are higher than 0.9 and SRMR values are also lower than suggested criteria (0.08).

M1 is an invariance model combining the two separate models and with no equality constraints specified between Port A and B, representing similar patterns between the ports. It should be confirmed that M1 also has an acceptable model fit and the chi-square value and the degrees of freedom of M1 are equal to the sum of those of the two separate models, which indicates configural invariance (Hair *et al.* 2010). M1 has an adequate fit (χ^2/df=1.71; CFI=0.92; TLI=0.90; SRMR= 0.065) and the chi-square is equal to the sum of the two models (423.604=217.426+215.178; 252=126+126).

Table 8.4 Measurement invariance test for PSCO

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
Port A	217.426	126	1.725	0.924	0.907	0.065			
Port B	215.178	126	1.707	0.918	0.900	0.065			
M1	432.604	252	1.717	0.921	0.904	0.065			
M2	445.382	266	1.674	0.921	0.909	0.072	12.778	14	0.544
M4	446.155	269	1.659	0.922	0.912	0.074	0.773	3	0.856
M6	446.339	270	1.653	0.923	0.912	0.074	0.184	1	0.668
M7	448.439	274	1.637	0.923	0.915	0.074	2.100	4	0.717
M8	475.899	297	1.602	0.921	0.919	0.074	27.460	23	0.237

The next stage is to test M2 with equality constraints specified on each factor loading between two ports. The difference in the chi-square between M2 and M1 is only 12.778 with 14 degrees of freedom, which indicates a non-significant difference (p=0.54). The 14 degrees of freedom represent the 14 factor loadings that were constrained to be equal between two ports. Also, the equality constraints on factor loadings did not worsen the overall model fit. These results confirm the factor loadings are invariant across Ports A and B, indicating metric invariance. Further, the regression

weights from PSCO to the four first-order factors are constrained to be equal in M4. The difference of 0.773 in the chi-square with 3 degrees of freedom indicates non-significant difference (p=0.856). Thus, the structural weights model (M4) was not rejected. The next stage of analysis involved testing for the invariance of the factor variances and covariances in M6. This model provided a chi-square of 446.339 with 270 degrees of freedom and the additional constraints did not result in a deterioration over M4 ($\Delta\chi^2$=0.184 with 1 df). The 1 degree of freedom represents the variance of PSCO and the covariances are not specified in the higher-order factor model. The small difference of the chi-square indicates the variance of PSCO is invariant across the two ports.

M7 and M8 test the equality of structural residuals of the first-order factors and measurement errors of the observed variables respectively. Byrne (2001) demonstrates that the equality test of these parameters is the least important hypothesis to test except in particular instances when it is of interest to test for the invariance reliability of an assessment measure across groups. In addition, he stated that it is widely accepted that to test the invariance of the measurement errors and residuals represents 'an overly restrictive test'. However, this study carries out these invariance tests to provide a more rigorous analysis of results. The equality constraints of M7 and M8 did not result in a substantial deterioration of model fit: $\Delta\chi^2$=2.1 with 4df (p=0.72); $\Delta\chi^2$=27.46 with 23df (p=0.27) respectively. This implies that Port A and Port B did not show any significant difference in factor loadings, regression weights, factor variance, factor residuals and measurement errors in the PSCO measurement model.

Table 8.5 presents the invariance test of the higher-order PSCI model (Figure 8.5). The test was conducted in the same order as in the PSCO model. The overall model fit measures in Table 8.5 suggest a marginally acceptable model fit for all the models from subgroup models to M8. The difference tests conclude that all the parameters of interest in the PSCI model are statistically invariant across Port A and B. The same results are shown in Table 8.6 for the higher-order PP model with acceptable model fits and non-significant chi-square differences. It is now possible to move on to a structural model invariance test based on the established full invariance of measurement models.

Figure 8.5 Higher-order PSCI measurement model

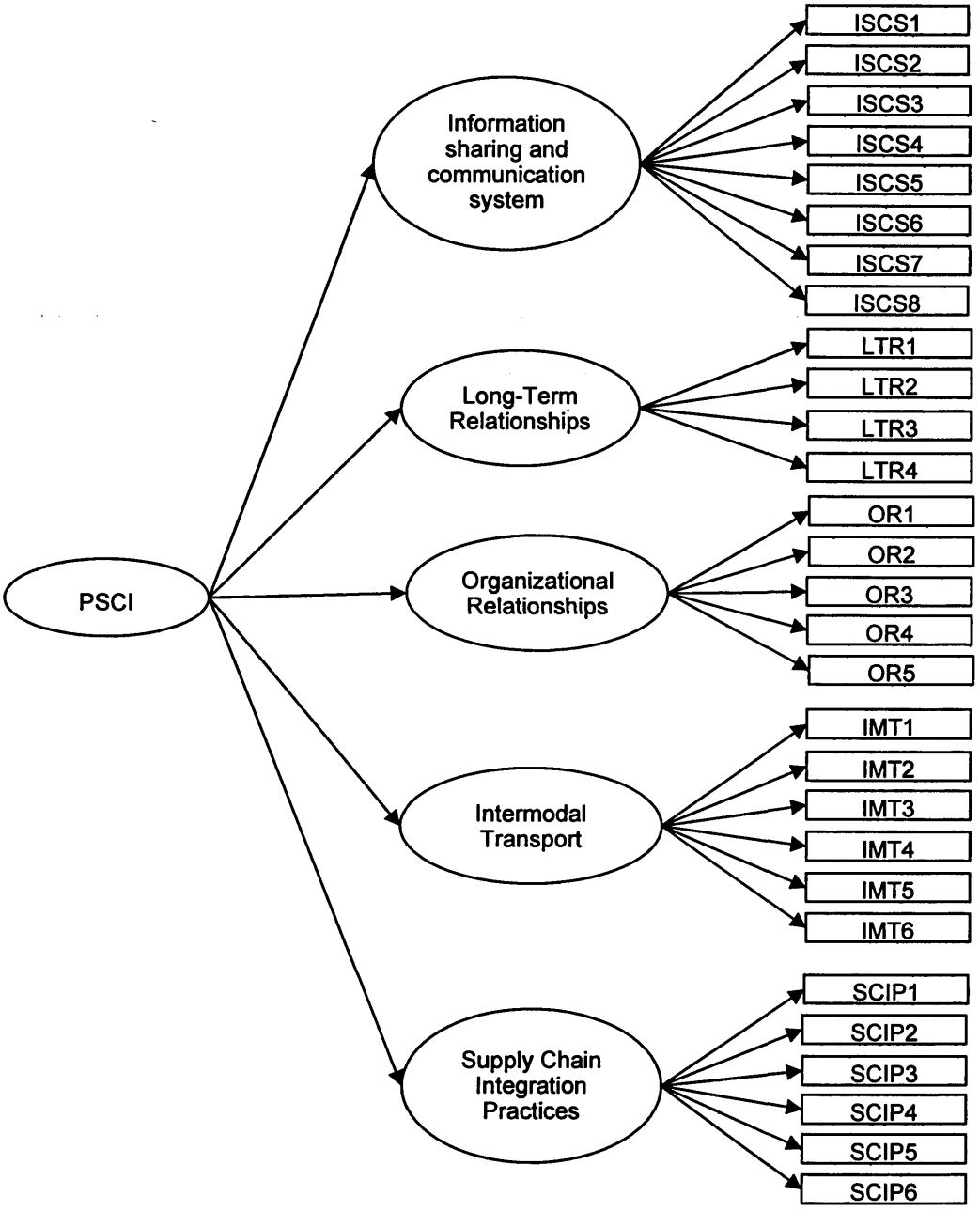


Table 8.5 Measurement invariance test for PSCI

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
Port A	493.87	310	1.59	0.895	0.881	0.070			
Port B	500.05	310	1.61	0.878	0.862	0.077			
M1	992.92	620	1.60	0.887	0.872	0.070			
M2	999.83	642	1.56	0.892	0.882	0.071	6.906	22	0.999
M4	1000.40	646	1.55	0.893	0.883	0.071	0.574	4	0.966
M6	1000.66	647	1.55	0.893	0.884	0.072	0.256	1	0.613
M7	1005.16	652	1.54	0.893	0.885	0.073	4.496	5	0.480
M8	1047.28	688	1.52	0.891	0.889	0.078	42.123	36	0.223

Figure 8.6 Higher-order PP measurement model

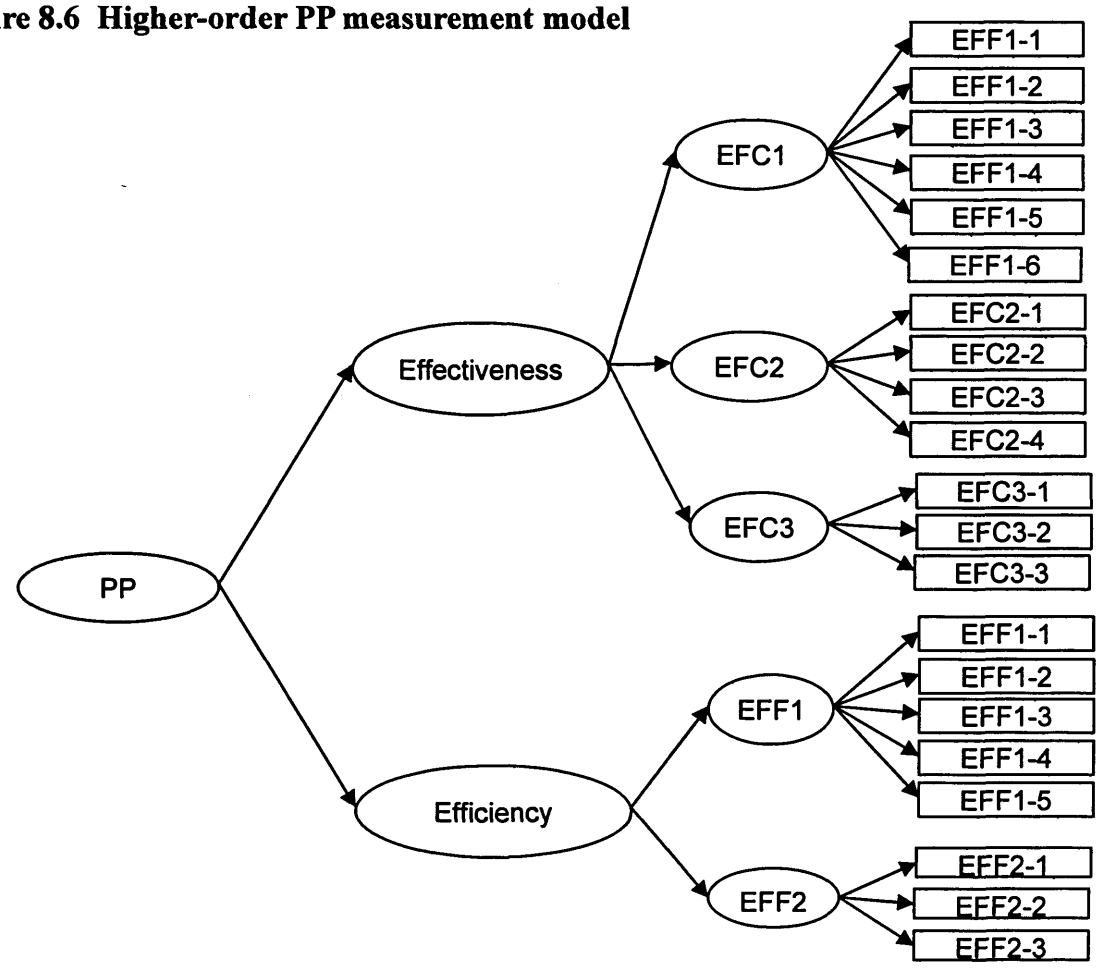


Table 8.6 Measurement invariance test for PP

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
Port A	285.022	181		0.932	0.922	0.072			
Port B	286.673	181		0.913	0.899	0.078			
M1	571.695	362	1.579	0.924	0.912	0.079			
M2	582.104	378	1.540	0.926	0.918	0.074	10.409	16	0.844
M4	584.347	382	1.530	0.927	0.919	0.082	2.243	4	0.691
M6	584.443	383	1.526	0.927	0.920	0.086	0.097	1	0.756
M7	600.060	389	1.543	0.923	0.917	0.086	15.617	6	0.016
M8	624.158	412	1.515	0.923	0.922	0.089	24.098	23	0.398

(2) Structural model

The structural model representing the causal relationships between PSCO, PSCI and PP was tested in Chapter 7. The model had an acceptable model fit (χ^2/df=2.2; CFI=0.90; TLI=0.89; SRMR=0.057) and the impacts of PSCO on PSCI and of PSCI on PP were found to be significant, positive and very strong (0.96 with $p<0.001$; 0.95 with $p<0.001$ respectively). A structural model invariance test can be conducted in

order to make sure either an entire model or causal relationships in the model can be invariantly applied across Ports A and B. This research test for both and the results are provided in Table 8.7.

Figure 8.7 Structural model in this study

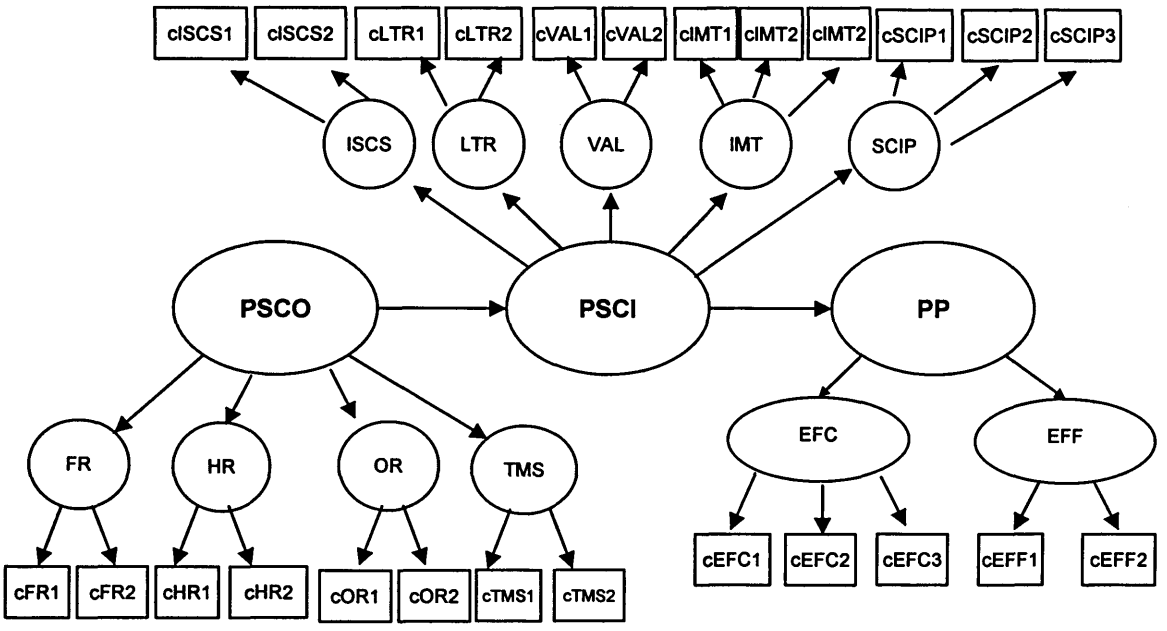


Table 8.7 Structural model invariance

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
Port A	437.154	282	1.550	0.914	0.900	0.061			
Port B	455.136	282	1.614	0.895	0.879	0.072			
M1	892.290	564	1.582	0.905	0.890	0.061			
M2	911.126	579	1.574	0.903	0.892	0.072	18.837	15	0.221
M4-1	914.747	587	1.558	0.905	0.890	0.075	3.621	8	0.890
M4-2	914.823	589	1.553	0.905	0.895	0.075	0.076	2	p>0.05
M6	915.097	590	1.551	0.905	0.896	0.078	0.273	1	0.601
M7	935.487	603	1.551	0.903	0.896	0.082	20.390	13	0.086
M8	1035.088	633	1.635	0.883	0.880	0.066	99.601	30	P<0.001

The subgroup models had a marginally acceptable fit and the sum of the chi-square values was equal to the chi-square of M1, indicating two groups had similar patterns. Comparison between M1 and M2 did not provide a significant difference ($\Delta\chi^2$=18.837 with 15 df; p=0.22). M4 was divided into M4-1 and M4-2 in contrast to the measurement model invariance tests. Both regression weights from first-order factors to higher-order factors and regression weights among PSCO, PSCI and PP are

constrained in M4 simultaneously. Thus, any discrepancy of structural relationships which is of primary interest in structural model invariance test, cannot be assessed individually. M4-1 constrained only the regression weights from first-order factors to higher-order factors and M4-2 constrained the PSCO-PSCI path and PSCI-PP path. Both differences between M2 and M4-1 ($\Delta\chi^2$=3.621 with 8 df; p=0.89) and between M4-1 and M4-2 ($\Delta\chi^2$=0.076 with 2 df; p>0.05) were not significant. An insignificant difference between M4-1 and M4-2 indicated that M4-2 with equality constraints on both PSCO-PSCI and PSCI-PP paths was not rejected. Therefore, the regression weights estimated in M4-2 for the two paths can be applied to Port A and B rather than those freely estimated in M1, M2 and M4-1 in Table 8.8. This point also concludes that the features characterising Ports A and B, for example, hub-ports vs. feeder-ports or container terminals vs. non-containerised cargo terminals, do not have a moderating effect on the causal relationships among PSCO, PSCI and PP in this study.

Table 8.8 Structural regression weights of Port A and Port B

Paths	Models	Port A Regression weights	Critical Ratio	Port B Regression weights	Critical ratio
PSCO-PSCI	M1	1.118 (0.958)	7.179***	0.770 (0.965)	6.390***
	M2	0.793 (0.953)	7.161***	0.724 (0.963)	7.453***
	M4-1	0.761 (0.953)	8.505***	0.742 (0.964)	8.843***
	M4-2	0.750 (0.951)	9.560***	0.750 (0.966)	9.560***
PSCI-PP	M1	1.357 (0.938)	7.182***	2.253 (0.920)	7.092***
	M2	1.962 (0.953)	7.803***	2.255 (0.921)	7.873***
	M4-1	2.114 (0.932)	8.686***	2.146 (0.923)	8.853***
	M4-2	2.132 (0.932)	10.064***	2.132 (0.922)	10.064***

Note: Numbers in brackets represents standardised regression weights; *** p<0.001

M8 showed a significant difference from M7 implying the error terms are not completely invariant across the two ports. However, it is over-restrictive to strictly apply the invariance of the error terms to the model invariance test (Byrne 2001) and previous research has suggested that small differences in error variance may often occur when there are slight differences in sample sizes between groups (Marcoulides and Wang 1990). In conclusion, the model invariance was confirmed between Ports A and B, implying this model and the causal relationships among PSCO, PSCI and PP can be equally applied to Ports A and B. Regarding testing H3a-1, the hypothesis was not rejected and supported by the invariance tests.

8.2.2 Factor mean invariance

The scores of the individual measurement items obtained from the questionnaire survey were compared between Ports A and B in Chapter 6. Although the comparison may provide some ideas to presume the result of the factor mean invariance test, it cannot guarantee the result. The factor means are measured indirectly through the measurement items while the measurement variables are directly measured and observable. This test examines the invariance of the mean values of the constructs between Ports A and B. In addition, both first-order and higher-order measurement models are tested to assess the extent of differences of first-order factors as well as higher-order factors.

(1) PSCO

A model invariance test was conducted again because the factor means and intercepts need to be estimated, and the equality constraints were imposed on the intercepts in Model 3 and on the factor means in Model 5. The suggested level of invariance for the factor mean is partial scalar invariance which was tested in M5. At first the first-order model was tested and the results were presented in Table 8.9. M1 and M2 could not be included because these two models were not identified due to the increased model complexity. All the chi-square differences were not statistically significant, indicating the parameters in the test were invariant across Ports A and B. In particular, the insignificant difference between M3 which estimated the factor means freely and M5 which constrained the factor means to be equal across the two ports indicates the means of the factors, i.e. FR, HR, OR and TMS are invariant.

The differences of the means of the factors were presented in Table 8.10. It should be noted that the factor means of Port B were fixed to zero to make comparisons. Thus, the numbers in column 'Difference' in Table 8.10 represent the difference of factor means of Port A from Port B. If the numbers are positive, the factor means of Port A are higher by such differences than those of Port B. The four first-order factors of PSCO had positive differences indicating Port A was evaluated higher in terms of the

four factors. However, three of them were not statistically significant. Although the mean of FR in Port A was significantly higher than in Port B at the 0.05 significance level, the difference is very slight (0.081) and, considering the model invariance test in Table 8.9, it was not distinguishable.

Table 8.9 Measurement invariance tests for PSCO

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
First-order									
M3	445.23	276	1.61	0.926	0.918	0.071			
M5	449.81	280	1.61	0.925	0.919	0.071	4.579	4	0.333
M6	452.76	290	1.56	0.929	0.925	0.074	2.952	10	0.983
M8	480.19	313	1.53	0.927	0.928	0.074	27.432	23	0.238
Higher-order									
M3	460.04	284	1.62	0.923	0.917	0.071			
M4	461.86	287	1.61	0.923	0.918	0.075	1.813	3	0.612
M5	463.39	288	1.61	0.923	0.918	0.075	1.538	1	0.215
M6	463.56	289	1.60	0.923	0.919	0.074	0.170	1	0.620
M7	477.45	293	1.63	0.919	0.915	0.082	13.888	4	0.008
M8	506.73	316	1.60	0.916	0.919	0.081	29.273	23	0.171

Table 8.10 Factor mean invariance tests for PSCO

Factors	Difference	Standard Error	Critical Ratio	p-value
First-order				
Financial Resources (FR)	0.081	0.165	1.960	0.05
Human Resources (HR)	0.324	0.114	0.710	0.48
Organisational Relationships (OR)	0.116	0.128	0.908	0.36
Top Management Supports (TMS)	0.171	0.170	1.006	0.31
Higher-order				
PSCO (M3)	0.161	0.128	1.253	0.210
PSCO (M4)	0.156	0.126	1.238	0.216

In order to test the factor mean invariance of PSCO, the higher-order PSCO model was put in the analysis as shown in Table 8.10. The mean value of PSCO was set to be equal in M5. Thus, the non-significant difference between M4 and M5 ($\Delta\chi^2$=1.538 with 1 df; p=0.215) indicates the mean value of PSCO is invariant across Ports A and B. Table 8.10 shows the mean difference of PSCO between the ports. The mean values could be estimated in both M3 and M4 before the equality constraints were imposed in M5. The differences from both models were positive, indicating the level of PSCO in Port A was evaluated higher than in Port B. However, they were very small and insignificant (0.161 with p=0.210; 0.156 with p=0.216).

(2) PSCI

The five first-order factors of PSCI were compared between Ports A and B in terms of the mean values of the factors. In the model invariance test of first-order PSCI model in Table 8.11, the difference of M5 from M3 was insignificant ($\Delta\chi^2$=5.936 with 5 df; p=0.313) indicating the mean values of the five factors were invariant across the ports. While Port A was evaluated higher in terms of the level of the five factors than Port B, the differences were found to be insignificant except for IMT (0.284 with p=0.05) as shown in Table 8.12. The mean values of PSCI for the two ports were also compared in the higher-order PSCI model. Similarly, M5 was not rejected and the differences of mean values of PSCI were not significant. However, it also needs noting that, while p-values of the difference tests among the models in Table 8.11 were high, the p-value of the difference test between M4 and M5 (0.089) was relatively close to 0.05, which is the critical value for significance at the 0.05 level. In addition the p-values of the mean differences in Table 8.12 (0.076; 0.089) were also close to 0.05.

Table 8.11 Measurement invariance tests for PSCI

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
First-order									
M3	1023.78	656	1.56	0.889	0.881	0.065			
M5	1029.72	661	1.56	0.888	0.882	0.065	5.936	5	0.313
M6	1040.22	676	1.54	0.890	0.886	0.068	10.495	15	0.787
M8	1084.65	711	1.53	0.887	0.888	0.074	44.438	35	0.132
Higher-order									
M3	1021.71	668	1.53	0.893	0.888	0.073			
M4	1022.57	672	1.52	0.894	0.889	0.072	0.859	4	0.930
M5	1025.46	673	1.52	0.893	0.889	0.072	2.890	1	0.089
M6	1025.70	674	1.52	0.894	0.889	0.072	0.273	1	0.626
M7	1030.21	679	1.52	0.894	0.890	0.073	4.507	5	0.479
M8	1072.20	715	1.50	0.892	0.894	0.078	41.898	36	0.227

Table 8.12 Factor mean invariance tests for PSCI

Factors	Difference	Standard Error	Critical Ratio	p-value
First-order				
Information Sharing and Communication System (ISCS)	0.285	0.189	1.509	0.13
Long-Term Relationships (LTR)	0.138	0.193	0.717	0.47
Value-Added Logistics (VAL)	0.196	0.155	1.270	0.20
Inter-modal Transport (IMT)	0.284	0.143	1.993	0.05
Supply Chain Integration Practices (SCIP)	0.296	0.176	1.685	0.09
Higher-order				
PSCI (M3)	0.299	0.169	1.773	0.076
PSCI (M4)	0.283	0.167	1.700	0.089

(3) PP

The PP measurement model has three layers of constructs. The first layer has five dimensions and they represent Effectiveness and Efficiency which are the second-order factors. Finally, PP is represented by these two second-order factors. The mean values of the factors in each layer were compared. The five first-order factors were invariant according to the non-significant difference between M3 and M5 in Table 8.13 ($\Delta\chi^2$= 8.174 with 5 df; p=0.147). The individual differences of the factor means are presented in Table 8.14. Similarly to the tests of PSCO and PSCI, the differences are positive and rather small (0.066 to 0.289) considering the five Likert scales. In addition, four factors among the five factors showed non-significant differences while EFC1 had a significant difference of 0.264 (p=0.035) between Ports A and B. This implies the quality of service in Port A was evaluated slightly higher than in Port B as EFC1 measured 'Service Quality' in the questionnaire. Subsequently, the invariance of the mean values of EFC and EFF were examined. Both the model invariance test in Table 8.13 and the factor mean invariance test in Table 8.14 indicate that the mean values of EFC and EFF are invariant across the two ports.

Table 8.13 Measurement invariance tests for PP

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
First-order									
M3	570.699	386	1.478	0.933	0.927	0.067			
M5	578.874	391	1.480	0.932	0.927	0.065	8.174	5	0.147
M6	600.841	406	1.480	0.929	0.927	0.079	21.967	15	0.109
M8	626.336	429	1.460	0.928	0.930	0.082	25.495	23	0.325
Second-order									
M3	596.977	397	1.504	0.927	0.923	0.074			
M4	598.054	400	1.495	0.928	0.925	0.075	1.077	3	0.783
M5	601.561	402	1.496	0.928	0.924	0.073	3.507	2	0.173
M6	615.435	405	1.520	0.924	0.921	0.081	13.875	3	0.003
M7	618.875	410	1.509	0.924	0.922	0.084	3.440	5	0.633
M8	643.090	433	1.485	0.924	0.926	0.086	24.215	23	0.392
Higher-order									
M3	612.759	400	1.532	0.923	0.923	0.078			
M4	613.865	404	1.519	0.924	0.924	0.082	1.106	4	0.893
M5	617.354	405	1.524	0.923	0.923	0.080	3.489	1	0.062
M6	617.917	406	1.522	0.923	0.923	0.091	0.563	1	0.453
M7	629.308	411	1.531	0.921	0.921	0.088	11.391	5	0.044
M8	653.882	434	1.507	0.920	0.920	0.091	24.575	23	0.373

Table 8.14 Factor mean invariance tests for PP

Factors	Difference	Standard Error	Critical Ratio	p-value
First-order				
Effectiveness 1 (EFC1)	0.264	0.125	2.105	0.035
Effectiveness 2 (EFC2)	0.289	0.172	1.685	0.092
Effectiveness 3 (EFC3)	0.066	0.189	0.350	0.726
Efficiency 1 (EFF1)	0.178	0.107	1.660	0.097
Efficiency 2 (EFF2)	0.169	0.113	1.498	0.134
Second-order				
EFC (M3)	0.230	0.126	1.833	0.067
EFC (M4)	0.202	0.120	1.683	0.092
EFF (M3)	0.182	0.097	1.884	0.060
EFF (M4)	0.169	0.096	1.764	0.078
Higher-order				
PP (M3)	0.231	0.119	1.946	0.052
PP (M4)	0.210	0.113	1.856	0.063

Finally the higher-order factor, PP, was tested as shown in Table 8.13 and 8.14. The factor means of PP were found to be equal across Ports A and B when applying strict rules. However the difference test in both model invariance and factor mean invariance provided a result that is very close to significant differences considering the high p-values of the tests between the other models in Table 8.13. In conclusion, the mean values of all the factors which can be considered in the three measurement models were compared between Ports A and B to test H3a-2. All the factor means in Port A were higher than in Port B. However, all the differences between the ports were not significant, indicating the factor means invariance across Ports A and B. These invariant results did not reject H3a-2 which assumed the factor means to be invariant across Ports A and B.

8.3 COMPARISON BETWEEN TOC AND PU GROUPS

In transportation and logistics studies, the perceptions of service providers and their customers have been an important topic regarding, for example, mode selection factors, service providers' performance, customer satisfaction, etc. Most of the studies proved differences while some showed similarities (Meixell and Norbis 2008; Tiwari *et al.* 2003). This study hypothesised the proposed structural model could be applied to TOCs which are a service provider group and PUs which are a customer group comprising SCs and FWDs (H3b-1 and H3b-2). This means, in statistical terms, the

covariances of the data from TOC and PU groups are hypothesised to have a similar structure. The descriptive statistics in Chapter 6 showed significant differences of the score of most questionnaire items between TOC and PU groups. The TOC group evaluated themselves higher for all the items than the PU group did. While these differences do not represent any discrepancy of the covariance structures, different results are expected from the result of the invariance test across Ports A and B. The sample sizes of TOC and PU groups are 52 and 75 respectively and the characteristics of the groups were detailed in Chapter 6 (see Section 6.1.2, p.173).

8.3.1 Model invariance

The same process is applied to the model invariance test between TOC and PU groups as to the invariance tests between Ports A and B. Measurement invariance is first tested and the structural model is compared between TOC and PU groups. The diagrams of models are not provided in this section because exactly the same models are tested.

(1) Measurement models

Table 8.15 shows the results of measurement invariance tests of three higher-order factor models which are PSCO, PSCI and PP altogether. The first two rows named TOC and PU in each measurement model represents a subgroup analysis for the model. The model fits of the subgroup analyses suggest poor fits considering the traditionally used criteria of the model fit measures (χ^2/df<3; CFI>0.9; TLI>0.9; SRMR<0.08) and the situation where more conservative criteria are suggested (e.g. CFI>0.95; TLI>0.95; SRMR<0.05). This means a baseline model was not established and, therefore, it is not possible to proceed further because it cannot be ensured whether the parameters estimated by the measurement models reflect what they were supposed to measure. However, given that poor fit is acknowledged for all the measurement models, comparing nested models which have similar structure and complexity but represent different levels of invariance across the groups may provide potential implications for the application of this model to different groups. Thus, this invariance test was carried out for information purposes.

Table 8.15 Measurement invariance tests

Models	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
PSCO									
TOC	252.127	126	2.001	0.818	0.779	0.131			
PU	320.442	126	2.543	0.829	0.792	0.091			
M1	573.569	252	2.276	0.825	0.787	0.104			
M2	614.750	266	2.311	0.810	0.781	0.115	41.181	14	p<0.001
M4	621.323	269	2.310	0.808	0.782	0.124	6.574	3	0.087
M6	626.521	270	2.320	0.806	0.780	0.129	5.198	1	0.023
M7	649.935	274	2.372	0.795	0.771	0.129	23.414	4	p<0.001
M8	693.636	297	2.335	0.784	0.777	0.120	43.700	23	0.006
PSCI									
TOC	647.158	361		0.691	0.652	0.146			
PU	855.966	361		0.774	0.746	0.0931			
M1	1503.327	722	2.082	0.749	0.718	0.146			
M2	1550.968	746	2.079	0.742	0.719	0.144	47.641	24	0.003
M4	1553.565	750	2.071	0.742	0.721	0.148	2.597	4	0.627
M6	1568.764	751	2.089	0.737	0.716	0.220	15.199	1	p<0.001
M7	1581.077	756	2.091	0.735	0.715	0.220	12.314	5	0.031
M8	1660.283	796	2.086	0.722	0.743	0.226	79.206	40	p<0.001
PP									
TOC	345.606	181		0.835	0.808	0.105			
PU	426.828	181		0.815	0.786	0.101			
M1	772.617	362	2.134	0.824	0.795	0.110			
M2	801.197	378	2.120	0.818	0.798	0.103	28.580	16	0.027
M4	809.926	382	2.120	0.816	0.798	0.121	8.279	4	0.068
M6	811.239	383	2.118	0.816	0.798	0.117	1.313	1	0.252
M7	829.076	389	2.131	0.811	0.796	0.121	17.837	6	0.007
M8	961.780	412	2.334	0.764	0.759	0.133	132.704	23	p<0.001

M1 was not rejected as the sum of model fits of subgroup analyses was equal to the model fit of M1 in every three measurement model. However, the difference between M1 and M2 which constrained factor loadings to be equal was significant, requiring the rejection of M2. In higher-order measurement models, M4 imposes equality constraints on regression weights from first-order factors to higher-order factors. Thus, combining M2 and M4 may represent an invariance model for all the factor loadings in the higher-order models. While M4 showed insignificant differences from M2 in every measurement model, the sum of the chi-square differences between M2 and M1 and between M4 and M2 was significant: e.g. in the PSCO model, the sum of the chi-square is 46.089 (35.239+10.850) associated with 23 df and the p-value is lower than 0.005.

(2) Structural model

Similarly, given the poor model fit and the failure to establish metric invariance of the three measurement models, the structural model was tested primarily to examine the interacting or moderating effect of categorising variable of TOC and PU groups. As expected, subgroup analyses in Table 8.16 suggested a very poor model fit of the structural model. While M1 was not rejected, the comparative test between M2 and M1 provided a significant difference indicating M2 was rejected. With M2 assumed to be correct, a further stage of invariance test was implemented. M4-1 was the model which constrained the regression weights from first-order factors to higher-order factors and M4-2 imposed equality constraints on both PSCO-PSCI and PSCI-PP paths. The difference between the two models was significant with $\Delta\chi^2 = 6.124$ associated with 2 df ($p<0.05$). Given the significant difference, M4-2a which constrained only PSCO-PSCI path and M4-2b which constrained only PSCI-PP path were specified to see exactly which path coefficient was different between the groups. Thus, they were compared with M4-1 rather than M4-2 with 1 degree of freedom.

Table 8.16 Structural model invariance

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
TOC	495.681	282	1.758	0.759	0.722	0.118			
PU	748.409	282	2.654	0.754	0.759	0.084			
M1	1244.019	564	2.206	0.755	0.718	0.118			
M2	1279.258	579	2.209	0.748	0.717	0.117	35.239	15	0.002
M4-1	1290.108	587	2.198	0.755	0.718	0.126	10.850	8	0.210
M4-2	1296.232	589	2.201	0.746	0.719	0.134	6.124	2	p<0.05
M4-2a	1295.219	588	2.203	0.746	0.719	0.133	5.111	1	p<0.05
M4-2b	1291.814	588	2.197	0.747	0.720	0.129	1.706	1	p>0.05
M6	1304.154	590	2.210	0.743	0.717	0.175	7.922	1	0.005
M7	1352.253	603	2.243	0.730	0.709	0.188	48.099	13	p<0.001
M8	1417.844	633	2.240	0.718	0.710	0.183	65.591	30	p<0.001

The results indicated that the coefficient of PSCI-PP was invariant and that of PSCO-PSCI was different between the groups. Thus, the regression weights estimated in M4-2b in Table 8.17 may represent the relationships between PSCO and PSCI and between PSCI and PP, and the feature categorising TOC and PU group has an interaction effect on these relationships, given the limitations presented above.

Table 8.17 Structural regression weights by group

Paths	Models	TOC Regression weights	Critical Ratio	PU Regression weights	Critical ratio
PSCO-PSCI	M1	1.169 (0.886)	2.269*	1.241 (0.943)	5.971***
	M2	1.155 (0.884)	3.644***	1.317 (0.941)	5.883***
	M4-1	0.972 (0.881)	4.961***	1.371 (0.943)	5.961***
	M4-2	1.238 (0.916)	6.021***	1.238 (0.922)	6.021***
	M4-2a	1.234 (0.918)	6.016***	1.234 (0.917)	6.016***
	M4-2b	0.995 (0.879)	4.971***	1.360 (0.945)	5.953***
PSCI-PP	M1	2.091 (0.791)	2.487*	1.228 (0.899)	6.192***
	M2	1.589 (0.802)	3.913***	1.343 (0.914)	6.674***
	M4-1	1.764 (0.769)	4.791***	1.330 (0.921)	6.769***
	M4-2	1.400 (0.708)	7.015***	1.400 (0.918)	7.015***
	M4-2a	1.646 (0.780)	4.870***	1.346 (0.912)	6.690***
	M4-2b	1.396 (0.663)	7.063***	1.396 (0.925)	7.063***

Note: Numbers in brackets represents standardised regression weights; *** $p<0.001$

8.3.2 Factor mean invariance

Although the factor mean invariance test also requires at least partial scalar invariance of measurement model, this invariance test was conducted for the same reasons as in the structural model invariance test above. In this comparison between TOC and PU groups, the factor means of PU groups were fixed to zero to produce relative differences from the factor means of TOC group. It also needs to be noted that M1 and M2 were not presented because these models were not identified due to the increased complexity by adding more requirements to estimate factor means and intercepts.

(1) PSCO

For both the first-order and higher-order measurement models of PSCO, M5 which constrained the factor means in the models to be equal was significantly different against the previous models (83.641 with 4 df, $p<0.001$; 77.781 with 1 df, $p<0.001$ respectively) as shown in Table 8.18. This indicated that the mean values of both first-order factors and higher-order factors were statistically different between TOC and PU groups. The mean differences are provided in Table 8.19, describing the factor means evaluated by TOC were significantly higher than those by PU group.

Table 8.18 Measurement invariance tests for PSCO

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
First-order									
M3	643.710	276	2.332	0.800	0.778	0.116			
M5	727.351	280	2.598	0.756	0.733	0.192	83.641	4	p<0.001
M6	761.657	290	2.626	0.743	0.729	0.219	34.306	10	p<0.001
M8	802.656	313	2.564	0.733	0.739	0.200	40.999	23	0.019
Higher-order									
M3	662.283	283	2.340	0.793	0.776	0.124			
M4	664.446	286	2.323	0.794	0.779	0.127	2.163	3	0.539
M5	742.227	287	2.586	0.752	0.735	0.219	77.781	1	p<0.001
M6	742.229	288	2.577	0.752	0.737	0.223	0.002	1	0.966
M7	765.964	292	2.623	0.742	0.729	0.218	23.735	4	p<0.001
M8	807.307	315	2.563	0.732	0.739	0.199	41.342	23	0.011

Table 8.19 Factor mean invariance tests for PSCO

Factors	Difference	Standard Error	Critical Ratio	p-value
First-order				
Financial Resources (FR)	0.637	0.118	5.386	p<0.001
Human Resources (HR)	1.016	0.153	6.650	p<0.001
Organisational Relationships (OR)	0.944	0.121	7.826	p<0.001
Top Management Supports (TMS)	1.163	0.139	8.349	p<0.001
Higher-order				
PSCO (M3)	0.892	0.124	7.216	p<0.001
PSCO (M4)	0.894	0.121	7.381	p<0.001

(2) PSCI

Table 8.20 and 8.21 provided the results of the invariance tests of factors of PSCI measurement model. Similar to the PSCO measurement model, the factor means on both first-order and higher-order levels were found to be significantly different between TOC and PU groups.

Table 8.20 Measurement invariance tests for PSCI

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
First-order									
M3	1561.613	760	2.055	0.743	0.725	0.137			
M5	1638.287	765	2.142	0.720	0.702	0.426	76.675	5	p<0.001
M6	1670.452	780	2.142	0.714	0.702	0.315	32.164	15	p<0.001
M8	1753.172	820	2.138	0.700	0.703	0.325	82.170	40	p<0.001
Higher-order									
M3	1592.232	774	2.057	0.737	0.724	0.150			
M4	1594.697	778	2.050	0.738	0.726	0.150	2.465	4	0.651
M5	1668.410	779	2.142	0.714	0.702	0.161	73.713	1	p<0.001
M6	1676.219	780	2.149	0.712	0.700	0.320	7.809	1	0.005
M7	1687.019	785	2.149	0.710	0.700	0.320	10.801	5	0.055
M8	1768.182	825	2.143	0.697	0.702	0.330	81.163	40	p<0.001

Table 8.21 Factor mean invariance tests for PSCI

Factors	Difference	Standard Error	Critical Ratio	p-value
First-order				
Information Sharing and Communication System (ISCS)	1.265	0.156	8.173	p<0.001
Long-Term Relationships (LTR)	1.261	0.159	7.949	p<0.001
Value-Added Logistics (VAL)	1.080	0.144	7.532	p<0.001
Inter-modal Transport (IMT)	0.800	0.138	5.793	p<0.001
Supply Chain Integration Practices (SCIP)	1.157	0.140	8.282	p<0.001
Higher-order				
PSCI (M3)	1.254	.154	8.155	p<0.001
PSCI (M4)	1.208	.146	8.226	p<0.001

(3) PP

As explained earlier, the PP measurement model has three layers of factors. Thus, all three levels of measurement model were put in the analysis to compare all the levels of factors between the groups. The factor means were found to be statistically significantly different across the groups in every level as M5 which constrained the factor means to be equal was rejected as shown in Table 8.22. In addition, the mean differences were relatively large, ranging from 0.56 to 1.37 considering 5 Likert scales as shown in Table 8.23, and they were also significantly different between TOC and PU groups. For all the factors in the PP model, it was found that the TOC group evaluated their terminal operations and management far better than the PU group did, of course given the statistical limitations.

Table 8.22 Measurement invariance tests for PP

Model	Model fits						Differences		
	χ^2	df	χ^2/df	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	p
First-order									
M3	834.346	386	2.162	0.807	0.790	0.103			
M5	929.419	391	2.377	0.769	0.752	0.275	97.073	5	p<0.001
M6	965.705	406	2.379	0.760	0.751	0.184	36.286	15	p<0.001
M8	1095.529	429	2.554	0.714	0.720	0.166	129.825	23	p<0.001
Second-order									
M3	862.396	397	2.172	0.800	0.788	0.127			
M4	876.402	400	2.191	0.795	0.785	0.122	14.007	3	0.003
M5	957.740	402	2.382	0.761	0.751	0.275	81.338	2	p<0.001
M6	970.398	405	2.396	0.757	0.748	0.189	12.659	3	0.005
M7	981.064	410	2.393	0.755	0.749	0.184	10.665	5	0.058
M8	1112.284	433	2.569	0.708	0.717	0.168	131.220	23	p<0.001
Higher-order									
M3	864.250	398	2.171	0.800	0.789	0.139			
M4	878.998	402	2.187	0.795	0.786	0.138	14.748	4	0.005
M5	958.745	403	2.379	0.761	0.751	0.271	79.74	1	p<0.001
M6	962.663	404	2.383	0.760	0.750	0.188	3.918	1	0.048
M7	981.064	410	2.393	0.755	0.749	0.184	18.401	6	0.005
M8	1112.284	433	2.569	0.708	0.717	0.168	131.220	23	p<0.001

Table 8.23 Factor mean invariance tests for PP

Factors	Difference	Standard Error	Critical Ratio	p-value
First-order				
Effectiveness 1 (EFC1)	0.832	0.114	7.300	p<0.001
Effectiveness 2 (EFC2)	1.371	0.134	10.226	p<0.001
Effectiveness 3 (EFC3)	1.376	0.148	9.278	p<0.001
Efficiency 1 (EFF1)	0.549	0.113	4.874	p<0.001
Efficiency 2 (EFF2)	0.751	0.115	6.511	p<0.001
Second-order				
EFC (M3)	0.910	0.106	8.595	p<0.001
EFC (M4)	0.923	0.105	8.772	p<0.001
EFF (M3)	0.561	0.109	5.143	p<0.001
EFF (M4)	0.605	0.108	5.609	p<0.001
Higher-order				
PP (M3)	0.912	0.108	8.474	p<0.001
PP (M4)	0.938	0.106	8.822	p<0.001

8.4 SUMMARY AND CONCLUSION

Multi-group SEM analysis was conducted on the structural model proposed in this research to examine whether this model can be applied to different environment and groups. Specifically, this analysis aimed to see if: (1) the measurement model can be used in different environments to measure what the model is supposed to measure; (2) the structural relationships can be applied to different environments; and (3) the factor means in the model are invariant across different environments. To this end, the entire data set was grouped in two ways which were designed in the sampling stage: Port A and B, and TOC and PU groups. The analysis proceeded with the testing of the proposed hypotheses presented in Table 8.24.

Table 8.24 Hypotheses testing

	Hypotheses	Rejected
Port A and B		
H3a-1 (Model)	Proposed model is applied invariantly across Port A and B	Not rejected
H3a-2 (Factor means)	Factor means are invariant across Port A and B	Not rejected
TOC and PU		
H3b-1 (Model)	Proposed model is applied invariantly across TOC and PU	Rejected
H3b-2 (Factor means)	Factor means are invariant across TOC and PU	Rejected

The result of the comparison between Ports A and B indicated that the proposed model achieved full invariance and the factor means were not different, demonstrating H3a-1 and H3a-2 were not rejected. Regarding the comparison between TOC and PU groups, a baseline model was not established. However the invariance test was conducted to obtain some potential implications, and provided the results that H3b-1 and H3b-2 were rejected, given the limitations.

CHAPTER 9

CONCLUSION

The primary objective of this study is to examine the causal relationships among Port Supply Chain Orientation (PSCO), Port Supply Chain Integration (PSCI) and Port Performance (PP). To achieve this objective, it was necessary first to hypothesise theses causal relationships and second to empirically examine the relationships. These two main tasks were accomplished through exploratory study and empirical study (see Chapter 1, Figure 1.2, p.5). The exploratory study primarily aimed to develop the research model and operationalise constructs in the model. Two rounds of literature review defined the positioning of this thesis (Chapter 2) and provided a theoretical basis to develop the research model (Chapter 3). The research model of this thesis was developed both from the literature review and the interview study conducted in South Korea (Chapter 5), proposing the research hypotheses tested in the empirical study. Methodological issues were also addressed for both port research in general and this thesis. The empirical study, afterwards, examined the research model and hypotheses proposed in the exploratory study. For the examination, the questionnaire survey was conducted in South Korea. A general picture of survey participants and their responses to the questions was provided by descriptive statistics (Chapter 6). Subsequently, the research model and hypotheses were tested with SEM (Structural Equation Modelling). The validity of three measurement models (PSCO, PSCI and PP) was examined, and the relationships among them were assessed (Chapter 7). This study also examined whether this research model can be applied to different ports and different interest groups using multi-group SEM analysis (Chapter 8).

9.1 RESEARCH FINDINGS AND IMPLICATIONS

The research questions of this study presented in Chapter 1 are as follows:

RQ1: What are the main dimensions and activities of the integration strategy of ports along supply chains?

RQ2: What are the organisational characteristics and capabilities to facilitate the integration strategy of ports along supply chains?

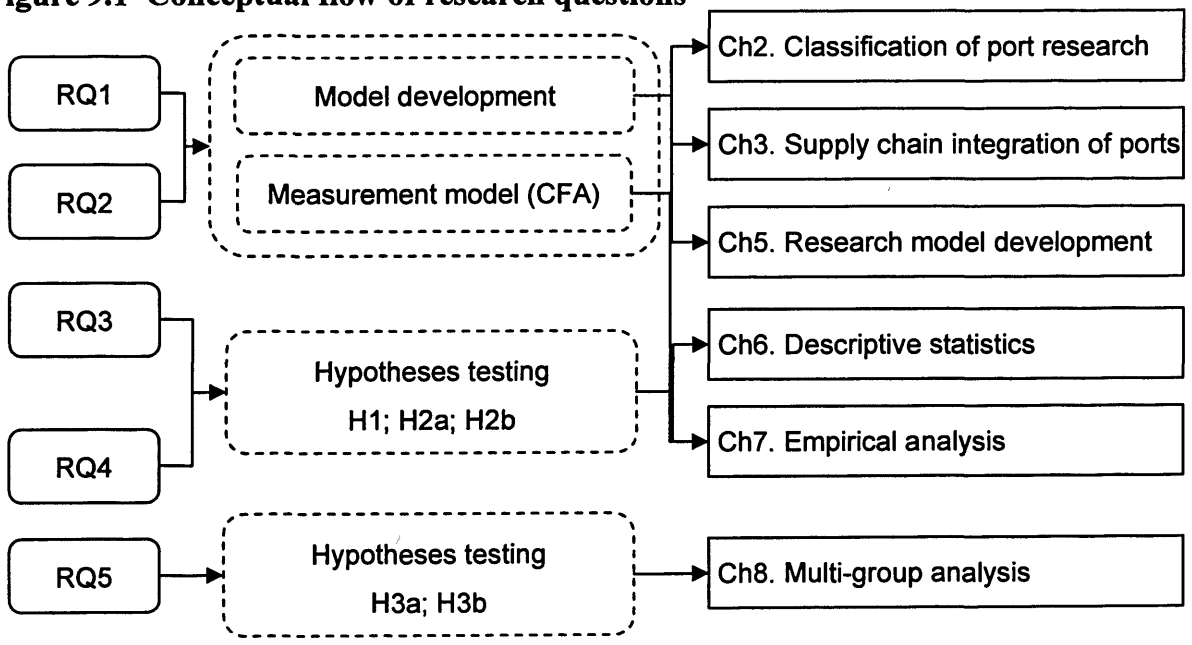
RQ3: What is the impact of the integration strategy on port performance?

RQ4: How strongly do organisational characteristics and capabilities contribute to the integration strategy of a port along supply chains?

RQ5: Can these relationships be equally applied to different environments?

Figure 9.1 illustrates how these research questions were addressed in this study. RQ1 and RQ2 concern how PSCI and PSCO can be conceptualised and represented in order to operationalise these concepts. Thus, these questions were dealt with in the model development process which was undertaken in Chapter 3 and 5. During the process, the other construct, PP was also operationalised. However, the capability and appropriateness of the three constructs to be used to test the causal relationships could not be empirically confirmed, only theoretically justified. Therefore, the validity of the three theoretical constructs was examined using CFA (Confirmatory Factor Analysis) in Chapter 7.

Figure 9.1 Conceptual flow of research questions



The remaining research questions, RQ3, 4 and 5, were addressed in the form of hypotheses to be tested in the empirical analysis. The hypotheses proposed in this study are as follows:

H1: PSCO has a positive impact on PSCI

H2a: PSCI has a positive impact on PP

H2b: PSCO has an indirect and positive impact on PP through PSCI

H3: The research model and causal relationships in the model are applied in the same way across ports with different operational characteristics and different groups which are port operators and port users.

RQ3 and 4 were transformed into H1, H2a and H2b which were tested in Chapter 7 and RQ5 was also dealt with by H3 in Chapter 8. The research findings and implications are detailed in this order.

9.1.1 Model development and Measurement model (CFA): RQ1 and RQ2

PSCI was expressed as 'a strategy undertaken by a seaport terminal to integrate various functions and organisations in a supply chain to become an integral part of the supply chain'. This construct was found to theoretically have five dimensions through literature review and interview with practitioners and academics: ISCS (Information Sharing and Communication Systems), LTR (Long-Term Relationships), VAL (Value-Added Logistics), IMT (Inter-Modal Transport) and SCIP (Supply Chain Integration Practices). The theoretical construct, PSCI, was empirically validated successfully with CFA. This indicates that PSCI is a multi-dimensional construct which cannot be represented by only one factor or dimension. In other words, PSCI involves five different phenomena which exist independently but are highly correlated in the same direction. In addition, the high regression weights from PSCI to the sub-dimensional factors demonstrate that PSCI substantially explains or influences the five phenomena. Therefore, a Terminal Operating Company (TOC) with a high level of PSCI must (1) have been sharing a high level of information, including information concerning cargo tracking, inventory management, forecasting and marketing with other supply chain

members using integrated information systems; (2) have established a long-term relationship with other supply chain members through managing relationships with the supply chain members systemically; (3) have the capability to provide customised VAL and IMT services effectively as well as efficiently; and (4) always have evaluated and benchmarked its performance to provide better services than competitors.

PSCO was expressed as 'the organisational characteristics and attributes facilitating the implementation of PSCI' in this study. PSCO was also found to be represented by four theoretical constructs by semi-structured interview study: FR (Financial Resources), HR (Human Resources), OR (Organisational Relationships) and TMS (Top Management Support). The measurement model, PSCO, was also successfully validated, proving PSCO is a multi-dimensional construct. The PSCO conceptualization suggests that TOCs seeking PSCI must have sufficient financial and human resources as well as the ability to manage both inter-departmental and inter-organisational relationships. The financial resources do not necessarily mean the company has sufficient financial capability, but the FR construct concerns whether the company has willingness and intention to invest for integrating functionally along supply chains. The HR construct also concerns whether human resources of the company have adequate capabilities to develop and provide the integrated logistics services and the human resources are offered educational opportunities by the company. These constructs are closely related with supports from top management. The empirical analysis showed that the PSCO of a TOC had the strongest contribution to TMS among the four constructs. Therefore, this conceptualization also, equally importantly, emphasises that strong top management support is necessary for successful implementation of both PSCO within TOCs and PSCI across supply chain members.

The specifics of implementing PSCO and PSCI including both high level dimensions and detailed scale items provide further managerial implications. The constructs and dimensions may offer ideas and guidelines on implementing PSCO and PSCI at a higher level. The measurement scale items may provide direct and actionable information at a practical level. Thus, managers can use the measurement scales as

strategic and managerial tools when implementing both PSCO within a firm and PSCI across firms. In addition, managers can adopt the measurement scale partly or fully as measures to evaluate the progress towards PSCO and PSCI. Apart from the research questions addressed in this section, the PP (Port Performance) measurement model which was also successfully validated provides important implications. This construct comprises two second-order constructs which are 'Effectiveness' and 'Efficiency'. This implies the respondents believe that port performance is multifaceted, demonstrating it should not be limited to one aspect of port operation and management. In particular, when studying performance-related implications of new trends or activities of port management involved with logistics and supply chain issues, both effectiveness and efficiency need to be considered. In addition, managers in TOCs are required to maintain a balanced focus on both effectiveness and efficiency, aiming to meet the goals of other supply chain members.

9.1.2 Hypotheses testing: RQ3 and RQ4

For RQ3 and 4, three hypotheses which were H1 (PSCO-PSCI), H2a (PSCI-PP) and H2b (PSCO-PSCI-PP) were proposed and empirically tested in Chapter 7. The findings of the test are described in this order.

(1) Impact of PSCO on PSCI: H1

This relationship was supported by examining the suggested structural model indicating the PSCO of a TOC positively contributes to implementing PSCI. The degree of contribution was found to be very strong: the regression weight from PSCO to PSCI was 1.29 (standardised weight=0.96), statistically indicating it is expected that PSCO is to increase the level of PSCI by 1.29 with one level of increase in 5 Likert scales. Thus, this concludes that PSCI is substantially influenced by PSCO. PSCO is the organisational characteristics and practices of being proactive and willing to implement PSCI and should happen inside individual TOCs. PSCI is the sum total of all the strategic actions undertaken by the TOCs across supply chain members to be an integral part of supply chains. This results, therefore, strongly suggests that managers

of TOCs seeking the successful implementation of PSCI must first have PSCO inside the TOCs.

The empirical analysis also tested four sub-hypotheses under H1, which represent causal relationships between the four individual first-order factors of PSCO and PSCI (see Section 6.3.2, Chapter 6). This test was attempted not only to assess the causal relationships but also to compare the structural model with higher-order factors and the model with first-order factors. H1-3 (OR-PSCI) and H1-2 (HR-PSCI) were supported but H1-1 (FR-PSCI) and H1-4 (TMS-PSCI) were not, whereas PSCO was proved to have a strong contribution to PSCI. This means the structural model with the higher-order factors is superior in terms of nomological validity. In addition, the contributions of the individual first-order constructs to PSCI cannot be guaranteed statistically and only the contribution of PSCO converging from the four sub-dimensions can be assured. Thus, only one or two first-order factors do not facilitate the implementation of PSCI better than PSCO can, and it is not likely to say a TOC has a high level of PSCO only because the TOC has a high level of either FR or HR. This implies that TOCs must manage and have concern for all the four dimensions simultaneously for better consequences when the TOCs adopt the integration strategies.

(2) Impact of PSCI on PP: H2a

This relationship was also found to be statistically significant, indicating a TOC's implementing PSCI improves the performance of the TOC. The strength of the contribution of PSCI to PP turned out to be high with the regression weight of 1.26 (standardised weight=0.95). Therefore, it is statistically expected for the PP of a TOC to be improved by 1.26 points in 5-Likert scales by 1 point of increase of PSCI of the TOC. Thus, this concludes that the PP of a TOC is positively influenced by PSCI. In addition, considering the PP construct encompasses both the effectiveness and the efficiency of terminal operations, the consequences of PSCI are not limited to improving either internal efficiency or external effectiveness. Both aspects of port performance can be improved by seeking PSCI. This implication can be supported by testing the sub-hypotheses under H2a which propose the positive impacts of PSCI on

the second-order factors of PP: H2a-1 represents PSCI-EFC path and H2a-2 represents PSCI-EFF path. Both paths were strongly supported with regression weights of 1.27 (standardised weight=0.93) and 0.86 (standardised weight=0.90) respectively.

(3) Indirect impact of PSCO on PP: H2b

With the evidence that both the PSCO-PSCI path and the PSCI-PP path were strongly supported, the indirect impact of PSCO through PSCI on PP could be assessed (H2b). This assessment explains how well-managed intra-organisational capabilities influence the performance of the organisation by implementing inter-organisational strategies along supply chains. It was also found that PSCO also positively influences PP indirectly when it is realised by implementing PSCI. The indirect impact also turned out to be strong with a regression weight of 1.632 (=1.262*1.293) as PSCO-PSCI and PSCI-PP paths had strong impacts.

Thus, a strong orientation to supply chain integration within a TOC enables the TOC to adopt and implement a strategy integrating across various functions and organisations along supply chains beyond the boundary of the TOC, and in turn, this strategy involves better performance of the TOC. In conclusion, the integration strategy of ports along supply chains (PSCI) should be firmly based on the strong orientation to supply chain integration within individual TOCs (PSCO), and the successful implementation of this strategy necessarily involves significant improvement of performance of the TOCs (PP).

9.1.3 Multi-group analysis: RQ5

Multi-group SEM analysis was conducted in order to answer the RQ5. This analysis aimed to see if (1) the measurement model can be used in different environments to measure what the model is supposed to measure, (2) the structural relationships can be applied to different environments, (3) the factor means in the model are invariant across different environments. To do so, RQ5 was transformed into four hypotheses as follows:

H3a-1: The proposed model is applied invariantly across Ports A and B
H3a-2: The factor means are invariant across Ports A and B
H3b-1: The proposed model is applied invariantly across TOC and PU
H3b-2: The factor means are invariant across TOC and PU

(1) Invariance between Ports A and B: H3a

The comparison was made between Port A and B which have different characteristics testing H3a-1 and H3a-2. Considering the various characteristics of the two ports (connectivity to shipping routes, cargo throughput, ratio of container cargoes to general cargoes), Port A can be categorised as a hub port handling primarily containerised cargoes while Port B can be categorised as a feeder port handling primarily dry bulk and general cargoes. Accordingly, model invariance across the two ports indicates that the examined model and the implications can be equally applied to Ports A and B, and furthermore, it provides a possibility to carefully interpret that they can be equally applied to both hub ports and feeder ports as well as both container terminals and non-containerised cargo terminals. On the other hand, rejecting the hypotheses proposing invariance indicates that the variables categorising the groups have an interaction or moderating effect on the examined model.

Firstly, the measurement model invariance test indicated that the three measurement models achieved full invariance across Ports A and B. This means the respondents from both Ports A and B believe the three constructs are multi-dimensional and they can be represented and measured by their lower-order constructs. In addition, the implications derived from validating the measurement models matter equally to both ports (see Section 9.1.1, p.255 for the implications). Subsequently, the structural model invariance test also did not show any significant differences between the two ports not rejecting H3a-1. Therefore, it was found that the causal relationships and their weights can be equally applied to both ports.

Thirdly, the mean values of all the constructs (latent variables) in all the three measurement models were compared between the two ports. The mean values of all the

factors of Port A, including PSCO, PSCI and PP, were found to be slightly higher than those of Port B. However the differences were not statistically significant to not reject H3a-2. Therefore, it can be concluded that there was no sufficient evidence to say that the levels of PSCO and PSCI of hub ports or container terminals are higher than those of feeder ports or non-containerised cargo (dry bulk and general) terminals. In conclusion, the features characterising Ports A and B, for example, hub port vs. feeder port or container port vs. non-container port, do not have a moderating effect on the causal relationships among PSCO, PSCI and PP and the levels of them in this study.

(2) Invariance between TOC and PU groups: H3b

The proper invariance tests across TOC and PU groups could not proceed further than the baseline model because the baseline model was not established for either TOC group or PU group. Thus, any results from these invariance tests are not valid and reliable. This means it cannot be ensured whether the parameters estimated by the measurement models reflect what they were supposed to measure. However, the whole process of invariance tests was conducted in order to obtain any potential implications despite the statistical limitations. Given the poor fitting of the measurement models and the structural model, the discrepancy between the two groups was statistically significant. The equality constraints imposed on the parameters in the measurement models and structural models deteriorated model fits significantly. In addition, the factor means were not invariant with the factor means evaluated by the TOC group as significantly higher than those by the PU group.

It is not surprising that these two groups have different perspectives on the issues this study raises and the phenomena this study attempts to prove exists. The integration of seaports along supply chains, as explained in Chapter 2 (Section 2.6.1, p.41) and Chapter 5 (see Section 5.2.1, p.141), is one of the solutions suggested by researchers and adopted by the port industry to cope with the challenges derived from shipping companies' evolution to global mega carriers. Thus, the adoption and implementation of this strategy by the port industry may cause competing and conflicting relationships with their customers (i.e. shipping companies and freight forwarders) in maritime

transport-based logistics markets. However, shipping companies obviously want TOCs to stay within the boundary shipping companies can control, and freight forwarders also will not accept TOCs expanding service ranges into their traditional business area. Accordingly, it is obvious that the respondents of the PU group answered the questionnaire very differently from the respondents of TOC group. Firstly the PU group rated all the items lower than the TOC group did without exception. Secondly the patterns of the deviations varied to a considerable extent (see Chapter 6, Figure 6.3, p.178; Figure 6.5, p.183; Figure 6.7, p.187). Under this circumstance, it is very unlikely that the covariance structures of the data of the two groups converge in the same or a similar way. Therefore, it is not possible to provide conclusions or infer implications from the results of these invariance tests and, in turn, the hypotheses also cannot be tested. This division between TOC and PU groups may not be useful to provide meaningful implications, or less useful than comparison between ports geographically. For this comparison, other multivariate analysis techniques may be more useful than SEM which applies strict criteria of model fits.

9.2 CONTRIBUTION AND LIMITATION

This study has theoretical contributions to a considerable extent. This investigation was the first effort to assess an impact of the integrating activities and strategies of seaport terminals along supply chains (i.e. PSCI) on port performance. This has previously not been sufficiently examined despite some researchers' efforts (e.g. Song and Panayides, 2008). In addition, the antecedents to the integration strategy of ports along supply chains were identified and their theoretical construct (i.e. PSCO) was validated statistically. Also, its impact on PSCI and PP was evaluated, which is also the first time that this has been attempted. This extension of the research model intended to expand the research scope and discussions from focusing on inter-organisational strategies of ports to combining the inter-organisational strategies with intra-organisational capabilities oriented to supply chain integration. Consequently it was possible to assess the impact of PSCO-PSCI path on PP rather than the impact of PSCI on PP only. This enabled this research to provide more useful managerial implications on how to

manage and utilize the resources and capabilities within firms to effectively integrate along supply chains. This study, otherwise, could have ended up with showing a positive causal relationship between PSCI and PP without providing more useful managerial implications. With regard to measurement items, the well defined and examined constructs and measurement scales would facilitate communication among researchers.

This research has important contributions in methodological terms. This study adopted SEM (Structural Equation Modelling) to examine the relationships between constructs which are abstract in nature and are not able to be captured directly. This analytical tool has not been used much in port research while maritime researchers have recently been increasingly using this technique. Therefore, the analysis process described and practiced in this study can provide guidance to maritime researchers who will potentially use this technique. In particular, the analytical techniques used in this study address various issues and include advanced techniques in SEM. Firstly, SEM was compared with other similar techniques, PLS and regression, in various ways (see Chapter 4, Section 4.4.2, p.115). This comparison provides useful information on the advantages and disadvantages of SEM over other techniques and the situations SEM needs to be used. Secondly, this study dealt with the issues of higher-order factor analysis, which were when and how to use the higher-order factor analysis (see Chapter 4, Section 4.4.4, p.126) and showed various practical examples in Chapter 7. Finally, multi-group analysis was conducted with the detailed procedure of this analysis (see Chapter 8, Section 8.1.1, p.226). The multi-group analysis in this study covered most of the possible research types which are generally chosen in multi-group analysis by conducting a measurement model invariance test, a structural model invariance test and a factor mean invariance test.

Managerial implications and practical contributions of this study were presented when discussing the research findings and implications in the previous sub-sections. Despite the contributions of this study, there are unavoidable limitations which need to be considered when discussing the conclusions of this study. This study tested the hypotheses proposed based on theory or observation before data were collected

because it is strongly suggested that SEM is used only for confirmatory purposes rather than exploratory purposes due to its statistical nature (Gefen *et al.*, 2000). Thus, this study did not test other possible relationships among the constructs. For example, a direct impact of PSCO on PP was not hypothesised due to a lack of theoretical justification and, thus, was not considered in the structural model. As discussed earlier, this study is the first effort to operationalize PSCO and test the causal relationships among the PSCI related constructs. However it does not mean the measurement scales used in this study are complete and there are no other antecedents to PSCI than PSCO. Therefore, refinement and supplements of the measurement scales may be able to strengthen the findings of this study. It should also be noted that careful consideration is required in interpreting and generalizing the findings of this study due to the fact that the data collection was geographically limited to one country.

These limitations leave a variety of scope for future research stemming from this thesis.

(i) Firstly, application of this model into wider geographical areas can be taken into account. Cross-validation of the research model of this thesis in different countries will provide opportunities to investigate practices relating to supply chain integration of seaport terminals in different situations, for example, in terms of port ownership. If the cross-validation and invariance of the model are verified, wider applicability of the research model will be ascertained. If the invariance tests fail, it will be very useful to investigate the factors or situations which make a difference in applying this research model.

(ii) Further development of alternative or extended models is another option. It is possible to consider the involvement of other dimensions of port performance as a dependent variable or factors which have negative impacts on PSCI as an independent variable. For example, financial performance measures can be included in the research model, extending from current performance measures which are basically concerned with operational performance. Conflicting relationships and power relationships among supply chain members can be included as factors negatively affecting PSCI. Thus, extending the current model can be pursued as long as it is theoretically justified.

(iii) Apart from examining the research model of this thesis, it is strongly suggested for future research to further investigate the typology of PSCI presented in Chapter 5. The four types of PSCI emerged during the semi-structured interview and demonstrated different approach to PSCI. Future research may be able to investigate the characteristics of firms in each type such as corporate governance and the commodities they handle.

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APPENDIX A: QUESTIONNAIRE IN ENGLISH

Dear Sir,

I am a PhD researcher in Logistics and Operation Management section of Cardiff Business School, Cardiff University. I am conducting research on supply chain integration of ports. This Questionnaire aims to identify a relationship between the organisational characteristics of terminal operating companies, port supply chain integration and performance. This study will help to investigate how to develop competitive advantage and performance of ports in changing logistics environments. It would be most appreciated if you would kindly support me by completing the attached Questionnaire from the perspectives of your organisation.

This questionnaire is for the research purposes only. Therefore your responses will be dealt with confidentially and will not be disclosed to any third party. Any geographical or other comparisons will not identify companies by name.

This questionnaire will take about 15 minutes to complete. Please return complete questionnaire via e-mail (woosh@cf.ac.uk). If you are not sure of the answer to a question, please provide your best estimated response. If you wish to receive a summary of the survey findings, please e-mail me and I will be happy to send the summary to you when the research is over.

Thank you very much for your time and patience. Please feel free to contact me if you would like to talk about the study or have any questions.

Authenticated by
Dr. Stephen Pettit (supervisor)

Yours sincerely,

Su Han Woo (Mr)
PhD researcher
Cardiff Business School
Cardiff University

[Survey questionnaire for Terminal Operting Companies]

SECTION 1. SUPPLY CHAIN INTEGRATION OF PORTS

Please indicate your level of agreement with the following statements concerning supply chain integration which your terminal has: 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree; N=not applicable.

Supply chain integration of Ports	Strongly disagree ⟷ Strongly agree					
	1	2	3	4	5	N
Information sharing and ICT						
1. We provide information concerning shipment and cargo tracking.						
2. We share information concerning inventory management with supply chain members.						
3. We exchange information concerning supply and demand forecasts with supply chain members.						
4. We exchange information concerning marketing strategy with supply chain members.						
5. We use integrated electronic data interchange to communicate with partners in the supply chain.						
6. We use integrated information systems to share data/information with partners in the supply chain.						
7. We adopt computerized port service systems for our supply chain operations.						
8. We use the latest IT technology in the industry to support supply chain goals.						
Long-term relationships						
9. We substantially reduced channel complexity over the past three years to closely work with a selected set of supply chain members.						
10. We have facilitated a strong and long-term supply chain relationship fostering cooperation with each other.						
11. Relationships with supply chain members are based on trust rather than contractual obligations.						
12. We have guidelines for developing, maintaining, and monitoring long term supply chain relationships with supply chain members.						
Value-added logistics service						
13. We have adequate facilities for adding value to cargoes.						
14. We have the capacity to adapt a service to meet the customers' specifications.						
15. We have the capacity to launch new tailored services should the need arise.						
16. We have the capacity to deliver even more tailored services to different market segments.						
17. We have the capacity to handle different types of cargo.						

Supply chain integration of Ports	Strongly disagree ⟷ Strongly agree					
	1	2	3	4	5	N
Intermodal transport service						
18. We have the capacity to convey cargo through the most diversified routes/modes at the least possible time.						
19. We have a variety of services to handle the transferring of cargo from one mode to another						
20. We have adequate connectivity for the multimodal interface.						
21. We have reliable service operations for the multimodal interface.						
22. We provide cost-effective multimodal operations.						
23. We evaluate alternative routes for the more efficient multimodal transport of containers via our Terminal.						
Supply chain integration practices						
24. We collaborate with other supply chain partners to plan for greater supply chain optimization.						
25. We seek to identify other competing supply chains for containers that might flow through our terminal.						
26. We benchmark the logistics/supply chain options available for cargoes that will flow through our port vis-a -vis alternative routes via competing ports.						
27. We seek to identify least cost options for the transport of cargoes to hinterland destinations.						
28. We constantly evaluate the performance of the transport modes available for linking our port/terminal to its hinterland destinations.						

SECTION2. SUPPLY CHAIN ORIENTATION OF PORTS

Please indicate your level of agreement with the following statements concerning supply chain orientation or capabilities which your terminal has accomplished: 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree; N=not applicable.

Supply chain orientation of ports	Strongly disagree ⟷ Strongly agree					
	1	2	3	4	5	N
Organizational relationships						
1. Our goals and objectives are consistent with those of our supply chain members.						
2. Our CEO and the CEOs of our supply chain members have similar operating philosophies.						
3. We are willing to make cooperative changes with our supply chain members.						
4. We believe our supply chain members must work together to be successful.						
5. Our supply chain members trust each other.						
6. We keep promises with our supply chain members.						
7. We deal with supply chain members with honesty.						
Top management support						
8. Top management repeatedly tell employees that our continued success depends on its adapting to new logistics environment such as supply chain integration.						
9. Top managers repeatedly tell employees that building, maintaining, and enhancing long-term relationships with supply chain members are critical to our business's success.						
10. Top managers repeatedly tell employees that sharing valuable strategic/tactical information with supply chain members is critical to our business's success.						
11. Top managers repeatedly tell employees that sharing objectives and philosophy is critical to our business's success.						
12. Top management offers various education opportunities about supply chain management and integration.						
Financial and human resources						
13. We have the financial resources to invest for supply chain integration when necessary.						
14. We are willing to invest for supply chain integration when necessary.						
15. We play a high priority on investment for supply chain integration.						
16. Our workforce have a good understanding of new logistics environments.						
17. Our workforce have the capabilities to develop new logistics services (e.g. integrated logistics services).						
18. We constantly offer education opportunities about supply chain integration to enhance the workforce' capabilities.						

SECTION 3. PORT PERFORMANCE

Please indicate how your company performs, compared to your major competitors, in the following performance areas: 1=much worse, 2=worse, 3=no difference, 4=better, 5=much better.

Port performance	Much worse ←			→ Much better		
	1	2	3	4	5	N
Effectiveness						
1. We provide a consistent reliable service.						
2. We handle cargoes on quoted or anticipated time.						
3. We handle cargoes on customers' time requirements.						
4. Our service lead-time is appropriate.						
5. Annual number of complaints from customers						
6. We provide shipment information accurately.						
7. We respond promptly to the need of customers.						
8. We have quick decision making process.						
9. We are flexible in terms of volume and type of cargo handling.						
10. We deal with unexpected events or situations well.						
11. Our total service price is:						
12. Our cargo handling charge is:						
13. Our charge for auxiliary services is:						
Efficiency						
14. Our cargo throughput per crane is:						
15. Our cargo throughput per acre is:						
16. Our ship waiting time is:						
17. Our ship turnaround time is:						
18. Our time for loading/unloading cargo is:						
19. Our time for mode transit is:						
20. Our time for truck entry is:						
21. Our time from cargo's entry to its exit is:						

[Survey questionnaire for port users (SCs and FWDs)]

SECTION 1. SUPPLY CHAIN INTEGRATION OF PORTS

Please indicate your level of agreement with the following statements concerning supply chain integration of terminals in the ports indicated below from your company's point of view: 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree; N=not applicable.

Supply chain integration of ports	Ports	Stongly disagree ← → Strongly agree				
		1	2	3	4	5
Information sharing and ICT						
1. Terminals in the ports provide information concerning shipment and cargo tracking.	Port A					
	Port B					
2. Terminals in the ports share information concerning inventory management with supply chain members.	Port A					
	Port B					
3. Terminals in the ports exchange information concerning supply and demand forecasts with supply chain members.	Port A					
	Port B					
4. Terminals in the ports exchange information concerning marketing strategy with supply chain members.	Port A					
	Port B					
5. Terminals in the ports use integrated electronic data interchange to communicate with partners in the supply chain.	Port A					
	Port B					
6. Terminals in the ports use integrated information systems to share data/information with partners in the supply chain.	Port A					
	Port B					
7. Terminals in the ports adopt computerized port service systems for our supply chain operations.	Port A					
	Port B					
8. Terminals in the ports use the latest IT technology in the industry to support supply chain goals.	Port A					
	Port B					
Long-term relationships						
9. Terminals in the ports have substantially reduced channel complexity over the past three years to closely work with a selected set of supply chain members.	Port A					
	Port B					
10. Terminals in the ports have facilitated a strong and long-term supply chain relationship fostering cooperation with each other.	Port A					
	Port B					
11. The terminals' relationships with supply chain members are based on trust rather than contractual obligations.	Port A					
	Port B					
12. Terminals in the ports have guidelines for developing, maintaining, and monitoring long term supply chain relationships with supply chain members.	Port A					
	Port B					
Value-added services						
13. Terminals in the ports have adequate facilities for adding value to cargoes.	Port A					
	Port B					
14. Terminals in the ports have the capacity to adapt a service to meet the customers' specifications.	Port A					
	Port B					
15. Terminals in the ports have the capacity to launch new tailored services should the need arise.	Port A					
	Port B					
16. Terminals in the ports have the capacity to deliver even more tailored services to different market segments.	Port A					
	Port B					
17. Terminals in the ports have the capacity to handle different types of cargo.	Port A					
	Port B					

Supply chain integratin of ports	Ports	Stongly disagree ⟷ Strongly agree				
		1	2	3	4	5
Intermodal transport service						
18. Terminals in the ports have the capacity to convey cargo through the most diversified routes/modes at the least possible time.	Port A					
	Port B					
19. Terminals in the ports have a variety of services to handle the transferring of cargo from one mode to another	Port A					
	Port B					
20. Terminals in the ports have adequate connectivity for the multimodal interface.	Port A					
	Port B					
21. Terminals in the ports have reliable service operations for the multimodal interface.	Port A					
	Port B					
22. Terminals in the ports provide cost-effective multimodal operations.	Port A					
	Port B					
23. Terminals in the ports evaluate alternative routes for the more efficient multimodal transport of containers via their terminals.	Port A					
	Port B					
Supply chain integration practices						
24. Terminals in the ports collaborate with other supply chain partners to plan for greater supply chain optimization.	Port A					
	Port B					
25. Terminals in the ports seek to identify other competing supply chains for containers that might flow through their terminals.	Port A					
	Port B					
26. Terminals in the ports benchmark the logistics/supply chain options available for cargoes that will flow through their port vis-a -vis alternative routes via competing ports.	Port A					
	Port B					
27. Terminals in the ports seek to identify least cost options for the transport of cargoes to hinterland destinations.	Port A					
	Port B					
28. Terminals in the ports constantly evaluate the performance of the transport modes available for linking their terminals to their hinterland destinations.	Port A					
	Port B					

SECTION 2. SUPPLY CHAIN ORIENTATION OF PORTS

Please indicate your level of agreement with the following statements concerning supply chain orientation or capabilities of terminals in the ports indicated below from your company's point of view: 1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree; N=not applicable.

Supply chain orientation of ports		Stongly disagree ⟷ Strongly agree				
	Ports	1	2	3	4	5
Organizational relationships						
1. Goals and objectives of terminals in the ports appear to be consistent with those of our supply chain members.	Port A					
	Port B					
2. CEOs of terminals in the ports and the CEOs of our supply chain members have similar operating philosophies.	Port A					
	Port B					
3. Terminals in the ports appear to be willing to make cooperative changes with our supply chain members.	Port A					
	Port B					
4. Terminals in the ports believe our supply chain members must work together to be successful.	Port A					
	Port B					
5. Our supply chain members including terminals in the ports trust each other.	Port A					
	Port B					
6. Terminals in the ports keep promises with our supply chain members.	Port A					
	Port B					
7. Terminals in the ports deal with supply chain members with honesty.	Port A					
	Port B					
Top management support						
8. It is known that Top management in terminals repeatedly tell employees that their success depends on their adapting to new logistics environment such as supply chain integration.	Port A					
	Port B					
9. It is known that Top managers in terminals repeatedly tell employees that building, maintaining, and enhancing long-term relationships with supply chain members are critical	Port A					
	Port B					
10. It is known that Top managers in terminals repeatedly tell employees that sharing valuable strategic/tactical information with supply chain members is critical	Port A					
	Port B					
11. It is known that Top managers in terminals repeatedly tell employees that sharing objectives and philosophy is critical	Port A					
	Port B					
12. It is known that Top management in terminals offers various training opportunities	Port A					
	Port B					
Financial and human resources						
13. It is known that terminals in the ports have the financial resources to invest for supply chain integration when necessary.	Port A					
	Port B					
14. It is known that terminals in the ports are willing to invest for supply chain integration when necessary.	Port A					
	Port B					
15. It is known that terminals in the ports play a high priority on investment for supply chain integration.	Port A					
	Port B					
16. It is known that workforces in terminals in the ports have a good understanding of new logistics environments.	Port A					
	Port B					
17. It is known that workforces in terminals in the ports have the capabilities to develop new logistics services	Port A					
	Port B					
18. It is known that terminals in the ports constantly offer education opportunities about supply chain integration to enhance the workforce' capabilities.	Port A					
	Port B					

SECTION 3. PORT PERFORMANCE

Please indicate how terminals in the ports indicated below performs, compared to their major competitors, from your company's point of view: 1=much worse, 2=worse, 3=no difference, 4=better, 5=much better.

Port performance		Stongly disagree ⟷ Strongly agree				
	Ports	1	2	3	4	5
Effectiveness						
1. Terminals in the ports provide a consistent reliable service.	Port A					
	Port B					
2. Terminals in the ports handle cargoes on quoted or anticipated time.	Port A					
	Port B					
3. Terminals in the ports handle cargoes on customers' time requirements.	Port A					
	Port B					
4. Service lead-time of terminals in the ports is appropriate.	Port A					
	Port B					
5. Annual number of complaints from customers	Port A					
	Port B					
6. Terminals in the ports provide shipment information accurately.	Port A					
	Port B					
7. Terminals in the ports respond promptly to the need of customers.	Port A					
	Port B					
8. Terminals in the ports have quick decision making process.	Port A					
	Port B					
9. Terminals in the ports are flexible in terms of volume and type of cargo handling.	Port A					
	Port B					
10. Terminals in the ports deal with unexpected events or situations well.	Port A					
	Port B					
11. Total service price of terminals in the ports is competitive	Port A					
	Port B					
12. Cargo handling charge of terminals in the ports is competitive	Port A					
	Port B					
13. Carge for auxiliary services of terminals in the ports is competitive	Port A					
	Port B					
Efficiency		much worse ⟷ much better				
14. Cargo throughput per crane of terminals in the ports is:	Port A					
	Port B					
15. Cargo throughput per acre of terminals in the ports is:	Port A					
	Port B					
		much longer ⟷ much shorter				
16. Ship waiting time of terminals in the ports is:	Port A					
	Port B					
17. Ship turnaround time of terminals in the ports is:	Port A					
	Port B					
18. Time for loading/unloading cargo in terminals in the ports is:	Port A					
	Port B					
19. Time for mode transit in terminals in the ports is:	Port A					
	Port B					
20. Time for truck entry in terminals in the ports is:	Port A					
	Port B					
21. Time from cargo's entry to its exit in terminals in the ports is:	Port A					
	Port B					

SECTION 4. RESPONDENT PROFILE

Please check where appropriate.

1. What are business areas of your company? (possible to pick more than one)

1) maritime transport ( ) 2) freight forwarding 3) warehousing ( ) 4) land transport ( )
5) manufacturing ( ) 6) trade ( )

2. What ports does your company primarily use? (possible to pick more than one)

1) Port A ( ) 2) Port B ( ) 3) Port C ( ) 4) Port D ( )
5) Port E ( ) 6) Others ( )

3. How long have you been employed by your company?
1) less than 5 years ( ) 2) 5-10 years ( ) 3) 10 – 20 years ( ) 4) more than 20 years ( )

4. Specify your position in your company
1) CEO ( ) 2) supervisory staff ( ) 3) managerial staff ( ) 4) staff ( )

APPENDIX B: QUESTIONNAIRE IN KOREAN

안녕하십니까? 귀사의 무궁한 발전을 기원합니다.
저는 국토해양부에 근무하고 있는 우수한 서기관입니다. 현재는 영국 카디프 경영대학에서 해운항만물류 박사과정을 이수 중에 있습니다.

제 연구주제는 항만이 공급사슬 (supply chain)을 따라 통합해 가는 전략 또는 현상에 대한 것입니다. 실제 현장에서는 이러한 현상들이 어떻게 일어나고 있으며 어떤 조직적인 특성이 이러한 현상을 더 원활하게 일어나게 하는 것인지에 대한 연구입니다.

이와 관련하여 해운 항만 분야 및 공공부문에 종사하시는 여러분께 설문을 의뢰하게 되었습니다. 이 설문은 연구목적으로만 활용될 것이며 따라서 모든 응답은 기밀로 취급되며 어떤 제 3 자에게도 공개되지 않을 것입니다. 귀하의 고견을 설문지에 담아주시면 제 연구에 큰 도움이 될 것입니다.

이 설문은 약 15 분 정도 소요될 것이며 완성된 설문은 저장하여 jazzlike@hanmail.net 또는 jazzlike@yahoo.com 으로 송부하여 주시기 바랍니다. 질문에 대한 답에 대해 확신이 없으시다 하더라도 최대한 추정하여 답하여 주시면 감사하겠습니다. 설문에서 자주 사용되는 용어에 대해서는 아래 에 설 명드리오니 참고하시기 바랍니다. 설문 결 과에 대해 알고 싶으신 분은 저에게 이메일로 요청하고 주시면 연구가 끝난 후에 요약본을 보내드리겠습니다. 귀한 시간 할애해 주셔서 감사드리며 궁금한 사항이 있으시면 언제든지 연락주시면 감사

Authenticated by
Dr. Stephen Pettit (supervisor)

영국 카디프 대학
해운항만물류 박사과정
우수한

< 참고 사항>

항만의 공급사슬로의 통합
: 항만(또는 터미널)이 전체 공급사슬내에서 제공되어 지는 서비스 또는 과정들을 수직적 통합 및 다양한 전략을 통하여 통합하여 제공하는 현상을 말함.

공급사슬 구성원
: 해당 터미널에서 처리하고 있는 화물의 공급사슬을 구성하고 있는 주체들을 말하며, 해운선사, 육상운송업체, 창고업체 뿐만 아니라 화주, 제3자 물류업체, 포워더 등을 포함함

[터미널 운영업체 대상 설문지]
제 1 부

다음은 항만이 공급사슬로 통합되어 가는 현상에 대한 질문들입니다. 귀 사의 터미널 운영 및 경쟁력 강화 전략과 관련하여 다음 기술하고 있는 내용에 대해 귀하가 동의하는 정도를 표시하여 주시기 바랍니다.
(1=아주 동의하지 않음; 2= 동의하지 않음; 3=중립; 4=동의함; 5=아주 동의함; N=답할 수 없음)

항만의 공급사슬로의 통합	동의하지 않음 ⟷ 동의함					
	1	2	3	4	5	N
정보 교환 및 정보교환 시스템 (Information sharing and ICT)						
1. 우리 터미널은 화물 선적 및 추적 관련 정보를 제공한다.						
2. 우리 터미널은 공급사슬의 구성원들과 창고관리 및 재고관리와 관련된 정보를 교환한다.						
3. 우리 터미널은 공급사슬의 구성원들과 해당 화물의 수요와 관련된 정보를 교환한다.						
4. 우리 터미널은 공급사슬의 구성원들과 해당 화물의 마케팅과 관련된 정보를 교환한다.						
5. 우리 터미널은 EDI를 사용하여 공급사슬의 구성원들과 정보 및 자료를 교환한다.						
6. 우리 터미널은 공급사슬의 구성원들과 자료 및 정보를 공유하기 위해 EDI 이외에 별도의 통합된 정보시스템을 사용한다.						
7. 우리 터미널은 컴퓨터화된 시스템을 이용하여 항만을 운영한다.						
8. 우리 터미널은 최신 정보통신 기술을 사용한다.						
장기적인 관계 형성 및 유지 (Long-term relationship)						
9. 우리 터미널은 공급사슬의 구성원들과 지난 몇년 동안 긴밀히 협력하여 작업을 절차화 및 간소화했다.						
10. 우리 터미널은 공급사슬의 구성원들과 장기적인 관계를 원활하게 형성해 왔다.						
11. 우리 터미널과 공급사슬의 구성원들과의 관계는 계약·의무에 기초하기 보다는 신뢰에 바탕을 두고 있다.						
12. 우리 터미널은 공급사슬의 구성원들과 장기적인 관계를 형성하고 관리해 나가는데 필요한 내부적인 방침이나 지침이 있다.						
부가가치 서비스 (Value-added services)						
13. 우리 터미널은 부가가치 서비스를 제공하는데 충분한 시설을 가지고 있다.						
14. 우리 터미널은 고객의 세부적인 요구사항에 맞게 서비스를 제공할 수 있는 역량이 있다.						
15. 우리 터미널은 새롭게 발생하는 수요에 대해 맞춤형 서비스를 개발할 수 있는 역량이 있다.						
16. 우리 터미널은 다양한 산업군에 따라 맞춤형 서비스를 제공할 수 있는 역량을 가지고 있다.						
17. 우리 터미널은 다양한 형태의 화물을 처리할 수 있는 역량을 가지고 있다.						

항만의 공급사슬로의 통합	동의하지 않음 ⟷ 동의함					
	1	2	3	4	5	N
복합운송 서비스(Multimodal operations and systems)						
18. 우리 터미널은 다양한 경로와 운송모드를 통해 화물을 운송할 수 있는 역량을 가지고 있다.						
19. 우리 터미널은 화물을 한 운송모드에서 다른 모드로 전환하는데 필요한 다양한 서비스를 제공할 수 있다.						
20. 우리 터미널은 복합운송 (multimodal transport) 을 위해 타 운송수단과의 연계성 (해상/도로, 해상/철도 등) 을 충분히 가지고 있다						
21. 우리 터미널은 신뢰성 있는 복합운송 (Multimodal transport) 서비스를 제공한다.						
22. 우리 터미널은 합리적인 비용으로 복합운송 (Multimodal transport) 서비스를 제공한다.						
23. 우리 터미널은 보다 효율적인 복합운송 (Multimodal transport) 경로 (대안) 를 항상 검토한다.						
공급사슬 통합 활동 (Supply chain integration practices)						
24. 우리 터미널은 공급사슬의 구성원들과 공급사슬을 최적화하기 위해 협력하고 있다.						
25. 우리 터미널은 타 터미널을 이용하고 있는 다른 화물의 공급사슬들을 파악하기 위해 노력하고 있다.						
26. 우리 터미널을 이용하고 있는 화물에 대해, 우리 터미널을 이용하는 경우와 타 경쟁 터미널을 이용하는 경우의 비용·시간 등을 비교한다.						
27. 우리 터미널은 현재 우리 터미널을 이용하고 있는 화물들에 대해, 다른 물류적 대안들을 파악하기 위해 노력한다.						
28. 우리 터미널은 화물이 배후 목적지까지 도착하는데 가장 경제적인 운송 경로 및 방안을 파악하기 위해 노력한다.						
29. 우리 터미널은 배후 목적지까지의 운송 활동에 대해 지속적으로 성과 (performance) 를 평가한다.						

제 2 부

다음은 항만의 공급사슬 통합에 대한 지향성과 관련된 질문들입니다. 귀 사의 및 터미널 운영 및 경쟁력 강화 전략과 관련하여 다음 기술하고 있는 내용에 대해 귀하가 동의하는 정도를 표시하여 주시기 바랍니다.

(1=강하게 동의하지 않음; 2= 동의하지 않음; 3=중립; 4=동의함; 5= 아주 동의함; N=답할 수 없음)

항만의 공급사슬 통합 지향성	동의하지 않음 ⟷ 동의함					
	1	2	3	4	5	N
조직적 관계 (Organizational relationships)						
1. 우리 터미널의 목표는 공급사슬 내의 다른 구성원들의 목표와 유사하거나 일치한다.						
2. 우리 터미널의 CEO는 공급사슬 내의 다른 CEO들과 유사한 운영 철학을 가지고 있다.						
3. 우리 터미널은 공급사슬내의 구성원들과 협력하여 변화를 추진할 의향이 있다.						
4. 우리 터미널은 공급사슬내 구성원들과 같이 협력해야 성공할 수 있다고 믿는다.						
5. 우리 터미널과 공급사슬내 구성원들은 서로 신뢰한다.						
6. 우리 터미널은 공급사슬내 구성원들과 약속한 것을 이행한다.						
7. 우리 터미널은 공급사슬내 구성원들에게 진실하게 대한다.						
최고 경영진의 지원 (Top management support)						
8. 우리 터미널의 임원진은 직원들에게 우리 터미널의 생존은 공급사슬 통합 등 새로운 환경에 적응해 나가는 데에 달려있다고 반복한다.						
9. 우리 터미널의 임원진은 직원들에게 공급사슬 구성원들과 장기적인 관계를 형성, 유지, 강화하는 것이 우리 터미널의 성공에 매우 중요하다고 반복한다.						
10. 우리 터미널의 임원진은 직원들에게 가치있는 전략적 정보들을 공급사슬 구성원들과 공유하는 것이 우리 터미널의 성공에 매우 중요하다고 반복한다.						
11. 우리 터미널의 임원진은 직원들에게 공급사슬 구성원들과 목표 및 철학을 공유하는 것이 우리 터미널의 성공에 매우 중요하다고 반복한다.						
12. 우리 터미널의 임원진은 직원들에게 공급사슬 관리 및 통합에 대한 다양한 교육기회를 제공한다.						
재정적 및 인적 자원 (Financial and human resources)						
13. 우리 터미널은 통합 물류 서비스 제공을 위해 필요할 경우 투자할 자금을 확보하고 있다.						
14. 우리 터미널은 통합 물류 서비스 제공을 위해 필요한 경우 자금을 투자할 의향이 있다.						
15. 우리 터미널은 통합 물류 서비스 제공을 위한 투자에 대한 우선 순위가 높다.						
16. 우리 터미널의 인력은 새로운 물류환경을 잘 이해하고 있다.						
17. 우리 터미널의 물류 인력은 새로운 물류서비스 (ex. 통합 물류서비스) 를 개발할 수 있는 역량이 있다.						
18. 우리 터미널은 인력자원의 역량 개발을 위해 물류통합, 공급사슬 관리 등과 관련된 교육을 지속적으로 해오고 있다.						

제 3 부

다음은 경쟁력 및 성과와 관련되 질문들입니다. 다음 기술하고 있는 성과 지표와 관련하여 주요 경쟁사와 비교하여 귀사의 성과를 평가해 주시기 바랍니다.

항만의 성과	동의하지 않음 ⟷ 동의함					
	1	2	3	4	5	N
서비스 효과성 지표 (Effectiveness)						
1. 경쟁 터미널에 비해 우리 터미널은 고객에 대한 서비스를 신뢰성 있게 제공하고 있다.						
2. 경쟁 터미널에 비해 우리 터미널은 계약에 명시된 또는 통상 예상되는 작업시간 안에 화물을 처리한다.						
3. 경쟁 터미널에 비해 우리 터미널은 고객의 불만 제기 회수가 적은 편이다.						
4. 경쟁사에 비해 우리 터미널은 고객이 요구하는 작업시간안에 화물을 처리한다.						
5. 경쟁사에 비해 우리 터미널은 서비스 제공에 소요되는 시간이 짧다.						
6. 경쟁사에 비해 우리 터미널은 화물운송과 관련된 정보를 정확하게 제공한다.						
7. 경쟁사에 비해 우리 터미널은 주요 고객의 요구사항에 대해 즉각적으로 대응한다.						
8. 경쟁사에 비해 우리 터미널은 고객의 요구에 따라 화물 처리량, 처리 화종, 화물처리 방식 등에 대해 유연하다.						
9. 경쟁사에 비해 우리 터미널은 고객의 요구에 따라 화물처리 스케쥴, 처리 절차의 변경에 대한 의사결정이 신속하다.						
10. 경쟁사에 비해 우리 터미널은 예상치 못했던 상황이나 사건에 대해 잘 대처한다.						
11. 경쟁사에 비해 우리 터미널의 전체 서비스 가격은 경쟁력이 있다.						
12. 경쟁사에 비해 우리 터미널의 하역비용은 경쟁력이 있다.						
13. 경쟁사에 비해 우리 터미널이 제공하는 항만관련서비스 비용은 경쟁력이 있다.						
서비스 효율성 지표 (Efficiency)						
	매우 낮음 ⟷ 매우 높음					
14. 경쟁사 대비 우리 터미널의 크레인당 연간 화물처리량						
15. 경쟁사 대비 우리 터미널의 면적당 연간 화물처리량						
	매우 길다 ⟷ 매우 짧다					
16. 경쟁사 대비 우리 터미널의 선박대기 시간						
17. 경쟁사 대비 우리 터미널의 선박작업 시간						
18. 경쟁사 대비 컨테이너 당 양/적하 시간						
19. 경쟁사 대비, 화물이 육상 운송모드 (트럭, 열차 등) 으로 이전되는데 소요되는 시간						
20. 경쟁사 대비, 트럭이 우리 터미널에 진입하기 위해 대기하는 시간						
21. 경쟁 터미널에 비해 우리 터미널에 화물이 진입하여 최종 빠져나오는데 소요되는 시간이 짧다.						

[항만고객(선사 및 포워더) 대상 설문지]

제 1 부

다음은 항만이 공급사슬로 통합되어 가는 현상에 대한 질문들입니다. 귀 사의 경험을 바탕으로 다음 항만의 터미널들에 대해 다음 기술하고 있는 내용에 귀하가 동의하는 정도를 표시하여 주시기 바랍니다.

(1=아주 동의하지 않음; 2= 동의하지 않음; 3=중립; 4=동의함; 5=아주 동의함)

항만의 공급사슬로의 통합	항만	동의하지 않음 ←→ 동의함				
		1	2	3	4	5
정보 교환 및 정보교환 시스템 (Information sharing and ICT)						
1. 터미널들이 화물의 선적 및 추적 관련 정보를 제공한다.	Port A					
	Port B					
2. 터미널들이 공급사슬의 구성원들과 창고관리 및 재고관리와 관련된 정보를 교환한다.	Port A					
	Port B					
3. 터미널들이 공급사슬의 구성원들과 해당 화물의 수요와 관련된 정보를 교환한다.	Port A					
	Port B					
4. 터미널들이 공급사슬의 구성원들과 해당 화물의 마케팅과 관련된 정보를 교환한다.	Port A					
	Port B					
5. 터미널들이 EDI 를 사용하여 공급사슬의 구성원들과 정보 및 자료를 교환한다.	Port A					
	Port B					
6. 터미널이 공급사슬의 구성원들과 자료 및 정보를 공유하기 위해 EDI 이외의 별도의 통합된 정보시스템을 사용한다.	Port A					
	Port B					
7. 터미널이 컴퓨터화된 시스템을 이용하여 항만을 운영한다.	Port A					
	Port B					
8. 터미널들이 최신 정보통신 기술을 사용한다.	Port A					
	Port B					
장기적인 관계 형성 및 유지 (Long-term relationships)						
9. 터미널들이 공급사슬의 구성원들과 지난 몇년 동안 긴밀히 협의하여 작업을 절차화 및 간소화 한 적이 있다.	Port A					
	Port B					
10. 터미널들이 공급사슬의 구성원들과 장기적인 관계를 원활하게 형성해 왔다.	Port A					
	Port B					
11. 터미널들과 공급사슬 구성원들과의 관계는 계약의무에 기초하기보다는 신뢰에 바탕을 두고 있다.	Port A					
	Port B					
12. 터미널들이 공급사슬의 구성원들과 체계적으로 장기적인 관계를 형성하고 관리하고 있다.	Port A					
	Port B					
부가가치 서비스 (Value-added services)						
13. 터미널들이 부가가치 서비스를 제공하는데 충분한 시설을 가지고 있다.	Port A					
	Port B					
14. 터미널들이 고객의 세부적인 요구사항에 맞게 서비스를 제공할 수 있는 역량이 있다.	Port A					
	Port B					
15. 터미널들이 새롭게 발생하는 수요에 대해 맞춤형 서비스를 개발할 수 있는 역량이 있다.	Port A					
	Port B					
16. 터미널들이 다양한 산업군에 따라 맞춤형 서비스를 제공할 수 있는 역량을 가지고 있다.	Port A					
	Port B					
17. 터미널들은 다양한 형태의 화물을 처리할 수 있는 역량을 가지고 있다.	Port A					
	Port B					

항만의 공급사슬로의 통합	항만	동의하지 않음 ←→ 동의함				
		1	2	3	4	5
복합운송 서비스**(Multimodal operations and systems)**						
18. 터미널들이 다양한 경로와 운송모드를 통해 화물을 운송할 수 있는 역량을 가지고 있다.	Port A					
	Port B					
19. 터미널들이 화물을 한 운송모드에서 다른 모드로 전환하는데 다양한 서비스를 제공할 수 있다.	Port A					
	Port B					
20. 터미널들이 복합운송 (multimodal transport) 을 위해 타 운송수단과의 연계성 (해상/도로, 해상/철도 등) 을 충분히 가지고 있다	Port A					
	Port B					
21. 터미널들이 신뢰성 있는 복합운송 (Multimodal transport) 서비스를 제공한다.	Port A					
	Port B					
22. 터미널들이 합리적인 비용으로 복합운송 (Multimodal transport) 서비스를 제공한다.	Port A					
	Port B					
23. 터미널들이 보다 효율적인 복합운송 (Multimodal transport) 경로 (대안) 를 검토하는 편이다.	Port A					
	Port B					
공급사슬 통합 활동 **(Supply chain integration practices)**						
24. 터미널들이 공급사슬의 구성원들과 더 나은 공급사슬 최적화를 위해 협력하고 있다.	Port A					
	Port B					
25. 터미널들이 경쟁 터미널에서 처리되고 있는 화물의 공급사슬을 파악하기 위해 노력한다.	Port A					
	Port B					
26. 터미널들이 자신의 터미널을 이용하는 경우와 타 경쟁 터미널을 이용하는 경우의 비용·시간 등을 비교한다.	Port A					
	Port B					
27. 터미널들이 현재 자신의 터미널에서 처리되는 화물에 대해 다른 물류적 대안들을 파악하기 위해 노력한다.	Port A					
	Port B					
28. 터미널들이 화물의 배후 목적지까지 도착하는데 가장 경제적인 운송 경로 및 방안을 파악하기 위해 노력한다.	Port A					
	Port B					
29. 터미널들이 배후 목적지까지의 운송활동에 대해 성과 (performance) 를 평가한다.	Port A					
	Port B					

제 2 부

다음은 항만들의 공급사슬 통합에 대한 지향성과 관련된 질문들입니다. 귀 사의 경험을 바탕으로 다음 항만의 터미널들에 대해 다음 기술하고 있는 내용에 귀하가 동의하는 정도를 표시하여 주시기 바랍니다.

(1=강하게 동의하지 않음; 2= 동의하지 않음; 3=중립; 4=동의함; 5= 아주 동의함)

항만의 공급사슬 통합 지향성		동의하지 않음 ←→ 동의함				
	항만	1	2	3	4	5
조직 관계 (Organizational relationships)						
1. 터미널들의 목표가 공급사슬 내의 다른 구성원들의 목표와 유사하거나 일치한다.	Port A					
	Port B					
2. 터미널들의 CEO들이 공급사슬 내의 다른 CEO들과 유사한 운영철학을 가지고 있다.	Port A					
	Port B					
3. 터미널들이 공급사슬내의 구성원들과 협력하여 변화를 추진할 의향이 있는 것으로 보여진다.	Port A					
	Port B					
4. 터미널들이 공급사슬내 구성원들과 같이 협력해야 성공할 수 있다고 믿는 것으로 보여진다.	Port A					
	Port B					
5. 터미널들과 공급사슬내 구성원들이 서로 신뢰한다.	Port A					
	Port B					
6. 터미널들이 공급사슬내 구성원들과 약속한 것을 이행한다.	Port A					
	Port B					
7. 터미널들이 공급사슬내 구성원들에게 진실하게 대한다.	Port A					
	Port B					
최고 경영진의 지원 (Top management support)						
8. 터미널의 임원진들이 직원들에게 터미널의 생존이 새로운 환경에 적응해 나가는 데에 달려있다고 강조하는 것으로 알고있다.	Port A					
	Port B					
9. 터미널의 임원진들이 직원들에게 공급사슬 구성원들과 장기적인 관계를 형성, 유지, 강화하는 것이 터미널의 성공에 매우 중요하다고 강조하는 것으로 알고있다.	Port A					
	Port B					
10. 터미널의 임원진들이 직원들에게 가치있는 전략적 정보들을 공급사슬 구성원들과 공유하는 것이 터미널의 성공에 매우 중요하다고 강조하는 것으로 알고있다.	Port A					
	Port B					
11. 터미널의 임원진들이 직원들에게 공급사슬 구성원들과 목표 및 철학을 공유하는 것이 터미널의 성공에 매우 중요하다고 강조하는 것으로 알고있다.	Port A					
	Port B					
12. 터미널의 임원진들이 직원들에게 공급사슬 관리 및 통합에 대한 다양한 교육기회를 제공하는 것으로 알고있다.	Port A					
	Port B					
재정적 및 인적 자원 (Financial and human resources)						
13. 터미널들이 통합 물류 서비스 제공을 위해 필요할 경우 투자할 재정적 역량이 있다.	Port A					
	Port B					
14. 터미널들이 통합 물류 서비스 제공을 위해 필요한 경우 자금을 투자할 의향이 있다.	Port A					
	Port B					
15. 터미널들이 통합 물류 서비스 제공을 위한 투자에 대해 적극적이다.	Port A					
	Port B					
16. 터미널들의 인력들은 새로운 물류환경을 잘 이해하고 있다.	Port A					
	Port B					
17. 터미널들의 인력들은 새로운 물류서비스 (ex. 통합 물류서비스)를 개발할 수 있는 역량이 있다.	Port A					
	Port B					
18. 터미널들이 인력자원의 역량 개발을 위해 물류통합, 공급사슬 관리 등과 관련된 교육을 지속적으로 한다.	Port A					
	Port B					

제 3 부

다음은 항만의 경쟁력 및 성과와 관련된 질문들입니다. 귀 사의 경험을 바탕으로 다음 항만의 터미널들에 대해 평가하여 주시기 바랍니다.

항만의 성과		동의하지 않음 ⟷ 동의함				
	항만	1	2	3	4	5
서비스 효과성 지표 (Effectiveness)						
1. 터미널들이 고객에 대한 서비스를 안정적으로 신뢰성 있게 제공하고 있다.	Port A					
	Port B					
2. 터미널들이 계약에 명시된 또는 통상 예상되는 작업시간 안에 화물을 처리한다.	Port A					
	Port B					
3. 터미널들에 대한 고객의 불만 제기 회수가 적은 편이다.	Port A					
	Port B					
4. 터미널들이 고객이 요구하는 작업시간안에 화물을 처리한다.	Port A					
	Port B					
5. 터미널들이 서비스를 제공하는데 소요되는 시간이 합리적이다.	Port A					
	Port B					
6. 터미널들이 화물운송과 관련된 정보를 정확하게 제공한다.	Port A					
	Port B					
7. 터미널들이 주요 고객의 요구사항에 대해 즉각적으로 대응한다.	Port A					
	Port B					
8. 터미널들이 고객의 요구에 따라 화물 처리량, 처리 화종, 화물처리 방식 등에 대해 유연하다.	Port A					
	Port B					
9. 터미널들이 고객의 요구에 따라 화물처리 스케쥴, 처리 절차의 변경에 대한 의사결정이 신속하다.	Port A					
	Port B					
10. 터미널들이 예상치 못했던 상황이나 사건에 대해 잘 대처한다.	Port A					
	Port B					
11. 터미널들이 제공하는 서비스의 전체 가격이 경쟁력있다.	Port A					
	Port B					
12. 터미널들이 제공하는 하역서비스의 가격이 경쟁력있다.	Port A					
	Port B					
13. 터미널들이 제공하는 항만관련서비스 비용이 경쟁력있다.	Port A					
	Port B					
서비스 효율성 지표 (Efficiency)		매우 낮음 ⟷ 매우 높음				
14. 터미널의 크레인당 연간 화물처리량	Port A					
	Port B					
15. 터미널의 면적당 화물처리량	Port A					
	Port B					
		매우 길다 ⟷ 매우 짧다				
16. 터미널들에서 선박대기 시간이 짧다.	Port A					
	Port B					
17. 터미널들에서 선박작업 시간 짧다.	Port A					
	Port B					
18. 터미널들에서 컨테이너 당 양/적하 시간이 짧다.	Port A					
	Port B					
19. 터미널들에서 화물이 육상 운송모드 (트럭, 열차 등) 으로 이전되는 데 소요되는 시간이 짧다.	Port A					
	Port B					
20. 트럭이 터미널에 진입하기 위해 대기하는 시간이 짧다.	Port A					
	Port B					
21. 화물이 터미널에 진입하여 최종 빠져나오는데 소요되는 시간이 짧다.	Port A					
	Port B					

APPENDIX C: LIST OF SELECTED JOURNALS

Journals	1980-1989	1990-1999	2000-2009	Total
Maritime Policy and Management (MPM)	55	82	96	233
Maritime Economics and Logistics (MEL)	0	2	99	101
Journal of Transport Geography (JTG)	0	11	18	29
International Journal of Transport Economics (JTEP)	1	8	17	26
Transportation Research Part A (TRpA)	5	1	15	21
Geojournal (GJ)	4	9	7	20
Transportation Research Part B: Methodological (TRpB)	3	5	12	20
Tijdschirft voor Economische en Sociale Geografie (TESG)	4	9	5	18
Transportation Research Part E (TRpE)	0	2	15	17
Transport Reviews (TR)	1	1	13	15
European Journal of Operation Research (EJOR)	0	0	14	14
Transportation Journal (TJ)	3	3	8	14
Coastal Management (CM)	3	7	3	13
Geoforum (GF)	5	4	3	12
Marine Policy (MP)	0	4	8	12
Environment and Planning A (EPA)	2	3	6	11
Journal of Transport Economics and Policy (JTEP)	4	3	4	11
Applied Economics (AE)	1	0	9	10
Transport Policy (TP)	0	4	6	10
International Journal of Logistics: Research and Applications (IJLRA)	0	0	9	9
International Journal of Physical Distribution and Logistics Management (IJPDLM)	3	1	5	9
International Journal of Production Economics (IJPE)	1	2	5	8
Journal of Waterway, Port, Coastal and Ocean Engineering (JWPCOE)	4	2	2	8
Growth and Change (GC)	2	1	4	7
European Journal of Transport and Infrastructure Research (EJTIR)	0	0	6	6
Review of Network Economics (RNE)	0	0	6	6
Industrial Relations Journal (IRJ)	0	3	2	5
Journal of Marine Science and Technology (JMST)	0	0	5	5
Journal of Urban Technology (JUT)	0	4	1	5
OR Spectrum (ORS)	0	0	5	5
British Journal of Industrial Relations (BJIR)	0	3	1	4
Computers and Industrial Engineering (CIE)	0	3	1	4
Economic Affairs (EA)	0	4	0	4
Economic Geography (EG)	1	1	2	4
Journal of Transport Security (JTS)	0	0	4	4
Simulation (Smltn)	1	2	1	4
Transportation Quarterly (TQ)	0	2	2	4
Transportation (Trptn)	0	0	4	4
Transport Science (TS)	0	2	2	4
International Association of Traffic and Safety Sciences (IATSS)	0	0	3	3
Journal of Industrial Relations (JIR)	0	2	1	3
Journal of Urban Planning and Development (JUPD)	0	0	3	3
Marine Pollution Bulletin (MPB)	0	0	3	3
Ocean and Coastal Management (OCM)	0	2	1	3
Professional Geographers (PG)	3	0	0	3
Transportation Research Part D: (TRpD)	0	0	3	3
Australian Geographers (AG)	2	0	0	2
Asian Pacific Viewpoint (APV)	0	0	2	2
Capital and Class (CC)	0	2	0	2
Economic Development Quarterly (EDQ)	0	0	2	2
Expert Systems with Applications (ESA)	0	0	2	2
Human Geography (HG)	1	1	0	2
International Journal of Logistics Management (IJLM)	0	0	2	2
International Journal of Transport Management (IJTM)	0	0	2	2
Industrial Relations (IR)	0	0	2	2
Journal of Development Economics (JDE)	0	1	1	2
Journal of Industrial Economics (JIE)	1	0	1	2
Journal of International Logistics and Transport (JILT)	0	0	2	2
Journal of Productivity Analysis (JPA)	0	0	2	2
Journal of Strategic Information Systems (JSIS)	0	0	2	2
Journal of Transportation Law, Logistics and Policy (JTLLP)	0	0	2	2
Logistics Information Management (LIM)	0	1	1	2

Networks and Spatial Economics (NSE)	0	0	2	2
Public Administration (PA)	1	1	0	2
Review of Urban and Regional Development (RURD)	0	0	2	2
Sociological Review (SR)	0	2	0	2
Transportation Research Part C (TRpC)	0	0	2	2
Transport (Trpt)	0	0	2	2
World Development (WD)	0	1	1	2
Work, Employment and Society (WES)	0	2	0	2
Asian Economic Journal (AEJ)	0	1	0	1
Applied Mathematics and Computation (AMC)	0	0	1	1
Annals of Operation Research (AOR)	0	0	1	1
Asian Pacific Education Review (APER)	0	0	1	1
Asian Pacific Journal of Marketing and Logistics (APJML)	0	0	1	1
Area	1	0	0	1
Benchmarking: an International Journal (BIJ)	0	0	1	1
Cities	0	0	1	1
Cambridge Journal of Economics (CJE)	0	1	0	1
European Journal of Industrial Relations (EJIR)	0	0	1	1
European Journal of Scientific Research (EJSR)	0	0	1	1
European Management Journal (EMJ)	0	0	1	1
Environment and Planning C (EPC)	1	0	0	1
International Journal of Computer Applications in Technology (IJCAT)	0	0	1	1
International Journal of Critical Infrastructures (IJCI)	0	0	1	1
International Journal of Decision Sciences, Risk and Management (IJDSRM)	0	0	1	1
International Journal of Environmental Technology and Management (IJETM)	0	0	1	1
International Journal of Integrated Supply Management (IJSM)	0	0	1	1
International Journal of Ocean Systems Management (IJOSM)	0	0	1	1
International Journal of Public Sector Management (IJPSM)	0	0	1	1
International Journal of Technology Management (IJTeM)	0	1	0	1
International Labor and Working-Class History (ILWCH)	0	0	1	1
Information and Management (IM)	0	0	1	1
Industrial Marketing Management (IMM)	0	0	1	1
International Review of Business Research Papers (IRBRP)	0	0	1	1
International Regional Science Review (IRSR)	0	0	1	1
Journal of Applied Transport (JAT)	0	1	0	1
Journal of Business Logistics (JBL)	0	0	1	1
Journal of Economics and Business (JEB)	0	0	1	1
Journal of Forecasting (JF)	0	0	1	1
Journal of Hazardous Materials (JHM)	0	0	1	1
Journal of Infrastructure Systems (JIS)	0	0	1	1
Journal of Loss Prevention in the process industries (JLP)	0	0	1	1
Journal of Labour Research (JLR)	0	0	1	1
Journal of Management Development (JMD)	0	1	0	1
Journal of Management Science (JMS)	0	1	0	1
Management Decision (MD)	0	0	1	1
Oxford Bulletin of Economics and Statistics (OBES)	0	1	0	1
Public Administration Review (PAR)	1	0	0	1
Public Management Review (PMR)	0	0	1	1
Political Geography (PolG)	0	0	1	1
Planning Perspectives (PP)	0	0	1	1
Politics and Society (PS)	0	0	1	1
Queuing Systems (QS)	0	0	1	1
Review of International Economics (RIE)	0	0	1	1
Research of Policy Research (RPR)	0	0	1	1
Regional Studies (RS)	0	0	1	1
Supply Chain Management: an international journal (SCM)	0	1	0	1
System Practice and Action Research (SPAR)	0	0	1	1
Safety Science (SS)	0	0	1	1
Transaction of the Institute of the British Geographers (TIBG)	0	1	0	1
Transport Reviews (TR)	0	1	0	1
Urban Geography (UG)	0	0	1	1
Utilities Policy (UP)	0	0	1	1
World Review of Intermodal Transportation Research (WRITR)	0	0	1	1
	114	213	513	840

APPENDIX D. CLASSIFICATION AND ANALYSIS OF PORT RESEARCH (CHAPTER 2 AND 4)

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
1	planning and development	economic impact	economic base analysis	economics	positivism	empirical / case study	case study	descriptive (index)
2	port management	IT	not specific	IT	positivism	empirical / case study	interview	na
3	competition and performance	competitiveness	not specific	OR	positivism	empirical / case study	economic modelling	regression
4	port management	HRM	not specific	HRM	positivism	empirical / statistical	survey	t-test
5	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	conceptual	na
6	port management	IT	not specific	geography	positivism	empirical / case study	case study	na
7	port management	TOC strategy	not specific	geography	positivism	empirical / case study	case study	na
8	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
9	terminal operation	land access OR	not specific	OR	positivism	analytical / mathematical	math modelling	LP
10	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
11	planning and development	optimal investment	not specific	OR	positivism	analytical / mathematical	math modelling	LP
12	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
13	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	LP
14	planning and development	demand analysis	utility theory	economics	positivism	empirical / statistical	economic modelling	logit model
15	competition and performance	competition	game theory	economics	positivism	empirical / case study	case study	game theoretical analysis
16	port management	TOC strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
17	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	conceptual	na
18	port in SC	inland logistics	not specific	not specific	positivism	empirical / case study	case study	descriptive
19	competition and performance	performance	not specific	not specific	positivism	analytical / conceptual	conceptual	na
20	planning and development	economic impact	not specific	not specific	positivism	analytical / conceptual	case study	na
21	port management	port pricing	game theory	economics	positivism	empirical / case study	case study	sensitivity analysis
22	planning and development	project appraisal	not specific	not specific	positivism	analytical / conceptual	conceptual	na
23	planning and development	development case	not specific	economics	positivism	empirical / case study	archival analysis	na
24	planning and development	development case	not specific	economics	positivism	analytical / conceptual	conceptual	na
25	spatial analysis	network analysis	not specific	OR	positivism	analytical / mathematical	math modelling	LP
26	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
27	port management	IT	not specific	public administration	positivism	empirical / case study	interview	na
28	port governance	port reform	port administration model	not specific	positivism	analytical / conceptual	case study	na
29	competition and performance	competitiveness	not specific	geography	positivism	analytical / conceptual	conceptual	na
30	spatial analysis	port system	not specific	not specific	positivism	analytical / conceptual	conceptual	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
31	planning and development	development case	not specific	not specific	positivism	empirical / case study	case study	descriptive
32	competition and performance	competitiveness	not specific	geography	positivism	analytical / conceptual	conceptual	na
33	port policy	national port policy	not specific	not specific	positivism	empirical / case study	case study	na
34	port governance	port reform	port administration model	not specific	positivism	analytical / conceptual	conceptual	na
35	port management	port strategy	not specific	economics	positivism	analytical / conceptual	economic modelling	descriptive
36	port governance	port reform	not specific	not specific	positivism	empirical / case study	survey	descriptive
37	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
38	spatial analysis	network analysis	not specific	geography	positivism	empirical / case study	case study	descriptive
39	port management	environmental management	not specific	environmental studies	positivism	analytical / conceptual	case study	na
40	port policy	environmental regulation	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
41	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	simulation	simulation
42	port policy	security regulation	not specific	logistics	positivism	analytical / conceptual	conceptual	na
43	port policy	regulation and competition	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
44	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA / tobit model
45	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
46	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
47	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
48	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
49	port governance	labour reform	not specific	Industrial relations	positivism	empirical / case study	case study	na
50	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	na
51	terminal operation	OR	not specific	OR	positivism	analytical / mathematical	conceptual	na
52	port governance	port reform	not specific	geography	positivism	empirical / case study	case study	na
53	port management	environmental management	not specific	environmental studies	positivism	empirical / case study	case study	na
54	planning and development	project appraisal	not specific	economics	positivism	analytical / conceptual	conceptual	na
55	port policy	national port policy	not specific	geography	positivism	analytical / conceptual	conceptual	na
56	competition and performance	performance	production theory	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
57	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
58	port governance	governance model	not specific	not specific	positivism	analytical / conceptual	conceptual	na
59	port policy	supranational policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
60	port management	port pricing	utility theory	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
61	port management	security management	not specific	not specific	positivism	analytical / conceptual	conceptual	na
62	port management	TOC strategy	not specific	marketing	positivism	empirical / statistical	survey	SEM
63	competition and performance	performance	SCM	not specific	positivism	empirical / case study	survey	descriptive

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
64	port in SC	redefining	not specific	logistics	positivism	analytical / conceptual	conceptual	na
65	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	simulation	simulation
66	planning and development	decision making process	not specific	not specific	interpretivism	empirical / case study	interview	na
67	port policy	supranational policy	not specific	geography	interpretivism	empirical / case study	interview	na
68	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
69	planning and development	demand analysis	not specific	economics	positivism	analytical / mathematical	economic modelling	simulation
70	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	regression
71	planning and development	decision making process	demand-supply analysis	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
72	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
73	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
74	port management	environmental management	not specific	public administration	positivism	analytical / conceptual	conceptual	na
75	port management	environmental management	not specific	not specific	positivism	analytical / conceptual	conceptual	na
76	port management	environmental management	not specific	geography	positivism	analytical / conceptual	conceptual	na
77	planning and development	development case	not specific	not specific	positivism	analytical / conceptual	case study	na
78	port governance	governance model	not specific	not specific	positivism	analytical / conceptual	case study	na
79	port governance	governance model	not specific	not specific	positivism	empirical / case study	survey	descriptive
80	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	conceptual	na
81	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
82	port in SC	inland logistics	not specific	logistics	positivism	analytical / conceptual	conceptual	na
83	port policy	environmental regulation	not specific	not specific	positivism	analytical / conceptual	case study	na
84	port management	environmental management	not specific	environmental studies	positivism	empirical / case study	case study	na
85	port management	port strategy	not specific	marketing	positivism	empirical / case study	survey	descriptive
86	competition and performance	competitiveness	not specific	not specific	positivism	empirical / case study	case study	descriptive
87	port policy	supranational policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
88	competition and performance	competitiveness	not specific	not specific	positivism	empirical / case study	case study	shift-share analysis
89	port in SC	redefining	not specific	strategic management	positivism	empirical / case study	survey	descriptive
90	port management	port pricing	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
91	port policy	environmental regulation	not specific	environmental studies	positivism	empirical / case study	survey	descriptive
92	port management	HRM	not specific	industrial relations	interpretivism	empirical / case study	interview	discourse analysis
93	competition and performance	competitiveness	not specific	not specific	positivism	empirical / statistical	case study	MCDM
94	port governance	port reform	not specific	economics	positivism	empirical / statistical	economic modelling	regression
95	port management	HRM	not specific	industrial relations	positivism	analytical / conceptual	conceptual	na
96	planning and development	economic impact	input-output analysis	economics	positivism	empirical / statistical	case study	input-output

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
97	planning and development	economic impact	input-output analysis	economics	positivism	empirical / statistical	case study	input-output
98	competition and performance	competitiveness	strategic positioning	strategic management	positivism	empirical / statistical	interview	MCDM
99	competition and performance	competition	not specific	geography	positivism	analytical / conceptual	case study	descriptive
100	competition and performance	competition	not specific	not specific	positivism	analytical / conceptual	content analysis	na
101	competition and performance	port selection	not specific	not specific	positivism	empirical / statistical	survey	factor analysis
102	terminal operation	terminal	not specific	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
103	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive (index)
104	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	conceptual	na
105	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
106	port governance	port reform	port administration model	not specific	positivism	analytical / conceptual	case study	na
107	planning and development	supply analysis	not specific	OR	positivism	empirical / statistical	survey	regression
108	terminal operation	yard operation	not specific	OR	positivism	analytical / conceptual	conceptual	na
109	terminal operation	yard operation	not specific	OR	positivism	empirical / statistical	math modelling	regression
110	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA / TDEA
111	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive
112	port governance	governance model	worlds of production	economics	positivism	analytical / conceptual	conceptual	na
113	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	LP
114	terminal operation	OR	ERP	OR	positivism	analytical / conceptual	conceptual	na
115	competition and performance	port selection	not specific	OR	positivism	analytical / statistical	economic modelling	MCDM
116	planning and development	supply analysis	not specific	OR	positivism	empirical / case study	math modelling	regression
117	planning and development	supply analysis	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
118	planning and development	optimal investment	not specific	OR	positivism	analytical / mathematical	economic modelling	economic model analysis
119	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	regression
120	port policy	security regulation	not specific	not specific	positivism	analytical / conceptual	conceptual	na
121	port management	environmental management	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
122	competition and performance	efficiency	not specific	economics	positivism	analytical / conceptual	conceptual	na
123	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	descriptive
124	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	Regression
125	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	descriptive
126	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	na
127	competition and performance	competition	not specific	geography	positivism	empirical / case study	case study	descriptive (index)
128	port policy	national port policy	not specific	geography	positivism	analytical / conceptual	conceptual	na
129	planning and development	development case	not specific	not specific	positivism	analytical / conceptual	conceptual	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
130	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
131	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
132	port management	environmental management	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
133	competition and performance	competitiveness	not specific	not specific	positivism	analytical / conceptual	conceptual	na
134	planning and development	supply analysis	not specific	not specific	positivism	analytical / conceptual	case study	descriptive
135	port governance	governance model	port administration model	economics	positivism	analytical / conceptual	case study	na
136	port governance	port reform	port administration model	economics	positivism	analytical / conceptual	conceptual	na
137	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
138	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
139	competition and performance	competitiveness	network theory	Geography	positivism	empirical / statistical	math modelling	Descriptive (index)
140	planning and development	demand analysis	not specific	economics	positivism	analytical / mathematical	math modelling	LP
141	port governance	governance model	port administration model	economics	positivism	empirical / statistical	economic modelling	DEA
142	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
143	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA / FDH
144	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
145	competition and performance	competition	not specific	not specific	positivism	analytical / conceptual	case study	na
146	competition and performance	competitiveness	not specific	not specific	positivism	analytical / conceptual	case study	na
147	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA / SFA
148	port governance	governance model	not specific	politics	positivism	analytical / conceptual	conceptual	na
149	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
150	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
151	planning and development	demand analysis	not specific	economics	positivism	empirical / statistical	math modelling	LP
152	port management	security management	not specific	not specific	positivism	empirical / statistical	math modelling	descriptive
153	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	conceptual	na
154	planning and development	economic impact	input-output analysis	economics	positivism	analytical / conceptual	conceptual	na
155	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	TFP
156	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	regression
157	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	ECM
158	spatial analysis	port system	not specific	economics	positivism	empirical / case study	case study	descriptive (index)
159	port management	port pricing	game theory	economics	positivism	analytical / mathematical	economic modelling	sensitivity analysis
160	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
161	port management	port strategy	collective action	not specific	positivism	empirical / case study	interview	descriptive
162	port management	port strategy	not specific	regional planning	positivism	empirical / case study	interview	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
163	competition and performance	competitiveness	not specific	not specific	positivism	empirical / statistical	survey	ANOVA
164	port in SC	inland logistics	not specific	not specific	positivism	empirical / case study	interview	descriptive
165	port management	TOC strategy	not specific	strategic management	positivism	analytical / conceptual	interview	descriptive
166	port management	port pricing	not specific	economics	positivism	empirical / case study	case study	descriptive
167	competition and performance	competition	contestable markets	economics	positivism	analytical / conceptual	conceptual	na
168	port policy	regulation and competition	not specific	economics	positivism	analytical / conceptual	conceptual	na
169	port management	port strategy	collective action	geography	positivism	empirical / case study	interview	descriptive
170	competition and performance	competition	not specific	economics	positivism	empirical / statistical	case study	shift-share analysis
171	port in SC	integration	network theory	logistics	positivism	analytical / conceptual	conceptual	na
172	planning and development	project appraisal	benefit-cost analysis	economics	positivism	analytical / conceptual	conceptual	na
173	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
174	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
175	competition and performance	performance	production theory	economics	positivism	empirical / case study	economic modelling	descriptive (index)
176	port management	TOC strategy	not specific	strategic management	positivism	analytical / conceptual	case study	na
177	port governance	port reform	not specific	geography	positivism	empirical / case study	case study	na
178	port management	port strategy	not specific	geography	positivism	analytical / conceptual	conceptual	na
179	port policy	regulation and competition	not specific	economics	positivism	analytical / mathematical	simulation	simulation
180	port policy	regulation and competition	price-cap regulation	economics	positivism	empirical / statistical	economic modelling	TFP
181	port management	security management	not specific	not specific	positivism	empirical / statistical	survey	descriptive
182	planning and development	optimal investment	not specific	OR	positivism	analytical / mathematical	math modelling	LP
183	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	simulation	simulation
184	planning and development	economic impact	supply-demand analysis	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
185	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
186	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA (shadow price)
187	port management	security management	not specific	not specific	positivism	analytical / conceptual	conceptual	na
188	port governance	port reform	not specific	geography	positivism	empirical / case study	survey	descriptive
189	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	regression
190	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	simulation	simulation
191	port management	port pricing	not specific	not specific	positivism	analytical / conceptual	conceptual	na
192	port management	port pricing	not specific	not specific	positivism	analytical / conceptual	conceptual	na
193	planning and development	project appraisal	not specific	economics	positivism	analytical / conceptual	conceptual	na
194	competition and performance	performance	not specific	not specific	positivism	analytical / conceptual	conceptual	na
195	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling / simulation	simulation

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
196	terminal operation	sea access OR	not specific	OR	positivism	analytical / conceptual	simulation	simulation
197	spatial analysis	port-city relationship	not specific	geography	positivism	empirical / statistical	case study	factor analysis
198	spatial analysis	network analysis	not specific	geography	positivism	empirical / case study	case study	descriptive
199	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	descriptive
200	spatial analysis	port-city relationship	port-city model	geography	positivism	empirical / statistical	math modelling	descriptive (index)
201	spatial analysis	port-city relationship	not specific	geography	positivism	empirical / statistical	case study	factor analysis
202	port in SC	integration	not specific	not specific	positivism	empirical / case study	case study	regression
203	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive
204	port management	port strategy	not specific	OR	positivism	analytical / mathematical	simulation	simulation
205	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	queueing model
206	port policy	regulation and competition	not specific	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
207	port policy	regulation and competition	not specific	economics	positivism	empirical / case study	case study	na
208	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
209	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
210	port management	HRM	collective bargaining	industrial relations	structuralism	empirical / case study	interview	na
211	port governance	port reform	not specific	public administration	positivism	analytical / conceptual	conceptual	na
212	planning and development	decision making process	not specific	public administration	positivism	analytical / conceptual	conceptual	na
213	port policy	regulation and competition	not specific	not specific	positivism	analytical / conceptual	case study	na
214	port policy	regulation and competition	not specific	not specific	positivism	analytical / conceptual	conceptual	na
215	port governance	port reform	not specific	public administration	positivism	analytical / conceptual	case study	na
216	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
217	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
218	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
219	port governance	port reform	not specific	economics	positivism	analytical / conceptual	case study	na
220	port policy	supranational policy	not specific	economics	positivism	analytical / conceptual	conceptual	na
221	port management	HRM	not specific	industrial relations	positivism	analytical / conceptual	conceptual	na
222	port management	environmental management	not specific	not specific	positivism	analytical / conceptual	conceptual	na
223	planning and development	demand analysis	not specific	economics	positivism	empirical / statistical	economic modelling	regression
224	port policy	regulation and competition	production theory	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
225	port policy	regulation and competition	price-cap regulation	economics	positivism	empirical / statistical	economic modelling	DEA
226	port in SC	inland logistics	not specific	logistics	positivism	empirical / case study	case study	na
227	planning and development	project appraisal	input-output analysis	economics	positivism	analytical / conceptual	case study	input-output
228	port policy	environmental regulation	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
229	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
230	port management	port strategy	not specific	geography	positivism	analytical / conceptual	conceptual	na
231	competition and performance	competition	site and situation	geography	positivism	analytical / conceptual	case study	na
232	spatial analysis	port system	centrality, intermediacy	geography	positivism	analytical / conceptual	case study	na
233	spatial analysis	network analysis	network analysis	geography	positivism	analytical / conceptual	conceptual	na
234	competition and performance	competitiveness	not specific	not specific	positivism	analytical / conceptual	conceptual	na
235	spatial analysis	network analysis	site and situation	geography	positivism	analytical / conceptual	conceptual	na
236	port policy	regulation and competition	coase theorem	economics	positivism	analytical / conceptual	conceptual	na
237	spatial analysis	network analysis	network analysis	geography	positivism	empirical / case study	case study	shift-share analysis
238	planning and development	project appraisal	benefit-cost analysis	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
239	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
240	port governance	port reform	not specific	economics	positivism	analytical / conceptual	conceptual	na
241	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
242	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
243	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	case study	na
244	spatial analysis	port-city relationship	not specific	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
245	planning and development	demand analysis	not specific	economics	positivism	empirical / statistical	economic modelling	ECM
246	planning and development	demand analysis	not specific	economics	positivism	analytical / mathematical	economic modelling	ECM
247	port policy	regulation and competition	cournot model	economics	positivism	empirical / case study	economic modelling	regression
248	competition and performance	competitiveness	not specific	economics	positivism	empirical / statistical	economic modelling	regression
249	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	simulation	simulation
250	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	case study	na
251	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
252	competition and performance	port selection	not specific	economics	positivism	empirical / statistical	economic modelling	logit model
253	port management	port pricing	marginal cost pricing	economics	positivism	empirical / statistical	survey	descriptive
254	competition and performance	port selection	utility theory	economics	positivism	empirical / statistical	economic modelling	logit model
255	port management	IT	not specific	IT	positivism	analytical / conceptual	conceptual	na
256	port governance	port reform	not specific	economics	positivism	analytical / conceptual	case study	descriptive
257	port management	environmental management	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
258	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	case study	regression
259	port policy	environmental regulation	not specific	not specific	positivism	analytical / conceptual	conceptual	na
260	port policy	environmental regulation	not specific	not specific	positivism	analytical / conceptual	conceptual	na
261	port management	environmental management	not specific	environmental studies	positivism	empirical / case study	survey	descriptive

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
262	port policy	regulation and competition	not specific	not specific	positivism	empirical / case study	survey / interview	descriptive
263	spatial analysis	port-city relationship	not specific	geography	positivism	empirical / case study	case study	na
264	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
265	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA (DF)
266	competition and performance	efficiency	production theory	economics	positivism	analytical / conceptual	content analysis	na
267	port governance	port reform	not specific	economics	positivism	empirical / statistical	economic modelling	SFA
268	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	LP
269	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
270	port management	environmental management	not specific	economics	positivism	empirical / case study	economic modelling	regression
271	planning and development	project appraisal	not specific	economics	positivism	analytical / conceptual	conceptual	economic model analysis
272	planning and development	optimal investment	not specific	economics	positivism	empirical / statistical	economic modelling	regression
273	competition and performance	competitiveness	RBV	strategic management	positivism	analytical / conceptual	interview	na
274	competition and performance	competition	not specific	economics	positivism	analytical / conceptual	case study	na
275	competition and performance	competition	not specific	economics	positivism	analytical / conceptual	case study	na
276	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
277	port policy	regulation and competition	not specific	economics	positivism	analytical / conceptual	conceptual	na
278	port governance	governance model	not specific	not specific	positivism	analytical / conceptual	case study	na
279	port governance	governance model	externality, public good	economics	positivism	analytical / conceptual	conceptual	na
280	port management	port strategy	not specific	economics	positivism	analytical / conceptual	conceptual	na
281	port policy	national port policy	not specific	economics	positivism	analytical / conceptual	conceptual	na
282	port policy	regulation and competition	economic rents	economics	positivism	analytical / conceptual	conceptual	na
283	port management	port pricing	marginal cost pricing	economics	positivism	analytical / conceptual	conceptual	na
284	port governance	port reform	not specific	economics	positivism	analytical / conceptual	economic modelling	na
285	competition and performance	competition	not specific	economics	positivism	analytical / conceptual	case study	descriptive
286	port in SC	integration	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
287	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	descriptive
288	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
289	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	math modelling	na
290	port management	port strategy	social responsibility	marketing	positivism	analytical / conceptual	conceptual	na
291	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
292	spatial analysis	port-city relationship	port-city model	economics	positivism	empirical / case study	case study	descriptive
293	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	case study	na
294	port management	security management	not specific	not specific	positivism	analytical / conceptual	conceptual	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
295	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
296	competition and performance	competitiveness	not specific	geography	positivism	empirical / case study	case study	na
297	competition and performance	port selection	not specific	economics	positivism	analytical / statistical	economic modelling	MCDM
298	competition and performance	competitiveness	not specific	not specific	positivism	empirical / statistical	survey	Duncan test
299	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	simulation	simulation
300	competition and performance	competitiveness	value added	economics	positivism	empirical / statistical	survey	descriptive (index)
301	competition and performance	competitiveness	competitive advantage	strategic management	positivism	empirical / statistical	survey	regression
302	competition and performance	competitiveness	RBV	strategic management	positivism	empirical / statistical	survey	factor analysis
304	planning and development	economic impact	not specific	economics	positivism	empirical / case study	case study	na
304	port management	port pricing	not specific	geography	positivism	analytical / conceptual	conceptual	na
305	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive
306	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	conceptual	na
307	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	regression
308	port management	port pricing	marginal cost pricing	economics	positivism	analytical / conceptual	conceptual	na
309	port governance	port reform	not specific	economics	positivism	empirical / case study	case study	descriptive
310	port management	port pricing	not specific	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
311	port management	port pricing	marginal cost pricing	economics	positivism	analytical / conceptual	case study	na
312	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
313	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	conceptual	simulation
314	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
315	planning and development	project appraisal	not specific	economics	positivism	analytical / conceptual	conceptual	na
316	port management	port strategy	not specific	regional planning	positivism	analytical / conceptual	case study	na
317	spatial analysis	port system	Hayuth model	geography	positivism	empirical / case study	case study	descriptive
318	spatial analysis	network analysis	hinterland concept	geography	positivism	analytical / conceptual	conceptual	na
319	spatial analysis	port-city relationship	port-city model	geography	positivism	analytical / conceptual	conceptual	na
320	spatial analysis	port system	Hayuth model	geography	positivism	empirical / case study	case study	descriptive (index)
321	spatial analysis	port system	Hayuth model	geography	positivism	analytical / conceptual	conceptual	na
322	spatial analysis	network analysis	site and situation	geography	positivism	analytical / conceptual	conceptual	na
323	planning and development	supply analysis	not specific	not specific	positivism	empirical / case study	case study	descriptive
324	terminal operation	OR	not specific	OR	positivism	analytical / conceptual	conceptual	na
325	port management	port strategy	not specific	economics	positivism	analytical / conceptual	conceptual	na
326	port management	TOC strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
327	competition and performance	competition	not specific	economics	positivism	analytical / conceptual	conceptual	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
328	planning and development	demand analysis	not specific	not specific	positivism	analytical / conceptual	conceptual	na
329	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
330	port management	security management	not specific	not specific	positivism	analytical / conceptual	conceptual	na
331	port management	environmental management	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
332	port management	HRM	not specific	geography	Interpretivism	analytical / conceptual	conceptual	na
333	port policy	environmental regulation	not specific	public administration	positivism	empirical / case study	survey	descriptive
334	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	case study	na
335	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	na
336	port policy	supranational policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
337	competition and performance	competitiveness	not specific	not specific	positivism	empirical / case study	survey / interview	descriptive
338	planning and development	supply analysis	not specific	OR	positivism	analytical / mathematical	simulation	simulation
339	planning and development	project appraisal	not specific	strategic management	positivism	analytical / mathematical	case study	simulation
340	spatial analysis	network analysis	hinterland concept	geography	positivism	empirical / case study	case study	descriptive (index)
341	port governance	port reform	not specific	economics	positivism	empirical / case study	case study	regression
342	port management	port pricing	price differentiation	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
343	port management	port pricing	price differentiation	economics	positivism	analytical / mathematical	economic modelling	LP
344	planning and development	decision making process	not specific	public administration	positivism	analytical / conceptual	conceptual	na
345	planning and development	development case	not specific	geography	positivism	empirical / case study	case study	na
346	spatial analysis	port-city relationship	port-city model	geography	positivism	analytical / conceptual	conceptual	na
347	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	na
348	spatial analysis	port-city relationship	not specific	geography	interpretivism	empirical / case study	interview	na
349	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive (index)
350	planning and development	supply analysis	not specific	OR	positivism	analytical / mathematical	simulation	simulation
351	port management	port strategy	not specific	strategic management	positivism	empirical / statistical	survey	MCDM
352	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
353	competition and performance	competitiveness	not specific	OR	positivism	empirical / case study	math modelling	LP
354	competition and performance	competitiveness	not specific	OR	positivism	empirical / statistical	survey	MCDM
355	port management	HRM	not specific	industrial relations	positivism	empirical / statistical	economic modelling	Regression
356	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
357	planning and development	demand analysis	not specific	economics	positivism	empirical / statistical	economic modelling	ECM
358	port management	HRM	not specific	HRM	positivism	analytical / conceptual	conceptual	na
359	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
360	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	analytical

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
361	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
362	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
363	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
364	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
365	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	simulation	simulation
366	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
367	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
368	port management	environmental management	not specific	not specific	positivism	analytical / conceptual	conceptual	na
369	port governance	governance model	not specific	not specific	positivism	analytical / conceptual	case study	na
370	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
371	port governance	port reform	not specific	not specific	positivism	empirical / case study	survey	ANOVA
372	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
373	port management	port strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
374	planning and development	demand analysis	not specific	not specific	positivism	analytical / conceptual	conceptual	na
375	port management	HRM	not specific	industrial relations	positivism	empirical / case study	survey	descriptive
376	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
377	port governance	governance model	structure of provision	politics	positivism	empirical / case study	case study	na
378	port in SC	integration	structure of provision	politics	positivism	empirical / case study	case study	na
379	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	queueing model
380	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	na
381	planning and development	supply analysis	production theory	economics	positivism	empirical / statistical	economic modelling	regression
382	port management	TOC strategy	production theory	economics	positivism	empirical / statistical	economic modelling	regression
383	port management	TOC strategy	production theory	economics	positivism	empirical / statistical	economic modelling	regression
384	port in SC	inland logistics	not specific	logistics	positivism	empirical / case study	survey	descriptive
385	planning and development	demand analysis	not specific	economics	positivism	empirical / case study	math modelling	LP
386	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	conceptual	na
387	port governance	port reform	not specific	economics	positivism	analytical / conceptual	conceptual	na
388	port policy	environmental regulation	not specific	not specific	positivism	analytical / conceptual	case study	na
389	planning and development	project appraisal	not specific	economics	positivism	analytical / mathematical	economic modelling	simulation
390	planning and development	project appraisal	not specific	economics	positivism	analytical / mathematical	economic modelling	simulation
391	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
392	port management	environmental management	not specific	environmental studies	structuralism	analytical / conceptual	conceptual	na
393	port management	HRM	not specific	HRM	positivism	analytical / conceptual	conceptual	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
394	port policy	regulation and competition	not specific	economics	positivism	analytical / conceptual	economic modelling	na
395	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
396	port governance	port reform	not specific	economics	positivism	empirical / case study	case study	descriptive
397	port management	IT	not specific	OR	positivism	analytical / mathematical	simulation	simulation
398	planning and development	supply analysis	not specific	OR	positivism	analytical / mathematical	simulation	simulation
399	planning and development	demand analysis	not specific	OR	positivism	empirical / case study	math modelling	LP
400	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	Regression
401	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
402	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
403	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	LP
404	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
405	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	LP
406	port management	port pricing	not specific	OR	positivism	analytical / mathematical	math modelling	LP
407	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
408	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
409	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
410	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	simulation	simulation
411	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
412	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	TFP
413	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
414	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
415	planning and development	optimal investment	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
416	port management	environmental management	not specific	strategic management	positivism	analytical / conceptual	case study	na
417	terminal operation	OR	not specific	OR	positivism	analytical / conceptual	conceptual	na
418	port in SC	inland logistics	network analysis	OR	positivism	empirical / case study	economic modelling	descriptive
419	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling / simulation	simulation
420	port management	port strategy	not specific	geography	positivism	analytical / conceptual	conceptual	na
421	spatial analysis	port system	Hayuth model	geography	positivism	empirical / case study	case study	descriptive (index)
422	port management	port pricing	not specific	economics	positivism	analytical / conceptual	conceptual	na
423	port management	security management	not specific	not specific	positivism	analytical / conceptual	case study	criticality analysis
424	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
425	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	math modelling	markov modelling
426	port in SC	integration	transaction cost theory	marketing	positivism	empirical / statistical	survey	SEM

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
427	port in SC	integration	marketing channel	marketing	positivism	empirical / statistical	survey	SEM
428	port management	port pricing	queueing theory	economics	positivism	analytical / mathematical	math modelling	analytical
429	port management	port pricing	queueing theory	economics	positivism	analytical / mathematical	math modelling	analytical
430	port management	port pricing	queueing theory	economics	positivism	analytical / mathematical	math modelling	analytical
431	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
432	planning and development	optimal investment	not specific	OR	positivism	analytical / conceptual	conceptual	na
433	competition and performance	competitiveness	cournot model	economics	positivism	empirical / case study	economic modelling	descriptive (index)
434	competition and performance	competition	not specific	economics	positivism	empirical / case study	case study	descriptive (index)
435	planning and development	demand analysis	neural network model	economics	positivism	empirical / statistical	simulation	simulation
436	port governance	governance model	e-market model	economics	positivism	analytical / conceptual	conceptual	na
437	planning and development	demand analysis	inventory theory	OR	positivism	analytical / mathematical	math modelling	analytical
438	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
439	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	simulated annealing
440	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
441	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	descriptive
442	competition and performance	competitiveness	not specific	OR	positivism	empirical / case study	math modelling	LP
443	port in SC	integration	not specific	OR	positivism	analytical / mathematical	simulation	simulation
444	spatial analysis	port-city relationship	not specific	geography	positivism	empirical / case study	case study	descriptive (index)
445	spatial analysis	port-city relationship	port-city model	geography	positivism	analytical / conceptual	conceptual	na
446	port management	IT	not specific	IT	positivism	empirical / case study	case study	na
447	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	simulation	simulation
448	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	math modelling	LP
449	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling / simulation	LP
450	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
451	competition and performance	port selection	not specific	economics	positivism	empirical / statistical	survey	MCDM
452	competition and performance	port selection	not specific	economics	positivism	empirical / statistical	survey	MCDM
453	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
454	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	simulation	simulation
455	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
456	planning and development	development case	not specific	not specific	positivism	analytical / conceptual	case study	na
457	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
458	port governance	port reform	not specific	not specific	positivism	empirical / case study	case study	na
459	spatial analysis	port system	not specific	not specific	positivism	analytical / conceptual	case study	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
460	port in SC	redefining	agency theory	economics	positivism	analytical / conceptual	case study	na
461	competition and performance	competitiveness	network theory	economics	positivism	empirical / case study	economic modelling	logit model
462	port in SC	inland logistics	not specific	not specific	positivism	empirical / statistical	survey	ANOVA, EFA
463	planning and development	project appraisal	not specific	economics	positivism	analytical / conceptual	conceptual	na
464	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
465	planning and development	demand analysis	not specific	OR	positivism	analytical / mathematical	simulation	simulation
466	port management	port strategy	not specific	strategic management	positivism	empirical / statistical	survey	CART
467	port management	port strategy	not specific	strategic management	positivism	empirical / statistical	survey	logit model
468	competition and performance	port selection	utility theory	economics	positivism	analytical / conceptual	economic modelling	logit model
469	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
470	competition and performance	port selection	utility theory	economics	positivism	empirical / statistical	economic modelling	logit model
471	competition and performance	port selection	utility theory	economics	positivism	empirical / statistical	economic modelling	logit model
472	planning and development	supply analysis	not specific	not specific	positivism	analytical / conceptual	conceptual	na
473	planning and development	supply analysis	not specific	not specific	positivism	empirical / statistical	survey	correlation
474	port governance	port reform	not specific	not specific	positivism	empirical / case study	interview	na
475	port in SC	redefining	supply chain strategy	logistics	positivism	analytical / conceptual	conceptual	na
476	competition and performance	competitiveness	not specific	not specific	positivism	empirical / statistical	survey / interview	factor analysis
477	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	conceptual	na
478	competition and performance	performance	Leanness	OR	positivism	analytical / conceptual	conceptual	na
479	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	shift-share analysis
480	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive (index)
481	port management	security management	not specific	geography	positivism	empirical / case study	case study	cluster analysis
482	competition and performance	port selection	site and situation	geography	positivism	analytical / conceptual	conceptual	na
483	competition and performance	competition	not specific	geography	positivism	empirical / case study	case study	shift-share analysis
484	port management	port strategy	not specific	not specific	positivism	empirical / case study	interview	na
485	port management	port strategy	not specific	not specific	positivism	empirical / case study	interview	na
486	port management	port pricing	not specific	economics	positivism	empirical / statistical	economic modelling	Regression
487	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
488	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
489	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
490	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	case study	na
491	port management	port strategy	not specific	geography	positivism	analytical / conceptual	conceptual	na
492	spatial analysis	network analysis	site and situation	geography	positivism	empirical / case study	survey	descriptive

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
493	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive (index)
494	competition and performance	competition	not specific	geography	positivism	analytical / conceptual	conceptual	na
495	spatial analysis	network analysis	site and situation	geography	positivism	empirical / case study	case study	descriptive
496	spatial analysis	network analysis	site and situation	geography	positivism	empirical / case study	case study	regression
497	spatial analysis	network analysis	network analysis	geography	positivism	empirical / case study	case study	descriptive (index)
498	port governance	labour reform	not specific	economics	positivism	empirical / case study	interview	na
499	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	na
500	port management	port pricing	marginal cost pricing	economics	positivism	analytical / conceptual	conceptual	na
501	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	sensitivity analysis
502	port management	TOC strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
503	port management	port strategy	game theory	logistics	positivism	analytical / mathematical	economic modelling	game theoretical analysis
504	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
505	competition and performance	competition	not specific	economics	positivism	empirical / case study	case study	regression
506	planning and development	decision making process	not specific	not specific	positivism	analytical / conceptual	conceptual	na
507	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
508	terminal operation	OR	not specific	OR	positivism	analytical / conceptual	conceptual	na
509	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
510	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	na
511	port management	environmental management	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
512	competition and performance	port selection	not specific	not specific	positivism	empirical / statistical	survey	ANOVA, factor analysis
513	competition and performance	port selection	not specific	not specific	positivism	empirical / statistical	survey	ANOVA, t-test
514	competition and performance	port selection	not specific	not specific	positivism	empirical / statistical	survey	descriptive
515	competition and performance	port selection	not specific	not specific	positivism	empirical / statistical	survey	ANOVA
516	planning and development	economic impact	economic base analysis	economics	positivism	empirical / statistical	case study	descriptive (index)
517	planning and development	supply analysis	not specific	economics	positivism	analytical / mathematical	economic modelling	simulation
518	planning and development	supply analysis	not specific	OR	positivism	analytical / mathematical	simulation	simulation
519	terminal operation	land access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
520	port policy	public involvement	not specific	public administration	positivism	analytical / conceptual	conceptual	na
521	competition and performance	competitiveness	not specific	OR	positivism	empirical / case study	math modelling	LP
522	port policy	regulation and competition	competitive advantage	strategic management	positivism	empirical / case study	interview	na
523	competition and performance	competitiveness	not specific	economics	positivism	empirical / statistical	survey	ANOVA
524	competition and performance	port selection	utility theory	economics	positivism	empirical / statistical	survey	logit model
525	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
526	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
527	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
528	port management	port pricing	queueing theory	OR	positivism	analytical / mathematical	math modelling	queueing model
529	planning and development	supply analysis	queueing theory	OR	positivism	analytical / mathematical	math modelling	queueing model
530	planning and development	supply analysis	queueing theory	OR	positivism	analytical / mathematical	math modelling	queueing model
531	port management	IT	technology acceptance model	IT	positivism	empirical / statistical	survey	SEM
532	spatial analysis	port system	Hayuth model	geography	positivism	empirical / case study	case study	shift-share analysis
533	competition and performance	competition	contestable markets	economics	positivism	analytical / conceptual	conceptual	na
534	port management	TOC strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
535	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive (index)
536	spatial analysis	network analysis	not specific	geography	positivism	empirical / case study	case study	descriptive
537	competition and performance	competition	consumer theory	economics	positivism	empirical / case study	case study	descriptive (index)
538	spatial analysis	port system	TMG model	geography	positivism	analytical / conceptual	conceptual	na
539	port in SC	redefining	not specific	not specific	positivism	analytical / conceptual	conceptual	na
540	port in SC	redefining	not specific	not specific	positivism	analytical / conceptual	conceptual	na
541	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
542	port management	port strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
543	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
544	competition and performance	competitiveness	not specific	geography	positivism	analytical / conceptual	conceptual	na
545	spatial analysis	port-city relationship	not specific	geography	positivism	empirical / case study	case study	descriptive
546	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	case study	na
547	port management	TOC strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
548	port management	TOC strategy	not specific	geography	positivism	analytical / conceptual	conceptual	na
549	port management	TOC strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
550	planning and development	economic impact	input-output analysis	economics	positivism	empirical / statistical	case study	input-output
551	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive (index)
552	port management	IT	not specific	not specific	positivism	empirical / case study	interview	na
553	terminal operation	OR	Leanness	OR	positivism	analytical / conceptual	conceptual	na
554	port management	HRM	not specific	HRM	positivism	empirical / statistical	survey	descriptive
555	port policy	supranational policy	not specific	not specific	positivism	empirical / statistical	survey	descriptive
556	port in SC	integration	agility	OR	positivism	analytical / conceptual	conceptual	na
557	port policy	supranational policy	not specific	not specific	positivism	empirical / case study	interview	na
558	port governance	port reform	not specific	economics	positivism	empirical / case study	case study	descriptive

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
559	port policy	supranational policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
560	port policy	regulation and competition	not specific	economics	positivism	analytical / conceptual	conceptual	na
561	planning and development	development case	not specific	geography	positivism	analytical / conceptual	conceptual	na
562	port in SC	redefining	not specific	logistics	positivism	analytical / conceptual	conceptual	na
563	port in SC	integration	not specific	logistics	positivism	empirical / statistical	survey	CFA
564	port in SC	integration	not specific	logistics	positivism	empirical / statistical	survey	CFA
565	competition and performance	efficiency	production theory	economics	positivism	analytical / conceptual	content analysis	na
566	port management	port strategy	not specific	marketing	positivism	empirical / statistical	survey	factor analysis
567	competition and performance	competitiveness	SERVQUAL	marketing	positivism	empirical / statistical	survey	cluster analysis
568	competition and performance	competitiveness	SERVQUAL	marketing	positivism	empirical / statistical	survey	logit model
569	planning and development	economic impact	not specific	economics	positivism	empirical / case study	case study	descriptive
570	competition and performance	competitiveness	not specific	strategic management	positivism	empirical / case study	case study	descriptive (index)
571	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	simulation	simulation
572	planning and development	supply analysis	not specific	OR	positivism	analytical / mathematical	simulation	simulation
573	port management	security management	not specific	economics	positivism	empirical / statistical	economic modelling	regression
574	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
575	port management	TOC strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
576	planning and development	demand analysis	not specific	OR	positivism	analytical / mathematical	simulation	simulation
577	terminal operation	land access OR	not specific	OR	positivism	analytical / mathematical	simulation	simulation
578	port management	TOC strategy	not specific	geography	positivism	empirical / statistical	economic modelling	regression
579	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
580	Planning and development	development case	not specific	regional planning	positivism	analytical / conceptual	case study	na
581	port policy	regulation and competition	not specific	economics	positivism	analytical / conceptual	conceptual	na
582	port management	port pricing	not specific	economics	positivism	analytical / mathematical	economic modelling	LP
583	port management	environmental management	not specific	environmental studies	positivism	analytical / statistical	conceptual	na
584	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	simulation	simulation
585	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
586	port management	TOC strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
587	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
588	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive
589	port in SC	integration	supply chain strategy	logistics	positivism	analytical / conceptual	conceptual	na
590	port policy	regulation and competition	not specific	not specific	positivism	analytical / conceptual	conceptual	na
591	port management	security management	not specific	not specific	positivism	analytical / conceptual	conceptual	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
592	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	na
593	port management	security management	not specific	OR	positivism	analytical / conceptual	conceptual	na
594	port management	port strategy	not specific	regional planning	positivism	analytical / conceptual	conceptual	na
595	planning and development	development case	not specific	regional planning	positivism	analytical / conceptual	case study	na
596	port policy	supranational policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
597	port management	port pricing	not specific	not specific	positivism	empirical / case study	case study	descriptive
598	port governance	port reform	not specific	not specific	positivism	empirical / case study	case study	na
599	port in SC	inland logistics	not specific	OR	positivism	analytical / mathematical	math modelling	LP
600	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
601	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	interview	na
602	port in SC	inland logistics	not specific	not specific	positivism	empirical / statistical	survey	descriptive
603	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	regression
604	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	na
605	port policy	national port policy	not specific	geography	positivism	analytical / conceptual	conceptual	na
606	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	conceptual	na
607	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	na
608	spatial analysis	port system	Rimmer model	geography	positivism	empirical / case study	case study	descriptive
609	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
610	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	na
611	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	na
612	competition and performance	performance	not specific	not specific	positivism	empirical / case study	case study	descriptive
613	planning and development	project appraisal	not specific	economics	positivism	empirical / case study	case study	descriptive
614	spatial analysis	network analysis	network analysis	geography	positivism	analytical / conceptual	conceptual	na
615	port in SC	redefining	competitive advantage	strategic management	positivism	analytical / conceptual	conceptual	na
616	port in SC	redefining	not specific	logistics	positivism	analytical / conceptual	conceptual	na
617	port policy	regulation and competition	not specific	logistics	positivism	analytical / conceptual	conceptual	na
618	port in SC	redefining	not specific	logistics	positivism	analytical / conceptual	conceptual	na
619	competition and performance	efficiency	production theory	economics	positivism	empirical / case study	economic modelling	SFA (DF)
620	port in SC	redefining	not specific	OR	positivism	empirical / case study	case study	SADT
621	competition and performance	efficiency	production theory	economics	positivism	analytical / statistical	economic modelling	DEA
622	port management	security management	not specific	OR	positivism	empirical / statistical	archival analysis	event tree analysis
623	planning and development	development case	not specific	regional planning	positivism	analytical / conceptual	case study	na
624	port management	environmental management	not specific	OR	positivism	analytical / mathematical	simulation	simulation

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
625	port in SC	inland logistics	not specific	not specific	positivism	empirical / case study	interview	na
626	port in SC	inland logistics	network analysis	OR	positivism	analytical / conceptual	conceptual	na
627	competition and performance	efficiency	production theory	economics	positivism	empirical / case study	economic modelling	economic model analysis
628	competition and performance	port selection	not specific	economics	positivism	empirical / statistical	survey	factor analysis
629	port management	TOC strategy	game theory	economics	positivism	empirical / case study	economic modelling	game theoretical analysis
630	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	regression
631	port governance	labour reform	strike model	industrial relations	positivism	empirical / statistical	case study	regression
632	port management	HRM	strike model	industrial relations	positivism	empirical / statistical	economic modelling	regression
633	port governance	labour reform	not specific	industrial relations	structuralism	analytical / conceptual	interview	na
634	port governance	port reform	not specific	economics	positivism	empirical / statistical	survey	descriptive
635	port governance	labour reform	not specific	industrial relations	positivism	empirical / case study	survey / interview	descriptive
636	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
637	planning and development	development case	not specific	not specific	positivism	analytical / conceptual	case study	na
638	planning and development	demand analysis	not specific	economics	positivism	analytical / mathematical	economic modelling	time series analysis
639	planning and development	supply analysis	not specific	regional planning	positivism	analytical / conceptual	conceptual	na
640	port management	HRM	not specific	industrial relations	positivism	analytical / conceptual	conceptual	na
641	planning and development	demand analysis	not specific	economics	positivism	empirical / statistical	economic modelling	regression
642	planning and development	decision making process	system theory	organisational studies	Interpretivism	analytical / conceptual	conceptual	na
643	planning and development	project appraisal	not specific	geography	positivism	empirical / case study	economic modelling	regression
644	port governance	port reform	not specific	economics	positivism	analytical / conceptual	case study	descriptive
645	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	simulation	simulation
646	port management	security management	not specific	organisational studies	positivism	empirical / statistical	survey	SEM
647	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA / cluster analysis
648	port governance	port reform	not specific	not specific	positivism	empirical / case study	case study	na
649	planning and development	optimal investment	not specific	economics	positivism	empirical / case study	economic modelling	analytical
650	planning and development	optimal investment	not specific	economics	positivism	empirical / case study	economic modelling	queueing model
651	planning and development	project appraisal	not specific	economics	positivism	analytical / conceptual	conceptual	na
652	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	conceptual	na
653	competition and performance	port selection	not specific	not specific	positivism	empirical / statistical	survey	descriptive
654	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	conceptual	na
655	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	case study	na
656	port management	port strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
657	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	conceptual	na

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
658	port management	TOC strategy	not specific	geography	positivism	empirical / case study	case study	na
659	spatial analysis	port system	Hayuth model	geography	positivism	empirical / case study	case study	na
660	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
661	port management	port strategy	life cycle theory	marketing	positivism	analytical / conceptual	conceptual	na
662	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
663	port management	port strategy	not specific	not specific	positivism	empirical / case study	case study	na
664	competition and performance	competitiveness	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
665	port management	environmental management	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
666	competition and performance	competition	not specific	geography	positivism	empirical / case study	case study	na
667	competition and performance	competition	co-opetition	economics	positivism	analytical / conceptual	conceptual	na
668	competition and performance	performance	production theory	economics	positivism	empirical / statistical	economic modelling	regression
669	port in SC	integration	not specific	logistics	positivism	empirical / statistical	survey	regression
670	competition and performance	competitiveness	not specific	not specific	positivism	empirical / statistical	survey	MCDM
671	port management	TOC strategy	not specific	strategic management	positivism	empirical / statistical	case study	descriptive
672	terminal operation	OR	not specific	OR	positivism	analytical / conceptual	content analysis	na
673	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	na
674	spatial analysis	port system	not specific	geography	positivism	analytical / conceptual	case study	na
675	terminal operation	OR	not specific	OR	positivism	analytical / conceptual	content analysis	na
676	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
677	port management	environmental management	not specific	environmental studies	positivism	empirical / case study	survey	descriptive
678	port governance	labour reform	not specific	economics	positivism	analytical / conceptual	case study	na
679	planning and development	development case	institutional theory	organisational studies	positivism	analytical / conceptual	case study	na
680	port management	port pricing	price differentiation	economics	positivism	analytical / mathematical	conceptual	na
681	port management	port pricing	price differentiation	economics	positivism	analytical / conceptual	conceptual	na
682	competition and performance	performance	not specific	economics	positivism	empirical / case study	case study	descriptive
683	port governance	governance model	not specific	not specific	positivism	analytical / conceptual	case study	na
684	port policy	public involvement	not specific	not specific	positivism	analytical / conceptual	conceptual	na
685	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
686	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
687	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	na
688	competition and performance	performance	Learning curves	economics	positivism	empirical / statistical	math modelling	regression
689	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	simulation	simulation
690	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	analytical

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
691	competition and performance	performance	production theory	economics	positivism	analytical / conceptual	conceptual	na
692	port policy	regulation and competition	not specific	economics	positivism	analytical / conceptual	conceptual	na
693	competition and performance	performance	not specific	economics	positivism	analytical / conceptual	economic modelling	na
694	port management	port pricing	not specific	economics	positivism	analytical / conceptual	conceptual	na
695	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	regression
696	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	regression
697	planning and development	project appraisal	not specific	economics	positivism	analytical / conceptual	conceptual	na
698	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	regression
699	spatial analysis	port-city relationship	not specific	geography	positivism	empirical / case study	case study	na
700	spatial analysis	network analysis	network analysis	geography	positivism	empirical / case study	math modelling	descriptive (index)
700	competition and performance	port selection	utility theory	economics	positivism	empirical / statistical	economic modelling	logit model
701	competition and performance	competitiveness	not specific	OR	positivism	empirical / statistical	survey	MCDM
702	planning and development	decision making process	not specific	public administration	positivism	analytical / conceptual	conceptual	na
703	competition and performance	competitiveness	portfolio analysis	strategic management	positivism	empirical / case study	case study	descriptive
704	competition and performance	competitiveness	not specific	not specific	positivism	empirical / case study	case study	na
705	port management	HRM	not specific	HRM	positivism	analytical / conceptual	conceptual	na
706	port management	port pricing	not specific	economics	positivism	analytical / conceptual	conceptual	na
707	port governance	port reform	not specific	economics	positivism	analytical / conceptual	case study	descriptive
708	port governance	labour reform	not specific	HRM	positivism	empirical / case study	case study	na
709	port policy	security regulation	not specific	not specific	positivism	analytical / conceptual	conceptual	na
710	competition and performance	port selection	utility theory	economics	positivism	empirical / statistical	survey	logit model
711	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive (index)
712	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	na
713	planning and development	development case	not specific	regional planning	positivism	empirical / case study	case study	na
714	planning and development	development case	not specific	regional planning	positivism	empirical / case study	case study	descriptive
715	spatial analysis	port-city relationship	not specific	geography	positivism	empirical / case study	case study	descriptive
716	port policy	national port policy	not specific	geography	positivism	analytical / conceptual	case study	na
717	planning and development	demand analysis	not specific	economics	positivism	empirical / statistical	economic modelling	regression
718	competition and performance	performance	production theory	economics	positivism	empirical / case study	economic modelling	regression
719	competition and performance	performance	not specific	economics	positivism	empirical / statistical	math modelling	regression
720	competition and performance	performance	not specific	economics	positivism	empirical / statistical	math modelling	factor analysis
721	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
722	competition and performance	port selection	not specific	economics	positivism	empirical / statistical	survey	regression

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
723	competition and performance	performance	not specific	economics	positivism	empirical / case study	case study	descriptive
724	competition and performance	competitiveness	production theory	economics	positivism	empirical / statistical	survey	regression
725	competition and performance	port selection	not specific	not specific	positivism	empirical / statistical	survey	logit model
726	port in SC	integration	not specific	economics	positivism	empirical / statistical	survey	CFA, t-test
727	planning and development	supply analysis	production theory	economics	positivism	analytical / conceptual	conceptual	na
728	port management	security management	not specific	not specific	positivism	analytical / conceptual	conceptual	event tree analysis
729	port governance	labour reform	not specific	economics	positivism	analytical / conceptual	case study	na
730	competition and performance	competition	not specific	not specific	positivism	analytical / conceptual	conceptual	na
731	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA (DF)
732	port policy	national port policy	not specific	politics	positivism	empirical / case study	interview	MCDM
733	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
734	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	na
735	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	na
736	port management	HRM	not specific	industrial relations	positivism	analytical / conceptual	conceptual	na
737	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	na
738	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	conceptual	na
739	port management	HRM	not specific	industrial relations	positivism	analytical / conceptual	conceptual	na
740	port governance	labour reform	not specific	industrial relations	structuralism	empirical / case study	case study	na
741	port governance	labour reform	strike model	industrial relations	positivism	empirical / statistical	economic modelling	regression
742	port management	HRM	not specific	industrial relations	positivism	analytical / conceptual	conceptual	na
743	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	na
744	port governance	labour reform	not specific	economics	positivism	analytical / conceptual	case study	na
745	port management	HRM	not specific	HRM	positivism	empirical / case study	case study	descriptive
746	port management	HRM	not specific	industrial relations	positivism	empirical / statistical	survey	cluster analysis
747	port governance	labour reform	not specific	industrial relations	positivism	analytical / conceptual	case study	na
748	port management	HRM	not specific	industrial relations	positivism	analytical / conceptual	conceptual	na
749	port governance	port reform	not specific	not specific	positivism	empirical / case study	survey	descriptive
750	port governance	labour reform	not specific	industrial relations	positivism	empirical / case study	survey	descriptive
751	port management	HRM	not specific	industrial relations	positivism	empirical / case study	case study	correlation
752	port policy	regulation and competition	inventory theory	economics	positivism	analytical / mathematical	simulation	simulation
753	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA / tobit model
754	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
755	competition and performance	competitiveness	SERVQUAL	marketing	positivism	empirical / case study	survey	regression

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
756	competition and performance	port selection	not specific	economics	positivism	empirical / statistical	survey	MCDM
757	port in SC	inland logistics	not specific	economics	positivism	analytical / conceptual	conceptual	na
758	spatial analysis	port system	not specific	geography	positivism	empirical / statistical	math modelling	descriptive (index)
759	port management	IT	not specific	IT	positivism	analytical / conceptual	conceptual	na
760	planning and development	project appraisal	not specific	public administration	positivism	analytical / conceptual	conceptual	na
761	port management	environmental management	not specific	economics	positivism	empirical / case study	case study	descriptive
762	port management	port strategy	not specific	strategic management	positivism	empirical / case study	case study	na
763	spatial analysis	port system	network theory	geography	positivism	analytical / conceptual	conceptual	na
764	spatial analysis	port system	network theory	geography	positivism	analytical / conceptual	conceptual	na
765	spatial analysis	network analysis	not specific	geography	positivism	empirical / case study	case study	descriptive
766	port policy	regulation and competition	contestable markets	economics	positivism	analytical / conceptual	conceptual	na
767	port management	environmental management	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
768	port management	TOC strategy	not specific	strategic management	positivism	analytical / conceptual	conceptual	na
769	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	simulation	simulation
769	competition and performance	competitiveness	network theory	geography	positivism	empirical / statistical	math modelling	descriptive (index)
771	planning and development	demand analysis	utility theory	economics	positivism	empirical / statistical	economic modelling	logit model
772	planning and development	demand analysis	utility theory	economics	positivism	empirical / statistical	economic modelling	logit model
773	port governance	port reform	not specific	not specific	positivism	analytical / conceptual	case study	na
774	planning and development	economic impact	not specific	economics	positivism	analytical / conceptual	conceptual	na
775	competition and performance	competition	not specific	economics	positivism	analytical / conceptual	conceptual	na
776	port governance	governance model	not specific	not specific	positivism	analytical / conceptual	conceptual	na
777	port in SC	redefining	inventory theory	OR	positivism	analytical / mathematical	math modelling	na
778	port policy	public involvement	not specific	economics	positivism	analytical / conceptual	conceptual	na
779	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	conceptual	na
780	planning and development	project appraisal	not specific	public administration	positivism	analytical / conceptual	conceptual	na
781	terminal operation	OR	not specific	OR	positivism	analytical / conceptual	conceptual	na
782	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	simulation	simulation
783	spatial analysis	port-city relationship	not specific	geography	positivism	analytical / conceptual	conceptual	na
784	planning and development	development case	not specific	regional planning	positivism	empirical / case study	case study	descriptive
785	planning and development	demand analysis	not specific	economics	positivism	empirical / statistical	economic modelling	regression
786	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
787	port in SC	inland logistics	not specific	not specific	positivism	empirical / statistical	survey	t-test
788	port in SC	inland logistics	not specific	not specific	positivism	empirical / statistical	survey	t-test

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
789	port management	IT	not specific	IT	positivism	empirical / case study	case study	na
790	spatial analysis	port system	Hayuth model	geography	positivism	empirical / case study	case study	na
791	port in SC	inland logistics	not specific	geography	positivism	analytical / conceptual	case study	na
792	spatial analysis	port system	not specific	geography	positivism	empirical / case study	case study	descriptive
793	port governance	governance model	not specific	geography	positivism	analytical / conceptual	case study	na
794	port governance	governance model	not specific	geography	positivism	analytical / conceptual	case study	na
795	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
797	port management	port strategy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
798	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
799	competition and performance	competitiveness	not specific	not specific	positivism	empirical / case study	case study	descriptive
800	port in SC	redefining	not specific	logistics	positivism	analytical / conceptual	conceptual	na
801	port in SC	redefining	marketing channel	marketing	positivism	empirical / case study	case study	descriptive
802	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA / SFA
803	planning and development	project appraisal	not specific	public administration	positivism	analytical / conceptual	conceptual	na
804	competition and performance	port selection	not specific	not specific	positivism	empirical / case study	interview	descriptive
805	port management	HRM	not specific	HRM	positivism	analytical / conceptual	conceptual	na
806	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	regression
807	planning and development	decision making process	not specific	public administration	positivism	analytical / conceptual	conceptual	na
808	port management	IT	institutional theory	IT	positivism	analytical / conceptual	case study	na
809	competition and performance	port selection	not specific	economics	positivism	empirical / statistical	survey	MCDM
810	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
811	port policy	national port policy	not specific	not specific	positivism	analytical / conceptual	conceptual	na
812	port management	security management	not specific	geography	positivism	empirical / case study	case study	na
813	planning and development	demand analysis	welfare theory	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
814	port in SC	inland logistics	not specific	geography	positivism	analytical / conceptual	conceptual	na
815	port policy	environmental regulation	not specific	environmental studies	positivism	analytical / conceptual	conceptual	na
816	port management	IT	not specific	IT	positivism	analytical / conceptual	conceptual	na
817	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
818	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	DEA
819	planning and development	demand analysis	not specific	OR	positivism	analytical / mathematical	math modelling	LP
820	competition and performance	efficiency	production theory	economics	positivism	empirical / statistical	economic modelling	SFA
821	competition and performance	competition	utility theory	economics	positivism	analytical / mathematical	economic modelling	economic model analysis
822	competition and performance	competition	not specific	economics	positivism	empirical / statistical	economic modelling	ECM

No	Research theme	Research topic	Theory and model	Discipline	Paradigm	Strategies	Research method	Analysis
823	competition and performance	competition	not specific	economics	positivism	empirical / case study	case study	descriptive (index)
824	port policy	environmental regulation	not specific	environmental studies	positivism	empirical / case study	case study	na
825	competition and performance	competitiveness	not specific	not specific	positivism	empirical / statistical	survey	MCDM
826	competition and performance	competitiveness	not specific	not specific	positivism	empirical / statistical	survey	factor analysis
827	terminal operation	terminal	not specific	OR	positivism	analytical / conceptual	conceptual	na
828	port management	security management	not specific	not specific	positivism	empirical / statistical	economic modelling	logit model
829	planning and development	economic impact	input-output analysis	economics	positivism	empirical / case study	case study	input-output
830	planning and development	economic impact	not specific	economics	positivism	empirical / case study	survey	descriptive
831	planning and development	economic impact	not specific	economics	positivism	empirical / statistical	economic modelling	regression
832	terminal operation	terminal	not specific	OR	positivism	analytical / mathematical	simulation	simulation
833	planning and development	demand analysis	game theory	economics	positivism	analytical / mathematical	economic modelling	LP
834	terminal operation	sea access OR	not specific	OR	positivism	analytical / mathematical	math modelling	analytical
835	spatial analysis	network analysis	network analysis	OR	positivism	analytical / mathematical	math modelling	na
836	port policy	regulation and competition	not specific	not specific	positivism	analytical / conceptual	conceptual	na
837	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	LP
838	terminal operation	yard operation	not specific	OR	positivism	analytical / mathematical	math modelling	heuristic method
839	planning and development	demand analysis	not specific	OR	positivism	analytical / mathematical	math modelling	LP
840	planning and development	demand analysis	not specific	OR	positivism	empirical / statistical	math modelling	regression

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APPENDIX E. ASSESSMENT OF NORMALITY

Variable	min	max	skew	c.r.	kurtosis	c.r.
PSCO						
FR1	1.000	5.000	-.156	-.517	-.032	-.053
FR2	1.000	5.000	-.298	-.987	-.459	-.762
FR3	1.000	5.000	-.060	-.197	-.914	-1.516
HR1	1.000	5.000	-.590	-1.957	-.313	-.519
HR2	1.000	5.000	-.596	-1.975	-.184	-.305
HR3	1.000	5.000	-.129	-.427	-.265	-.440
TMS1	2.000	5.000	-.341	-1.130	-1.074	-1.782
TMS2	1.000	5.000	-.627	-2.080	-.109	-.181
TMS3	2.000	5.000	-.340	-1.128	-.854	-1.416
TMS4	2.000	5.000	-.139	-.461	-1.039	-1.724
TMS5	1.000	5.000	-.169	-.560	-.742	-1.230
OR1	1.000	5.000	-.343	-1.139	-.574	-.952
OR2	1.000	5.000	-.593	-1.967	-.252	-.418
OR3	1.000	5.000	-.499	-1.655	-.613	-1.017
OR4	1.000	5.000	-.757	-2.511	-.106	-.176
OR5	1.000	5.000	-.165	-.548	-.525	-.871
OR6	2.000	5.000	-.025	-.082	-.914	-1.516
OR7	1.000	5.000	-.242	-.802	-.818	-1.357
Multivariate					38.946	5.896
PSCI						
ICT8	1.000	5.000	-.597	-2.746	-.364	-.837
ICT7	1.000	5.000	-.854	-3.931	-.009	-.020
ICT6	1.000	5.000	-.235	-1.079	-.931	-2.142
ICT5	1.000	5.000	-.513	-2.359	-.834	-1.919
ICT2	1.000	5.000	-.278	-1.280	-.668	-1.537
ICT1	1.000	5.000	-.903	-4.155	.428	.984
SCP6	1.000	5.000	-.222	-1.020	-.604	-1.390
SCP5	1.000	5.000	-.255	-1.175	-.842	-1.938
SCP2	1.000	5.000	-.273	-1.257	-.612	-1.408
SCP4	1.000	5.000	-.541	-2.487	-.156	-.359
SCP3	1.000	5.000	-.633	-2.912	-.187	-.431
SCP1	1.000	5.000	-.670	-3.080	-.068	-.156
MOS6	1.000	5.000	-.367	-1.690	-.520	-1.197
MOS5	1.000	5.000	-.233	-1.074	-.095	-.218
MOS2	1.000	5.000	-.214	-.985	-.150	-.344
MOS4	1.000	5.000	-.448	-2.063	-.242	-.557
MOS3	1.000	5.000	-.322	-1.483	-.253	-.582
MOS1	1.000	5.000	-.298	-1.372	-.257	-.591
VAS5	1.000	5.000	-.585	-2.694	.095	.217
VAS2	1.000	5.000	-.579	-2.663	-.243	-.559
VAS4	1.000	5.000	-.270	-1.243	-.454	-1.044
VAS3	1.000	5.000	-.425	-1.957	-.449	-1.034
VAS1	1.000	5.000	-.081	-.371	-.716	-1.647
LTR3	1.000	5.000	-.341	-1.567	-.247	-.567
LTR2	1.000	5.000	-.323	-1.487	-.472	-1.087
LTR4	1.000	5.000	-.339	-1.561	-.386	-.888
LTR1	1.000	5.000	-.467	-2.150	-.566	-1.301
Multivariate					93.652	13.335

Variable	min	max	skew	c.r.	kurtosis	c.r.
PP						
EFF2	1.000	5.000	-.391	-1.798	.235	.540
EFF5	1.000	5.000	-.235	-1.081	-.308	-.708
EFF4	2.000	5.000	-.141	-.649	-.680	-1.564
EFF8	2.000	5.000	.216	.993	-.650	-1.494
EFF7	2.000	5.000	-.001	-.006	-.893	-2.053
EFF6	2.000	5.000	.229	1.052	-.456	-1.050
EFF3	1.000	5.000	-.095	-.438	-.385	-.886
EFF1	1.000	5.000	-.337	-1.550	-.085	-.195
EFC13	1.000	5.000	-.183	-.842	-.642	-1.477
EFC12	1.000	5.000	-.209	-.961	-.729	-1.677
EFC11	1.000	5.000	-.143	-.657	-.891	-2.051
EFC10	1.000	5.000	-.202	-.931	-.561	-1.290
EFC9	1.000	5.000	-.247	-1.138	-.781	-1.796
EFC8	1.000	5.000	-.323	-1.484	-.273	-.628
EFC7	1.000	5.000	-.188	-.866	-.777	-1.788
EFC6	1.000	5.000	-.337	-1.550	-.297	-.684
EFC5	1.000	5.000	-.201	-.923	-.207	-.477
EFC4	2.000	5.000	-.374	-1.720	-.505	-1.162
EFC3	1.000	5.000	-.706	-3.250	.279	.641
EFC2	2.000	5.000	-.517	-2.377	-.178	-.410
EFC1	2.000	5.000	-.191	-.879	-.586	-1.349
Multivariate					64.131	11.627

APPENDIX F MAHALANOBIS DISTANCE

(1) PSCO

Observation number	Mahalanobis d-squared	p1	p2
44	41.479	.001	.083
57	32.675	.018	.340
10	31.924	.022	.185
18	31.478	.025	.087
41	30.165	.036	.088
45	30.162	.036	.031
23	29.507	.043	.022
66	29.252	.045	.010
63	29.161	.046	.003
12	27.560	.069	.015
7	26.707	.085	.022
50	26.249	.094	.019
46	24.754	.132	.088
20	24.633	.135	.056
48	24.595	.136	.030
53	24.410	.142	.021
55	23.982	.156	.022
2	23.876	.159	.013
11	22.429	.213	.096
47	21.572	.252	.203
31	21.331	.263	.189
16	20.828	.288	.247
26	20.689	.295	.207
15	20.524	.304	.179
64	20.360	.313	.154
33	19.144	.383	.474
19	19.133	.384	.380
17	19.017	.391	.331
65	18.776	.406	.331
51	18.369	.432	.399
42	18.332	.434	.321
56	18.203	.442	.283
32	17.894	.463	.313
37	17.510	.488	.377
27	17.264	.505	.387
35	16.980	.524	.415
4	15.515	.626	.890
59	15.127	.653	.925
24	14.322	.708	.985
9	14.258	.712	.977
39	14.188	.717	.966
1	14.182	.717	.942
60	14.095	.723	.921
5	14.003	.729	.897
29	13.985	.730	.846
40	13.795	.742	.838
49	13.150	.783	.934

Observation number	Mahalanobis d-squared	p1	p2
25	12.563	.817	.975
21	11.904	.852	.994
6	11.871	.854	.988
14	11.747	.860	.982
8	11.170	.887	.994
13	10.664	.908	.998
61	10.160	.927	.999
3	10.123	.928	.997
30	9.883	.936	.997
43	9.756	.940	.994
36	9.032	.959	.999
62	8.789	.964	.998
54	8.458	.971	.997
58	8.209	.975	.994
28	7.780	.982	.993
22	7.495	.985	.983
52	6.249	.995	.996
38	2.301	1.000	1.000
34	2.301	1.000	1.000

(2) PSCI

Observation number	Mahalanobis d-squared	p1	p2
14	62.176	.000	.017
58	61.169	.000	.000
41	57.698	.001	.000
30	55.116	.001	.000
7	51.159	.003	.000
20	49.513	.005	.000
51	48.676	.006	.000
38	48.595	.007	.000
40	47.128	.010	.000
21	45.225	.015	.000
3	44.457	.019	.000
113	42.694	.028	.000
94	42.260	.031	.000
43	42.169	.032	.000
70	42.156	.032	.000
63	41.768	.035	.000
64	40.890	.042	.000
31	39.271	.060	.001
50	38.861	.065	.001
27	38.258	.074	.001
56	37.130	.093	.007
26	36.721	.100	.008
55	36.495	.105	.007
98	36.419	.106	.004
22	36.098	.113	.004
90	35.932	.117	.003
29	35.248	.133	.008
28	35.248	.133	.004
6	34.519	.151	.014
120	34.265	.158	.014
8	33.985	.166	.016
23	33.932	.168	.010
97	33.793	.172	.008
52	33.744	.174	.005
68	32.668	.208	.043
4	32.653	.209	.028
67	32.572	.212	.021
111	31.659	.245	.095

Observation number	Mahalanobis d-squared	p1	p2
112	31.659	.245	.066
13	31.554	.249	.056
15	31.371	.256	.055
85	31.334	.258	.040
84	31.334	.258	.026
2	31.119	.266	.028
34	30.768	.281	.043
82	30.707	.283	.033
83	30.707	.283	.021
37	29.661	.330	.144
24	29.271	.348	.210
86	28.708	.375	.365
91	28.699	.376	.303
46	28.693	.376	.245
11	27.802	.421	.569
19	27.716	.426	.539
59	27.489	.438	.575
88	27.031	.462	.714
81	26.951	.466	.686
53	26.796	.475	.691
124	26.662	.482	.686
122	26.632	.484	.634
121	26.183	.508	.765
89	26.096	.513	.744
75	25.881	.525	.773
12	25.101	.569	.941
87	25.001	.574	.935
65	24.527	.601	.974
96	24.122	.624	.989
74	24.022	.629	.988
119	23.966	.632	.984
93	23.846	.639	.983
57	23.656	.649	.986
17	23.611	.652	.981
127	23.559	.655	.975
62	23.044	.683	.993
16	22.958	.687	.992
33	22.351	.719	.999
107	22.233	.725	.999
108	22.233	.725	.998
1	21.940	.740	.999
125	21.794	.748	.999
92	21.543	.760	.999
126	21.365	.769	.999
61	21.245	.775	.999
39	20.841	.794	1.000
47	20.343	.816	1.000
66	20.287	.818	1.000
104	19.970	.832	1.000
95	19.834	.838	1.000
103	19.599	.847	1.000
54	19.573	.848	1.000
78	19.532	.850	1.000
79	19.532	.850	1.000
76	19.494	.851	1.000
123	19.398	.855	1.000
9	19.047	.868	1.000
10	18.755	.879	1.000
36	18.684	.881	1.000
35	18.684	.881	1.000
25	18.245	.896	1.000
116	18.024	.903	1.000

(3) PP

Observation number	Mahalanobis d-squared	p1	p2
51	55.633	.000	.007
14	42.554	.004	.077
21	41.122	.005	.032
56	39.865	.008	.017
30	39.654	.008	.004
28	38.969	.010	.002
29	38.969	.010	.000
85	38.780	.010	.000
58	35.997	.022	.002
84	35.575	.024	.001
70	35.539	.025	.000
94	35.058	.028	.000
96	34.290	.034	.000
95	34.290	.034	.000
27	34.148	.035	.000
91	34.103	.035	.000
41	33.694	.039	.000
20	32.656	.050	.000
31	32.476	.052	.000
52	32.101	.057	.000
53	31.263	.069	.000
119	31.145	.071	.000
79	30.778	.077	.000
114	30.658	.080	.000
81	30.490	.083	.000
26	29.782	.096	.000
87	29.633	.100	.000
86	29.262	.108	.000
64	29.128	.111	.000
107	28.815	.119	.000
71	28.638	.123	.000
46	28.048	.139	.000
112	27.722	.148	.001
111	27.722	.148	.000
78	26.824	.177	.004
97	26.613	.184	.004
33	26.589	.185	.002
47	26.379	.192	.003
5	25.398	.230	.028
37	24.946	.249	.057
105	24.803	.256	.054
42	24.739	.259	.042
39	24.617	.264	.038
54	24.138	.286	.083
8	24.129	.287	.059
121	23.726	.307	.104
108	23.431	.321	.141
77	22.818	.354	.314
50	22.566	.368	.366
118	22.561	.368	.302
117	22.561	.368	.242
2	22.479	.372	.219
18	22.278	.384	.244
34	22.120	.393	.253
103	21.793	.412	.342
83	21.749	.414	.299
82	21.749	.414	.240

Observation number	Mahalanobis d-squared	p1	p2
92	21.172	.448	.460
62	21.085	.454	.437
61	21.085	.454	.369
120	20.871	.467	.414
76	20.653	.480	.464
123	20.188	.509	.651
24	20.041	.519	.663
19	19.682	.541	.777
36	19.406	.559	.838
35	19.406	.559	.790
125	19.289	.567	.788
75	19.212	.572	.769
93	18.956	.588	.825
23	18.851	.595	.818
55	18.831	.596	.776
67	18.687	.605	.786
115	18.442	.621	.836
116	18.442	.621	.788
122	18.128	.641	.862
66	18.034	.647	.853
3	17.719	.667	.910
100	16.988	.712	.989
9	16.874	.719	.988
98	16.332	.751	.998
4	15.898	.775	1.000
6	15.620	.791	1.000
49	15.312	.807	1.000
113	15.080	.819	1.000
74	15.010	.822	1.000
127	15.008	.823	1.000
90	14.604	.842	1.000
68	14.567	.844	1.000
99	14.362	.854	1.000
106	14.190	.861	1.000
7	13.501	.890	1.000
40	13.454	.892	1.000
44	13.421	.893	1.000
104	13.410	.894	1.000
13	13.123	.904	1.000
89	13.106	.905	1.000
88	13.106	.905	1.000
72	12.867	.913	1.000
1	12.823	.915	1.000

CARDIFF BUSINESS SCHOOL ETHICAL APPROVAL FORM: PHD THESIS RESEARCH

(For guidance on how to complete this form, please see http://www.cf.ac.uk/carbs/research/ethics.html)

For Office Use: Ref **Meeting**

Does your research involve human participants? Yes ☒ No ☐
If you have answered 'No' to this question you do not need to complete the rest of this form, otherwise please proceed to the next question

Does your research have any involvement with the NHS? Yes ☐ No ☒
If you have answered **Yes** to this question, then your project should firstly be submitted to the NHS National Research Ethics Service. Online applications are available on http://www.nres.npsa.nhs.uk/applicants/ . It could be that you may have to deal directly with the NHS Ethics Service and bypass the Business School's Research Ethics Committee.

Name of Student: Su Han Woo

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Section: Logistics and Operation Management

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Names of Supervisors: Stephen Pettit, Anthony Beresford, Peter Marlow

Supervisors' Email Addresses: pettit@cf.ac.uk

Title of Thesis: Development a Port Performance Measurement Framework in Changing Logistics Environments

Start and Estimated End Date of Research: 01/10/2007 – 30/09/2011

Please indicate any sources of funding for this research: Korean Government

1. Describe the Methodology to be applied in the research

Firstly interview will be conducted for exploratory study and subsequently questionnaire survey will be conducted for empirical study. The interview will be conducted face to face with interviewees. The questionnaire of the survey will be sent and collected by post or email.

2. Describe the participant sample who will be contacted for this Research Project. You need to consider the number of participants, their age, gender, recruitment methods and exclusion/inclusion criteria

For the interview, interviewee will be senior managers in port operating companies, shipping companies and port authority, and academics. The number of interviewees is expected to be approximately 30 and they will be generally male and in mid 40's. Potential interviewees will be asked to participate in interview on telephone and via email by researcher.

For the survey, sample group will be port operating,companies and port authorities. The potential participants' age and gender, and recruitment methods will be the same as those of the interview. However the number of participants is expected to be greater than that of interviewees, which will be more than 100.

3. Describe the consent and participant information arrangements you will make, as well as the methods of debriefing. If you are conducting interviews, you must attach a copy of the consent form you will be using.

1) Interview

Before conducting interview, the objects, nature and process of the research will be presented to the interviewees. In addition the interviewees will be informed that participation is voluntary and participants had the opportunity to consider the information, ask questions and have these answered satisfactorily. The contents above will be also included in the consent forms (Attachment 1 and 2). After conducting interview and collecting data, the participants will be provided with a description of the nature of the investigation and the hypothesis of the research. In addition the way of dealing with and analysing the collected data will be provided. The draft questionnaire is presented in Attachment 3.

2) Survey

The questionnaire will be sent to the potential participants with the cover letter which describes the objects, nature and process of the research. The letter will also present that the collected data will be used only for research purpose and confidentially and anonymously. The draft letter and questionnaire are presented in Attachment 4.

4. Please make a clear and concise statement of the ethical considerations raised by the research and how you intend to deal with them throughout the duration of the project

During the research 'confidentiality' and 'anonymity' can be main ethical issues. Basically the research will follow Cardiff Business School Research Ethics Guideline and Code of Ethics of Academic of Management. For each participants of the interview the written informed consent which will be reasonably understandable to the participants will be obtained. The confidential information will be treated as such even if it lacks legal protection or privilege. In addition personal identifiers' name will be deleted before the information is made publicly available.

PLEASE NOTE that you should include a copy of your questionnaire

NB: Copies of your signed and approved Research Ethics Application Form together with accompanying documentation must be bound into your Dissertation or Thesis.

5. ***Please complete the following in relation to your research:***

		Yes	No	n/a
(a)	Will you describe the main details of the research process to participants in advance, so that they are informed about what to expect?	☒	☐	☐
(b)	Will you tell participants that their participation is voluntary?	☒	☐	☐
(c)	Will you obtain written consent for participation?	☒	☐	☐
(d)	Will you tell participants that they may withdraw from the research at any time and for any reason?	☒	☐	☐
(e)	If you are using a questionnaire, will you give participants the option of omitting questions they do not want to answer?	☒	☐	☐
(f)	Will you tell participants that their data will be treated with full confidentiality and that, if published, it will not be identifiable as theirs?	☒	☐	☐
(g)	Will you offer to send participants findings from the research (e.g. copies of publications arising from the research)?	☒	☐	☐

PLEASE NOTE:
If you have ticked No to any of 5(a) to 5(g), please give an explanation on a separate sheet.
(Note: N/A = not applicable)
There is an obligation on the lead researcher to bring to the attention of Cardiff Business School Ethics Committee any issues with ethical implications not clearly covered by the above checklist. .

Two copies of this form (and attachments) should be submitted to Ms Lainey Clayton, Room F09, Cardiff Business School.

Signed SH. Woo

Print Name SU HAH WOO

Date 03/10/2008

SUPERVISOR'S DECLARATION

As the supervisor for this research I confirm that I believe that all research ethical issues have been dealt with in accordance with University policy and the research ethics guidelines of the relevant professional organisation.

Signed S Pettit (Primary supervisor)

Print Name S. PETTIT

Date 8/10/08

STATEMENT OF ETHICAL APPROVAL

This project has been considered using agreed School procedures and is now approved.

Signed J Solomon (Chair, School Research Ethics Committee)

Print Name J. Solomon

Date 16/11/2009