THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Integrated Logistics Platform

The context of the port relational exchanges and systematic integration

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ABSTRACT

With relentless global competition, the cutting edge of today's business environment remains fully fledged within a vastly evolving market. For this, the port industry is confronted with challenges and opportunities at the same time. Challenges are evident in the ongoing logistics-restructured environment, and in the quest to keep the port efficient connecting node in supply chains. On the other hand, opportunities arise from a plethora of new scholarly articles addressing the port within themes of logistics, supply chain management (SCM), and value-adding chains. This evolving need brought the concept of an integrated logistics platform to life, which is the focus of this thesis. The purpose of this thesis is to explore the port industry in order to develop an integrated logistics platform concept through the identification of key elements and mechanisms for systematic integration as well as barriers that hinder the adoption of the concept.

Increasingly, many researchers have admitted the changing role(s) of the ports within supply chains; and thereby it is not restricted to the traditional role of simple point of transshipment. To reflect on this, different theories and methods were used to explore major port involvement in supply chains, and more importantly, to derive relevant value-adding attributes that have linking functions. The interrelated nature of the SCM framework (network structure, business process, and management components) played a major role in identifying key elements and mechanisms that support the logistics platform's systematic integration.

Remarkably, the provision of distribution and value-added logistics activities within the gateway position of major seaports has become a source of competitive advantage and an important business model. An integrated logistics platform concept is one of these strategies aiming to integrate the sea/land interfaces with the inland-logistics equation. The capability of integrating different forms of interfaces relies on the port organization to: support supply chain coordination in which all member-firms work closely as if one single domain, adopt key business process integration by identifying linkages to logistics activities, and to enhance system optimization that allows supply chain visibility for the entire system.

Key words: competitive advantage, interfaces, logistics platform, port industries, supply chain management, transportation.

LIST OF APPENDED PAPERS

The thesis is based on the work contained in the following papers:

Paper I

Almotairi, B. and Lumsden, K. (2009) "Port logistics platform integration in supply chain management." *Int. J. Shipping and Transport Logistics*, Vol. 1, No. 2, pp. 194-210.

An earlier version of this paper was published in *The 3rd Int. Conference on Port and Waterways proceedings, Dubrovnik, Croatia, 18-19. September, 2008.*

Paper II

Almotairi, B. and Lumsden, K. (2009) "Significant value-added attributes in port supply chain systems." *The 14th Int. Symposium on Logistics (14thISL) proceedings, Istanbul, Turkey, 5-7. July, 2009.*

Under review process in The Transportation Journal (TJ) for publication consideration, 2011.

Paper III

Almotairi, B. and Stefansson, G. (2010) "Integrated logistics platform – An empirical analysis from the port industry." *The 22nd NOFOMA Conference proceedings, Kolding, Denmark, 10-11. June. 2010.*

Submitted to special issue at The International Journal of Logistics Management (IJLM) for publication consideration, 2011.

Paper IV

Almotairi, B., Flodén, J., Stefansson, G. and Woxenius, J. (2011) "Information flows supporting hinterland transportation by rail: Applications in Sweden." *Int. J. Research in Transportation Economic,* Vol. 33, No. 1, pp. 15-24.

An earlier version of this paper was presented at *The Dry-port conference, Edinburgh, UK, 21-22. October, 2010.*

Paper V

Almotairi, B. and Stefansson, G. (2011) "Managing supply chain interfaces – A framework towards an integrated logistics platform." *The 23rd NOFOMA Conference proceedings, Harstad, Norway, 9-10. June. 2011.*

Submitted to The International Journal of Logistics Research and Applications (IJLRA) for publication consideration, 2011.

Paper VI

Almotairi, B. (2011) "Barriers to supply chain integration – A combined view of different partners in port industry." *The 16th Int. Symposium on Logistics (16thISL) proceedings, Berlin, Germany, 11-13. July, 2011.*

Submitted to The International Journal of Shipping and Transport Logistics (IJSTL) for publication consideration, 2012.

To my family

PREFACE

To be a scientific scholar is not a merit in itself, but knowing the surrounding scientific communities is. As a research journey has walked me between theory and practice, it would be difficult to forget all individuals and organizations that have made this research possible.

First and foremost, I would like to express my deepest gratitude to my main supervisor, Professor Kenth Lumsden. Your inspiration, trust and guidance through the entire research process were of great importance. Thank you for being my mentor and not just a supervisor!

Associate Professor Gunnar Stefansson, many thanks for your helpful comments and invaluable criticism that pinpointed the weakest part of my arguments and texts. Having a long standing debate with you regarding concept, theory and method have engendered my understanding a great deal. You made my research momentum/thrust reach further indeed!

I strongly believe that research is a creative process and that collaboration and teamwork is crucial and central to research success. In this respect, I would like to thank Professor Johan Woxenius and Assistant Professor Jonas Flodén for sharing knowledge and experience in analyzing the information flows structure.

Before any PhD candidate approaches the final deadline, he or she needs to remember those who gave lasting and insightful feedback. Associate Professor Rickard Bergqvist, your feedback and constructive comments have contributed to reshaping the final version of this thesis. Thank you for the good work!

To my colleagues at the Department of Logistics and Transportation, thank you for making everyday work exciting and enjoyable; special thanks go to Stig-Arne Mattsson, Dan Andersson, Sönke Behrends, Per Medbo and Ola Hultkrantz for the good company and discussions.

I would like to thank Chalmers University of Technology for providing excellent working conditions; my thanks also extend to all companies, governmental bodies and individuals that agreed to be interviewed and studied. The data collection process and procedures would not have been easy without your support and well appreciated permission.

This thesis has been supported financially by the Saudi Government and its branches: The Ministry of the Interior, The Ministry of Higher Education, The Saudi Embassy and Cultural Attaché in Germany, as well as The Saudi Embassy in Sweden. I owe all of you my sincere gratitude.

A special acknowledgment goes to my parents, sisters and brothers. You have been encouraging and supportive at all times…

Last but not least, many thanks to my family: my wife, my sons and daughters for the support and encouragement that you have given me during many years of study. You have contributed more than you know! Thank you all!

Göteborg, March 2012

Badi Almotairi

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TERMINOLOGY

The terminology that is used in the covering paper as well as in appended papers is presented below. The definitions for the following terms are from the "Terminology on combined transport" Economic Commission for Europe (2001), if not marked otherwise.

Container is a generic term for a box to carry freight, strong enough for repeated use, usually stackable and fitted with devices for transfer between modes. Most maritime containers are ISO containers. Two main standards exist in terms of length: 20 and 40 feet (6.10 and 12.20 meters), and one and two TEUs (twenty foot equivalent unit), respectively.

Feeder service is a short sea shipping service which connects at least two ports in order for the freight (generally containers) to be consolidated or redistributed to or from a deep-sea service in one of these ports.

Intermodal transport is the movement of goods in one and the same loading unit or road vehicle, which uses successively two or more modes of transport without handling the goods themselves in changing modes.

Intermodal Transport Unit (ITU) is a container, a swap body and a semi-trailer suitable for intermodal transport.

Interfaces are considered to be areas of 'exchanging' information and goods flows between two or more logistics systems, i.e., information or physical interfaces (Stefansson and Russell, 2008).

Multimodal transport is the carriage of goods by two or more traffic modes.

Port is "an area made up of infrastructure and superstructure capable of receiving ships and other modes of transport, handling their cargo from ship to shore and vice-versa and capable of providing logistics services that create value-added" (Paixão and Marlow, 2003).

Paradigm is "the basic belief system or world-view that guides the investigators, not only in choices of method but in ontologically and epistemologically fundamental ways" (Guba and Lincoln, 1994).

System concept is defined by Checkland (1993) as follows:

"The central concept system embodies the idea of a set of elements connected together, which form a whole, thus showing properties which are properties of the whole, rather than properties of its component parts."

Systematic is to comprise or resemble a system, which is characterized by the use of order and planning (The Free Dictionary, 2011).

TEU is a twenty-foot equivalent unit. A standard unit based on an ISO container 20 feet in length (6.10 m) is used as a statistical measure of traffic flows or capacities. One standard 40' ISO Series 1 container equals 2 TEUs.

Transshipment is the movement of ITUs from one means of transport to another. It is equally defined when containers are handled twice within the same terminal and revenues are derived from each transaction (McCalla, 2008).

“A map of a seaport can be particularly misleading…”

J H Bird (1984, p. 21)

1 INTRODUCTION

> *"It is clear that ports are now operating in a new environment – which is globalized, corporatized, and privatized and is exceptionally competitive; it is also a logistics-restructured environment." Ross Robinson (2002, p. 245)*

…indeed the trajectory of the theoretical discourse on the modern seaport has not been a linear one; this is true where former models and concepts appear to be increasingly divorced from empirical reality (Olivier and Slack, 2006). Evidently, the seaport's developments evolve continuously, adapting to new technologies, structural and operational changes, and revised working practices or other aspects on a systematic basis (Beresford *et al.*, 2004). It is nothing less than a paradigm shift in port industry (Robinson, 2002). A new paradigm would seek to ground the port within themes of *logistics*, *supply chain management (SCM),* and *value-adding chains*…

1.1 Background and problem area

During the past decades the market environment in which seaports operate has been substantially changing; existing literature on port industry (e.g., Paixão and Marlow, 2003; Olivier and Slack, 2006; Pettit and Beresford, 2009) suggests that these changes, which were driven by the globalization process, resulted from:

(1) Strong growth in containerized cargo versus the containerization effect;
(2) The increased efficiency of inland distribution patterns and network dimensions;
(3) Advanced technological breakthroughs and the need for accurate information for planning and operations; and
(4) Increased pressure on ports to comply with the international security requirements.

While the extension of the globalization process into the port industry involves a series of socio-economic, financial and political changes that occurred in the last decades (Paixão and Marlow, 2003; Pettit and Beresford, 2009), the above elements were given considerable attention by scholars in recent years and were

seen as aptly adequate to explain the dramatic changes that occurred in the port industry from different perspectives:

1.1.1 Seaside interface perspectives

Liner shipping has experienced an explosion in container ship size. The maritime part of the intermodal transport chains has employed ever larger ships to cope with increasing transport demand and to facilitate lower unit costs as discussed by Cullinane and Khanna (2000). Although total freight volume varies according to regional economic structure, types of commodities and freight origin and destination, the global trade expressed in TEUs (world container traffic) at country league top 10 trade corridors has grown exponentially in recent years (consult Figure 1).

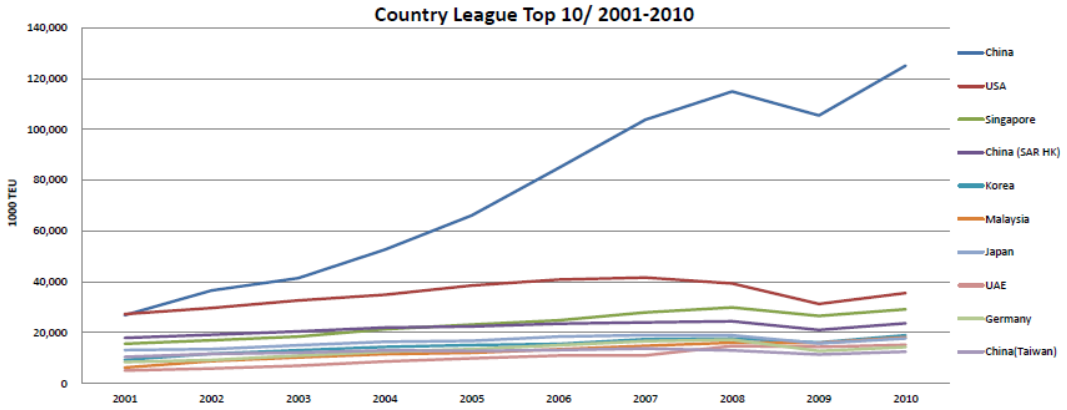


Figure 1 World container traffic/country league top 10 – 2001~2010 1000 TEUs (Containerization International Yearbook, 2012)

Not only has world container traffic remarkably increased, but also world container throughput as the summation of all containers handled by ports, either as imports, exports or transshipment (Rodrigue *et al.*, 2009). Figure 2 illustrates both the world container traffic and throughput between 1980 and 2008 (Millions of TEUs).

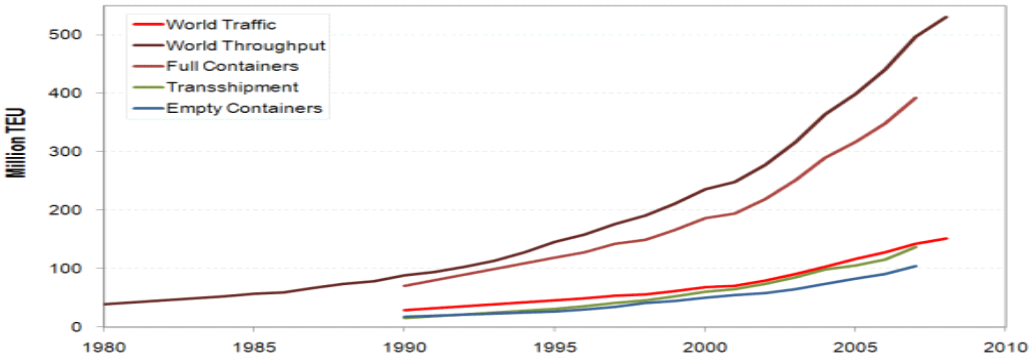


Figure 2 World container traffic and throughput 1980~2008 Millions TEUs (adapted from Drewry Shipping Consultants, cited in Rodrigue et al., 2009)

While the volume of container traffic represents the total number of containers being carried by sea (Rodrigue *et al.*, 2009), the volume of container throughput reflects the intensity of manufacturing (catchment areas for cargoes) and thus more shipping activities into the port (Notteboom and Winkelmans, 2001; Notteboom and Rodrigue, 2005; Mangan *et al.*, 2008; Ding and Teo, 2010). With the number of latest vessels on order reaching 18,000 TEUs (Maersk Line, 2011) to fully utilize the economies of scale, progress in ports and hinterland operations must match (Parola and Sciomachen, 2005; McCalla, 2007). Hence, a dramatic increased capacity in container traffic and throughput entails various input scenarios upon container operations, logistical systems and ports (Cullinane and Khanna, 2000). While many scholars attempted to visualize the implication's scenarios associated with the incremental increase in container volume, others investigated the role of the port at large, especially port connectivity in the world shipping network. For instance, Notteboom and Rodrigue (2005) introduced the port regionalization phase that goes beyond the traditional port perimeter to port governance and functional focus linking it more closely to inland freight distribution centers. To answer the following question: What is the role of port connectivity in the world shipping network, and how does it affect port throughput? Ding and Teo (2010) examined the container port traffic data from the Containerization International Yearbook dated from 1982 to 2006, for almost all the world's major ports. Over the ensuing 25 years, the world container traffic volume among major world ports has grown almost tenfold – from slightly above 40 Million TEUs in 1982 to over 400 Million TEUs in 2005. By using the truncated lognormal distribution model, the study reveals a strong correlation between the degree of connectivity of the port and its container throughput data that has been utilized.

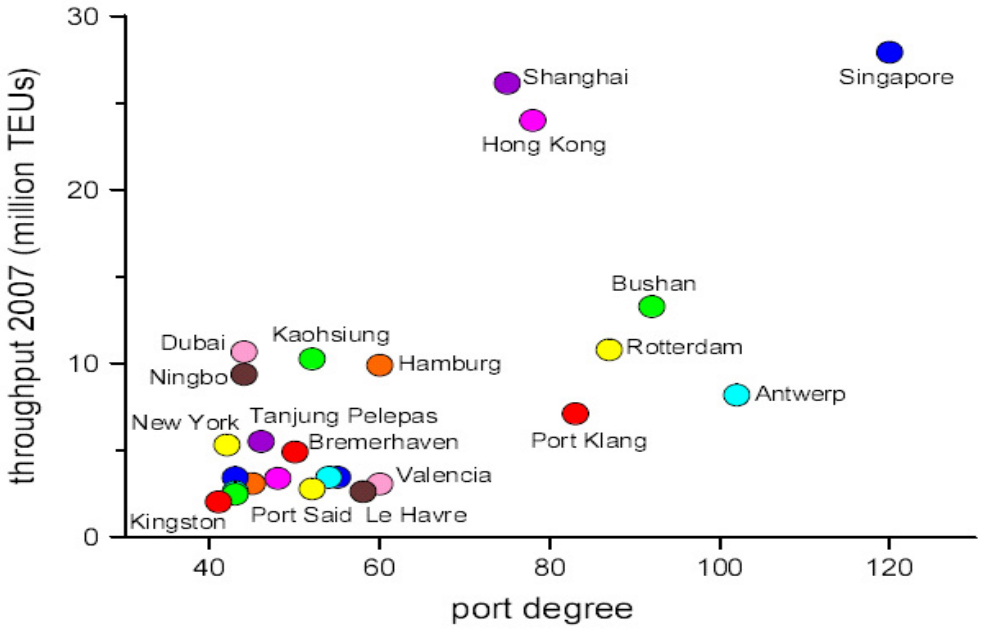


Figure 3 The port connectivity (degree) versus throughput in year 2007 (Ding and Teo, 2010)

Figure 3 shows the relationship between the connectivity (degrees) and port throughputs in the year 2007 [degree data cited from Hu and Zhu (2009)]. Here, port degree is part of the network's construction, which represents the number of directions passengers or cargoes can travel at a given port, or simply the number of nodes which can be reached without changing the line (Hu and Zhu, 2009).

1.1.2 Landside interface perspectives

Efficient inland distribution patterns and networking dimensions are becoming very important elements in the landside logistics equation; the considerably more difficult task, though little regarded, is that of defining the functionality and capacity of the sub-systems linked into the terminal (Robinson, 2002). These sub-systems are to reshape the landside logistics patterns, which are complex multimodal transports of networks linking the main gateway position (seaport) with the correspondent network of nodes as conceptualized and explained by Lumsden (2006). According to Bichou and Gray (2005), the port system not only serves as an integral component of the transport system, but also is a major sub-system of the broader production, trade and logistics systems. In a practical world, ports are continuously interacting with a variety of businesses and market players (Bichou and Gray, 2005). Carbone and De Martino (2003) investigate the changing role of Le Havre port with the current evolution of international maritime trade patterns, which gives rise to the port industry as a dynamic node in the international production and distribution network. They claim that port has gained the status of a crossroads between the production and distribution spheres. As a link in a larger logistics chain, the role of port exceeds the simple function of service to ship and cargo. Apart from their role as the traditional sea/land interface, ports are a good location for value-added logistics (VAL), in which members of different channels can meet and interact (Bichou and Gray, 2004).

In this kind of business process transformation, Carbone and De Martino (2003) take the initiative to analyze port operator integration processes with the automotive supply chain (between the port of Le Havre and Renault's supply chain). The authors call for a wider supply chain analysis due to potential opportunities for creating customer value-added. These opportunities encompass a wide range of logistics and value-added activities, developed in conjunction with industrial and commercial businesses (Paixão and Marlow, 2003). With this development as a natural effect by constant industrial changes and expansion toward sea access, the port industry has engaged in activities beyond its boundaries and ought to cope with industrial uncertainty. Paixão and Marlow (2003) propose an agile port concept—ensuring that port remains proactive elements along the supply chain and to prevent the supply drifting apart from the demand. It's no wonder that the emphasis of the growing link between ports and economic growth increased recently, especially with the introduction of demand management strategy. Gattorna (2006) argues for a dynamic capability in supply chain designs so that member-firms can respond to any changes. A global supply chain taxonomy developed by Christopher *et al*. (2006) with four supply chain strategies has been proposed to highlight some roles that ports can handle in the context of different supply chain strategies (Mangan *et al.*, 2008).

1.1.3 Logistics integration perspectives

With the increased demand of containerization, the technological breakthroughs in cargo handling, terminal operations, the shipping industry and other modes of transportation trigger the evolution of one of the most important trends in the history of the port industry (Kia *et al.*, 2000; Olivier and Slack, 2006). It is in the business-to-business data sharing and efficient management of information flows between parties that beginning to transform the global supply chains of international trade (Stefansson, 2002). In international transportation and logistics services, the already vigorous growth in the volume of global trade is likely to be further accelerated by the state of the art technology which is facilitating new connections between buyers and suppliers (Kia *et al.*, 2000). Diverse communication systems exist to support the information flow and further to carry out an effective and efficient transition of consignments (Stefansson, 2002). Kia *et al.* (2000) investigate various electronic devices in major container ports in Australia by using a simulation model to indicate the positive impact of the electronic devices on the operational system of a container terminal. The study noted how information technology has become an essential part of the rapid and accurate transfer and processing of enormous volumes of data processed in international transport firms and port organizations. It is no wonder that these technological breakthroughs and the concomitant advances in naval engineering, which gave rise to containerization, have engendered a number of scholarly deliberations for how the port could be conceptualized (Olivier and Slack, 2006). However, empirical research has yet to consider available ICT applications and functionalities, integration among different applications types, and the critical role of the technology providers in the adoption of ICTs within the logistics and freight transportation arena (Perego *et al.*, 2011).

In tandem, but not unrelated to the previous elements, is maritime security and more precisely; Does port border really matter? Maritime security remains a critical issue, requiring that ports expand operation capacity without compromising the safety of humans. With security regulations likely to continue to intensify, more research is needed on container security technology such as electronic seals, container tracking (e.g., RFID), and equipment screening (Maloni and Jackson, 2005). Therefore, supply chain security heavily relies on logistics integration, the advancement of technological breakthroughs and innovative solutions.

1.1.4 Problem area

From the previous discussion, major changes affecting ports have resulted from incremental containerization growth and intermodal transportation, advances in freight logistics and information technology, and the integration of world markets (Helling and Poister, 2000). Hence, the development of global supply chains has increased the pressure on the maritime haul, on port operations, and last but not least on freight logistics and distribution systems (Notteboom and Rodrigue, 2005; Robinson, 2006). As these important trends take hold in the marketplace, the role of ports becomes more important than ever (Bagchi and Paik, 2001).

More precisely, the hallmark success for port industry as a critical connecting node in supply chains is to facilitate the exchange of goods and services and the related information among the various individual supply chains (Chadwin *et al.*, 1989; Goss, 1990).

Despite the complex nature of ports from the managerial and entrepreneurial point of view, due to multipart organizations in which institutions and functions often intersect at various levels (Robinson, 2002; Carbone and De Martino, 2003; Bichou and Gray, 2004; Bichou and Gray, 2005), the port industry searches for different strategies to cope with the prevailing and pervasive restructuring of the logistics or supply chain environment (Robinson, 2002; Bichou and Gray, 2004; Bichou and Gray, 2005; Olivier and Slack, 2006; Robinson, 2006; Mangan *et al.*, 2008; Panayides and Song, 2008). One of these strategies aiming to integrate the sea/land interface with inland-logistics is based on a concept of an integrated logistics platform that is the focus of this thesis. The concept emerges as natural ingredients of the logistics/SCM elements aimed at exploring a firm's value-chain mechanisms. This is to point out the importance of creating dynamic relationships between member-firms in order to adapt to high-variety strategies. The common threads linking these strategies are the increasing integration of ports into the transport network, the growing recognition of the port as a natural focus for industrialization and value-addition, and the development of port-related logistics activities taking account of corporate commercial strategies, technological developments and market forces (Pettit and Beresford, 2009).

To summarize, there is a demand to explore interfaces between member-firms as well as transport and economic activities in the port industry due to globalization effects. This is in line with the recent call to re-conceptualize the port, from a single, fixed, spatial entity to a network of logistics and transport operators working under a corporate logic (Olivier and Slack, 2006). Figure 4 illustrates the port industry elements from seaside and landside interface perspectives.

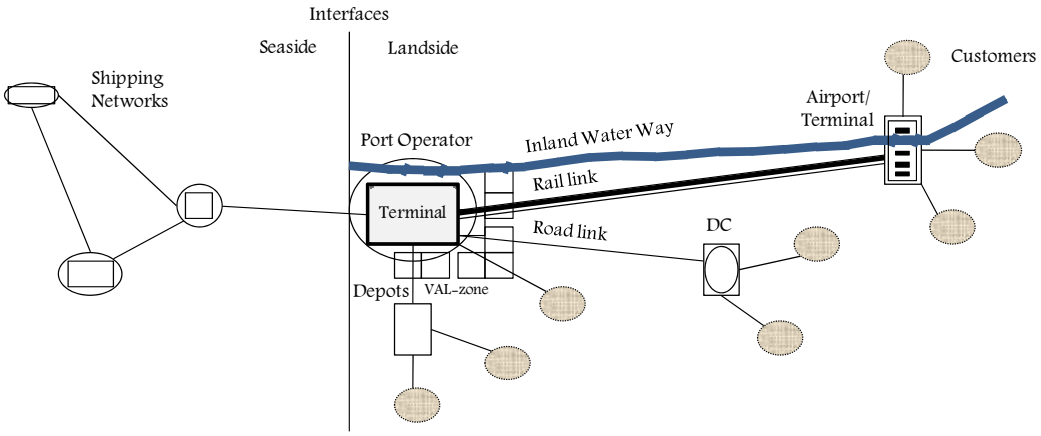


Figure 4 The port industry elements from seaside and landside interface perspectives

With the increased demand in container port operation and industrial progress in developing value-added logistics in close proximity to ports, a systematic integration between supply chain interfaces has become a prerequisite for the entire logistics system to function (consult Figure 4). By this, common obstacles and segmentation of the port business in terms of trade, logistics and supply chain are thought to be adequately solved. Because the port industry incorporates commercial strategies as integrated elements within the supply chain environment, many researchers will suggest grounding the port within themes of *logistics*, *SCM,* and *value-adding chains*. This thesis emphasizes the importance of systematic integration between supply chain interfaces that might be obtained by a common platform of logistics and information transactions. In addition, there is an indication that the current state of knowledge on ports' emerging role(s) and integration in supply chains appears to be modest as far as business economics research is concerned (Carbone and De Martino, 2003; Bichou and Gray, 2004; Mangan *et al.*, 2008).

1.2 Purpose and research questions

In the background and problem area section, it is argued that port is a critical connecting node in supply chains, whereas the sea/land interfaces need to be integrated with the inland-logistics equation. This concurs with the current and emerging role(s) played by ports in the context of logistics/SCM practice and strategy. Hence, the systematic integration between supply chain interfaces is persistent. While many researchers call for a fundamental epistemological way of thinking and paradigm shift in port industry (Robinson, 2002; Olivier and Slack, 2006), this thesis intends to fill this gap and to contribute to the knowledge of an integrated logistics platform concept.

The purpose of this thesis is to explore the port industry in order to develop an integrated logistics platform concept through the identification of key elements and mechanisms for systematic integration as well as barriers that hinder the adoption of the concept.

To achieve this overall purpose, two research areas are successfully investigated. Exploring and picturing major *changing role(s) of the port industry* is the departure point. This is more concerned with the future of ports as a logistics platform and current interaction discipline. Adding to this, identifying relevant value-added attributes in port supply chains that have a linking function gives another dimension to answer the first research area. The second research area deals with *systematic integration adoption*. This is to integrate the sea/land interface with the inland-logistics equation. While the key elements include the network structure, business process, and management components necessary for operational integration, mechanisms embrace analyzing information facility structure (integrative information and integrative technology), and defining a different form of supply chain interfaces. Additional work following from this also includes determining barriers that hinder the adoption of an integrated logistics platform. The main research areas and links between them are shown in Figure 5.

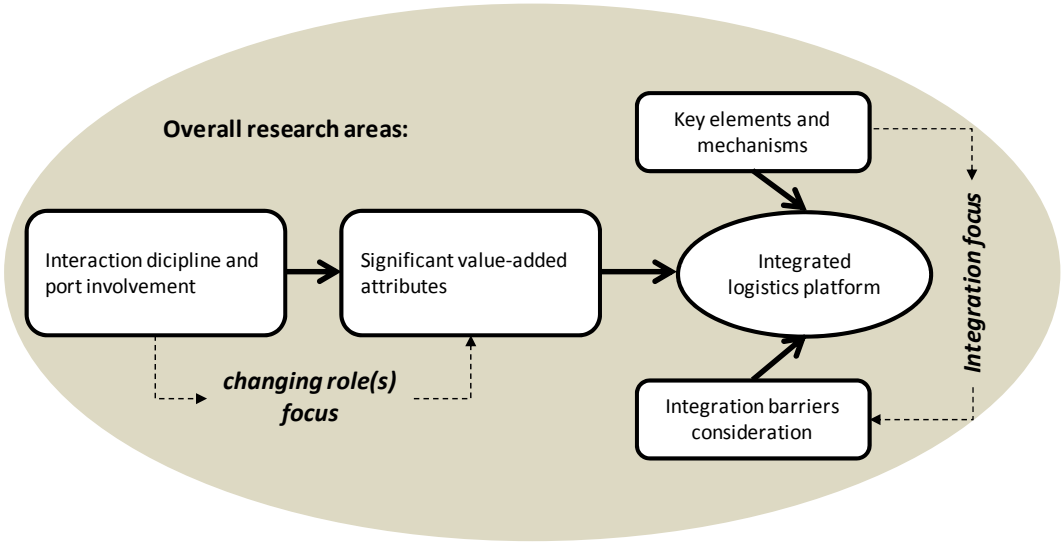


Figure 5 Main research areas and links between them

In this type of research, the formulation of the research problem depends on the researcher's knowledge, competence and how research progresses in the same field of study. On this basis, specific research questions (RQs) are formulated for each of the defined research areas, and are discussed as follows:

The changing role(s) of the port industry: As the study deals with new trends in the port industry, the question that crosses the research arena is how to redefine the role(s) of the port in order to guarantee that it remains efficient connecting node and functional elements in the supply chains. To reflect on this evolving need and to build up a solid starting point for further research-work, this research area consists of two research questions:

RQ1: What is the major changing role(s) of the port industry concerning the port involvement in supply chains?

The changing role(s) of the port industry has been the trigger to investigate the port's major involvement in supply chains. While this research deals with new trends, which required ports' adaptation to the high variety strategy, interaction discipline between various member-firms in the supply chain needs to be investigated. This is to understand the problem area, and furthermore to bring about what will be seen as an improvement in the situation. Thus, a comprehensive theoretical analysis is initiated to sketch the preliminary picture of the port logistics structure.

In the course of answering this research area, the next research topic searches for significant value-added attributes that have a linking function in the port supply chain systems. Considering the importance of value-chain concept in improving firms' interconnectivity and interoperability, this research topic aims to answer the next research question:

RQ2: What are the significant value-added attributes that have a linking function in the port supply chain systems?

Research question two is devoted to searching for relevant value-added attributes from literature perspectives; these value-added attributes include activities, services, and tasks. They comprise physical and virtual value added which are mutually dependent and interacting elements. Once these value-added attributes are identified, an appropriate methodological construct is obtained to rank and prioritize the findings. This is to spot those value-added attributes highlighted by different domain perspectives (academia, experts, and decision makers [DM]) with linking functions, those capable of further facilitating the objectives of supply chain integration.

Systematic integration adoption: From the previous research results regarding port involvement in supply chains and the identified value-added attributes that have a linking function, systematic integration adoption is suggested in the form of an integrated logistics platform. This is to answer the following research questions:

RQ3: What are key elements and mechanisms that support systematic integration adoption?

Once the major changing role(s) of the port is pictured, the focus is shifted to integration issues, such as identifying key elements and mechanisms supporting systematic integration and at the same time barriers hindering the adoption. While the key elements include the network structure, business process, and management components necessary for operational integration, mechanisms embrace analyzing information facility structure (integrative information and integrative technology), and define different forms of supply chain interfaces. Additional work follows from this, including determining viable impediments to the supply chain integration, which is considered an effective tool to further facilitate the synergy of intra- and intercompany coordination and linkage optimization.

RQ4: What are barriers that can hinder systematic integration adoption?

Research question four is focused on determining barriers to supply chain integration and on developing a combined view of different partners in port industry concerning viable impediments to an integrated logistics platform. Therefore, a triangulation method consisting of a literature review, a cross functional survey, and in-depth case studies has been carried out to accomplish the purpose. This is done to engender the overall understanding of the possible barriers to port's integration, and more importantly to examine these barriers from different perspectives.

All previously mentioned issues are meant to develop the overall integration efforts; in particular the identification of key elements of an integrated logistics platform: network structure, business process, and management components. Stemming from that, supportive mechanisms that work as drivers for systematic

integration contributed to the overall integration purpose through the identification of the nature of interfaces as well as by analyzing information facility structure. At last, barriers that can hinder systematic integration are considered.

Each of the four research questions is addressed in the appended papers (PI – PVI). Figure 6 shows the main research areas, associated research questions, and the links between them.

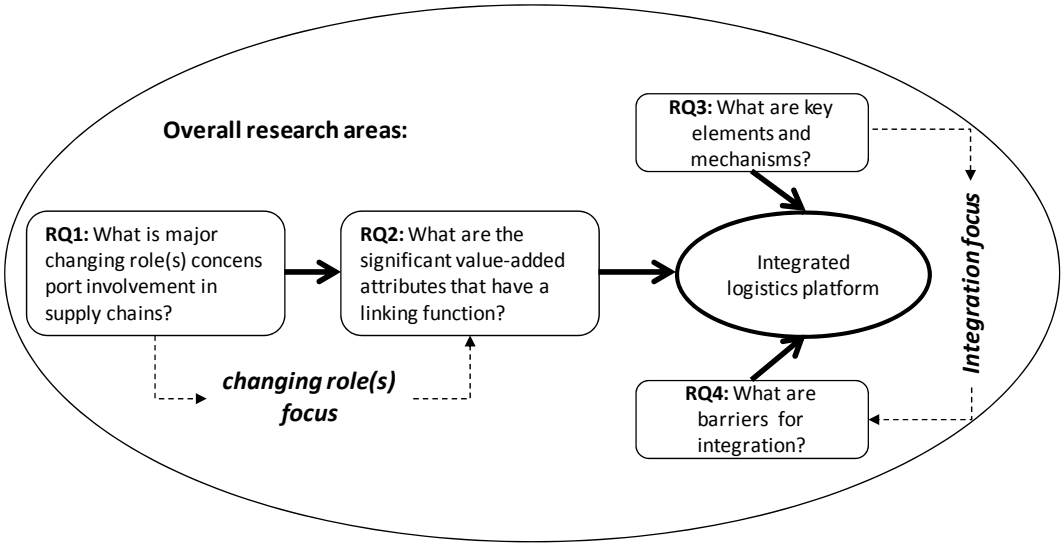


Figure 6 Main research areas, associated research questions, and links between them

1.3 Scope and delimitations

The scope of this thesis is the modern seaports in recent paradigm development. In response to the current paradigm shift toward an efficient logistics-restructured environment, the purpose of this thesis is to explore the port industry in order to develop an integrated logistics platform concept through the identification of key elements and mechanisms for systematic integration as well as barriers that hinder the adoption of the concept. By this, the sea/land interfaces need to be integrated with the inland-logistics equation. To do so, functional member-firms within the port industry have to be included—both primary and secondary member-firms. In particular, primary member-firms—shipping lines, container terminal and transport operators—are in focus. Apart from that, other supporting member-firms, such as port authorities and governmental bodies are also included as the situation permits. The scope as such is quite broad and gives the opportunity for the research to highlight different perspectives. Nevertheless, to keep the research consistent with researchers in the same field, this research attempted to address the port from logistics/SCM perspectives: network structure, business process, and management components as an interrelated nature and main elements of the SCM domain (Lambert and Cooper, 2000).

Unlike manufacturing industries, ports are bi-directional logistics systems that provide services in different forms: procurement and pre-assembly activities in a sort of value-addition to the crossing shipments. Although the port industry is seen as an integral part of the production systems, no specific industry or production system was the focus of this research. In addition, economic, financial and legal perspectives of an integrated logistics platform application such as cost analysis, legal implications or different forms of contract relationships are excluded. This is due to its viable variation from region to region, country to country, and from case to case. Furthermore, only a standardized unit of load (i.e., containers) is studied and analyzed in this research.

With regard to data collection, such detailed information regarding either different phases of the integration process or the development of the ports' operations and information systems are considered to be sensitive issues and are dealt with cautiously. This is due to competition between respective ports world-wide, and the potential of the imitation effect. However, none of the above issues have influenced the overall purpose of the study.

1.4 Outline of the thesis

The thesis consists of a covering paper and six appended papers.

1.4.1 The covering paper

The main purpose of the covering paper is to summarize what has been written in the appended papers, and to give an overview as well as an interrelation of the subject. It is structured as follows:

Chapter 1 (Introduction) reviews the current state of knowledge and research in the field is given. It represents the background of the research and the problem area, purpose and research questions, and scope and delimitations of the research.

Chapter 2 (Frame of reference) gives deeper discussions and understanding on different theories and concepts that are relevant to the topic. It provides an explanation of the problem being studied whereas the frame of reference that is used during the whole research process is adequately explained.

Chapter 3 (Research methodology) presents the research process with chosen scientific approaches and methods. It gives methodological descriptions as well as research quality evaluations.

Chapter 4 (Summary of the appended papers) presents the appended papers and gives an overview of the relationship between the papers. The chapter sets out to answer the research questions put forward in each research paper. Hence, for each paper, the purpose and the most important findings are briefly discussed.

Chapter 5 (Analysis) analyzes findings from the papers with regard to the research questions. Furthermore, the chapter gives an overview of the main findings,

describing the relation and connection between the papers and the research questions.

Chapter 6 (Contribution and further research) presents the contribution of the thesis to the field of study and some ideas for further research avenues as well.

1.4.2 The appended papers

An illustration of the appended papers with references to the authors and co-authors is given. In addition, a brief discussion from the point of the reception they received (by the journals, conferences, and published institutions) is explained.

Five of the appended papers are co-authored: Paper I, II by my main supervisor Kenth Lumsden; Paper III, V by my second supervisor Gunnar Stefansson; Paper IV by my second supervisor Gunnar Stefansson, and Johan Woxenius and Jonas Flodén; I am the primary author of these papers. I am the single author of paper VI.

Paper I "Port logistics platform integration in supply chain management" is published in *Int. J. Shipping and Transport Logistics*, Vol. 1, No. 2, pp. 194-210. Published in *The 3rd Int. Conference on Port and Waterways proceedings, Dubrovnik, Croatia, 18-19. September, 2008.*

Paper II "Significant value-added attributes in port supply chain systems" is published in *The 14th Int. Symposium on Logistics (14thISL) proceedings, Istanbul, Turkey, 5-7. July, 2009.*

Paper III "Integrated logistics platform – An empirical analysis from the port industry" is published in The *22nd NOFOMA Conference proceedings, Kolding, Denmark, 10-11. June, 2010.*

Paper IV "Information flows supporting hinterland transportation by rail: Applications in Sweden" is published in *Int. J. Research in Transportation Economic,* Vol. 33 No. 1, pp. 15-24.
Presented in *The Dry-port conference, Edinburgh, UK, 21-22. October, 2010.*

Paper V "Managing supply chain interfaces – A framework towards an integrated logistics platform" is published in *The 23rd NOFOMA Conference proceedings, Harstad, Norway, 9-10. June, 2011.*

Paper VI "Barriers to supply chain integration – A combined view of different partners in port industry" is published in *The 16th Int. Symposium on Logistics (16thISL) proceedings, Berlin, Germany, 11-13. July, 2011.*

2 FRAME OF REFERENCE

The frame of reference gives deeper discussions and understanding on different theories and concepts that are relevant to the research topic. It provides an explanation of the problem being studied whereas the frame of reference that is used during the whole research process is adequately explained.

The theoretical framework in this thesis is based on two interrelated theoretical areas, which are (see Figure 7):

(1) System theory; and
(2) Supply chain theory

The reasons for choosing this framework are related to: (1) the paradigm shift suggested by previous research endeavors, which seek to ground the port with themes of *logistics, SCM and value-adding chains*; and (2) types of research and research questions as indicated in the introductory chapter.

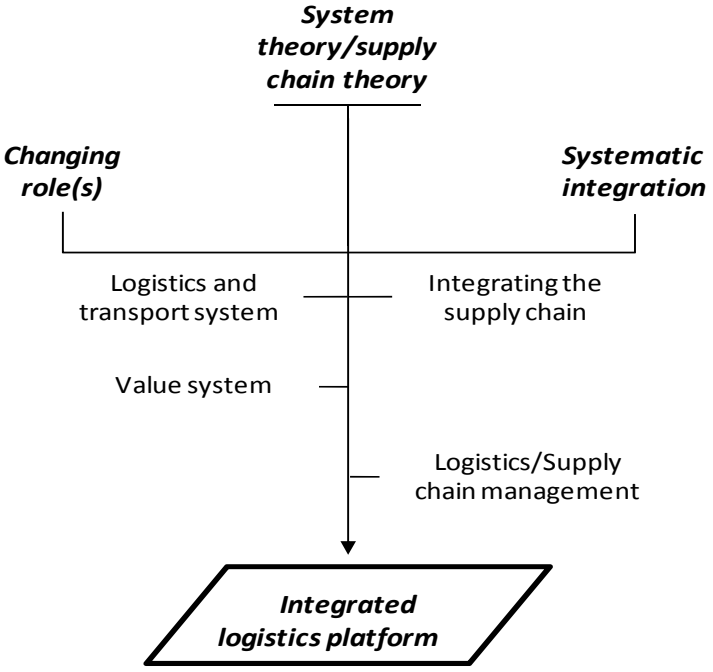


Figure 7 The theoretical framework's presentation in this research-work

As an aspect of system theory, system dynamic in the form of (1) logistics and transport system and (2) value system are employed to understand the changing dynamics of the port industry (i.e., changing role/s). A system notion is considered because it looks to the whole as property of interconnected systems, and more importantly, it further explains the integration process, which aptly fits with supply chain theory chosen to explore the systematic integration adoption. This includes theories from supply chain integration, logistics and supply chain management as shown in Figure 7.

2.1 Logistics and transportation system

A logistics system is a network of related activities with the purpose of managing the orderly flow of material and personnel within the logistics channel (Stock and Lambert, 2001). Moreover, it is the functional silos within companies and also deals with the management of flows across supply chains (Lambert and Cooper, 2000). In general, logistics systems have been described in terms of operational characteristics, structural context and managerial context (Persson, 1995). Furthermore, Woxenius and Sjöstedt (2003) have worked out a combined model of transportation and logistics sub-systems both for freight and passenger movement. In the freight model, four different entities or components are identified: goods, vehicles, facilities and infrastructure. This model is shown in Figure 8.

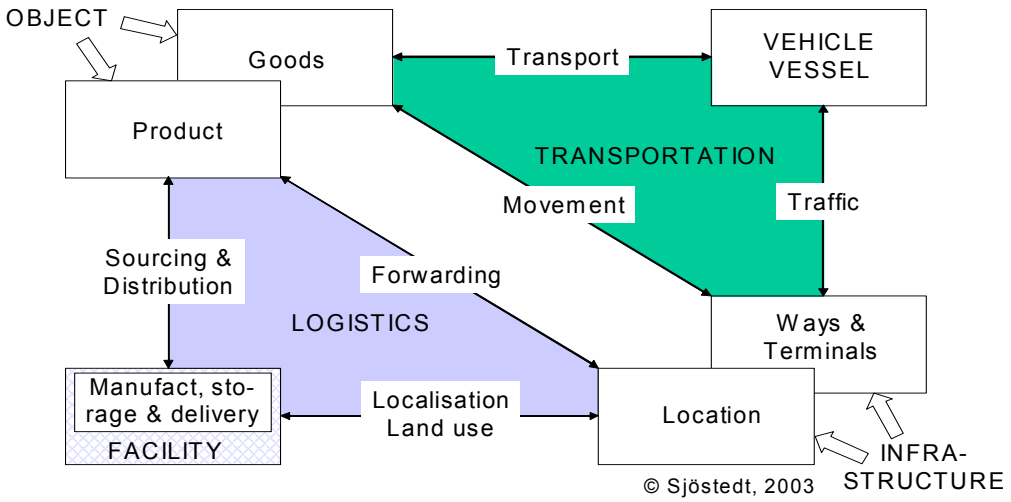


Figure 8 Transportation and logistics as complementary sub-systems (Woxenius and Sjöstedt, 2003)

The four entities are associated by relationships: sourcing and distribution, land use, transportation and finally traffic. Logistics activities take place in facilities located in relation to infrastructure – warehouses, terminals and production facilities. These facilities are supplied with products by means of transportation. The transportation is carried out by vehicles/vessels, which results in traffic. Transportation is the activity within logistics that achieves the movement of

products along a supply chain between point-of-origin and point-of-consumption. It creates time and place utility since a product produced at one point has very little value to the prospective customer unless it is available at the point where and at the time when it will be consumed (Stock and Lambert, 2001).

These sub-systems are seen as complementary and necessary to reshape the landside logistics patterns, which are complex multimodal transports of networks linking the main gateway position with the correspondent network of nodes. In Figure 9 gateway positions are linked by intramodel and intermodal transport networks based on the traffic modes; intermodal gateways link refers to different traffic modes, while intramodel gateways link networks use the same traffic modes.

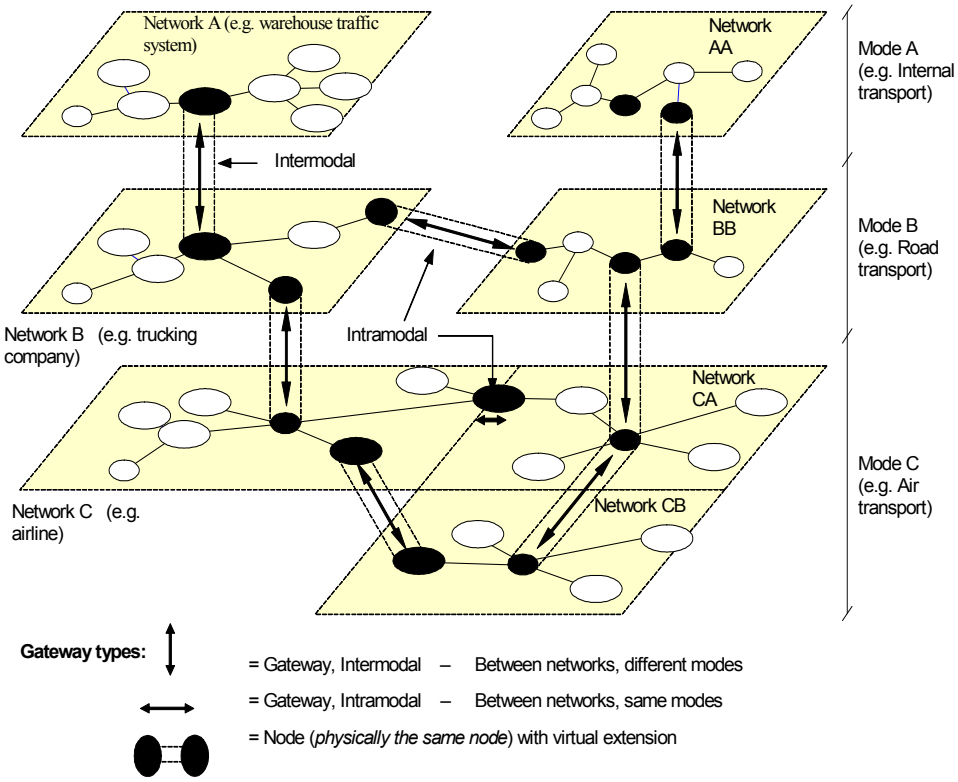


Figure 9 Gateways position with intermodal and intramodal transport network-links (Lumsden, 2006)

Traditional examples of intermodal gateways are seaports, airports and intermodal road-rail terminals. Intramodal gateways include, among others, consolidation terminals where trucks operating long-distances and pick-up and delivery routes are coordinated respectively, and seaports offer transshipment between trans-ocean container vessels and feeder vessels or barges (Lumsden, 2006).

2.2 Value and value-added concept

While organizations in most industry sectors, including transport and distribution, are embracing the value concept, there is still little agreement about what "value"

means and even less about how to create it (Brewer, 2001). The study of the value concept still prevails and has been sustained over time. Classical economists such as Adam Smith distinguish between *value in use* and *exchange value*; that is, that amount of some commodity or medium of exchange that is considered to be an equivalent for something else; a fair or adequate equivalent or return (Oxford Dictionary, 2009). In other words, value is something that satisfies the demand of an agent (Brewer, 2001), whereas value, that is *market value*, is created from an aggregate of the costs of the principal agents of production, namely land, labor and capital into a given product or service. *Value in use* refers to the worth that a product or quantity of goods has for the well-being of a certain business (von Bohm-Bawerk, 1959; Brewer, 2001). It is worth noting that the subjective estimations of value refer to individuals deciding which products and services will benefit them and in what measure; this is referred to as marginal utility value—that is the added benefit derived from each additional unit of product or service (Brewer, 2001). Here, value creation comes as an essential ingredient of competitive advantage, and thereby rests on the understanding and interpretation of both customer perceptions and demands, as well as the capacity to build products and services with attributes that are deemed to be in the customer's interest (Porter, 1980; Johansson et al., 1993). Creating value can only be attained if the stakeholders can exchange resources, share knowledge and skills, and build supply chain capabilities for the pursuit of goal achievement (Brewer, 2001). According to Porter (1980; 1985), value is further created externally to the organization through a vertical supply chain linking suppliers of resources to customers (buyers) and through customers to customers (end user).

With reference to *value-added*, scholars had utilized the concept of value in an *adding-value* sense. For instance, Bowersox *et al*. (2007) define the value-added service as a unique or specific activity that firms can jointly develop to enhance their efficiency and effectiveness, and in turn, to foster customer success. In the context of business management, the notion of value-added or value-relevance is expressed in how to grow a larger share of the profitable revenue by a willingness to perform a broader range of value-added services while enhancing managerial profitability (Bowersox *et al.*, 2000). In the maritime field, there is a wide expression of value-adding activities along with supply chain systems. For instance, Robinson (2002) suggests that ports form part of a value-driven chain system and as such they can add value to the goods passing through them. It is the ability of the port to add value to the provided services in the context of facilitating the further objectives of the supply chain systems (Panayides and Song, 2008). Therefore, value-added activity is an activity along the chain that adds value to the product or service and that the final customer is willing to pay for (Carbone and De Martino, 2003). Scholars identified two types of value-adding that are of utmost importance, namely, physical value-added, which refers to the world of resources that can be seen and touched, and virtual value-added, which is made of information capability, i.e., electronic commerce. These types of value-added components are mutually dependent and interacting elements (Rayport and Sviokla, 1996). As briefly discussed, *value-added* takes different types and forms; it might include the ability to launch new tailor-made services for the port users (Paixão and Marlow, 2003; Bichou and Gray, 2004), to cater to

specific needs of market segments (Marlow and Paixão, 2003), and to be adaptable to the customer needs, playing the role of distributor, developing continuous replenishment and providing cross-docking activities (Paixão and Marlow, 2003). Carbone and De Martino (2003) indicate that value-added services such as procurement and pre-assembly are becoming of considerable significance and may well shape the future development of ports. Since researchers admitted that the values of an organization are an important ingredient of its strategic position, the link between value and competitiveness has strengthened and takes two theoretical pathways. The first pathway is the industry organization perspectives (Porter, 1980), and the second is the resource-based view of the enterprise (Wernerfelt, 1984; Barney, 1991).

2.3 Supply chain versus value chain

A supply chain is defined by Mentzer *et al.* (2001, p. 4) as follows:

> "*A set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer."*

Value-chain refers to a connected series of links of core and secondary activities; comprising inbound logistics, operations, outbound logistics, marketing and sales, and services that lead to the business outcomes of each enterprise (Porter, 1980). The assumption underlying the value-chain concept is that each activity either adds or removes value from the products or services at hand. This approach gives rise to two important notions. First, the earlier notion of *value-added*; that is the amount by which the value of an article is increased at each stage of its production by the agent or agents producing it, exclusive of the cost of materials and bought-in parts and service. Second is a more recent notion of *value analysis*, the systematic and critical assessment of how to improve the relationship to the customer by focusing on total costs in relation to end-user value (Brewer, 2001). A principle component of this approach today is supply chain mapping, whereby the focus is on measuring time and cost throughout the logistics pipeline (Christopher, 1998). The essence of value-chain is that it is a coordinated network of assets, capabilities and processes that have been identified as the most relevant to a specific market opportunity (Walters, 2007). Unlike a supply chain, which is by definition internally and externally focused, Porter's original value-chain model focused primarily on internal participants (Trent, 2004). Furthermore, to differentiate between the two concepts, Cox (1999) has a long-standing debate arguing to understand the physical resources, the exchange relationship, and the ownership and control required within a supply chain to create and deliver values. Figure 10 illustrates supply and value-chain mapping in the light of power structure and value appropriation.

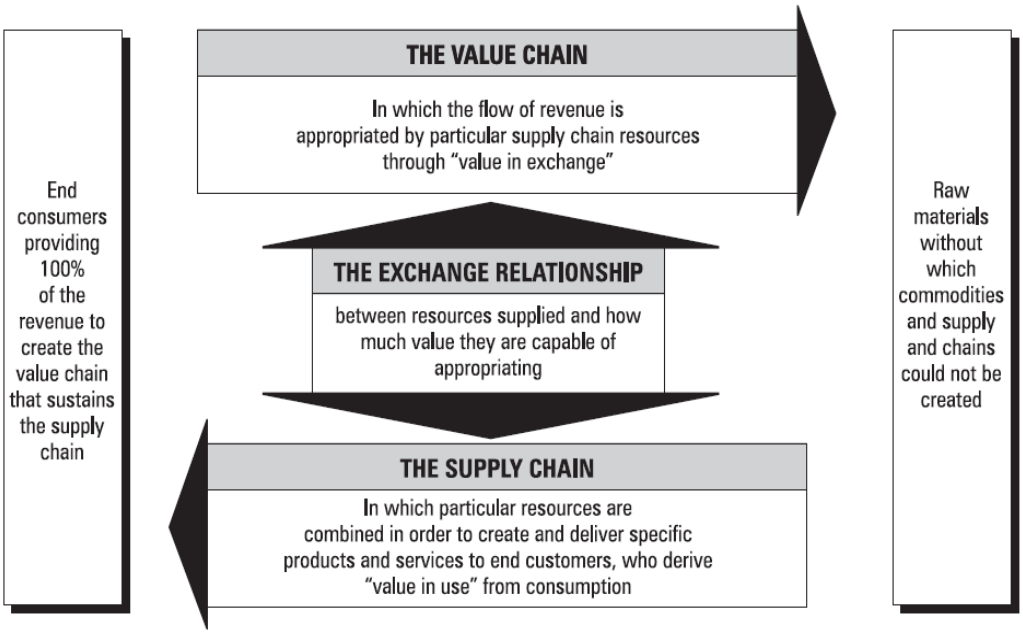


Figure 10 Supply and value-chain mapping (adapted from Cox, Business Success, Earlsgate Press, 1997, p. 207, and cited in Cox, 1999)

2.4 Integrating the supply chain

Stevens (1989) identified four stages of supply chain integration and discussed the planning and operating implications of each stage as follows:

(1) Stage I, "the base line." The supply chain is a function of fragmented operations within the individual company and is characterized by staged inventories, independent and incompatible control systems and procedures, and functional segregation;
(2) Stage II begins to focus on internal integration, characterized by an emphasis on cost reduction rather than performance improvement, buffer inventory, initial evaluations of internal trade-offs, and reactive customer service;
(3) Stage III reaches toward internal corporate integration and is characterized by full visibility of purchasing through distribution, medium-term planning, tactical rather than strategic focus, emphasis on efficiency, extended use of electronics support for linkages, and a continued reactive approach to customers; and
(4) Stage IV achieves supply chain integration by extending the scope of integration outside the company to embrace suppliers and customers.

With these stages, Stevens (1989) argued that the potential of integrating the supply chain can't be ignored. This potential will, however, only be realized by recognizing the connections and inter-relationships between the component parts of the supply chain and ensuring a good fit between its design and operation and the company's competitive strategy (Stevens, 1989).

2.5 Logistics/supply chain management

A strategic perspective

In order to view the strategic perspective of the SCM, Bechtel and Jayaram (1997) pictured the development and advancement of supply chain thought over time. Five distinct "*schools of thought*" have been identified and analyzed. Table 1 illustrates these schools of thought as a strategic standpoint for SCM.

Table 1 SCM school of thought

Chain awareness school	Recognition of existence of a chain of functional areas which should be managed. Emphasis on including all chain members from beginning to end. Focus on material flow
Linkage/logistics school	Begins to investigate how linkages between the functional areas can be exploited for competitive advantage, especially in the area of logistics and transportation. Emphasis on linkages between functional areas where logistics and transportation are the focus
Information school	Emphasis on flow of information as the "backbone of effective SCM." All chain members need feedback on how their customers and end users perceive their performance. Information flow can be bidirectional
Integration/process school	Emphasis on integrating supply chain areas into a system defined as a set of processes. In contrast to linkage school, links of the chain are not considered as being in any particular order or causality. Decision makers are free to explore alternative configurations of the supply chain
The future	Two themes: (1) SCM concept closely tied to concept of partnership and strategic alliances (2) Development toward end-user driven supply chain as "seamless demand pipelines"

Source: Adapted from Bechtel and Jayaram, 1997, and cited in Mills et al. (2004)

It covers the development of SCM thought from the early 1980s when researchers first coined the term 'supply chain' (e.g., Jones and Riley, 1985 - chain awareness school) to the latest work in the 1990s when researchers focused on integrating supply chain areas into a system defined as a set of processes (e.g., Hewitt, 1994). Likewise, and based on the literature review, Mentzer *et al*. (2001) proposed that SCM as a management philosophy has the following common characteristics: 1) a systems approach to viewing the supply chain as a whole, and to managing the total flow of goods inventory from the supplier to the ultimate customers; 2) a strategic orientation toward cooperative efforts to synchronize and converge intra-

firm and inter-firm operational and strategic capabilities into a unified whole; and 3) a customer focus to create unique and individualized sources of customer value, leading to customer satisfaction. It is worth noting that there are different starting points and ways of perceiving SCM notions and even less about its theoretical domain as well as discipline's origins. In response to such different views "Turf wars" and turf setting discussions, as Mentzer *et al.* (2008) phrase it, on the origins and definition of SCM are thus not without merit, and have become an intricate part of research endeavors in the area. As thus, Mentzer *et al*. (2008, p. 31) noted that:

> *"In academia, the determination of a definition and bounds for "SCM" has very real implications for faculty. Awarding faculty lines, merit raises, budgets, curriculum design, and tenure and promotion..., if SCM is "owned" by operations research/management scientists, research will evolve mathematical modeling and teaching will focus on decision analysis tools [...], if SCM is "owned" by logistics it resembles integrated logistics, and so on."*

SCM encompasses a multidisciplinary perspective relating to a large body of knowledge and rests on multiple outlets that appeal not only to integrate the separate functional areas, but also to manage the relational exchanges and inter-organizational aspects.

Key Definitions

Logistics management was defined by the Council of Supply Chain Management Professionals (CSCMP) in 2010 as follows:

> *"Logistics management is that part of the supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services, and related information between the point-of-origin to the point-of-consumption in order to meet customers' requirements (www.cscmp.org)."*

This definition explicitly declares that logistics management is only a part of SCM. More importantly, it represents the functional silos within companies and also deals with the management of flows across supply chains (Lambert and Cooper, 2000). On the other hand, SCM goes beyond the company boundaries; it is viewed as logistics outside the firms to include customers and suppliers. This was clearly indicated by the Global Supply Chain Forum (GSCF), a group of non-competing firms taking the initiative to improve the theory and practice of SCM.

The definition of SCM was developed and used by GSCF as follows:

> *"Supply Chain Management is the integration of key business processes from end user through original suppliers that provides product, services, and information that add value for customer and other stakeholders (Lambert and Cooper, 2000)."*

As business management has entered the era of internetwork competition, SCM represents one of the most significant paradigm shifts in modern business management practice (Lambert and Cooper, 2000). The common characteristics of logistics and SCM are the call for integration approach, cooperative efforts and corporate customer value. To determine these types of commonality, a logistics/SCM framework has to be defined from different perspectives. As such, many researchers attempt to identify and conceptualize these important constituents/elements of both logistics/SCM.

Frameworks

With reference to a logistics/SCM framework, Persson (1995) has introduced a modified framework based on his earlier work, which described the logistics components in terms of operational characteristics, structural context and managerial context. The framework focused on the process of transforming inputs to the product/service at the producer, which are delivered to the customer/user. Persson refers to this as response cycles, which would be a combination of several processes.

Lambert and Cooper (2000) propose a closely interrelated nature of SCM's elements that are assumed essential to design and successfully manage a supply chain. The findings from Lambert and Cooper's (2000) work suggest that these elements include: supply chain network structure, supply chain business processes, and supply chain management components.

"A model of supply chain management" has been presented by Mentzer *et al*. (2001). The model has four important features: *inter-corporate coordination, inter-functional coordination, the supply chain flows, and member of the supply chain.* Altogether they have the goal to reach customer satisfaction, value, profitability, and competitive advantage. The model includes explicit flows in the supply chain, supply chain structure and two different types of coordination (*inter-functional and inter-corporate*).

Bowersox et al. (2002) have developed a SCM framework describing the different flows between what they call the resources based and the end customer. These separate flows in the supply chain can be divided into: *product/service value flow, market accommodation flow, information flow, and cash flow.* The framework also includes suggestions for different components that comprehend SCM, and these components are *behavioral context, relationship, planning and control context, measurement, technology and planning, operational context, material and service supplier integration, internal operation, and customer integration.* The framework combines supply chain components as well as different flows effect. Furthermore, recently Stock and Boyer (2009) advocated that activities, benefits and constituents/components are three broad themes to draw the scope and boundaries of SCM's framework.

After reviewing the previously discussed frameworks, Lambert and Cooper's (2000) framework appeared to be more comprehensive than the others, simply because it explicitly included three interrelated natures of SCM's elements that are

assumed essential to design and successfully manage a supply chain. And it gives more coverage compared to the other proposed model and frameworks. The framework depicts SCM as a system of interconnected elements: supply chain network structure, supply chain business processes, and supply chain management components (see Figure 11).

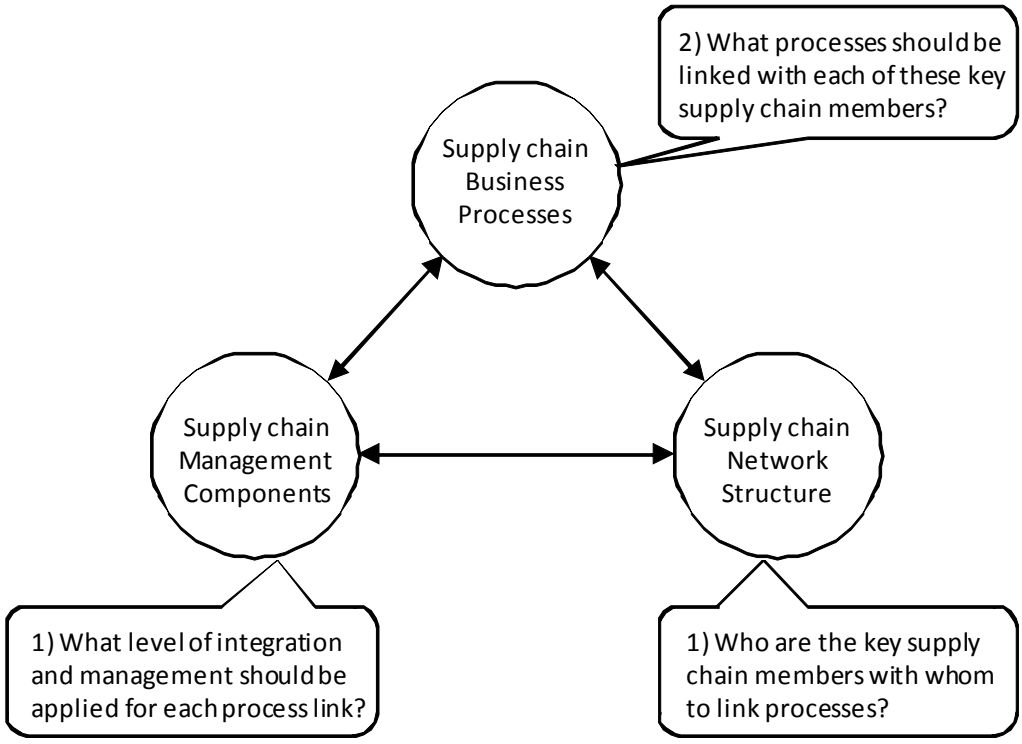


Figure 11 Supply chain management framework: elements and key decisions (Lambert and Cooper, 2000)

(1) Network structure concerns the arrangement of the members of the supply chain and their relations. The closeness of the relationship at different points in the supply chain will differ according to the level of partnership appropriate for particular supply chain links (Lambert *et al.*, 1996). As thus, network structure dimensions include the length of the supply chain and the number of suppliers and customers at each level, where the supply chain looks less like a pipeline or chain than an uprooted tree of an extensive network of customers and suppliers (Lambert *et al.*, 1998). In order to configure the supply chain network structure, Lambert and Cooper (2000) suggest three primary aspects of a company's network structure: the members of the supply chain, the structural dimensions of the network and the different types of process links across the supply chain. However, to make a very complex network more manageable, it seems appropriate to distinguish between primary and supporting members. Primary members are "all those autonomous companies and strategic business units who carry out value-adding activities (operational and/or managerial) in the business processes designed to produce a specific output for a particular customer or market." In contrast, supporting members are "companies that simply provide resources, knowledge utilities, or assets for the primary

members of the logistics chain" (Porter, 1984; Davenport, 1993; Lambert and Cooper, 2000). According to Lambert and Cooper (2000), network structure is supposed to answer the question: Who are the key supply chain members with whom to link processes?

(2) *Business processes* concern activities and flows in the supply chains. Lambert and Cooper (2000) stress that successful SCM requires a change from managing individual functions to integrating activities into key supply chain processes. Davenport (1993) defines a process as "a structured and measured set of activities designed to produce a specific output for a particular customer or market." He argues that process is a specific ordering of operational activities across time and space, with a beginning and end, and clearly identifies inputs and outputs as a structure for action. Håkansson and Snehota (1995) stress that "the structure of activities within and between companies is a critical cornerstone of creating unique and superior supply chain performance." Supply chain business processes can cross intra- and inter-organizational boundaries independent of formal structure (Cooper *et al.*, 1997). This concurs with the view on processes presented by Lambert *et al*. (1998). To clarify the main objective of this component, Lambert and Cooper (2000) posed the question: What processes should be linked with each of these key supply chain members?

(3) *Management components* are the third element of the SCM framework (see Figure 11). It is concerned with the composition of all operations, systems, business functions and organizations involved in the management of a particular supply chain (Stock and Boyer, 2009). The management components of SCM are common, critical and fundamental across all business processes, members, and relationships (Stock and Lambert, 2001). Lambert and Cooper (2000) divided management components into two separate groups: the physical and technical group, which includes the most visible, tangible, measurable, and easy-to-change elements. The second is the managerial and behavioral group, which is less tangible and visible and is often difficult to assess and alter. The groundwork for successful SCM is established by understanding each of these SCM elements and their interdependence. Hewitt (1994) states that true intra- and intercompany business process management, or redesign, is only likely to be successful if it is recognized as a multi-component change process, simultaneously and explicitly addressing all SCM elements. As the level of integration is determined by the number of management components required, Lambert and Cooper (2000) posed the question: What level of integration and management should be applied for each process link?

However, addressing the SCM main elements has to be associated with relevant value-chain mechanisms as inherent elements of the firm's competitive advantage. Porter (1985) identified several ways in which key activities within the firm's value-chain could yield competitive advantage to a firm *vis-á-vis* its competitors. These include: identifying candidate activities, which must be subsequently separated and studied in depth, and the role of linkages between activities within

the value-chain. Linkages reflect tradeoffs among activities to achieve the same overall result. According to Porter (1985), linkages could yield competitive advantage in two ways – optimization and coordination.

2.6 Logistics platform

Platform concept

The term 'platform' has been defined diversely, ranging from being general and abstract (Robertson and Ulrich, 1998) to being industry and product specific (Sanderson and Uzumeri, 1995; Ericsson and Erixon, 1999). In addition, the meaning of platform differs in scope; for instance, some definitions and descriptions focus mainly on the product and artifact itself (Meyer and Utterback, 1993; McGrath, 1995), whereas others try to explore the platform concept in terms of a firm's value-chain (Sawhney, 1998). But researchers agreed on the common attributes of the platform thinking: to increase a firm's flexibility and responsiveness and assist in gaining market share from the competitors (Sawhney, 1998; Abrahamsson *et al.*, 2003), and one way to make the system architecture operational is by interfacing their independent subsystems (Meyer and Lehnerd, 1997; Asan *et al.*, 2004).

Logistics platform definition

An insight from industry by Cambra-Fierro and Ruiz-Benitez (2009) highlighted the importance of the intermodal logistics platform as a source of competitive advantage. Integrating particular activities within a specific supply chain setting was seen a key determinant for the company's success. According to the authors, inter-modal logistics platform is where different agents of the supply chain can be integrated in the same physical place […] assisting logistics flows and acting as strategic interfaces between networks of global and regional dimensions […] with an aim to improve supply chain efficiency. Obviously, the emphasis here is on the inter-modality *per se*, and the study doesn't touch upon what member-firms were in the questions as well as the system boundary and how to accomplish such integration.

Aldin and Stahre (2003) discussed the logistics platform along with electronic commerce and marketing channels. The logistics platform term was used to indicate how logistics may support the development of marketing channels and improve flexibility. Collaboration in multiple marketing channels using electronic power is possible only when vertical and horizontal development take place. According to the authors, logistics platform is a homogenous part of the logistics system in the supply chain […] that is centrally controlled and designed by focal organizations […] in a way that it is a resource-base for new marketing channel positions. Hence, the study focuses on the marketing strategies and how the logistics platform may streamline information flows by an extensive use of business-to-business electronic commerce. No precise definition was given and the authors call for more research in this area involving accurate definitions and hypothetical testing.

The European Association of Freight Villages (EUROPLATFORMS) (2011) provided the following definition of the logistics platform: "a defined area within which all activities relating to transport, logistics and distribution of goods, both for national and international transit, are carried out by various operators […] it is run by a single body, either public or private, and is equipped with all the public facilities to carry out the above mentioned operations." The emphasis here is on the spatial, infrastructure and central control by a single entity, with no indication to the system integration or inter-organizational relationships. Leal and Salas (2009) simplified this definition with respect to: (1) unimodal distribution centers, (2) logistics area, and (3) multimodal platforms. The author's definition highlighted the importance of the coordination between different agents in order to link both logistics and transportation activities as shown in Table 2.

Table 2 Terms used in relation to logistics platform

Source	Term	Definition/description
(Cambra-Fierro and Ruiz-Benitez, 2009)	Intermodal logistics platform	Where different agents of the supply chain can be integrated in the same physical place […] assisting logistics flows and acting as strategic interfaces between networks of global and regional dimensions […] with an aim to improve supply chain efficiency.
(Aldin and Stahre, 2003)	Logistics platform	A homogenous part of the logistics system in the supply chain […] that is centrally controlled and designed by focal organizations […] in a way that it is a resource-base for new marketing channel positions.
EAFV for EUROPLATFORMS	Logistics platform	"A defined area with which all activities relating to transport, logistics and the distribution of goods, both for national and international transit, are carried out by various operators. It is run by a single body, either public or private, and is equipped with all the public facilities to carry out the above mentioned operations"
(Leal and Salas, 2009)	Logistics platform	A specialized area with the infrastructure and services required for co-modal transportation and added value of the products making use of the infrastructure
(Váncza et al. 2010)	Logistics platform	The provision of a complex service for communicating and evaluating all relevant information that may affect the operation of supply channels
(Abrahamsson et al., 2003)	Logistics platform	A homogenous part of the logistics system, which a logistics organization centrally managed and controls, and has the power to design in a way that it is a resource-base for new market positions. This includes concept for: (1) Logistics operations; (2) Physical structure, processes, activities; and (3) Information systems for design, operations and reporting

Apart from these definitions, Váncza *et al*. (2010) obtained another approach based on the network perspectives to define the logistics platform concept. This is to match future demand and supply by relying on asymmetric and partly uncertain information. For approaching the two main conflicting goals – high service level and low overall costs throughout the network – there is a need for a specific coordination media to manage the intentions and interactions of the partners. The authors described the logistics platform that provides a complex service for communicating and evaluating all relevant information that may affect the operations of supply channels. The main idea of the concept is to provide ways to integrate information flows between partners in line with relevant system design architecture. Ultimately, the definition is more focused on the information visibility that is essential to streamline supply chain operations.

Abrahamsson *et al*. (2003) depicted the logistics platform concept in line with the increased business dynamic capability and how to improve strategic flexibility. The increased interaction between marketing and logistics channels and the need for high-dynamic effectiveness were considered to be the logic behind the platform development. Using flexibility and organizational theories and based on multiple case-studies, the authors attempted to describe, define, and exemplify the logistics platform concept as follows:

> "A homogenous part of the logistics system, which a logistics organization *centrally* manages and *controls*, and has the power to design in a way that it is a *resource base* for new market positions. This includes concept for *logistics operations*, *a physical structure*, *processes and its activities* as well as the *information systems needed for design, operations and reporting.*"

In defining the logistics platform concept, Abrahamsson *et al*. (2003) borrowed the term *resource base* from network theory describing logistics as a knowledge resource (Håkansson and Snehota, 1995) and used other terms such as *central control*, *logistics concept, logistics structure*, and *processes and related activities* as well. The insertion of such a wide-array of terms made the definition very broad in the sense that it covers almost everything and consequently touches nearly all areas of business (see Table 2 for more details).

From the previous discussions, the authors strived to bring up a comprehensive definition of the logistics platform concept; however, the definitions differ by nature due to the emerging discipline of the concept. Within the logistics management field, six definitions have been discussed that found adherence to inter-modality, information visibility, interfaces and interactions between logistics and marketing, and more of general to cover all business areas.

All terms related to the logistics platform, mentioned above, together with the definition/description and the sources are summarized in Table 2.

3 METHODOLOGY

Methodology is the theory of methods (Glaser, 1992, p. 7). This chapter of the thesis represents the philosophical and methodological considerations underlying this research construct. This is to discuss different assumptions about research as well as the dimensions of research methodology; strategy, design, process and quality.

3.1 Research paradigms

In scientific research, there are two types of research traditions: qualitative and quantitative. Qualitative research is often taken to mean inductive, theory-generating, subjective, and non-positivist processes. In contrast, quantitative research is often taken to mean deductive, theory-testing, objective, and positivist processes (Lee, 1998). However, and considering the purpose of this thesis, "*to explore the port industry…,*" both qualitative and quantitative research approaches are seen as appropriate.

Bryman and Bell (2007) discussed qualitative and quantitative research methodologies within the framework of research strategy, research designs and a description of how the research process was conducted. On top of that, Bryman and Bell (2007) labeled the underlying assumption about research and the research quality as an important construct of these research methodologies and the overall framework. As thus, and based on Bryman and Bell's (2007) work, a conceptual framework for this chapter was developed as shown in Figure 12.

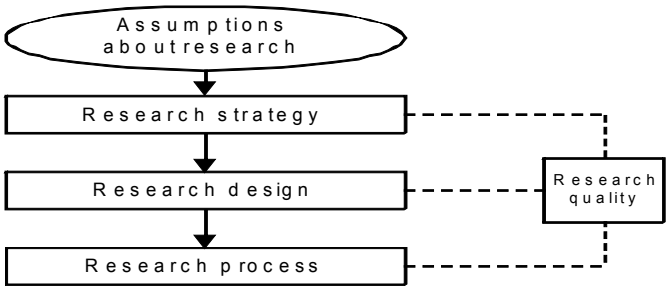


Figure 12 A conceptual framework describing the qualitative and quantitative research methodologies construct (based on Bryman and Bell, 2007)

Before addressing the proposed conceptual framework, it is invaluable to refer to both Silverman (2000) and Frankel *et al*. (2005), who agreed that choosing a research methodology is influenced by several factors, some of which include:

- The researcher's philosophical stance – assumptions about research
- The nature of the phenomena under study
- The format of the research questions
- The extent of control required over behavioral events in the research context

To describe reality from a research perspective, researchers advocate that certain assumptions about reality and how it is constituted have to be made. To motivate this notion, assumptions about research as the first part of the proposed framework will be discussed hereafter.

3.2 Assumptions about research

To discuss different forms of research methods, there is a need to understand the philosophical and methodological considerations underlying the research work. The central focus of the methodological considerations is summarized by Bryman and Bell (2007, p. 4-5), and there are two points assumed of particular relevance, stated as follows:

(1) Methods of management and business research are closely tied to different visions of how organizational reality should be studied (i.e., methods are not simply neutral tools).
(2) There is a question of how research methods and practice connect with wider social scientific enterprise (i.e., research data is invariably collected in relation to an often pressing organizational problem).

According to Bryman and Bell (2007) and many other scholars, qualitative and quantitative research differ with respect to the connection between theory and research, epistemological considerations and ontological considerations. Table 3 illustrates the fundamental differences between qualitative and quantitative research strategies in relation to these aspects. With reference to the connection between theory and research, quantitative research entails a deductive approach to the relationship between theory and research, in which the accent is placed on the testing of theories. On the other hand, qualitative research predominantly emphasizes an inductive approach to the relationship between theory and research, in which the emphasis is placed on the generation of theories (Bryman and Bell, 2007). In relation to ontology considerations and epistemology considerations, Morgan and Smircich (1980) argue that the assumptions about ontology and epistemology directly influence the methodological approach we adopt. These considerations deserve more attention, especially how they are related to the chosen approach. Consequently, it will be in focus in the following sub-sections.

Table 3 The fundamental differences between qualitative and quantitative research strategies.

	Quantitative	Qualitative
Principal orientation to the role of theory in relation to research	Deductive; testing theory	Inductive; generation of theory
Epistemological orientation	Natural science model, in particular positivism	Interpretivism
Ontological orientation	Objectivism	Constructionism

Source: Bryman and Bell (2007)

Ontology

Ontology is the theory about the general properties of our reality and the object of study. The central issue in ontology orientation was indicated by Bryman and Bell's (2007) question of whether entities in society can be regarded as an objective reality in the eyes of the actors/people (objectivism) or if they are constructed by their actions and perceptions (constructivism). As thus, Bryman and Bell (2007) emphasize two ontological positions up for debate as follows:

- Objectivism – is an ontological position that asserts that social phenomena and their meanings have an existence that is independent of social actors. It implies that social phenomena and the categories that we use in everyday discourse have an existence that is independent or separate from actors.
- Constructionism – is an ontological position which asserts that social phenomena and their meanings are continually being accomplished by social actors. It implies that social phenomena and categories are not only produced through social interaction but that they are in a constant state of revision.

By this, many researchers claim that it is based on our assumptions and how we understand reality that would have an implication on the choice of methodology that we would like to implement in approaching a certain scientific problem (Solem, 2003).

Epistemology

Epistemology is the theory about knowledge and it deals with how we perceive the world and the relationship between the researcher and the known (Bryman and Bell, 2007). It concerns the question of what is (or should be) regarded as acceptable knowledge in a discipline. The central issue in this context is the question of whether or not the social world can and should be studied according to the same principles, procedures, and ethos as the natural sciences. Two positions

that affirm the importance of epistemology were debated by Bryman and Bell (2007) as follows:

- Positivism – is an epistemological position that advocates the application of the methods of the natural sciences to the study of social reality and beyond.
- Interpretivism – is taken to denote an alternative to the positivist orthodoxy that has held sway for decades. It is predicated upon the view that a strategy is required that respects the differences between people and the objects of the natural sciences and therefore requires the social scientist to grasp the subjective meaning of social action.

In short, those who tend to lean toward positivism believe that natural science and social science can be researched with the same methodology, and they claim that knowledge is not knowledge if it cannot be observed and tested through empirical data collection. In contrast, anti-positivism takes the notion that knowledge can be softer and can have more subjective forms (Morgan and Smircich, 1980).

Middle ground approach

In between these two extremes, as a middle ground approach, a systems approach has gained more and more attention. Gammelgaard (2004) draws on Arbnor and Bjerke (1997) to distinguish between three types of approaches: the *analytical approach*, the *systems approach* and the *actors' approach* (see Table 4).

Table 4 The scientific approaches based on Arbnor and Bjerke – (cited in Gammelgaard, 2004, p. 482)

	Analytical approach	Systems approach	Actors' approach
Theory type	Determining cause-effect relations. Explanations, prediction. Universal, time and value free laws	Models. Recommendations, normative aspects. Knowledge about concrete systems	Interpretation, understanding. Contextual knowledge
Preferred method	Quantitative (qualitative research only for validation)	Case studies (qualitative and quantitative)	Qualitative
Unit of analysis	Concepts and their relations	Systems: links, feedback mechanisms and boundaries	People – and their interaction
Data analysis	Description, hypothesis testing	Mapping, modeling	Interpretation
Position of the researcher	Outside	Preferably outside	Inside – as part of the process

The analytical approach can be compared to positivism and the research consists mainly of quantitative studies, which are analyzed in a positivistic way. The actors' approach can be compared to anti-positivism. Finally, the systems approach, which is suggested by Gammelgaard (2004), is to be used in logistics research to a greater extent to gain new knowledge. Based on these different views of reality, Gammelgaard (2004) categorized the three approaches and their relation to theory, method and the position of researchers as shown in Table 4. Note that in moving from the left to the right part of Table 4, the research becomes less abstract and more qualitative.

The systems approach focuses on the analysis and design of the total system with regard to all facets and variables (Churchman, 1981; Brill, 1998). This approach is often termed "holistic" as opposed to the "automistic," fragmentable approach of positivism (Gammelgaard, 2004). Adding to that, the systems approach is pragmatic in nature, and the search for an absolute truth is replaced by the search for a problem solution that works in practice, whereas the researcher's task is to create an understanding of a given part of the world, and to identify the system parts, links, goals and feedback mechanisms (Lilienfeld, 1978). According to Gammelgaard (2004) and Arbnor and Bjerke (1997), the theory of the systems approach is contextual rather than universal, i.e., to derive knowledge, it is necessary to analyze and compare cases instead of seeking universal cause-effect-relations. As thus, Churchman (1979) asserts that the ideal method in the systems approach is case study, which is applicable to both qualitative and quantitative methods (Gammelgaard, 2004). This research is based on a systems approach with some overlap with the analytical research approach (to be explained further in sections 3.3 and 3.4). Based on this approach, different research strategies were applied in this research and are explained below.

3.3 Research strategy

Research strategy is a way to describe how to get from the point of departure to the desired state by following a set of pre-specified procedures (adapted from Yin, 2003). The research strategies include but are not limited to: case study, survey, experiments and the analysis of archival information. To determine when to use each research strategy, Yin (2003) has set up three conditions: (1) the type of research question posed, (2) the extent of control an investigator has over actual behavioral events, and (3) the degree of focus on contemporary as opposed to historical events.

In this research, questions start with "What" to form the main research questions, which doesn't exclude any of the research strategies according to Yin (2003). Based on Yin (2003), "What" questions may either be *exploratory* (i.e., an exploratory case study) or about *prevalence* (in which surveys or the analysis of archival records would be favored). The second condition deals with control over the study environment. To "*explore the port industry…*," there is no imminent need to influence or to make changes in the system. What research aims for is to study changes made in the supply chain and further to develop systematic integration. Thus all research strategies are subject to be utilized except

experiments and modeling, which require control over the events. The third condition discusses the focus of the research and since this research is concerned with understanding current port involvements in the supply chains, contemporary events have to be realized. In conclusion, the focus of this study excludes experiments and history and consequently gives the choice between the remaining three different strategies: archival analysis, survey and case study.

A case study research strategy focuses on understanding the dynamic present in a single setting, building theories (Eisenhardt, 1989), and it gives details description of an organization, incident or phenomena (Bryman and Bell, 2007). This fulfills Ellram's statement (1996) that "*case studies are excellent for theory building, for providing details explanations of 'best practice' and providing more understanding of data gathered.*" In addition, Yin (2003) adds that: a case study is appropriate when boundaries between phenomenon and context are not evident. There are certainly uncertain boundaries between phenomenon and context in SCM, especially where scholars have tried to define these boundaries time after time (see Mentzer *et al*., 2001), but it is still a constantly evolving discipline. Consequently, case study was the dominant and most suitable strategy to gain knowledge and to answer the research questions put forward in this thesis. Nevertheless, this doesn't exclude the utilization of: Delphi technique, Analytical Hierarchy Process (AHP), Ground Theory Approach (GTA), and survey as complementary to the case study strategy (Yin, 2003). Here, it is important to recognize that case studies can incorporate one or multiple cases, qualitative and quantitative research and that it has a distinctive place in evaluation research (Guba and Lincoln, 1981; Yin, 1994).

Table 5 The classification of the four phases of research process within research ambition level

	Exploration	Theory building	Theory testing	Theory extension/refinement
Phase I	×			
Phase II	×		×	
Phase III		×		×
Phase IV		×		×

Voss *et al*. (2002) divided the research ambition level into: *exploration, theory building, theory testing, and theory extension/refinement.* Exploration refers to the uncovering of areas for research and theory development. Theory building refers to the identification/description of key variables, identification of linkages between variables, and identification of why these relationships exist. Theory

testing refers to the testing of theories developed in the previous ambition levels and to the predicting of future outcomes. Finally, theory extension/refinement refers to a better structure of the theories in light of the observed results. According to Yin (2003), these types of research ambitions are not locked into a particular category of research structure, but can all be used to strengthen each other and in different combinations. Within these research ambition levels, and based on the main research areas, four phases of the research processes are constructed in chronological order: *theoretical-based analysis, model design, key elements and mechanisms identification, and integration barriers consideration*. Table 5 shows a classification of the four phases of research processes within the Voss *et al*. (2002) research ambition level.

Two research processes dominate the academic arena: the deductive and the inductive research process. Deductive research follows a conscious direction from a general law to a specific case, while inductive research reasons through moving from a specific case to general law (Kirkeby, 1990). But, a priori specification of constructs can also help to shape the initial design of theory-building research (Eisenhardt, 1989). Another research approach is aptly titled "abductive" by Kovács and Spens (2005). An abductive approach is different from a mixture of deductive and inductive approaches (Dubois and Gadde, 2002); it is a process where the theoretical framework, empirical field-work, and case analysis evolve simultaneously, and it is particularly useful for the development of new theories. In studies relying on abduction, the original framework is successively modified, partially as a result of empirical findings, but also as a result of theoretical insights gained in the course of the study (Dubois and Gadde, 2002; Kovács and Spens, 2005). According to Kirkeby (1990), different streams of abductive research coexist in modern science, i.e., there are differences in the approach due to its use in different disciplines. The overall research carried out in this study might be characterized as having an "abduction" approach (see Figure 13), although it started with a broad literature review of existing research related to the subject of interest. Hence, the research process was developed gradually with inputs from empirical findings and new theoretical insights in order to understand the changing role(s) of the port industry; develop an integrated logistics platform concept by finding ways to integrate different parts of the system. Figure 13 depicts the overall approach carried out in this study.

The abductive research process in this thesis

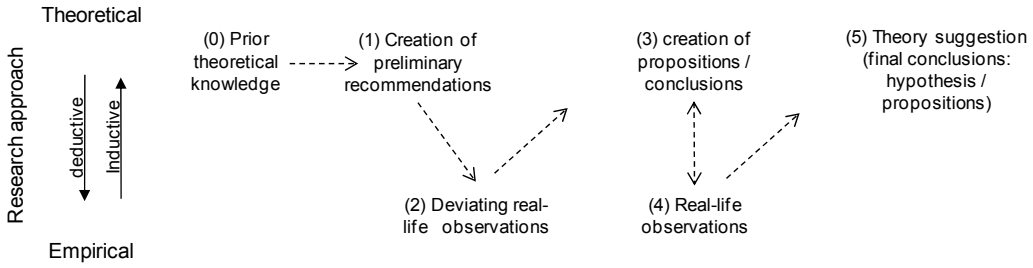


Figure 13 The abductive research process applied in this thesis (adapted from Kovacs and Spens, 2005)

In this thesis, the research process is structured in line with the main research areas described in the introduction chapter (section 1.2). As thus, the logical departure to address the first research area (*changing role/s*) is based on a broad literature review of existing research related to the subject of interest (Figure 13, step 0). According to Webster and Watson (2002), *"a review of prior, relevant literature is an essential feature of any academic project. An effective review creates a firm foundation for advancing knowledge. It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed."* The literature study focuses on the interaction discipline and major port involvements in supply chains. As a result, some preliminary recommendations (Figure 13, step 1) regarding port integration stages and conceptual frameworks are created and presented in the first paper, which serves as a basis for other papers that came later on. With these results, new studies are commenced encompassing several methodological steps (Figure 13, step 1-2), such as literature sourcing, the Delphi technique and the AHP. This is to indentify significant value-added attributes with linking functionalities. Based on this multi-disciplinary study (i.e., *empirical statistical research*), a model encompassing value-added attributes with a ranking and prioritization purpose is proposed; as thus suggestions have gradually been developed (Figure 13, step 3). By this, the second paper contributed to both the first research area and derived the idea of the second research area (*systematic integration*).

To address the second research area (*systematic integration*), integration issues in port operations and necessary constituents of an integrated logistics platform have to be explored. These include: key elements, mechanisms and barriers that might hinder systematic integration. Consequently, a series of papers (papers 3, 4, 5 and 6) using both theoretical propositions and inputs from empirical evidence have to be accomplished (Figure 13, steps 3-4). As thus, in each paper, a theoretical model proposition is used together with case study research for either *theory building or theory extension/refinements*, which are outlined as follows:

A theoretical model proposition and in-depth case study have been used to reveal an integrated logistics platform framework and its essential elements for systematic integration (paper 3). As an extension to this stage, the fourth paper was dedicated to analyzing how information and communication technology (ICT) was conveyed between actors within the port industry. To do so, a conceptual model and multi-case studies form the methodological choice in this paper. The main idea of mapping information flows is to achieve a better supply chain integration. Interfaces between major member-firms in the port organization are explored using a theoretical interface model together with multi-case studies, which form paper number five. In addition, viable impediments to supply chain integration are determined through a combined view of different partners in port industry (paper 6). Here, a literature review, cross-functional survey and in depth case studies have been carried out to accomplish this objective. Finally, all recommendations and conclusions from previous research, which might be expressed as a swinging circle between theoretical propositions and inputs from empirical evidence, contributed to the saturation of theory building or

extension/refinements in the form of final conclusions and suggestions (consult Figure 13, step 5).

3.4 Research design and process

A research design is a logical plan for getting from an initial set of questions to be answered to some set of conclusions (answers) about these questions (Yin, 2003). Another way of thinking about a research design is as a "blueprint" of research, dealing with at least four problems: what questions to study, what data are relevant, what data to collect, and how to analyze the results (Philliber *et al.*, 1980). These "blueprint" research problems have been incorporated throughout four phases within the main research areas: the *changing role(s)* and *systematic integration,* as follows:

The changing role(s) of the port industry has been the trigger to investigate the port's major involvement in supply chains and interaction discipline. Adding to this, identifying relevant value-added attributes in port supply chains that have a linking function gives another dimension to answer the first research area. In this context, two phases addressing the *changing role(s)* of the port industry are conducted as follows:

Theoretical-based analysis (Phase I)

With the purpose of investigating the changing role(s) played by port industry in supply chains, a comprehensive theoretical analysis is conducted to study interaction discipline between various member-firms within port industry and the same to answer the first research question:

RQ1: What is the major changing role(s) of the port industry concerning the port involvement in supply chains?

To address the first research question, a logical departure is to conduct comprehensive literature reviews. This is to develop an understanding about the phenomenon being studied, integrate underlying relationships between concepts, and thereby add new insight into traditional problems through logical relationship-building (Wacker, 1998). In addition, real-world perspective (e.g., case study examples) is used to illustrate and support the conceptualization process. Therefore, this phase is different from others, simply because it's conceptual – its findings are grounded mainly in literature.

To identify different role(s) played by the port industry in supply chains, this phase incorporates: (1) key elements in the port definitions, (2) the development of port integration stages; and (3) soft system perspectives which embrace both domains—the real-world and system thinking activities. As thus, key elements in port definitions are discussed from value-chain, logistics and SCM perspectives. Secondly, Stevens' (1989) integration framework is suggested to investigate port logistics evolution in the supply chains. Finally, the abstract level of Soft System Methodology (SSM) is considered as a way of thinking that focuses on some-real

world situations which are perceived as problematic, aiming always to bring about what will be seen as an improvement in the situation (Checkland, 1994). As explained by Checkland (1994), the most effective systems thinker is forward-looking and will always be considering the conceptual models, comparing them with what exists in the real-world, and thereby predicting the possible changes that are likely to emerge. Hence, the purpose of SSM as expressed by Checkland and Scholes (1990) is to support the process of creating the models of different interpretations, and thereby making them subject to reflection and debate. This is complemented with the related literature reviews from the port, logistics and SCM fields, which contributes, in turn, to building an insightful understanding of the port logistics structure. The result of this phase is accounted for in Paper I: *Port logistics platform integration in supply chain management.*

Model design (Phase II)

In the course of identifying the changing role(s) of the port industry, the second phase is associated with the growing notion of the value-added logistics (VAL), particularly their identifications and significance to the port supply chain systems. Therefore, the purpose of this phase is to answer the second research question:

RQ2: What are the significant value-added attributes that have a linking function in the port supply chain systems?

Besides searching for relevant value-added attributes from literature perspectives, an appropriate methodological construct is obtained to rank and prioritize the identified value-added attributes from different domain perspectives. Hence, literature sourcing is conducted to identify relevant value-added attributes, which formed the foundation of this phase. On this basis, the Delphi technique is implemented to rank the identified value-added attributes from experts' opinions, and more importantly to categorize the large number of these attributes in order to make available use of the AHP. This is followed by pair-wise comparison to determine the significant value-added attributes from the port key manager perspective. The purpose of this empirical statistical research is to empirically verify theoretical relationships from actual business, whereas each of these methods (Delphi technique and AHP) has the goal to statistically analyze the data (Wacker, 1998) as explained below:

Literature sourcing is conducted with the aim of identifying relevant value-added attributes in port supply chain systems. The reviews are focused on literature addressing the port on the global logistics arena and supply chain discipline published within the time period of 1998-2008. The findings are primarily retrieved from logistics and SCM journals and textbooks, although publications are also found (through database searches) in transport management and marketing journals. These value-added include activities, services and tasks. Its compromise physical and virtual value added attributes which are mutually dependent and interacting elements.

The Delphi forecasting technique is used in this study in order to evoke expert opinion. This technique is not a substitute for other scientific testing, but rather an

option for a complex and intertwined subject that crosses over disciplinary boundaries (Grisham, 2008). Brill *et al*. (2006) describe the Delphi technique as a particularly good research method for deriving consensus among a group of individuals having expertise on a particular topic where information sought is subjective and participants are separated by physical distance (Linstone and Turoff, 2002). To achieve such an objective as a prior method to the AHP, the Delphi technique is implemented for two main reasons:

(1) To rank the identified value-added attributes, the Delphi technique is used to evoke experts' opinions concerning their importance compared to the literature perspectives and, more importantly;
(2) To group the large number of the proposed value-added attributes through appropriate categorization procedures. This is associated with the study undertaken by Lirn *et al.* (2003) to identify independent attributes through repeated survey rounds in the process of inclusion of related attributes, and furthermore to provide pre-existing information for prioritizations (Duffield, 1993).

To do so, Scheele (1975) suggested that the Delphi panel must be selected from stakeholders who will be directly affected, experts with relevant knowledge and experience, and facilitators in the field under study.

Table 6 Delphi technique expert's specifications

Field of Expert	Participating Expert	No. of Round	No. of Session	Title of Expert
Academic Panel	1	4	2	Prof. in Logistics and Transportation
	2	4	2	Prof. in Logistics and Info. Management
	3	4	2	Prof. in Logistics and Transportation
	4	4	2	Prof. in Logistics Management
	5	4	2	Prof. in Logistics and Transportation
Practitioner Panel	1	4	2	Operational Manager – Container Terminal
	2	4	2	Business Development Manager – Port
	3	4	2	Corporate Strategy Director – Port
	4	4	2	Operational Manager – Container Terminal
	5	4	2	Planning Manager – Container Terminal

Thus, two panels of experts having expertise in the field of logistics transport and management are made up of five practitioners (Port and Container Terminal Management) from anonymous world-class ports and five professional academics who are selected to obtain the result (consult Table 6).

Two rounds in each session are assigned to each panel in order to fulfill the above objectives. In the first session each panel is asked to rank the identified value-added attributes using five-point Likert scales (i.e., ranking purpose). In the second session, a similar scale is used to fuse a large number of value-added attributes identified from the literature review (i.e., grouping purpose). However, these processes involved taking into account the panel choices (median) for each session in the previous round and their own initial choices as well. The results initiate a ranking preference and categorization (i.e., independent value-added attributes) for all the identified value-added attributes.

AHP is a decision-aiding method aimed at quantifying relative priorities for a given set of alternatives on a ratio scale (Al-Harbi, 2001). To employ AHP, Saaty (1990; 2008) suggested four main steps. These steps are illustrated and applied in this research as follows:

(1) Define the goal, and determine the kind of knowledge sought. In this study the overall objective is to prioritize value-added attributes in the port supply chain systems. Literature sourcing provides us with a considerable number of value-added attributes as required to form the basis of this research-work;
(2) Define attributes and sub-attributes that can determine decision hierarchy. While independent value-added attributes spur from the Delphi technique, which form the second level of the proposed hierarchical model, the other four main constructs of value-added attributes are a synthesis from the work developed by Almotairi and Lumsden (2009), and are: Information communication value, Multi-modal transport value, Critical asset value and Customer relation value. Note that these constructs are adjusted somehow to meet the AHP model and research objectives;
(3) Construct a set of pair-wise comparison matrices. Each element is evaluated against its peers with respect to the parent nodes. The pair-wise comparisons are done in terms of which element dominates the other. In this step, the decision maker can express his preference between each pair of elements as equally, moderately, strongly, very strongly and extremely preferable. These verbal judgments can be translated into numerical values in the relative scale of measurement from 1 to 9. However, there are $n(n-1)$ judgments required to develop the set of matrices in this step, where reciprocals are automatically assigned in each pair-wise comparison. In this paper, five matrices of judgment have been constructed;
(4) Use the matrix of pair-wise comparisons in each set of attributes to calculate the Priority vector (PV). The Priority vector is the principal eigenvector of the matrix. It gives the relative priority of the attribute measured in ratio scale (Saaty, 1990; Al-Harbi, 2001).

Synthesizing from the above described procedures, the final hierarchical model can be developed. The calculation can be done manually or automatically. In this research we obtain a prioritization result by the AHP software, Expert Choice.

By this, the entire methodological construct (literature sourcing, Delphi technique and AHP) has been composed and presented as one model design. The data combines literature analysis, interviews of experts involving academics and practitioners, and finally port key manager opinions. The model is developed in detail in Paper II: *Significant value-added attributes in port supply chain systems.*

Systematic integration adoption is considered due to: (1) findings from previous research (Phase I and II) which indicated that there is an evolving need to integrate the sea/land interface with land-side logistics equations; and (2) the quest to guarantee that port remains efficient connecting node and functional elements in supply chains. In this context, two phases addressing the systematic integration adoption are conducted as follows:

Key elements and mechanisms identification (Phase III)

This phase formulates the major part of this research-work and is designed to cover different integration issues, in particular the identification of key elements and mechanisms supporting systematic integration. This aim is connected to the third research question:

RQ3: What are key elements and mechanisms that support systematic integration adoption?

The purpose of this phase is to explore integration issues in port operations by identifying necessary elements of an integrated logistics platform that can be used as a framework for systematic integration. An interview guide and semi-structure questions (see Appendix IV) to undertake an in-depth case study are based on: experience from previous research, literature reviews, and theoretical model formulation. The theoretical model is formulated out of a well-known SCM framework (Lambert and Cooper, 2000) as well as value-chain mechanisms. Thus, the study examines three elements related to port industry: network structures, key business processes and selected management components.

To acquire the empirical evidence, an in-depth exploratory case study of corporate transport and logistics entities – i.e., port industry – engaged in connecting the blue water operation to the landside freight corridor and manufacturing are the core of this research study. The qualitative data for this paper comes mainly from the Port of Gothenburg and its primary members of the supply chain in Sweden: (1) Shipping line companies, (2) Container terminal operators, (3) Rail operators, (4) Truck operators; and (5) Volvo logistics corporations. This is to include corporate transport and logistics entities engaged in connecting the blue water operation with the landside freight corridor and manufacturer. The Port of Gothenburg and its close primary member-firms have been chosen due to its ongoing plan to re-structure the port process in order to cope with the vast market need. The other reason for choosing these sites relates to the port efforts to

position themselves as a natural hub for northern Europe. A case study is used because it is recommended for studies of contemporary phenomena in real-life contexts (Yin, 1989). As thus, types of research questions starting with "What?" (and their derivatives as well) are being posed during interrogation (see Appendix IV). Therefore, the underlying approach used for the research behind this topic is based on a literature review as well as in-depth case study. A multi-level of an integrated logistics platform framework and its associated results in this phase are accounted for in Paper III: *Integrated logistics platform – an empirical analysis from the port industry.*

As an extension from the previous topic, a connected research theme emerged to analyze how information and communication technology (ICT) is used to support the hinterland transport of maritime containers. It focuses on the way information is conveyed between actors, and particularly on what information the actors exchange and by which media they do it. Although the study used the same Lambert and Cooper (2000) framework, the focus in this topic is more on the management components. The literature review is contributed to construct a conceptual model showing the relationship between integrative information and integrative technology, which in turn is related to the business process integration and an ICT maturity model.

Empirical evidence is based on multiple case studies with member-firms involved in Swedish hinterland rail transport: (1) Gävle container terminal, (2) Hallsbergs terminalen, (3) IKEA, (4) Intercontainer, (5) PGF Tåg, (6) Port of Gothenburg, (7) Vänerexpressen; and (8) Hogia. Rail shuttles to other Swedish seaports are an emerging business and Swedish hinterland transport is arguably suitable for illustrating and analyzing how information flows supporting hinterland transport of container by rail are managed. Sweden has consequently been chosen as the empirical setting in this study. Eight interviews have been conducted to collect data on hinterland information flows. Five terminals, three intermodal operators, two ports, one shipper, and one software supplier have been interviewed. Thus, the interviews cover 12 functional network members in the supply chain. The main idea of mapping and analyzing information flows is to achieve a better supply chain integration. The outcome of this research topic is accounted for in Paper IV: *Information flows supporting hinterland transportation by rail: Applications in Sweden.*

With the aim of facilitating further the objective of supply chain integration, the final research topic in this phase is devoted to exploring current interfaces between major member-firms in port organization. A structured literature review is obtained to disclose a theoretical interface model (Sanchez, 2000). This model is used to define and describe different natures of interfaces.

A ground theory approach (GTA) is employed for this qualitative study due to: (1) the newness of the subject, studying supply chain interfaces, in particular between major member-firms in port organizations, and (2) a critical cornerstone of GTA, constant comparison (Glaser and Strauss, 1967; Locke, 2001), which is known as "coding of data." Within this context, coding of the data is informed by Sanchez's (2000) interface model for dissecting product design.

Exploratory interviews (see Appendix IV) are conducted to better understand the nature of supply chain interfaces and their characteristics. While anonymity is promised to the participants, Table 7 illustrates information regarding the organization and respondents' profiles. Four shipping lines, three global terminal operators, one trucking company, one logistics service provider (LSP), one single trade association, and finally, two port authorities are included. Position titles of the participants included Director of Corporate Strategy, General Manager of Operations and Marine, Senior Manager of Business Development, Container Terminal Operations Manager, Container Terminal Planning Manager, General Manager of Cluster Operations, Shipping Line General Manager, and Senior Manager of Project and Business Innovation.

Table 7 Organization and respondent profiles

Interview organization	**Channel position**	**No of participants**	**Logistics**	**IT**
1	Port authority	1		X
2	Port authority	1		X
3	Terminal operator	4	X	X
4	Terminal operator	1	X	X
5	Terminal operator	2	X	X
6	Shipping line	1		X
7	Shipping line	1	X	X
8	Shipping line	1	X	X
9	Shipping line	2	X	X
10	Trucking company	1	X	
11	Trade association	2		X
12	LSP	1	X	X

The interviews occurred with 18 managers from ten private companies and two governmental bodies with responsibilities in information technology and/or logistics management. The number of interviews is higher than the eight respondent minimum suggested by McCracken (1988) and highlights the ability for this exploratory study to provide insights into inter-organizational relationships and systematic integration within logistics management. This is to develop a framework contributing to enhance the port's member-firms integration

through better management of interfaces. The result of this research topic is accounted for in Paper V: *Managing supply chain interfaces – a framework towards an integrated logistics platform.*

Integration barriers consideration (Phase IV)

To engender the overall understanding of the possible barriers to ports' integration, this phase comes to determine barriers to supply chain integration within the port industry setting. It is to develop a combined view of different partners in the port industry concerning viable impediments to an integrated logistics platform. To fulfill this essential objective, the fourth research question is formulated as follows:

RQ4: What are barriers that can hinder systematic integration adoption?

The purpose of this phase is to determine barriers to supply chain integration and to develop a combined view of different partners in port industry concerning viable impediments to an integrated logistics platform. Therefore, a combination of a literature review, a cross functional survey, and in-depth case studies is served as an input to this phase:

Literature review helps to formulate the theoretical domain of this study. As thus, a framework for barriers to supply chain integration includes: (1) define the term "barriers to supply chain" within the logistics management context, and (2) identify and classify barriers that were extracted from literature in accordance with the interrelated nature of SCM main elements. To align these barriers index with the Lambert and Cooper SCM framework, logistics experts in the field (professors with knowledge of maritime logistics research and doctoral student experts in the same field) contributed to finalize substantive content and avoid unwanted duplication.

Cross functional survey is deployed to capture how functional managers view barriers in their supply chain setting. As thus, a one-page barriers index is developed, and the preliminary survey is reviewed by several academics that are familiar with the subject matter. Their feedback is used to modify the survey instrument. The final set of the barriers index (see Appendix IV) is exposed to four different groups of managers within the port industry: shipping line managers, terminal managers, port authority managers, and trucking company managers. The survey is conducted face-to-face with the previously mentioned managers in order to explain the presumed methodology and to eliminate potential bias. The final set of the barriers index is measured by a five-point Likert scale anchored by strongly disagree (1) and strongly agree (5). This is to indicate the degree of deficiency that each variable would cause to the port supply chain integration.

In-depth case studies are conducted in order to explore the "why" behind our survey findings (Yin, 2003). It is determined that interviews ought to be conducted with the same respondents in the early surveys. While the allocated respondents are managers in leading organizations in the port industry, their

channel positions as key members in different stages of the supply chain allowed the cross-case analysis as suggested by Eisenhardt (1989). The insight gained by combining the surveys with the interviews yielded a rich and robust view of main barriers to modern port's supply chain integration practice. The outcomes of this phase are accounted for in Paper VI: *Barriers to supply chain integration – a combined view of different partners in port industry.*

Data sources in relation to the research strategies and design as discussed above are all summarized in Table 8, giving an overview of the same in connection with the research papers.

Table 8 The data sources during the research design and strategies applied in the papers

Data sources	**Research papers**	**Research strategy and design**
Literature study	*Paper I* *Port logistics platform integration in supply chain management*	Conceptually based *(Phase I)*
Literature study Questionnaires	*Paper II* *Significant value-added attributes in port supply chain systems*	Survey study *(Phase II)*
Literature study Interviews Documentation	*Paper III* *Integrated logistics platform – an empirical analysis from the port industry*	Case study *(Phase III)*
Literature study Interviews	*Paper IV* *Information flows supporting hinterland transportation by rail: Applications in Sweden*	Case study *(Phase III)*
Literature study Interviews Documentation Observations	*Paper V* *Managing supply chain interfaces – a framework towards an integrated logistics platform.*	Case study *(Phase III)*
Literature study Interviews Questionnaires	*Paper VI* *Barriers to supply chain integration – a combined view of different partners in port industry*	Survey study and case study *(Phase IV)*

An overall view of the research design and process; which contains further details regarding the connection between the research phases, research questions, papers, companies and organizations characteristics and geographical areas involved in the research is summarized in Appendix III.

3.4.1 Data collection methods

Data collection methods in this research are reliant on: (1) the nature of the pressing problem characteristics, and (2) types of research questions. According to Marshall and Rossman (2006), it is important to match the data collection methods with the purpose of the study. Both qualitative and quantitative research methods are used separately and in combination to generate answers to questions relevant to the research. All applied data collection methods are briefly described below in chronological order:

Literature review

The starting point of any data collection in this research—whether it's in all appended papers or in the covering paper is literature review. According to Webster and Watson (2002), *"a review of prior, relevant literature is an essential feature of any academic project. An effective review creates a firm foundation for advancing knowledge. It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed."* The literature review covers many areas related to the nature of the research questions put forward, and thus includes but not limited to: intermodal transportation, port logistics systems, logistics and SCM approaches to port, logistics and information technology, and port integration and supply chain interfaces. Tracing the references by looking to the reference list is also performed and relevant papers found in journals (of a diverse nature) have been tackled as well. The literature sources are mainly scientific journals: conference proceedings, dissertations, EU projects documentations, and strategic management-oriented publications. These sources are of particular importance and engender all research process development, especially the early phase for initial exploration of the port as a logistics platform. Published materials on the Internet, annual reports and archival records of the involved companies and organizations are helpful and are used as a compensation for some empirical shortcoming.

Questionnaire

A questionnaire facilitates data collection in large populations and contributes to low costs per object. It is important that the questions are simple in character and the responses well-defined for the respondent. The possibility for correcting unclear responses is limited and costly so the design of the questionnaire is of utmost importance (Ronald and Johnny, 2005). In Phase II of the research process a questionnaire method is used. The choice of method is in line with the Delphi technique and AHP procedures. For instance, in the Delphi technique two panels of experts having expertise in the field of logistics and transport management are made up of five practitioners (Port and Container Terminal Management) and five professional academics who are selected to obtain the result. Two rounds in each session are assigned to each panel; in the first session each panel is asked to rank the identified value-added attributes using five-point Likert scales (i.e., ranking purpose), while a similar scale is used to group these attributes (i.e., grouping purpose). On the other hand, the questionnaire is utilized in AHP in the form of pair-wise comparison matrices. Each element is evaluated against its peers with

respect to the parent nodes. The pair-wise comparisons are done in terms of which element dominates the other. In this way, the decision maker can express his preference between each pair of elements as equally, moderately, strongly, very strongly and extremely preferable (Saaty, 1990; Saaty, 2008). These verbal judgments can be translated into numerical values in the relative scale of measurement from 1 to 9. It gives the relative priority of the attribute measured in ratio scale (Saaty, 1990; Al-Harbi, 2001).

Interviews

Interviews are probably the most widely employed method in qualitative research (Bryman and Bell, 2007). In Phase III (papers III, IV, and V) of the research process, qualitative data collection methods are the predominant method. The reason for this is the nature of the research questions, which required a non-predetermined structure where knowledge and understanding could be developed gradually and inductively (Creswell, 1994). Dubois and Gadde (2002) make a distinction between "active data" and "passive data"; active data is what the researcher has set to find out, while passive data is associated with the discovery. With this reasoning, active data can be gathered by structured interviews whereas passive data requires more unstructured approaches. To help uncover the interviewee's view, the researcher should only introduce a few general topics, but otherwise he/she needs to respect how the interviewee structures the responses. The focus needs to be on the interviewee's view, not how the researcher views the phenomenon (Marshall and Rossman, 2006). To ensure this, the questions to be formulated in the interview guide should not be so specific that they prevent the interview from going in alternate directions that might arise in the course of the interview (Bryman and Bell, 2007). Therefore, the interviews in Phase III of this research are designed as semi-structured interviews (consult Appendix IV). This is to reveal both "passive/active data" and to secure that all relevant aspects and topics are covered.

Direct observations

While visiting a field study, conducting direct observation is one way of data collection methods. It serves as yet another source of evidence in case study (Yin, 2003). This method is employed in Phase III's (paper V) research process, and it is mainly of unstructured participant observation type. It allows researchers to perceive reality from "inside" the case study rather than from "outside" of it, i.e., interviews. In addition, direct observation contributes to understanding the practical developments of port industry; and it is often done jointly with a demonstration about how things work in the practical world.

Analyzing documents

The greatest strength of analyzing documents is that it is unobtrusive and nonreactive since it can be conducted without interaction with the settings in any way (Flick, 2006). Also, transparency is high, since information can be checked by the reader (Marshall and Rossman, 2006). Hence, documents can be a fruitful data source; however, they are not just a representation of facts or reality.

Documents can be solicited for the research, i.e., they have been produced dedicated for the research, or they can be unsolicited. Hence, the context and the use and function of the document need to be taken into account. Criteria for assessing the quality of documents are: a) authenticity, i.e., is it a primary or secondary document; b) credibility, which refers to the accurateness of the document and the reliability of the producer; c) representativeness, i.e., is it typical of its kind; and d) meaning, i.e., is it clear and comprehensible (Flick, 2006). Analyzing documents is used in Phase III (paper III and V) before and after the interview, encompassing both primary and secondary sources. While the author reviews documents exists in the company's formal websites before the interview, additional documents are taken from the companies themselves after the interview for further analysis. These types of documents include: annual reports, promotion materials, and statistics. This gives valuable input and thoughtful amounts of data about the organization subject for interviews.

3.4.2 Data analysis methods

Data analysis consists of examining, categorizing, tabulating, testing, or otherwise recombining both quantitative and qualitative evidence to address the initial propositions of a study (Yin, 2003). The general analytical strategies rely on theoretical propositions, setting up a framework based on rival explanations, and developing case descriptions. These strategies are practiced with specific analytical techniques, namely: *pattern matching, explanation building, time series analysis, logic models, and cross-case synthesis* (Yin, 2003).

The most preferred general analytical strategy employed in this research-work is *relying on theoretical propositions*. The original objectives and design of the case study presumably are based on such propositions, which in turn reflect on a set of research questions, a review of the literature and new hypotheses or propositions. These propositions contribute to shape the initial data collection plan and give priority to the relevant analytic strategies such as *pattern matching, explanatory building* and *cross-case synthesis* techniques. The logic behind utilizing *pattern matching* is simply that it gives the opportunity to compare an empirically based pattern with a predicted one. Coinciding with this technique is *explanatory building* where the goal is to analyze the case study data by building an explanation about the case. A similar procedure, for exploratory case studies, has been commonly cited as part of a hypothesis-generating process (Glaser and Strauss, 1967). This particular technique is applied in Phase III/Paper V with an emphasis on the GTA's constant comparison and coding of data, whereas cross-case synthesis was originally deployed.

The overall research design and process components with methodologies applied discussed above are summarized in Table 8, giving an overview of the same in connection to the papers. Table 8 also gives insight into all different methods and combinations of research strategies applied for this study.

3.5 Research quality

To judge the quality of any research, scholars suggest different evaluation criteria for qualitative and quantitative research. However, there is a recognition – albeit to varying degrees – that validity and reliability are applied equally well to both types of research (Lee, 1998; Yin, 2003; Bryman and Bill, 2007). As thus, Yin (2003) advocates that construct validity, internal validity, external validity, and reliability are essential criteria for evaluating the quality of case studies research:

Construct validity

Construct validity is to establish the correct operational measures for the concepts being studied (Yin, 2003). Three tactics are identified by Yin (2003) to ensure construct validity, namely, using multiple sources of evidence, establishing a chain of evidence and having key informants review draft case study reports. All these tactics are being utilized in the study of this thesis. Triangulation, which is the use of different techniques to study the same phenomenon (Easterby-Smith *et al.*, 2002; Patton, 2002), is employed in three different forms:

(1) Data triangulation is used through collecting data at different times and from different sources. For instance, several persons are interviewed within the same company in Phase III and then verified when possible at interviews with other companies in the same supply chain setting. On top of that, some statements are validated by using sources other than interviews, such as documentations and direct observations.
(2) Methodological triangulation is represented by the utilization of both quantitative and qualitative techniques. This is obvious whether it's within the phase itself or across the whole research process. Within phases, the Delphi technique is employed tangent to AHP in Phase II, and functional survey is combined with case study strategy in Phase IV/Paper VI. Across the whole research, methodological triangulation is employed as part of the systematic combining process.
(3) Triangulation of theory is employed where theories are taken from different disciplines to explain the phenomenon of logistics platform. The application of theories from different domains is the most central choice of this research. SSM, the value chain concept, the interface model and the SCM framework have been adopted to explain some phenomena in the port industry.

To maintain a chain of evidence, the external observer—reviewer or reader should follow the derivation of any evidence, ranging from initial research questions to ultimate case study conclusions and vice versa, i.e., research design (Yin, 2003). Finally, all draft case study reports are sent back for review by the key informants.

Internal validity

Internal validity is used to establish a causal relationship, whereby certain conditions are shown to lead to other conditions (Yin, 2003). It raises the question: How confident can we be that the independent variable really is at least

in part responsible for the variation that has been identified in the dependent variable (Bryman and Bill, 2007)? According to Yin (2003), internal validity is only a concern for causal or explanatory studies, which means that it applies only to Phase II/paper II (i.e., ranking and prioritization model design).

To ensure internal validity the following measures have been taken: (1) the study strives for producing a large scale of variables to ensure content validity and coverage, (2) each technique involved is followed according to its procedural steps, i.e., Delphi and AHP, and (3) statistical calculations are done by well-known software, i.e., Expert Choice and statistical validation done by the statistical department, Chalmers University of Technology. In addition, face validation is also applied through introducing the model to the expert's opinion in the fields of logistics and port management.

External validity

External validity deals with the problem of knowing whether a study's findings are generalizable beyond the immediate case study or the specific context of the study (Yin, 2003; Bryman and Bill, 2007). There are two types of generalization: (1) analytical generalization, and (2) statistical generalization (Yin, 2003). While case study relies on analytical generalization, survey research relies on statistical generalization.

Single case study is applied in this research on one occasion where more insight and in-depth case analysis is persistent. Other studies are of multiple case designs to affirm the single case study findings, and thereby external validity is improved. In addition, replication logic is of particular importance, especially in the theoretical framework development in Phase III/Paper III, IV, and Phase IV/Paper VI whereas a well-known SCM framework is used as a starting point to re-confirm the integrated logistics platform theoretical saturation. Furthermore, all appended papers are presented at international academic conferences and are considered for publication.

Consequently, the processes and frameworks developed are possible to use in port industry with similar contexts and settings. Nevertheless, replication logic should be possible and there is no reason that the findings of this study are not applicable to other similar industry settings.

Reliability

The underlying issue of reliability is whether the process of the study is consistent and reasonably stable over time and across researchers and methods (Miles and Huberman, 1994). According to Yin (2003), the goal of reliability is to minimize errors and biases in a study. To achieve reliability, it is necessary to document the procedures and to develop a case study database.

To ensure reliability of this study, all procedures regarding data collection are well documented. Case study protocol (normally contains questions to be asked as well as general rules to be followed) is established based on literature reviews and

expertise from the field. Appendix IV shows case study protocol questions being used in the study.

In addition, a short presentation before commencing the interviews is given by the author to minimize potential bias. With regard to data collection, the author always started by labeling the respondent's business contact and position for further inquiry. Usually interviews are combined with direct observations or short demonstrations by key respondents. When finished with the interviews, they are immediately typed in the computer and consequently saved in the database. Finally, respondents are asked to reconfirm the interview report to eliminate misunderstanding and incorrect interpretation.

4 SUMMARY OF THE APPENDED PAPERS

This chapter presents the six appended papers on which this thesis is based. Moreover, it gives an overview of the inter-relationship between the appended papers, and for each paper the purpose and the most important findings are briefly discussed.

4.1 Inter-relationship between the papers

The starting point of this research is Paper I (conceptually based). This is to provide a broad comprehensive theoretical analysis of the port logistics platform integration in SCM. The importance of this paper emerges as the concept under investigation is not yet well-known, despite being pointed out as strategically important by researchers. Based on that the areas of interest for the next paper (PII) are identified, and that is the basic principle for all subsequent papers. As thus, Paper II emerges as an evolving need to enhance our understanding of the logistics platform by looking for significant value-added attributes that have a linking function. Hence, Papers I and II are about the changing role(s) of the port industry (i.e., interaction discipline and linking function). Based on these paper results Paper III is initiated to ground the findings from all the previous research empirically; and more importantly to explore integration issues and the necessary elements for systematic integration.

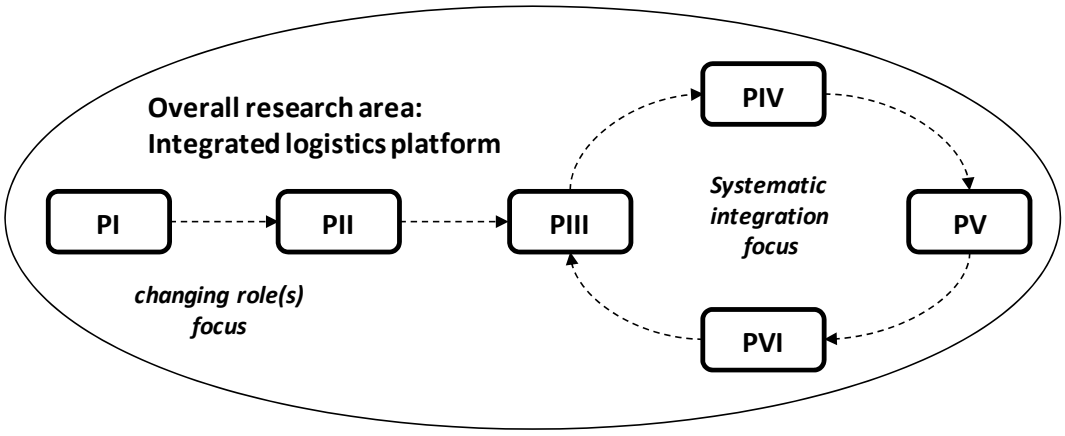


Figure 14 Inter-relationship between the research papers

In continuation of the previous research-work, Papers IV and V are focused on the integration mechanisms (information analysis and interface exploration). The final Paper (PVI) contributes to the systematic integration adoption by looking for barriers consideration. Figure 14 illustrates the inter-relationship between all the research papers.

4.2 Overview of the papers

4.2.1 Paper I – Port logistics platform integration in supply chain management

Purpose

Due to the increased acceleration of global competition, ports like other functional supply chain members are continuously interacting with a variety of businesses and market players. As such, it's considered indispensible to investigate such an interaction discipline. With this, the paper attempts to define the key principles behind the port logistics platform phenomena. This implies pre-study of major key elements in port, and logistics and supply chain systems definitions in order to understand the problem area. An appropriate integration framework is suggested to understand various role(s) played by the ports in the supply chains. Thus, the hypothesis behind this paper is that the contemporary port logistics set-ups have to be tackled within the framework of logistics and SCM. Here, it is argued that supply chain performance has become a critical source of sustainable advantage in many industries such as the port industry.

The main purpose of the paper is to investigate the port interaction discipline and involvement in supply chains. By this, a conceptual framework that is able to mirror the current key characteristics of the port logistics set-ups is proposed. This is based on a comprehensive theoretical analysis—supported by real-world examples. Whereas the port logistics evolution in the supply chain is highlighted through a well-known systematic integration approach (Stevens, 1989), SSM adheres to the development of the conceptual framework. The secondary objective is to contribute to the body of knowledge in the context of port, logistics and SCM.

Findings

It has been asserted in this paper that the scope of the port role(s) is extended to encompass more activities and processes beyond its boundaries, which might be influenced by corporate goals in adding value to different supply chain processes. This view is based on key elements within the definition of port and the suggestion of the systematic integration approach. Four stages of the port logistics integration in supply chains are identified: the base line, the internal integration focus, the corporate internal integration, and finally the supply chain integration. By this, the port developments in the supply chain are highlighted, and the planning and operating implications of each stage have been briefly discussed. As a result, and drawing from that, a conceptual framework provides an illustration of

the port logistics platform components, their inter-relationship and the processes involved.

As there is a plethora of articles justifying the significant emergence of the port logistic platform concept, the real-world examples also show a strong trend toward logistics platform applications at least in the world-class port, which encourages ports to become more integrated in the supply chain. The reasons may vary, but a common denominator is that every member-firm in the logistics platform has to be involved.

4.2.2 Paper II – Significant value-added attributes in port supply chain systems

Purpose

The growing notion of VAL has changed the role(s) of ports and thereby derived ports to engage in activities more than the traditional point of freight transshipment. To enhance our understanding of the future of port as a logistics platform, the value-chain concept is utilized in order to indicate a potential linking function between different member-firms within the port supply chain setting. Thus, considering the importance of the value-chain concept in improving the firm interconnectivity and interoperability, a methodological construct consists of: (1) literature sourcing, (2) the Delphi technique; and (3) AHP (employed to disclose various domain perspectives).

The theme of this paper is to identify relevant value-added attributes in port supply chain systems. The importance of these value-added attributes is to be evaluated by different domain perspectives through utilizing an appropriate methodological construct. The underlying approach of this study is to disclose the idea of academic (literature souring) with experts' ideas (Delphi technique) as well as the decision maker (AHP), specifying significant value-added attributes revealed from different domain perspectives.

Findings

With the identification of promising value-added attributes, different techniques have been utilized to evaluate the importance of these value-added attributes representing various domain perspectives. Consequently, the ranking and prioritization model is formulated out of three main steps: step 1 illustrates the findings of the literature sourcing; this includes the identification of the value-added attributes and their number of *occurrences*. This is followed by step 2 where value-added attributes are ranked and grouped; this involves the experts' choices: *Median-M, Standard Deviation-SD, and Average Median Rank (Avg.-M Rank)*. The decision maker's relative priority ends up the model through *Priority vector-PV, and Consistency ratio-CR* measurements. The result from the cross-domain synthesis shows that "information communication value" is the most valuable attribute revealed by both Delphi experts and the port decision maker, among other main constructs of attributes. Other important agreements among experts and port key management indicated that "access to distribution network,"

"logistics and transport integral facility" and "reliable custom clearance services" are the most important value-added attributes among others in the same category.

4.2.3 Paper III – Integrated logistics platform – An empirical analysis from the port industry

Purpose

Much of the published work deals with inter-organizational changes, primarily between shipping companies through merger and acquisitions processes, and the relations between shipping lines and terminal or inland transport operators (Notteboom and Winkelmans, 2001; Slack and Frémont, 2005; Olivier and Slack, 2006). However, addressing the seaport organizations within the logistics and supply chain management (SCM) framework has rarely been covered (Carbone and De Martino, 2003; Mangan et al., 2008; Panayides and Song, 2008). In fact, Bichou and Gray (2004, p. 50) state "much of the literature advocating the future of ports as logistics centers […] overlooks logistics integration of the various activities performed." The real future competition will not be between port and individual transport carriers *per se*, but between a handful of "total logistics chains" (Fleming and Baird, 1999).

With the rapid and pervasive restructuring of the supply chain in which ports are embedded, the need for a fundamental epistemological way of thinking toward systematic integration is persistent. The purpose of this paper is to explore the integration issues in port operations and identify necessary elements of an integrated logistics platform that can be used as a framework for systematic integration.

Findings

The study examines three elements related to port industries: network structure, key business process, and selected management components. In addition, value-chain mechanisms that yield the linkage optimization necessary for the firms' competitive advantages are also explored. The study suggests that the successful implementation of an integrated logistics platform lies on the port organization's ability to:

(1) Support supply chain coordination in which all member-firms work closely as if one single domain;
(2) Adopt key business process integration by identifying links to logistics activities (like combined transport carrying capacity and other linking activities); and
(3) Enhance system optimization by bridging interfaces through the proprietary information system, allowing supply chain visibility for the entire system.

With reference to value-chain mechanisms, both combined transport carrying capacity and the automatic match between facility-based operations and the transport distribution network are identified and assumed imperative linking

mechanisms. Furthermore, a multi-level integrated logistics platform is operationalized through underpinning two discrete pathway levels in which port industry has been found to work: (1) Level I – resource-based pathway – transshipment and; (2) Level II – industry organization pathway – replenishment. These levels are inextricably linked and cover elements of port logistics chains and the environment within which they are embedded, though each level reflects quite different perspectives.

4.2.4 Paper IV – Information flows supporting hinterland transportation by rail: Applications in Sweden

Purpose

The development of global supply chains has increased the pressure on the maritime haul, on port operations, and last but not least on freight logistics and distribution systems (Notteboom and Rodrigue, 2005; Robinson, 2006). As these important trends take hold in the marketplace, the role of ports becomes more important than ever (Bagchi and Paik, 2001). More precisely, the hallmark success for port industry as a critical connecting node in the supply chain is to facilitate the exchange of goods and services and the related information among the various individual supply chains (Chadwin *et al.*, 1989; Goss, 1990). As a continuation of the previous research findings, this paper puts more focus on the management components element. The focus is on what information the actors exchanged and by which media they do it.

The main purpose of this paper is to analyze how information and communication technology (ICT) is used to support the hinterland transport of maritime containers. It focuses on the way information is conveyed between actors using an ICT facility structure, and how integrative information is used by different partners' information systems in order to make different transport operations more efficient.

Findings

To draw the findings from this research work, an imperative two-dimensional conceptualization model of an integrated supply chain strategy is formulated out of: (1) Integrative information (communication and information flow structure) and (2) Integrative technology (IT facility structure). To tie these dimensions together, a framework of maturity of business integration and their IT support in supply chain has been used which includes four maturity levels: (1) disconnected, (2) internal integration, (3) intra-company integration and limited external integration; and (4) multi-enterprise integration (Heinrich and Simchi-Levi, 2005).

The overall results show that the IT and IS maturity level is fairly low in the hinterland information flow, but that it is rapidly improving as many actors currently invest in new ISs, and consequently modernize their systems. This is caused by pressure from customers and a desire to reduce administrative tasks.

With regard to information and communication flow structure, the study concludes that the introduction of EDI connections, efficient data sharing and commitment of the involved supply chain members are of utmost important to streamline the supply chain flows. On the other hand, the integrative technology can, however, be significantly improved to facilitate the information flow, with a focus on automating data exchange. The development of a higher level business integration is related to the development of more advanced ICT solutions. As shown by Heinrich and Simchi-Levi (2005), it is important that business integration is aligned with, or at a level higher than, the IT maturity in order to avoid inefficiencies. It is therefore important that the actors also develop their business integration processes and not only invest in IT. The overriding conclusion drawn is that the two influential dimensions must work in tandem for the best effect.

4.2.5 Paper V – Managing supply chain interfaces – A framework towards an integrated logistics platform

Purpose

A key challenge facing organizations is the need to integrate functions as well as supply chain (Pagell, 2004). To face this challenge, the supply chain interface—as an area of "exchange" between one trading partner to another to achieve the successful transfer of goods or information is in focus. As such, competitive interaction in these interfaces determines how firms may improve their performance and competitiveness (Sanchez and Heene, 1997; Gadde *et al.*, 2003).

The purpose of this paper is to explore current interfaces between major member-firms in the port organizations and to develop a framework to integrate these member-firms through better management of interfaces. It focuses on understanding: (1) what interfaces exist and (2) how we can describe and then manage the interfaces so that the involved parties can begin to better understand one another and build an efficient logistics platform and further improve supply chain performance.

Findings

This explorative research study shows that interface specifications traced back to information flow and data and information content together with information technology integration are: (1) media; (2) transfer; (3) data and information; (4) control and communication; and (5) user interface.

Associated with these findings, across-case synthesis gives some insight which led to draw the following conclusions:

- *Cooperation in the extended enterprise.* All parties internally and externally cooperate and work through any potential bottlenecks to create a seamless flow of goods. For instance, designated departments called 'corporate strategy' are those entitled to align interfaces along the supply chain in order to streamline process operations. i.e., "interface manager."

- *Cross-functional team.* To enable interface integration of resources, a multi-disciplinary team consisting of individuals who take responsibility for the management of the interface between service design and supply chain functions exists to ensure good visibility in the extended enterprise, i.e., trade association team-work.
- *Interface optimization.* To standardize a set of interface specifications, a gateway of a 'single window' to provide commercial drive for business-to-business services was established. Here *media*, *transfer* and *user* interfaces can, however, be the same for many services and are maybe unchanged for specific shippers although several services are provided.
- *Integrative technology.* This concurs with flexible and inter-connected information systems that are able to span the supply chain boundaries. Standardized technology allows information to flow seamlessly across the organizations, i.e., Java technology. Control and communication interfaces are acquainted with this factor, which is able to select data fields to be included and permit its accessibility.

By preparing the logistics platform and describing the services and the associated interface specifications in advance, expensive ad-hoc solutions and operation disturbances can potentially be avoided.

4.2.6 Paper VI – Barriers to supply chain integration – A combined view of different partners in port industry

Purpose

Determining and understanding barriers to supply chain integration can be an effective tool and further, a mechanism that facilitates the synergy of business processes across supply chains (Fawcett *et al.*, 2008; Richey *et al.*, 2009). Hence, this study follows the same approach taken by Fawcett *et al.* (2008) and Richey *et al.* (2009) in determining barriers to supply chain integration, but with a focus on port industry context.

The theme of this paper is to determine barriers to supply chain integration in port industry and to develop a combined view of different partners in port industry concerning viable impediments to an integrated logistics platform. The basic idea behind this study is to contribute to a better understanding of the barriers that exist in port supply chain setting.

Findings

The research shows that the most common barriers fall within the proposed barrier's framework construct, namely, network barriers, process barriers, and management barriers. Under these constructs, a deficiency in information systems (IS) and information technology (IT), inconsistent operating goals, and supply chain power inequalities are major barriers to supply chain integration.

Managers believe that understanding the management barriers is the key determinant for successful supply chain integration. However, running parallel to

optimize the effect of other barrier's construct will be the realistic view depending on the overall supply chain structure and design. Only then can proper understanding of the actual barriers to supply chain integration lead to leverage the integrated logistics platform and attain supply chain success.

4.3 Summary of the papers

The research purpose and main findings of each paper are summarized in Table 9.

Table 9 Summary of the appended paper's research purposes and main findings

Research papers	Research purpose	Main findings
Paper I	To investigate the port interaction discipline and involvement in supply chains based on a comprehensive theoretical analysis—supported by real-world examples.	Defined port changing role(s) and interaction discipline based on key elements in the port definitions, the development of port integration stages, and real-world examples and system thinking perspectives.
Paper II	To identify relevant value-added attributes in port supply chain systems—specifying their significant from different domain perspectives.	Identified, categorized, and evaluated relevant value-added attributes in port supply chain systems; and thereby the proposition of ranking and prioritization model.
Paper III	To explore the integration issues in port operations and identify necessary elements of an integrated logistics platform that can be used as a framework for systematic integration.	Identified key elements of an integrated logistics platform: network structure, business process, and management component, thereby drawing the system constituent and boundary.
Paper IV	To analyze how information and communication technology (ICT) is used to support the hinterland transport of maritime containers.	Analyzed information flows by showing what information the actors exchange and by which media they do it in order to achieve better supply chain integration.
Paper V	To explore current interfaces between major member-firms in the port organizations and to develop a framework to integrate these member-firms.	Identified informational interface specifications; and some insight towards an integrated logistics platform.
Paper VI	To determine barriers to supply chain integration in port industry and to develop a combined view of different partners in port industry concerning these impediments.	Determined barriers to systematic integration adoption: network barriers, process barriers and management barriers.

5 ANALYSIS

In this chapter, findings from the papers are analyzed with regard to the research questions. Furthermore, the chapter gives an overview of the main findings, describing the relation and connection between the papers and the research questions.

5.1 Interaction discipline and port involvements

This section gives answers to the first research question:

RQ1: What is the major changing role(s) of the port industry concerning the port involvement in supply chains?

Literature analysis asserted that the scope of the port role(s) is extended to encompass more activities and processes beyond its boundaries (Robison, 2002; Carbone and De Martino, 2003; Bichou and Gray, 2004). In the practical world, ports are continuously interacting with a variety of businesses and market players (Bichou and Gray, 2005). However, such interaction discipline may be influenced by corporate goals in adding value to different supply chain processes (Robinson, 2002, Carbone and De Martino, 2003). This view is incorporated into: (1) key elements in the port definitions, (2) the development of port integration stages; and (3) soft system perspectives which embrace both domains—the real-world and system thinking activities.

The port definitions differ in accordance with the types of research disciplines and port attributes being studied. But the key elements in these definitions with regard to contemporary logistics set-ups realized the port industry from *value-chain*, *logistics* and *SCM* perspectives. These key definitions are incorporated in all the appended papers and some of them following:

From value-chain perspectives:

> *"Ports are elements embedded in value-driven chain systems… and that it is important for the port and its service providers to offer sustainable value to its user's vis-à-vis other competing value-driven chain systems" (Robinson; 2002).*

From logistics perspectives:

"Ports are logistics systems along the supply chain which have to respond to pull logistics; their actions will contribute toward the reduction of inventory levels along the logistics pipeline, a fall in associated costs, and the fulfillment of tighter customers' requirements through higher service levels within shorter lead-times" (Ainsworth; 1992).

From SCM perspectives:

"The role of the ports related to supply chain should be defined as creating surplus for consumers and producers whose products pass through them, not merely the surpluses for the immediate port users, but also for the entire supply chain" (Goss; 1990).

On the basis of the above definitions, port gains the status of the cross-road where different channel members can meet and interact (Carbone and De Martino, 2003). As thus, the port and its service providers, port users and end customers are able to draw the role of the ports within the supply chain setting.

To investigate the port involvement in supply chains, a systematic approach undertaken by Stevens (1989) is suggested to identify the development stages of an integrated supply chain. Four stages are identified: the base line, the internal integration focus, the corporate internal integration, and finally the supply chain integration (Figure 15).

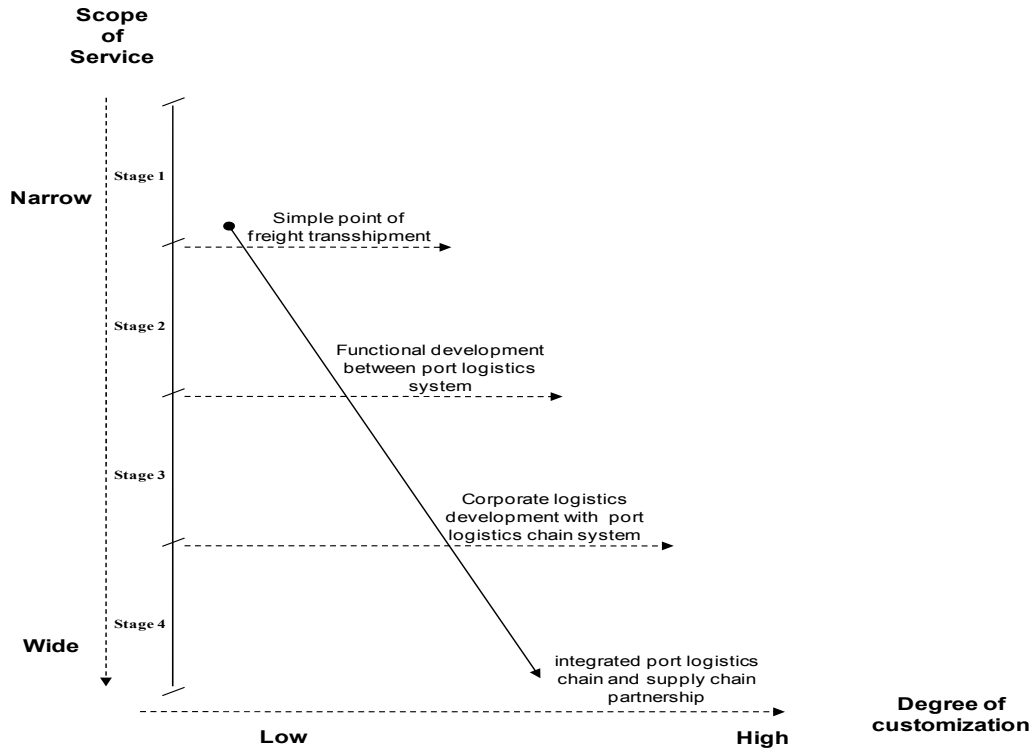


Figure 15 The port logistics evolution in the supply chains (adapted from Stevens,1989)

As Steven's approach puts more focus on planning and operating implications, the port logistics evolution in supply chains (consult Figure 15) is discussed as follows:

Stage 1 – The base line

In this stage, the supply chain is a function of fragmented operations within the individual company, and is characterized by staged inventories, independent and incompatible control systems and procedures and functional segregation.

As reflected in this stage, the port is considered to be a prime asset provider, whereas it functions as a *simple node for freight transshipment*. Many ports act as a simple transshipment hub, where freight passes between ship and land-side transport (Mangan *et al.*, 2008). Most probably, activities in the supply chain are delegated to a separate organization, "a sequential set of separate logistics operation-warehousing, depot operation, shipping, trucking, freight forwarder – are carried out by separate firm" (Robinson, 2002). In addition, more often there is little or no integration of the separate logistics elements. The establishment of an organizational boundary is a common practice in this stage, whereas each department (i.e., entity in the port such as shipping, trucking…, etc.) controls part of the physical and information flows. In this respect, inefficiencies within the operation of an individual supply chain are driven by an independent and often incompatible control system, and short-term planning, up to the point when it is barely responsive to the customer requirements. Consequently, this will put the port in jeopardy – affecting the whole supply chain. Thus, the next stage is more concerned with functional intra-firm integration.

Stage 2 – Internal integration focus

The second stage is an internal integration focus, characterized by an emphasis on cost reduction rather than performance improvement, buffer inventory, initial evaluations of internal trade-offs and reactive customer service.

Traditionally, port authorities have played the role of facilitators, focusing on the provision of superstructure and infrastructure for port operation, loading/unloading, temporary storage and intra-port operations (Song and Panayides, 2008). As a result of the previous stage, the port has become more concerned with capacity utilization: maximizing the logistics operation and providing a buffer inventory zone in order to accommodate ship and cargo which is the basic element of this stage. Song and Panayides (2008) stress that much of the research and development emphasis has been on the ability of the ports to carry out their function of accommodating ships and other modes of transport effectively and efficiently. In this respect, Robinson (2002) refers to this stage on his model as *functional integration*. Note that the focus at this stage is principally on the inward flow of goods. With regard to planning and control systems, ports have applied time-based planning to the physical flow helped by EDI techniques and control systems. However, cargo consolidation is affecting the distribution activities for inbound and outbound transport networks. It seems that terminal operations have been decoupled from transport operators, leading to poor

visibility of real customer demand and generally poor performance. Business functions are administered through the balance between inventory levels and free storage time. The balance between inventory levels, free storage time and inventory investment is treated as a trade-off notion, and is based on capacity utilization and the free flow of cargo. Customer service is improved to become reactive, and customers are served based on the first-in, first-out flow principle: reduced cycle times, improved labor utilization and increased capacity within capital expenditures (Paixão and Marlow, 2003). As such, the challenge for port operators is to find ways in which they can frequently meet different customer requirements without incurring an uneconomic escalation of cost (Paixão and Marlow, 2003).

Stage 3 – Corporate internal integration

The third stage is characterized by medium-term planning, a tactical rather than strategic focus, an emphasis on efficiency, extended use of electronic support for linkages and reacting to customer demand.

In this stage, port logistics development recognizes the importance of managing the physical/information flow outside the organization's boundaries. In this respect, the port transport system, as explained by Charlier and Ridolfi (1994), streamlines the port logistics activities from shippers to consignees and vice-versa. Consequently, the port network system has expanded to gain more hinterland and foreland accessibility. This trend is the result of forces in three segments of the integrated intermodal transportation systems: the ocean voyage, the transit through the port and the hinterland transport (Hayuth, 1981; Hayuth, 1982). A good example of carrier cooperation in the railway sector is the European Rail Shuttle (ERS), a joint venture between P&O Nedlloyed, Sea-land and Maersk. ERS operates shuttle trains between Rotterdam and inland terminals in Germany, the Benelux countries and Italy (Notteboom and Winkelmans, 2001). As a result, Notteboom and Rodrigue (2005) have introduced the port regionalization phase, as the port becomes a broader logistics zone and includes system dynamics, especially in port logistics-related activities. Since the integrated transportation system is supported by integrated planning and control systems such as EDI and RFID, synchronization between different transport modes is of utmost importance so that demand can't drift from supply. In relation to this, Paixão and Marlow (2003) proposed the JIT concept as a preparation phase for the internal integration toward a lean and agile port environment. They claim that by adopting these tools, a port will enrich the customer, enhance competitiveness and reach full system visibility.

Stage 4 – Supply chain integration

Full-stage integration is achieved by extending the scope of integration outside the company to embrace suppliers and customers.

The significance of the port logistics integration in this stage goes beyond the port logistics scale; it implies a change of focus to becoming more customer-oriented. Consequently, it is to penetrate the customer entity through the "door-to-door" or

"one-stop-shopping" concept. One example is a shipping line applies a door to door philosophy into intermodal logistics organization through issuing an intermodal bill of lading (B/L) to inland destination points (Notteboom and Winkelmans, 2001). Both vertical and horizontal integration help to facilitate value-added logistics offerings (Peeters *et al.*, 1994; Notteboom and Winkelmans, 2001; Durveaux, 2004; Ferrari *et al.*, 2006). The application of the concepts of on-time resource planning (OTRP) and on-time distribution planning (OTDP) as proposed by Paixão and Marlow (2003) will help to solve the problem of a lack of available tangible resources within the port entity.

By this, port involvement in supply chains is highlighted, and the planning and operating implications of each stage have been briefly discussed. As a result, and drawing from that, soft system perspectives that embrace both domains—the real-world and system thinking activities are considered to provide a stepwise illustration of the port logistics structure, inter-relationship, and processes involved (i.e., conceptually based).

While there is a plethora of articles justifying the future of port as a logistics platform, the real-world examples also show a strong trend toward maintaining port relational exchange and systematic integration at least in world-class ports. Although the reasons for this trend may vary, a common denominator is that every member-firm in the logistics platform has to be involved. This interaction is rooted in the exchange of products and services and is concerned with how two companies choose to organize the flow of goods and information between them (Gadde *et al.*, 2003).

5.2 Significant value-added attributes

By discussing the interaction discipline and port involvement in supply chains, this section gives answers to the second research question:

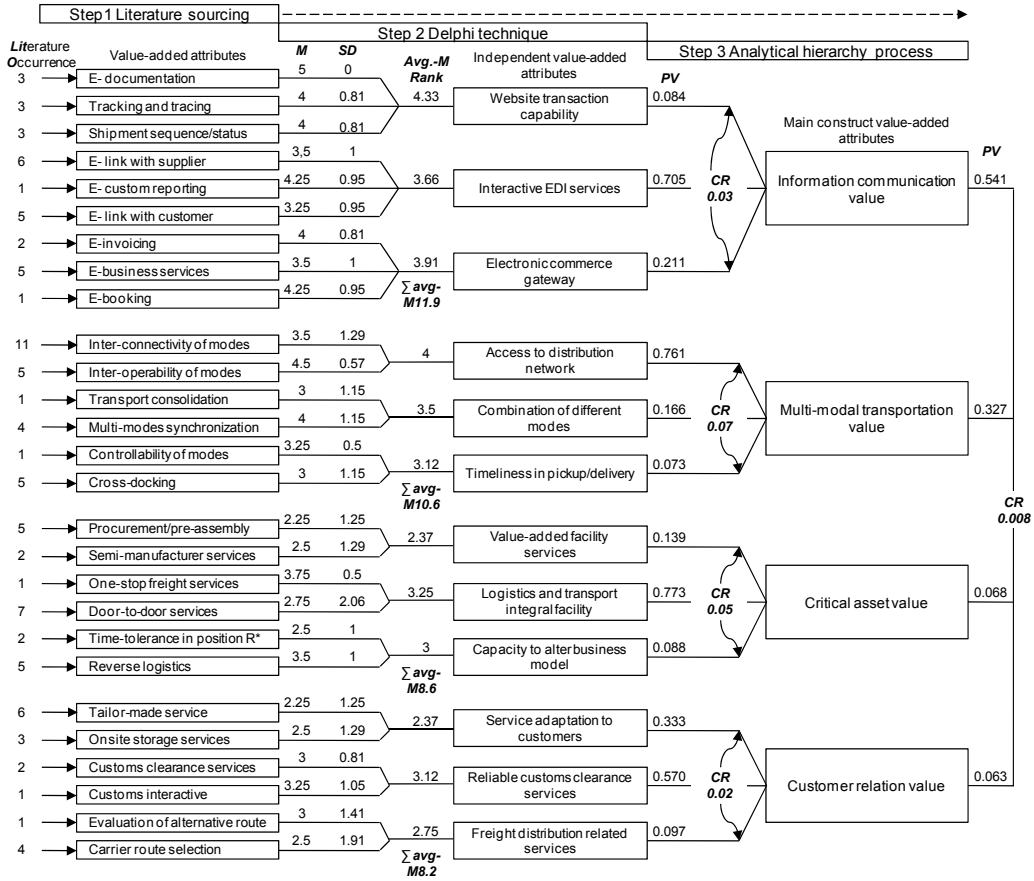
RQ2: What are the significant value-added attributes that have a linking function in the port supply chain systems?

To answer this research question, three methodological constructs are composed at once. The underlying approach behind this methodological construct is to disclose the idea of academic (literature souring) with experts' ideas (the Delphi technique) as well as the decision maker (AHP), specifying significant value-added attributes revealed from different domain perspectives. By this, all the above methodological constructs have been composed together and presented as one model design (consult Figure 16).

Starting with literature sourcing, the foundation of the research "value-added attributes" is identified and simultaneously marked with the associated literature's source. The literature sourcing identified 27 value-added attributes, and assumed implicitly the most important in the port supply chain systems from a literature perspective. Literature sourcing determines the importance level of each attribute through the ratio of "literature occurrences." For example, the value-added

attribute, "interconnectivity of modes" is marked with 11 out of 18 possible "literature occurrences." The total number of "literature occurrences" is 18 and therefore, we define the level of this value-added attribute importance here as 11/18. In a similar way, this ratio is applied to all other attributes in literature sourcing (Figure 16 – step 1).

The Delphi technique uses experts familiar with the subject to rank the identified value-added attributes, and more importantly to categorize the large number of these attributes in order to make available use of the AHP. This involves the expert's choices Median-M, Standard Deviation-SD, and Average Median Rank (Avg.-M Rank). The results initiate a ranking preference for all the identified value-added attributes and an independent value-added categorization as shown in Figure 16 – step 2.



Notes: M-median; SD-standard deviation; Avg.-M Rank -average mean rank; ∑ avg.-M- Sum of the average mean; PV- priority victor (i.e., the closer to one is the higher value); CR- consistency ratio (CR equal or < 0.10 percent means decision made consistent); R*-resources.

Figure 16 The ranking and prioritization model

To quantify relative priorities for a given set of alternatives on a ration scale, AHP as a decision-aiding method is employed. By following the AHP technique and

procedures, a final hierarchical model design is developed (see Figure 16 – step 3). The AHP prioritizes each independent and main construct of attributes through the Priority vector "weighted value" associated with the Consistency ratio. The closer the attribute's PV to the number one, the higher its value, and at the same time if CR is equal to or < 0.10 percent then the decision made is consistent for the same matrix. The results are summarized in Figure 16 – step 3.

As the model design to disclose different opinions is based on each domain perspective, there are two ways to read the result. On one hand, applying each method *per se* would indicate the evaluation for a certain domain related to specific attributes. On the other hand, it would be through cross-domain synthesis (see Figure 16 steps 1-3) that reflects different respondents' perspectives throughout a network of value-added attributes.

The study aims to specify significant value-added attributes revealed from different domain perspectives. Therefore, the significant finding disclosed from the cross-domain synthesis shows that *"Information communication value"* is seen as the most significant value-added attribute among other main constructs of attributes with an accumulation of (∑Avg.-M=11.9) and (PV= 0.541) as indicated from both the Delphi technique and AHP, respectively. Other important agreements among experts and port key management indicate that *"access to distribution network," "logistics and transport integral facility" and "reliable custom clearance services"* are the most important value-added attributes among other attributes in the same category as shown in Figure 16. These results are verified through literature findings which puts further emphasis on their importance from a broader standpoint.

5.3 Key elements and mechanisms

Previous research results show that much of the published work realized the ongoing changes in port industries within the major elements of logistics/SCM: supply chain network structure, supply chain business processes, and supply chain management components. Therefore, this section gives an answer to research question three:

RQ3: What are key elements and mechanisms that support systematic integration adoption?

A series of empirical studies are conducted in order to address the systematic integration issues, starting with the identification of key elements to draw the system boundary up to the mechanisms that support systematic integration. Therefore, the first study examines three elements related to the port industries. These are: network structures, business processes and management components. A multi-level integrated logistics platform framework is then formulated out of these elements as shown in Figure 17.

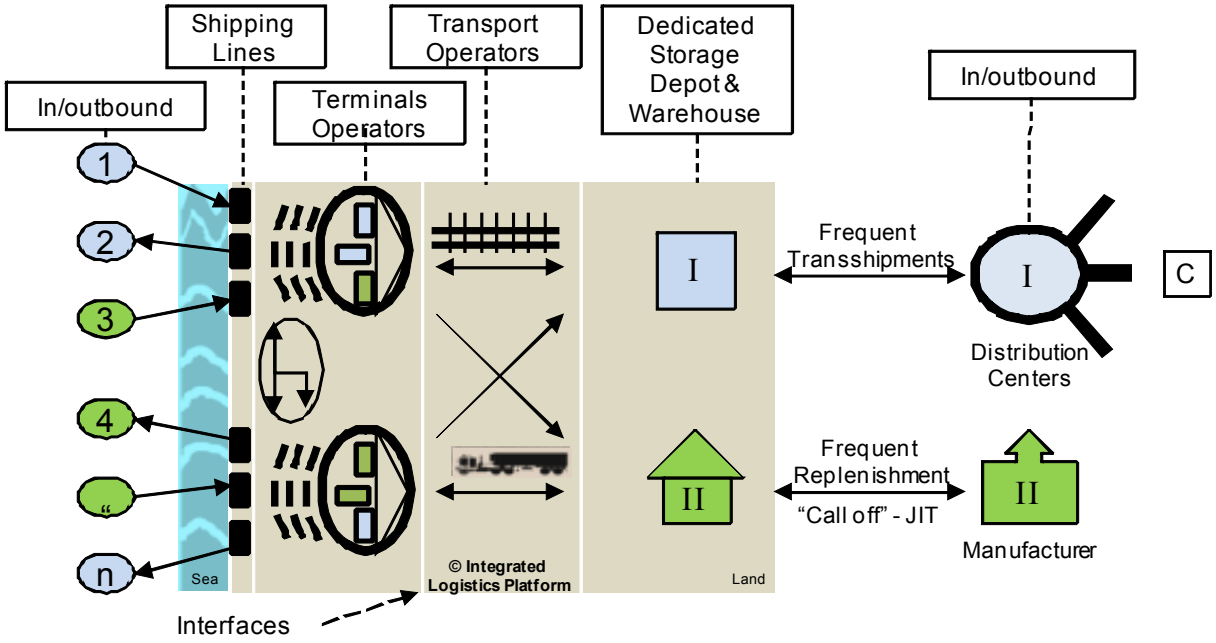


Figure 17 A multi-level of an integrated logistics platform framework

(1) *Network structure* concerns the arrangement of the members of the supply chain and their relations. The primary members of the logistics chains are: shipping line companies, container terminal operators (CTO), rail operators, transport operators and logistics service providers. These members are associated with facility-based units (FBU) [warehouses, depots and manufacturer's terminal facilities…etc]. Only primary members dealing with identical cargo unit-load (e.g., containers) are considered. Based on these primary members' relational exchanges, the logistics and transport network strategies are: Direct shipment (DS) strategy, Building volume (BV) strategy, Cross-docking (CD) strategy; and Value adding (VA) strategy. Note that these network strategies differ according to the customer's choice and values.

(2) *Business processes* concern activities and flow in the supply chains. The key dominant business processes revealed by the study are: in/outbound transport, in/outbound logistics, and terminal operations. Associated with these key business processes there is a plentiful amount of activities that make the flow between different business processes possible. It's these types of activities that contribute to the overall business process integration.

(3) *Management components* concern the composition of all operations, systems, business functions and organizations involved in the management of a particular supply chain (Stock and Boyer, 2009). Only the physical and technical group is considered, and in particular the communication and information flow facility structure. These include the information communication technologies' (ICTs) application in use, the function of integration, and the impact descriptions for each member-firm involved.

Based on the configuration of the previously explained elements, the port logistics system operates at several different levels. These are inextricably linked as elements of a system, but for the purpose of clarity are described in the presented framework (see Figure 17) within two discrete pathway levels:

Level I – resource-based pathways – *transshipment*; and

Level II – industry organization pathway – *replenishment*

These levels cover elements of port logistics chains and the environment within which they are embedded, though each level reflects quite different perspectives.

To identify mechanisms that support systematic integration adoption, two relevant themes emphasizing the management components as well as the nature of supply chain interfaces follow:

To emphasize the management components, a conceptual model showing the relationship between integrative information (communication and information flow structure), and integrative technology (IT facility structure) is formulated and related to business processes and an ICT maturity model. The maturity model consists of four levels: (1) disconnected, (2) internal integration, (3) intra-company integration and limited external integration; and (4) multi-enterprise integration (Heinrich and Simchi-Levi, 2005).

Interviews are conducted with actors involved in Swedish hinterland rail transport. The overall results show that the IT and IS maturity level is fairly low in the hinterland information flow, but that it is rapidly improving as many actors currently invest in new ISs, and consequently modernize their systems. The drivers behind information system modernization vary from actor to actor, but the common reasons are related to: (1) types of business model, (2) better connection with actors having more advanced and more highly functioning IT infrastructure, (3) facing the pressure caused by customers for controlling their shipments, and (4) the desire to reduce administrative tasks.

Within the information and communication flow structure, the study concludes that the introduction of EDI connections and efficient data sharing, and commitment of the involved supply chain members is of utmost importance to streamline the supply chain flows. If not, the integration maturity levels will differ from actor to actor and this may become troublesome as data sharing becomes difficult, leading to reduced competition.

On the other hand, the integrative technology can, however, be significantly improved to facilitate the information flow, with a focus on automating data exchange. The development of higher level business integration is related to the development of a more advanced ICT solution. As shown by Heinrich and Simchi-Levi (2005), it is important that business integration is aligned with, or at a level higher than, the IT maturity in order to avoid inefficiencies. It is therefore important that the actors also develop their business integration processes and not

only invest in IT. The overriding conclusion drawn is that the two influential dimensions must work in tandem for the best effect.

The second mechanism is related to the nature of supply chain interfaces. The study is devoted to exploring current interfaces between major member-firms in port organizations and to develop a framework to integrate these member-firms through better management of interfaces.

This explorative research study shows that interface specifications traced back to information flow and data and information content together with information technology integration are: (1) media, (2) transfer, (3) data and information, (4) control and communication, and (5) user interface, bearing in mind that the information interface is where information meets information.

Associated with these findings, across-case synthesis gives some insight which led to draw the following conclusions:

- *Cooperation in the extended enterprise.* All parties internally and externally cooperate and work through any potential bottlenecks to create a seamless flow of goods. For instance, designated departments called 'corporate strategy' are those entitled to align interfaces along the supply chain in order to streamline process operations. i.e., "interface manager."
- *Cross-functional team.* To enable interface integration of resources, a multi-disciplinary team consisting of individuals who take responsibility for the management of the interface between service design and supply chain functions exists to ensure good visibility in the extended enterprise, i.e., "trade association team-work."
- *Interface optimization.* To standardize a set of interface specifications, a gateway of a 'single window' to provide commercial drive for business-to-business services is established. Here *media*, *transfer* and *user* interfaces can, however, be the same for many services and are maybe unchanged for specific shippers although several services are provided.
- *Integrative technology.* This concurs with flexible and inter-connected information systems that are able to span the supply chain boundaries. Standardized technology allows information to flow seamlessly across the organizations, i.e., Java technology. Control and communication interfaces are acquainted with this factor, which is able to select data fields to be included and permit its accessibility.

By preparing the logistics platform and describing the services and the associated interface specifications in advance, expensive ad-hoc solutions and operation disturbances can potentially be avoided.

5.4 Integration barriers consideration

Because previous research-works put a focus on the key elements and mechanisms supporting the systematic integration, this research topic comes as a

complementary by focusing on integration barriers and the same giving answers to the fourth research question:

RQ4: What are barriers that can hinder systematic integration adoption?

To answer this research question, the study develops a new construct of barriers that align with Lambert and Cooper's (2000) SCM framework. These constructs of barriers are:

(1) *Network barriers,* which concern obstacles that impede the structural relationships. It is the hindrance to the arrangement of the members of the supply chain and their relations. According to Lambert and Cooper (2000) network structure includes: the members of the supply chain, the structural dimensions of the network and the different types of process links across the supply chain;
(2) *Process barriers,* which refer to impediments to activities and flows in the supply chains. Lambert and Cooper (2000) define process as a structure of activities designed for action with a focus on end customers and on the dynamic management of flows involving products, information, cash, knowledge, and/or ideas. Thus, any hindrance to these functional, and/or cross-functional activities can be classified within process barriers; and
(3) *Management barriers,* which concern obstacles that impede fundamental management components. Lambert and Cooper (2000) divided fundamental management components into two separate groups: the physical and technical group, which include the most visible, tangible, measurable, and easy-to-change elements. The second is the managerial and behavioral group, which is less tangible and visible and is often difficult to assess and alter.

Based on the above barrier's framework construct, a pool of potential barriers index is adapted from the research-work of Fawcett *et al.* (2008) with the aid of the researcher's expert in logistics management. Determining and understanding barriers to supply chain integration can be an effective tool and further, a mechanism that facilitates the synergy of business processes across supply chains (Fawcett *et al.*, 2008; Richey *et al*., 2009).

The research shows that the most common barriers fall within the proposed barrier's framework construct, namely, network barriers, process barriers, and management barriers. Under these constructs, deficiencies in information systems (IS) and information technology (IT), inconsistent operating goals, and supply chain power inequalities are major barriers to supply chain integration.

Managers believe that understanding the management barriers is the key determinant for successful supply chain integration. However, running parallel to optimize the effect of other barriers' constructs will be the realistic view depending on the overall supply chain structure and design. Only then can proper understanding of the actual barriers to supply chain integration lead to a leverage integrated logistics platform and attain supply chain success.

5.5 Summary of the papers' findings and contributions in relation to research questions

The main findings from the papers in relation to the research questions are summarized in Table 10.

Table 10 Summary of the papers' main findings in relation to the research questions

Research papers	Main findings
Paper I	Defined port changing role(s) and interaction discipline based on key elements in the port definitions, the development of port integration stages, and real-world examples and system thinking perspectives.
Paper II	Identified, categorized, and evaluated relevant value-added attributes in port supply chain systems; and thereby the proposition of ranking and prioritization model.
Paper III	Identified key elements of an integrated logistics platform: network structure, business process, and management component, thereby drawing the system constituent and boundary.
Paper IV	Analyzed information flows by showing what information the actors exchange and by which media they do it in order to achieve better supply chain integration.
Paper V	Identified informational interface specifications, and some insight toward an integrated logistics platform.
Paper VI	Determined barriers to systematic integration adoption: network barriers, process barriers and management barriers.

An overview of the contribution from each paper to answering the research questions is discussed in chapter 4 (section 4.3). As thus, research question one is devoted to searching for port interaction discipline and involvement in supply chain. A comprehensive answer to this research question is accounted for in Paper I. Nevertheless, research question two gives another dimension for understanding the changing role(s) of the port industry from value-added perspectives, and thereby Paper II comes along to answer research question two, respectively. Unlike other research questions, research question three is answered through a series of papers. Hence, Papers III, IV, and V contribute to answer research question three, which concerns the identification of key elements and mechanisms supporting systematic integration.

An overview of the contribution from each paper to answering the research questions is presented in Table 11.

Table 11 Contribution from each paper to answering the research questions

	Paper I	Paper II	Paper III	Paper IV	Paper V	Paper VI
RQ1	x					
RQ2		x				
RQ3			x	x	x	
RQ4						x

Finally, research question four, with the aim of determining barriers that might hinder systematic integration is accounted for in Paper VI. This paper comes as complementary to the previous research-work, focusing on integration barriers from SCM perspectives.

From the previous discussions, and from Table 10 and Table 11, the single finding and contribution of each paper when summarized lead to the completion of the overall purpose of the thesis where the changing role(s) of the port industry has been explored. The concept of an integrated logistics platform was developed through the identification of key elements and mechanisms that support systematic integration as well as barriers that hinder the adoption of the concept.

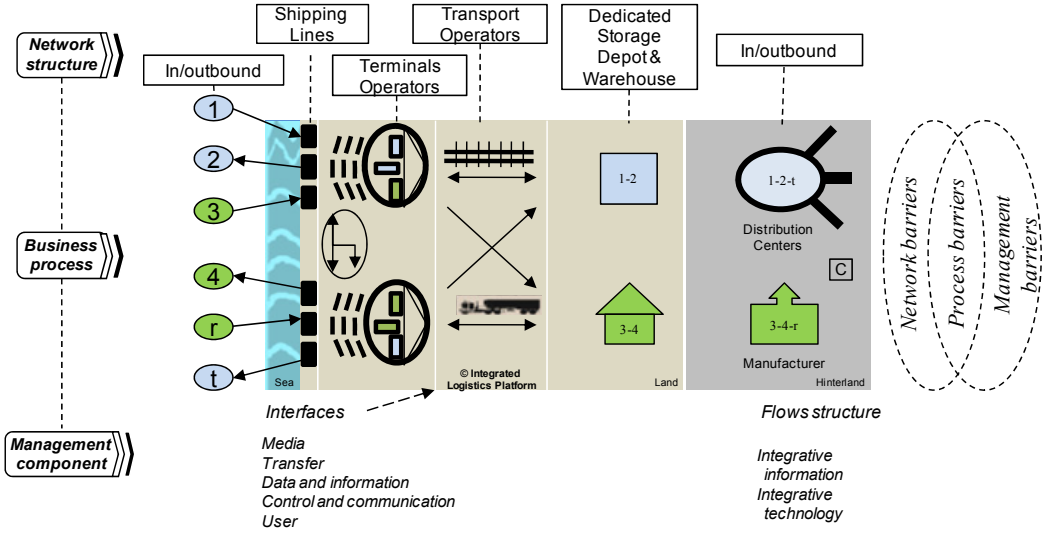
6 CONTRIBUTIONS AND FURTHER RESEARCH

This chapter provides the contributions that can be drawn from the studies performed in this thesis. Furthermore, some ideas for possible future research are proposed.

6.1 The overall thesis contribution

An integrated logistics platform framework

The proposition followed throughout this thesis is that the hallmark success for port industry as a critical connecting node in supply chains is to facilitate the exchange of goods and services and the related information among various individual supply chains. With a vastly evolving globalization process, there is a need to explore interfaces between agents as well as transport and economic activities in order to integrate the sea/land interface with an inland-logistics equation. The general purpose of this thesis is *"to explore the port industry in order to develop an integrated logistics platform concept..."* In this thesis, systematic integration is suggested in the form of an integrated logistics platform framework (see Figure 18):



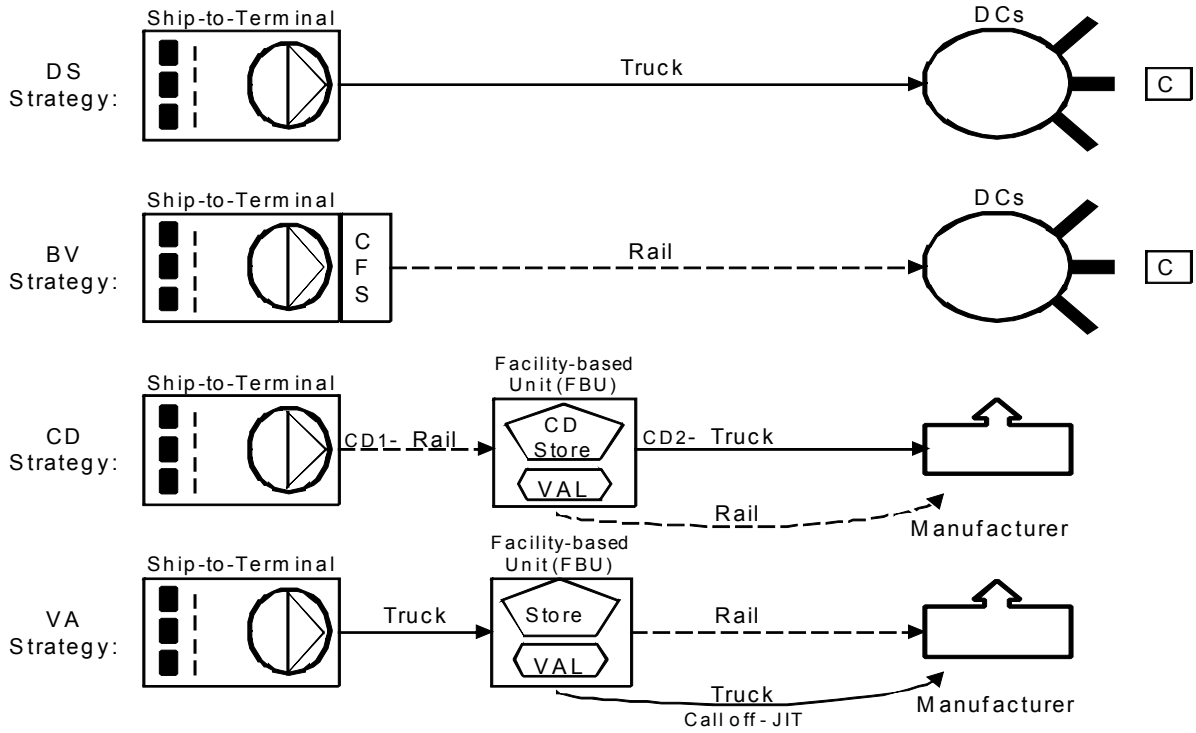
***Notes**: Transshipment flows = (1-2- t). Replenishment flows = (3-4-r).*
Figure 18 Integrated logistics platform framework

The capability of integrating different forms of interfaces relies on the port organization to:

- Support supply chain coordination in which all member-firms work closely as if one single domain;
- Adopt key business process integration by identifying links to logistics activities (like combined transport carrying capacity and other linking activities); and
- Enhance system optimization by bridging interfaces through the proprietary information system, allowing supply chain visibility for the entire system.

Support supply chain coordination

The perception of supporting supply chain coordination is more reliant on the firm's network structure and how each firm perceived its potential value-creation. Network structure concerns the arrangement of the members of supply chains and their relations; this simply implies both primary and secondary member-firms are able to draw the system constituents and boundary. By this, logistics and transport network strategies can be obtained from the general network representation. In this thesis four types of network strategies for the imported container cargo flows are recognized (see Figure 19) as follows:



***Notes**: C: Customer; CD: Cross docking; CFS: Container Freight Station; VAL: Value Adding Logistics; JIT: Just In Time.*

Figure 19 Logistics and transport network strategies

(1) *Direct shipment (DS) strategy*. In this strategy, the shipping line coordinates with the container terminal and transport operator – truck operator – to ship containers directly to the client's premises (e.g., DCs) ship-to-truck. The shipping line takes the lead to optimize the entire network structure and act on behalf their clients. No physical value-adding takes place in this network strategy, and it is basically designed for time-sensitive and high value cargo. This strategy requires extensive integration efforts between the member-firms involved and the use of real-time information to control the shipment flow.

(2) *Building volume (BV) strategy*. This strategy is designed to build cargo volume for all member-firms. It is reinforced by dominant shipping line decisions that only full laden containers are allowed to be transshipped. For instance, the shipping line Maresk line follows these procedures to reduce the repositioning empty containers effect. The importance of this strategy is not only for shipping lines *per se*, but also for rail-links. To achieve economies of scale, containers are consolidated in container freight stations (CFS), and are made ready to be dispatched by the container terminal operator (CTO) between these types of modes. All the identified shipping lines and rail operators are in favor of this strategy as it provides more flexibility in achieving the required cargo volumes. The emphasis in this strategy is to use inter-modal transport (ship-to-rail), decentralized storage and centralized inventory stock.

(3) *Cross-docking (CD) strategy*. In this strategy, the containers are cross-docked from central terminals right away to the facility-based units (FBU) – ship-to-rail – without undue delays [CD1], with the availability to be cross-docked again to the manufacturer facility – rail-to-truck – [CD2]. However, not all shipments have to be cross-docked and there is evidence that some shipments need to be stored having value-adding activities in FBU before being taken away by rail. This type of strategy is designated for shipments with high frequency and less cargo volume. The emphasis is on fast and flexible transportation modes and the shipment pre-arrival coordination through sophisticated IT tools.

(4) *Value adding (VA) strategy*. The aim of this strategy is to provide a mixture of storage, value adding activities and at the same time a place for consolidating the cargo. For instance, Volvo Logistics Corporation (VLC) is directly linked and patched with inbound container flows. This means that containers transshipped by truck to the FBU have value adding activities specific for the production units and are then made ready for "JIT" operations. Other containers are split out and consolidated according to the designated manufacturer need and are made ready to be transported by rail. Both manufacturers and logistics providers plan and optimize the network structure. The emphasis of this strategy is to offer a variety of choices in order to have control over the material flows. These are included: storage, value adding activities, and flexible multimodal transport, which combine transport and logistics activities all together.

From the above discussion it seems obvious that major member-firms play a variety of roles within the *network structure*. Some of these roles are optimized by

independent firms, while others need to be integrated in order to accomplish the required task. This means that each member-firm involved has to contribute and to intervene fully or partially to perform the required function as has been described in the logistics and transport network strategies. Here, opportunities arise for all member-firms to coordinate and integrate to achieve synergies in delivering corporate customer value.

Scholars proposed other strategies in response to global supply chain. It incorporates lean and agile philosophies as appropriate. For instance, Paixão and Marlow (2003) proposed an agile port concept—ensuring that port remains proactive elements along the supply chain and to prevent the supply drifting apart from the demand. A global supply chain taxonomy developed by Christopher *et al*. (2006) with four supply chain strategies has been proposed to highlight some roles that ports can handle in the context of different supply chain strategies (Mangan *et al.*, 2008). Consequently, within port supply chain setting, companies need to continually assess their product range and market characteristics so that changing scenarios may be identified and appropriate supply chain designs configured.

Adopt key business process integration

The key business processes concern activities and flows in the supply chains. Integrating these activities and flows are of utmost importance and thereby the value-chain concept is central to inform their significance to the involved member-firms. This thesis identifies a plentiful amount of value-added attributes (physical and virtual) that makes integration between different business processes possible. In this context, value-added attributes come mainly from two research streams: literature-based and empirically driven. From literature-based research streams, this thesis provides a framework for categorizing the identified value-added attributes (i.e., activities, services and tasks) and proposes a model for ranking and prioritization purpose (Figure 16). From empirical evidence, there is a wide range of value-added attributes that can be of interest for various supply chain member-firms. It's these types of activities and flows that contribute to the overall business process integration.

Within the supply chain setting, port has been found to work with two inextricably logistics chain levels: (1) resource-based pathway/*transshipment (e.g., 1-2-t)*, and (2) industry organization pathway/*replenishment (e.g., 3-4-r)* as shown in Figure 18. In both levels, the key dominant business processes are: in/outbound transport, in/outbound logistics, and terminal operations. Associated with these key business processes there is a plentiful amount of activities that makes integration between different business processes possible.

Porter (1985) identified several ways in which key activities within the firm's value-chain could yield competitive advantage to a firm *vis-á-vis* its competitors. These include: identifying candidate activities, which must be subsequently separated and studied in depth, and the role of linkages between activities within the value-chain. Linkages reflect tradeoffs among activities to achieve the same overall result.

Enhance system optimization

To enhance system optimization, the study emphasizes management components through two mechanisms: (1) the relationship between integrative information (communication and information flow structure) and integrative technology (IT facility structure), and (2) the nature of supply chain interfaces:

Within the first mechanism, integrative information (communication and information flow structure), captures desired/valuable information that enables supply chain integration, and integrative technology (IT facility structure) captures flexible/interconnected information systems that are able to span the supply chain boundaries. To visualize how information flows can support business processes, the focus ought to be on what information the actors exchange and by which media they do it.

As a continuation, the second mechanism concerns exploring the nature of supply chain interfaces. Interface specifications traced back to information flow and data and information content together with information technology integration are: (1) media, (2) transfer, (3) data and information, (4) control and communication, and (5) user interface.

Associated with these findings, across-case synthesis gives some insight which led to draw the following conclusions:

- *Cooperation in the extended enterprise.* All parties internally and externally cooperate and work through any potential bottlenecks to create a seamless flow of goods. For instance, designated departments called 'corporate strategy' are those entitled to align interfaces along the supply chain in order to streamline process operations. i.e., "interface manager."
- *Cross-functional team.* To enable interface integration of resources, a multi-disciplinary team consisting of individuals who take responsibility for the management of the interface between service design and supply chain functions exists to ensure good visibility in the extended enterprise, i.e., "trade association team-work."
- *Interface optimization.* To standardize a set of interface specifications, a gateway of a 'single window' to provide commercial drive for business-to-business services is established. Here *media*, *transfer* and *user* interfaces can, however, be the same for many services and are maybe unchanged for specific shippers although several services are provided.
- *Integrative technology.* This concurs with flexible and inter-connected information systems that are able to span the supply chain boundaries. Standardized technology allows information to flow seamlessly across the organizations, i.e., Java technology. Control and communication interfaces are acquainted with this factor, which is able to select data fields to be included and permit its accessibility.

By preparing the logistics platform and describing the services and the associated interface specifications in advance, expensive ad-hoc solutions and operation disturbances as well as other viable SCM impediments can potentially be avoided.

6.2 Theoretical and practical contributions

Theoretical contributions

The first contribution is the framework for an integrated logistics platform, which integrates port's network structure, business process and management components (see chapter 6.1 and Figure 18). The relationships between shipping lines and terminal operators or inland transport operators have been the subject of various research-works (Notteboom and Rodrigue, 2005; Robinson, 2006) and all developed frameworks highlight that logistics integration, network orientation in the port and maritime industry have redefined the functional role(s) of the port and thereby they suggested the necessity of a comprehensive and strategic approach. However, addressing the seaport organizations explicitly within all these issues has rarely been covered (Carbone and De Martino, 2003; Mangan *et al.*, 2008). The framework developed in this thesis links interdependent member-firms based on three interrelated natures of SCM's elements. It shows the system constituents and elements that are assumed essential to design and successfully manage supply chains. The developed framework provides an understanding of the port logistics structure—focusing on key characteristics underpinning the port system functional integration. The framework can be a reference point for future theory development and empirical research on port relational exchanges and systematic integration.

The second contribution of this thesis is the developed ranking and prioritization model (consult chapter 5.2). Scholars believe that there is a significant potential for ports to engage in more value-added activities, a potential which is quite latent in the case of many ports (e.g., Mangan *et al.*, 2008). The model is based on literature reviews where a set of value-added attributes is categorized and evaluated by different techniques representing various domain perspectives. The underlying approach is to disclose the idea of academic (literature souring) with experts' ideas (the Delphi technique) as well as the decision maker (AHP) specifying significant value-added attributes revealed from different domain perspectives. Despite the diversification of value-added attributes, the model (see Figure 16) gives a unique approach to categorize and evaluate a set of value-added attributes through considering the importance of the value-chain concept in improving the firm's interconnectivity and interoperability.

The third contribution of this thesis concerns analyzing information flows structure, and more precisely, it is to highlight the relationship between integrative information (communication and information flow structure) and integrative technology (IT facility structure). To analyze information flows structure, the study provides a two-dimensional conceptualization of an integrated supply chain strategy: integrative information (communication and information flow structure) captures desired/valuable information that enables supply chain integration, and integrative technology (IT facility structure) captures flexible/interconnected information systems that are able to span the supply chain boundaries (see chapter 5.3). The thesis concludes that the development of higher level business integration is related to the development of a more advanced ICT solution. As shown by Heinrich and Simchi-Levi (2005), it is important that business

integration is aligned with, or at a level higher than the IT maturity in order to avoid inefficiencies. It is therefore important that the actors also develop their business integration processes and not only invest in IT. The overriding conclusion drawn is that the two influential dimensions must work in tandem for the best effect.

The fourth contribution of this thesis is related to exploring the current nature of interfaces between major member-firms in port organization. In this context, the explorative research study shows that interface specifications traced back to information flow and data and information content together with information technology integration are: (1) media, (2) transfer, (3) data and information, (4) control and communication, and (5) user interface. The thesis contributes to explore the nature of these interfaces and shows how across-case analysis gives some insight into an integrated logistics platform. Consequently, by preparing the logistics platform and describing the services and the associated interface specifications in advance, expensive ad-hoc solutions and operation disturbances can potentially be avoided.

The fifth contribution concerns the integration barriers consideration (see chapter 5.4). Determining and understanding barriers to supply chain integration can be an effective tool and further a mechanism that facilitates the synergy of business processes across supply chains (Fawcett *et al.*, 2008; Richey *et al.*, 2009). To this aim, the thesis has developed a construct of barriers that aligns with Lambert and Cooper's (2000) SCM framework. The proposed barrier's framework construct, namely, network barriers, process barriers, and management barriers are assumed imperative and the most identified barriers fall within the proposed barrier's framework. Only then can proper understanding of the actual barriers to supply chain integration lead to leverage integrated logistics platform and attain supply chain success.

Finally, the application of the framework for an integrated logistics platform identifies the potential of integrating different forms of interfaces within port's supply chain setting (see chapter 6.1). As thus, the framework integrates port's network structure, business process and management components by a common platform of logistics and information transactions. By this, common obstacles and segmentation of the port business in terms of trade, logistics and supply chain are thought to be adequately solved. The identified interactions and potentials of an integrated approach therefore contribute to the integration of various streams of research. In this way, this research can provide the context of studies going beyond the usual scope of either port network structure or business process and management components—focusing on the systematic integration of these areas all together.

Practical contribution

This thesis provides valuable roadmap towards an integrated logistics platform. The framework takes a holistic approach embracing three main elements: network structure, business process and management components, which concurs with the current and emerging role(s) played by ports in the context of logistics and SCM

practice and strategy. Consequently, opportunities arise for the involved supply chain members to collaborate and further facilitate the systematic integration as follows:

From the network structure perspective, this thesis identified four logistics and transport network strategies that give supply chain member-firms a great potential for competitive interaction (see chapter 6.1). This interaction is rooted in the exchange of products and services and is concerned with how two companies choose to organize the flow of goods and information between them (Gadde *et al.*, 2003). In this context, cooperation in the extended enterprise and cross-functional team are found to be imperative to streamline further the objectives of supply chain strategies.

From a business process perspective, this thesis identified a plentiful amount of value-added attributes (physical and virtual) that make integration between different business processes possible. In this context, value-added attributes come from two research streams: literature-based and empirically driven. This would allow port managers to assess which attributes are dominant over the others in terms of value preference.

From a management component perspective, this thesis has emphasized the management components in two ways. On one hand through information flows structure analysis, which is assumed to give insightful thought to practitioners on how information can boost the integration process. One other hand through exploring the nature of supply chain interfaces, which can be handled through interface optimization and integrative technology.

As has been discussed, practical contributions can be attained throughout the main framework's elements: network structure, business process and management components. Only crossing all these important elements will allow for preparing the logistics platform structure and describing the process and the associated interface specifications in advance.

6.3 Further research

Although the obtained results in this thesis are of a holistic approach, which in turn matched the criteria of the phenomenon under investigation, empirical evidence illustrates and exemplifies how a systematic integration can be achieved. A more in-depth understanding of how network structure and key business process elements have to be aligned by an appropriate network-interdependence and technology-enabled coordination strategies should be the focus of future research. In addition, interfaces between different member-firms within the port logistics system are indicated as an important aspect as well. This evidence is supported by and communicated throughout all the research-works. With this fact, further research on other types of interfaces (such as physical and organizational interfaces) would be of great interest.

Network interdependence

In paper III, in-depth case-study explores examples, set forth by the logistics and transport network strategies, which indicates that major member-firms can play a variety of roles within a given network structure. Some of these roles are optimized by independent firms, while others need to be integrated in order to accomplish the required task. This means that each member-firm involved has to contribute and to intervene fully or partially to perform the required function. Here, opportunities arise for all member-firms to coordinate and integrate to achieve synergies in delivering corporate customer value. The unavoidable question here is what level/degree of network interdependency is required for the organization to perform its function?

Technology-enabled coordination

With reference to technology-enabled coordination, none is more important than those that span the boundaries of the supply chain nodes, or physical locations (e.g., seaport and major gateway position) within the chain. This type of technology-enabled coordination is often referred to as inter-organizational information systems as indicated by a plethora of articles. In this subject, only selected management components - communication and information flow facility structure is addressed. With this, more insight and understanding of other remaining components will no doubt be of major concern.

Interfaces

Interface is a common theme when addressing an integrated logistics platform. It is more concerned with the aggregation of business units where both physical and virtual interactions need to be synchronized. This is assumed to be the core of an integrated logistics platform concept. What has been an interesting finding in this matter is that the number of interfaces increased toward the seaside access. To orchestrate such interfaces all members of the platform need to be on the same tune. However, not all interfaces have been addressed in this thesis and therefore, other types of interfaces such as physical and organizational interfaces will give another dimension to understand how an integrated logistics platform can be achieved.

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